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EXECUTIVE CHAMBERS

HONOLULU

BENJAMIN J. CAYETANO
GOVERNOR

OFC. OF ENVIRONMENTAL QUALITY CONTROL

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RECEIVED

May 30, 1995

Mr. Kazu Hayashida, Director
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Hayashida:

With this letter, I hereby accept the Final Environmental Impact Statement for the Barbers Point Harbor Basin Expansion and Tug Pier, and Future Pier and Storage Yard Improvements, Ewa, Oahu as satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes. The economic, social and environmental impacts which will likely occur should this project be built, are adequately described in the statement. The analysis, together with the comments made by reviewers, provides useful information to policy makers and the public.

My acceptance of the statement is an affirmation of the adequacy of that statement under the applicable laws but does not constitute an endorsement of the proposed action.

I find that the mitigation measures proposed in the environmental impact statement will minimize the negative impacts of the project. Therefore, should this project be implemented, I direct the Department of Transportation to perform all the mitigation measures disclosed in the statement. The mitigation measures are listed in the attached document.

With warmest personal regards,

Very truly yours,

Benjamin J. Cayetano

BENJAMIN J. CAYETANO

Attachment

c: Office of Environmental Quality Control ✓

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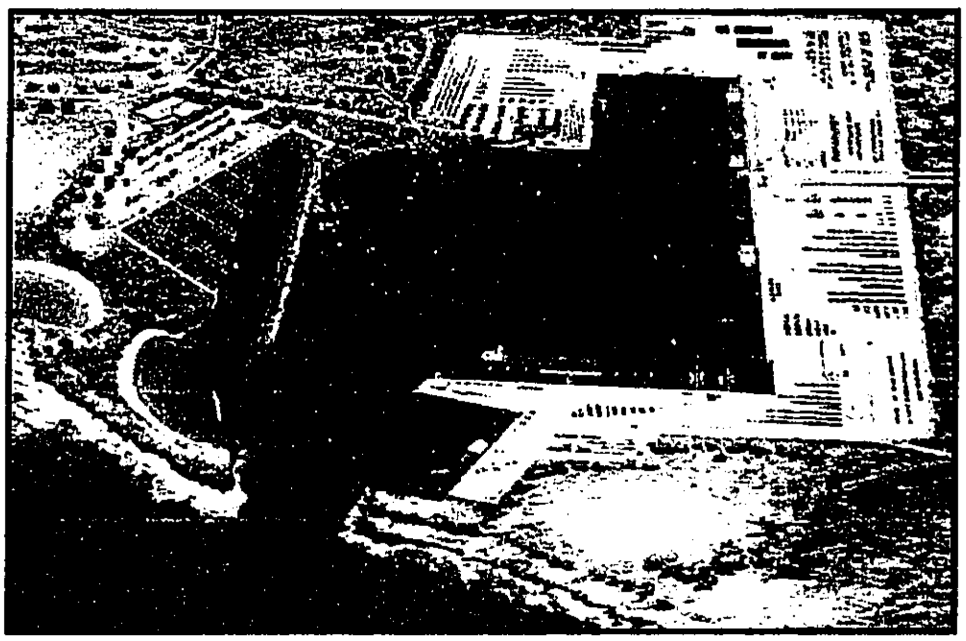
1995 - Oahu - FEIS -
Barbers Point

FILE COPY

Final Supplemental Environmental Impact Statement

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
Job H.C. 1823
and
Future Pier and Storage Yard Improvements at Barbers Point Harbor

Ewa, Oahu, Hawaii



Proposing Agency:
State of Hawaii Department of Transportation
Harbors Division
79 S. Nimitz Highway
Honolulu, HI 96813

Prepared by:
Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, HI 96813

January 1995

FILE COPY

Final

Supplemental Environmental Impact Statement

for

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
Job H. C. 1823
and
Future Pier and Storage Yard Improvements at Barbers Point Harbor

Ewa, Oahu, Hawaii

Prepared for:

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

Prepared by:

Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, HI 96813

January, 1995

Department of Transportation
State of Hawaii

Prepared by:
Harbors Division

Final

Supplemental Environmental Impact Statement

Administrative Action

for

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
Job H. C. 1823
and
Future Pier and Storage Yard Improvements at Barbers Point Harbor

Ewa, Oahu, 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

Date

CLARENCE OKAMURA
Acting Chief, Harbors Division
Department of Transportation

REVIEWED FOR CONTENT AND ACCEPTED BY STATE DEPARTMENT OF TRANSPORTATION

Date

KAZU HAYASHIDA
Director of Transportation

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EXECUTIVE SUMMARY

PROJECT DESCRIPTION

The State Department of Transportation (SDOT) proposes to continue the development of shoreside and berthing facilities at Barbers Point Harbor by the expansion of the existing harbor basin and construction of additional piers, storage yards, and related facilities. The development of Barbers Point Harbor was always envisioned as a time-phased development, and an environmental impact statement (EIS) prepared in 1978 described port facilities that were not projected for completion until the year 2030. Subsequent studies, such as the 2010 Master Plan for Barbers Point Harbor (1991) and the Honolulu Waterfront Master Plan (1989) have reaffirmed the need to continue the development of Barbers Point Harbor.

The complete development of Barbers Point Harbor through the year 2030 was previously addressed in the following three environmental impact statements:

1. Revised Environmental Impact Statement for the Barbers Point Deep Draft Harbor on Oahu, M&E Pacific, Inc., June 1978.
2. Barbers Point Harbor Final Environmental Impact Statement, U.S. Army Corps of Engineers, July 1976.
3. Barbers Point Harbor Supplement to the Final Environmental Impact Statement, U.S. Army Corps of Engineers, January 1977.

Although the environmental aspects of the work now proposed were addressed in these previous documents, conditions around Barbers Point Harbor have changed since these earlier EISs, and it is appropriate to address in more detail the specific work now proposed. Therefore SDOT has prepared this Supplemental Environmental Impact Statement (SEIS).

Barbers Point Harbor is located in an industrial area on the leeward (west) coast of Oahu. It currently has a 42 feet deep entrance channel, a harbor basin that is approximately 2,300 feet by 1,800 feet and 38 feet deep, two piers forming a continuous, 1,600 feet wharf, approximately 30 acres of storage yards, a barge pier and a basin approximately 600 feet by 400 feet and 21 feet deep with approximately five acres of storage yard, one general purpose pier, and an administration building. Construction will also soon be underway for Storage Yard S-3 (approximately 5.5 acres) and a 36,000 square feet transit cargo shed.

In addition, the U.S. Army Corps of Engineers is studying the possible deepening of the harbor entrance channel and harbor basin within the federal project limits. This federal project is not associated with the action proposed by the State in this Final SEIS.

The proposed work addressed in this Final SEIS consists of the following:

- extension of the harbor basin by approximately 1,100 by 1,100 feet along the northeast margin (Expansion Area A);
- removal of a triangular area of land measuring approximately 230 by 280 feet in the southern corner of the present basin (Expansion Area B);
- construction and operation of a tugboat pier;
- construction and operation of three additional piers for general cargo ships that will border Expansion Area A;
- construction of an approximately 300-foot extension of existing Pier 5;
- construction and operation of storage yards and other support facilitates adjacent to the new piers at Expansion Area A; and
- acquisition by the State of 140.5 acres necessary for Expansion Area A and the adjacent facilities from The Estate of James Campbell, and reclassification of this acreage's State land use designation from "Agricultural" to "Urban".

The work described above has been divided into 10 separate construction projects that are programmed over a 20-year period. The total cost of the land acquisition, project design and construction will be approximately $155 million in State funds.

Three construction methods for the basin expansion portion of the work are addressed in this Final SEIS, and include blasting with mechanical excavation, hydraulic dredging, and mechanical excavation without blasting. These three construction methods are most likely to be proposed by contractors bidding on the project.

About 2.5 million cubic yards of coral limestone rock removed from Expansion Areas A and B will require disposal. The material will be stockpiled for reuse at upland sites. This Final SEIS addresses the potential impacts of four stockpile sites located near the harbor. In various combinations, these four sites will have sufficient capacity to accommodate all of the material. Contractors could propose to remove some or all of the material to other sites. Potential impacts of removal and stockpiling at other sites are not addressed in this Final SEIS.

ENVIRONMENTAL SETTING

The proposed work borders the existing Barbers Point Harbor. Much of the land which will be affected is owned by the State, but some of it is presently owned by The Estate of James Campbell and the State is proceeding to acquire the necessary acreage. Most of the area that will be affected is presently used for coral mining and stockpiling.

Adjacent land uses include the Kenai and Campbell Industrial Parks, coral mining and stockpiling operations, the Ko Olina Resort, and sugar cane fields. The closest residential area is the Ko Olina Fairways residential development within the Ko Olina Resort.

A brackish aquifer within the caprock underlies the project area and is tapped for industrial purposes. The caprock overlies the Waianae Volcanic Series basalt aquifer, which is a source of potable water approximately four miles from the project site.

The coastal waters offshore of Barbers Point Harbor are used for boating, fishing and other recreational activities. Extensive water quality monitoring performed in conjunction with previous construction at Barbers Point Harbor and the Ko Olina Resort shows considerable variability in turbidity levels. Existing water quality in the harbor and nearshore waters nearly always exceeds State water quality standards for turbidity and certain nutrients.

PROBABLE IMPACT OF THE PROPOSED ACTION ON THE ENVIRONMENT

The impacts of most concern relate to water quality and noise and vibration levels during construction of the basin expansion work.

Regardless of the construction method, Expansion Area A will be constructed behind an enclosure berm which will minimize the amount of turbidity generated within the expansion area that will enter the harbor. The most critical period for water quality will be during the removal of the enclosure berm and construction of Expansion Area B. Numerical modeling of worst-case conditions which could prevail during the removal of the closure berm indicates that the resultant turbidity will be within the natural range of turbidity that has been measured in the harbor and nearshore waters. In addition, as verified by prior monitoring programs, the water quality impacts from the construction of the original deep-draft harbor and the artificial lagoons at the neighboring Ko Olina Resort were short-lived and relatively benign. Post-construction, the harbor may experience increased turbidity due to increased ship traffic, and there could be increased chances of water contamination by oil, sewage and other pollutants.

With respect to noise and vibration, project specifications will be developed which would restrict vibration levels to below those at which structural damage to adjacent structures could occur, and also to levels below those at which annoyance in residential areas could occur. If blasting is the selected excavation method, test blasting and monitoring programs could be conducted to assure that noise and vibration levels are acceptable. Modifications to construction procedures would be made to keep noise and vibration at acceptable levels. Although the exact types and locations of future cargo handling equipment are unknown at this time, mitigation measures have been suggested to reduce noise from the harbor after the new facilities became operational.

Although some of the proposed work is within a designated State Archaeological District, most of the areas which will be affected no longer contain archaeological resources that are recommended for preservation. A portion of the expansion area was reconfigured to avoid archaeological sites that have been recommended for preservation.

Few plants grow on the highly disturbed areas which will be affected. An endangered plant species that used to grow in the area was previously transplanted as part of a recovery program and was not found during botanical studies for the proposed action. Other threatened or endangered wildlife in the project vicinity include green sea turtles, humpback whales and Hawaiian stilts, but adverse impacts are not expected.

Field investigations have determined that ciguatera toxin is not present at Barbers Point Harbor, and ciguatera outbreaks in association with construction activities are not expected.

Other potentially adverse impacts will include:

- an increase in road traffic near the harbor;
- an increase in air pollution emissions from construction equipment and from increased road and vessel traffic during harbor operation;
- dust from construction activities and stockpiles, although mitigation measures will be employed to ensure that dust emissions are minimal;
- potential odors from stockpiles;

- an increase in stormwater runoff from paved areas, which will be mitigated by the installation of appropriate drainage systems;
- minor changes to the groundwater regime of the upper-most limestone aquifer;
- an increase in the demand for utilities;
- temporary, minor visual impacts resulting from the stockpiles which will be eventually removed;
- minor impacts on the terrestrial ecology; and
- minor and temporary impacts on marine organisms in the harbor and nearshore waters.

Beneficial impacts will include:

- provision of needed port facilities;
- increased overland transportation efficiency for cargoes destined for central and leeward Oahu;
- improvement in the surge conditions in the harbor;
- employment benefits;
- local economic development;
- increased government revenues; and
- production of usable raw materials (limestone).

RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA AND A LISTING OF PERMITS OR APPROVALS

The State and City and County of Honolulu have been planning for and investing in the infrastructure to support a shift of population and economic activity toward the Ewa region. The proposed harbor improvements support these government plans, policies and investments. The improvements will be compatible with existing industrial uses in the area. The proposed harbor improvements will support future land uses at Barbers Point Naval Air Station, the City of Kapolei, the Ko Olina resort and other residential, commercial and industrial developments proposed in Ewa.

Applicable permits and approvals that may be required for the proposed action include:

1. Department of the Army Permit, issued by the U.S. Army Corps of Engineers;
2. Section 401 Water Quality Certification, issued by the State Department of Health;

3. Coastal Zone Management Consistency Certification, issued by the Office of State Planning;
4. National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Construction Activities, issued by the State Department of Health;
5. State land use designation change from "agricultural" to "urban", issued by the State Land Use Commission;
6. State Department of Health Noise Variance if 24 hour hydraulic dredging operations are used as the construction method; and
7. Water Use Permit from the State Department of Land and Natural Resources.

ALTERNATIVES TO THE PROPOSED ACTION

One alternative would be to not proceed with the proposed action, leaving Barbers Point Harbor in its present configuration. With this alternative, there would not be additional piers and storage yards to accommodate the projected cargo volumes and types. This alternative would contribute to the increasing cost of business for shippers and the cost of living for Hawaii residents. This no-build alternative has been rejected from further consideration because the State's waterborne commerce needs would not be met.

Another alternative to the proposed action would be to construct the additional facilities at a different site. Other sites on Oahu were previously evaluated and dismissed in the Revised Environmental Impact Statement for the Barbers Point Deep Draft Harbor on Oahu (1978). This alternative is not consistent with the master plans for Barbers Point or Honolulu Harbors, and other candidate locations do not help implement the policy goal of expanding the economic base of leeward Oahu. Barbers Point Harbor, an existing harbor with room for expansion, has the appropriate infrastructure already in place, and the impacts of expanding Barbers Point Harbor will be less than initiating harbor development at a new site. The alternative of developing the needed port facilities at another site has therefore been rejected from further consideration.

Immediate use of the removed material for fill on other projects was also considered, but candidate projects have not yet completed the environmental approval process and therefore these alternatives were found to be unworkable. Ocean disposal of the removed material was rejected because the material has commercial value.

MITIGATION MEASURES PROPOSED TO MINIMIZE IMPACTS

Mitigation measures have been developed to minimize the adverse impacts of the proposed action. The most significant measures relate to water quality and noise and vibration levels during construction. Contract specifications in combination with monitoring programs and corrective actions will limit construction noise and vibration to acceptable levels. Measures to protect water quality will include excavation behind an enclosure berm, recycling of return water should hydraulic dredging be conducted, a Best Management Practice plan for runoff and erosion controls, and water quality and marine life monitoring programs. Other mitigation measures will control dust, protect threatened and endangered species, and mitigate the visual impacts at the possible stockpile sites.

CONSIDERATIONS AND POLICIES WHICH OFFSET THE ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION

While Honolulu Harbor is expected to continue to be the major center of waterborne commerce within the State, the further development of this harbor for maritime commerce is limited. The proposed expansion at Barbers Point Harbor will implement a previously planned phase in the development of a port closer to the growing number of cargo destinations in leeward Oahu. It will support the planned growth in leeward Oahu by providing employment and development opportunities, and assist in decreasing land transportation costs for goods destined for leeward Oahu. Future port activities at Barbers Point Harbor are designed to compliment the port activities planned for Honolulu Harbor.

UNRESOLVED ISSUES

Most issues and concerns relative to the proposed action have been addressed in this Final SEIS. Issues which remain to be resolved include:

- which of the excavation method alternatives will be utilized;
- which stockpiling scheme will be selected;
- details of the environmental monitoring programs;
- the exact types and locations of future cargo handling equipment; and
- the design of State Civil Defense warning devices to be installed at Barbers Point Harbor.

SDOT is aware of concerns regarding the proposed project, and will continue to work with agencies, residents, businesses, and interest groups in the area so that the final project plans meet project objectives and are responsive to public and agency concerns.

CHAPTER 1

PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 INTRODUCTION

The State of Hawaii Department of Transportation (SDOT) proposes to continue the development of shoreside and berthing facilities at Barbers Point Harbor by the expansion of the harbor basin and construction of additional piers, storage yards, and related facilities.

The environmental impacts of the initial construction and the complete development of Barbers Point Harbor were addressed in the following documents:

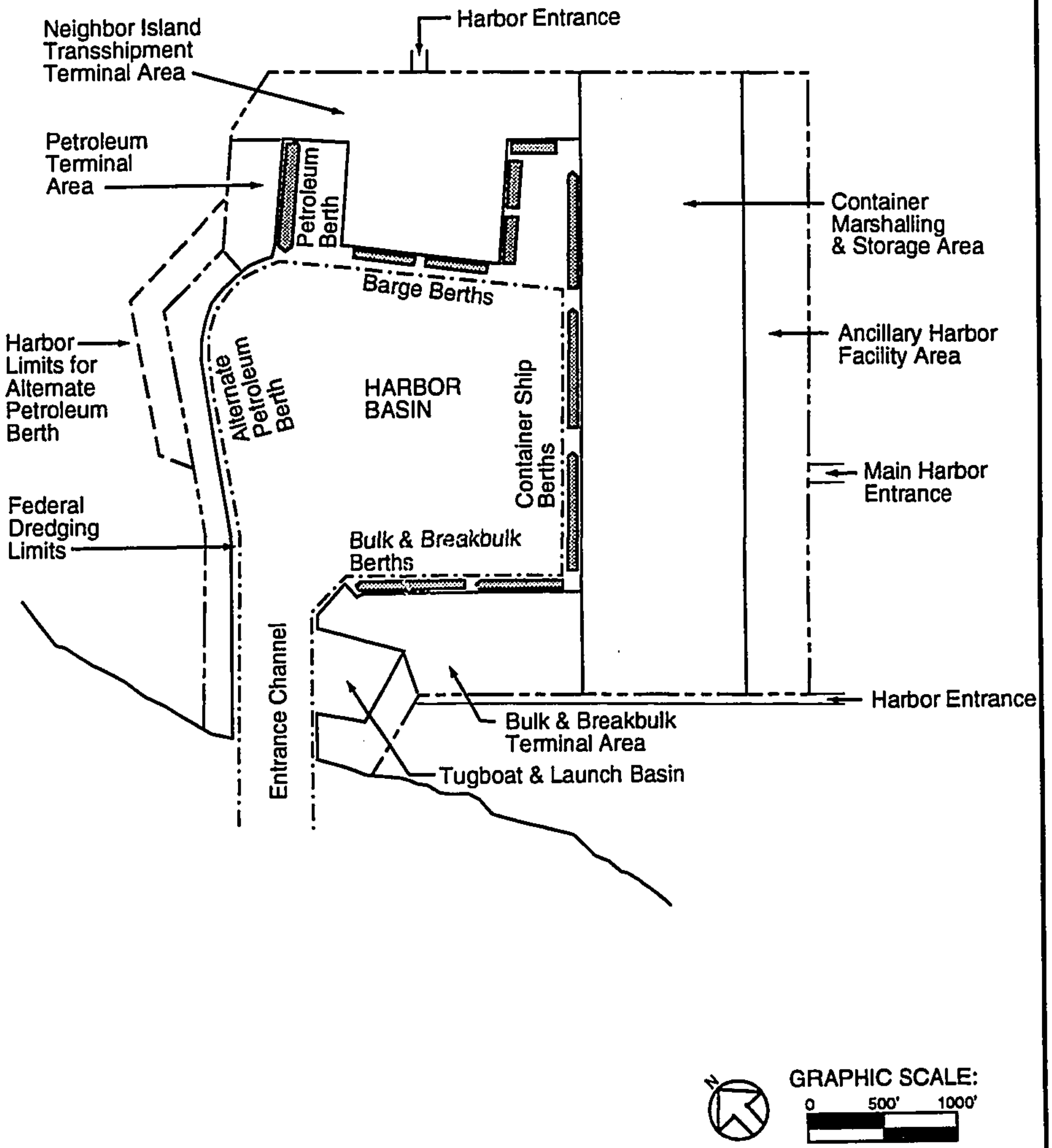
(1) Revised Environmental Impact Statement for the Barbers Point Deep-Draft Harbor on Oahu, M&E Pacific, Inc., June 1978 (pursuant to Chapter 343, Hawaii Revised Statutes);

(2) Barbers Point Harbor Final Environmental Impact Statement, U.S. Army Corps of Engineers, July 1976 (pursuant to the National Environmental Policy Act of 1969); and

(3) Barbers Point Harbor Supplement to the Final Environmental Impact Statement, U.S. Army Corps of Engineers, January 1977 (pursuant to the National Environmental Policy Act of 1969).

The 1978 EIS describes the development of shoreside facilities at Barbers Point Harbor as occurring in three phases, with the final phase projected to become operational in the year 2030. The conceptual plan described in the 1978 EIS is shown in Figure 1-1.

Although the work now proposed is a phase of the previously envisioned work and environmental impacts were assessed in the previous EISs, conditions in the vicinity of the harbor have changed since the publication of the EISs in the 1970s. It is also appropriate to address the environmental concerns related to the specific work now proposed. Therefore, in accordance with Chapter 343, Hawaii Revised Statutes, this Supplemental Environmental Impact Statement (SEIS) has been prepared to update and amplify the Revised Environmental Impact Statement for the Barbers Point Deep-Draft Harbor on Oahu (1978).



Source: State Department of Transportation, 1978

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

1978 State EIS Concept Plan Configuration
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 1-1

The proposed work covered by this Final SEIS (the "proposed action") is described in detail in Chapter 2, but generally includes the basin expansion, construction of new piers, storage yards, and other support facilities, and the State's acquisition of sufficient land for this work to proceed.

1.2 PROJECT NEED

The initial need for Barbers Point Harbor was:

- to provide additional deep-draft port and shoreside facilities on Oahu to supplement Honolulu Harbor;
- to establish a port closer to the growing number of cargo destinations in leeward Oahu; and
- to avoid the growing traffic congestion affecting goods movement on the approaches to Honolulu Harbor.

The requirements for Barbers Point Harbor are closely related to port activities at Honolulu Harbor. In the 2010 Master Plan for Honolulu Harbor (1986), Barbers Point Harbor was identified as a necessary supplemental facility to Honolulu Harbor, and the most appropriate site for the importation of certain dry-bulk cargoes and the exportation of construction materials. The capabilities, limitations and development goals of Honolulu Harbor were then reassessed in the Honolulu Waterfront Master Plan (1989). This Plan called for the relocation of certain port operations at Honolulu Harbor to Barbers Point Harbor in order to accommodate the relocation of some port operations within Honolulu Harbor, and the conversion of some port facilities, such as Fort Armstrong, to commercial waterfront activities. Both the 2010 Master Plan for Honolulu Harbor (1986) and the Honolulu Waterfront Master Plan (1989) reaffirmed the need to continue the development of Barbers Point Harbor.

As economic activity and population in leeward Oahu increased rapidly through the 1980s, it became necessary to reassess and redefine the specific facilities needed at Barbers Point Harbor. The Governor convened a Barbers Point Harbor Task Force in 1982 which identified future needs for port facilities in the following areas: general cargo, dry bulk cargo, liquid bulk cargo, and facilities.

Based on updated projections, a new planning effort was initiated in 1989 to reassess needs in the same four areas. This latest evaluation was published as the 2010 Master Plan for Barbers

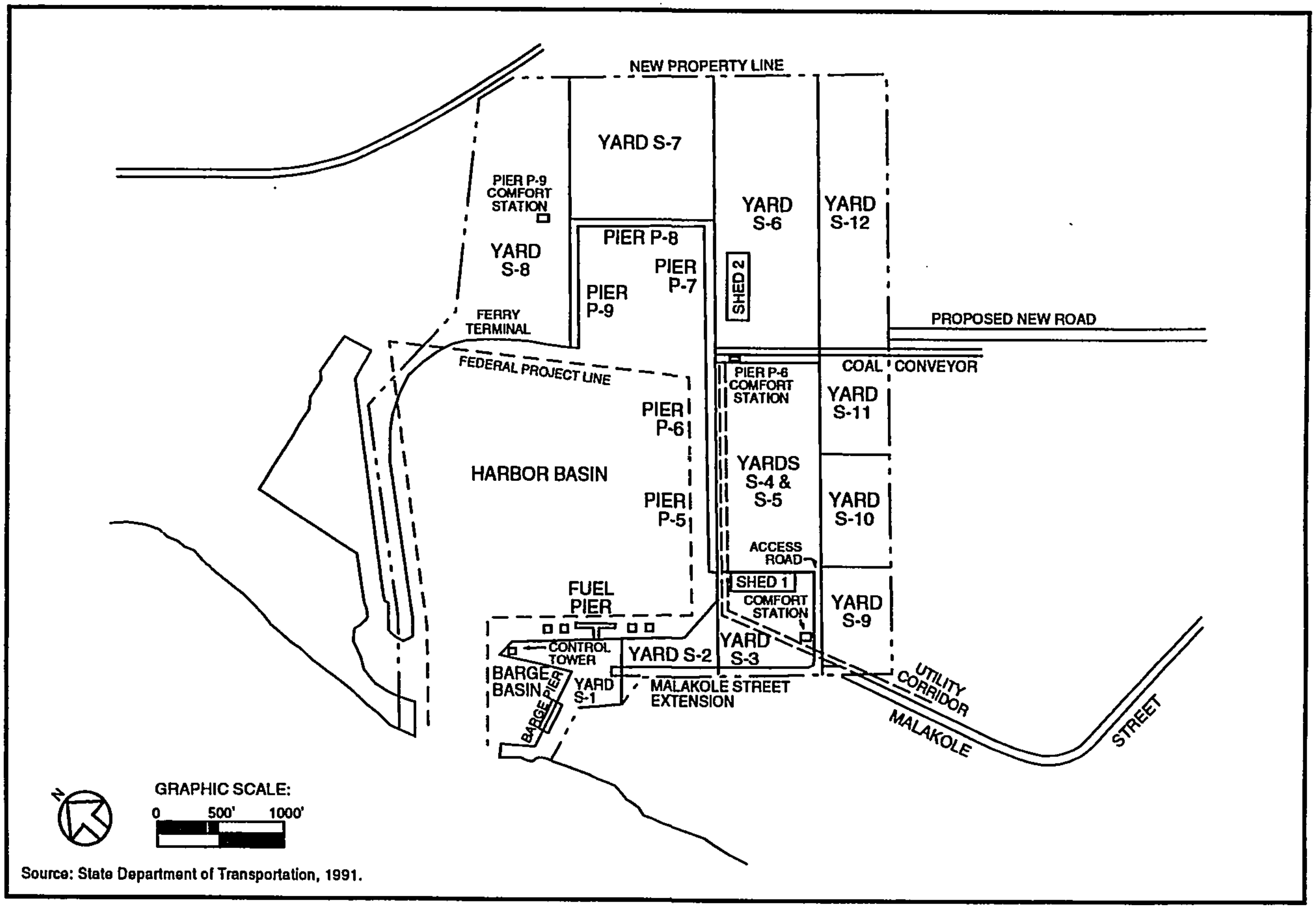
Point Harbor (1991). The 2010 Master Plan forecasted a need for additional vessel berths since existing Piers 5 and 6 were projected to reach 95 percent occupancy by 1995. (Such a high level of berth occupancy would result in unacceptable ship waiting time.) Therefore, it was recommended that additional piers be provided. The ultimate harbor development plan as described in the 2010 Master Plan is shown in Figure 1-2.

Figure 1-3 shows the cargo tonnage handled at Barbers Point Harbor. Since 1990 there has been an increase of about 500 percent in tonnage handled (1991--the first full year of operation after the expansion vs. 1993), and the tonnage handled in 1993 was more than double the tonnage handled in 1992. In 1991, 57 vessels called at Piers P-5 and P-6, and in 1993, 110 ships and 205 barges called, a six-fold increase in two years. In 1993, the two berths were occupied an average of 50 percent of the time. Therefore, Barbers Point Harbor is clearly being called upon to handle a rapidly increasing tonnage of cargo.

In addition, with the ongoing development of Campbell Industrial Park, the quickly growing "second city" at Kapolei, and other developments in the area, a large and increasing number of goods' destinations are in leeward Oahu. Increasing the use of Barbers Point Harbor will help reduce overland transportation costs for goods and materials destined for the leeward Oahu area through the utilization of a port facility closer to these destinations than Honolulu Harbor.

Another factor encouraging the harbor improvements at this time is related to the acquisition of the land for the harbor improvements. As discussed in more detail in Chapter 2, some of the proposed harbor improvements will be located on land presently owned by or recently acquired from The Estate of James Campbell (The EJC). The agreement under which the State is acquiring these lands, which was negotiated five years ago, includes a price discount on the portion of land to be purchased if the construction contract for the basin expansion is executed by October 1995. Certain dates for progressive improvements were also committed to by the State in the agreement.

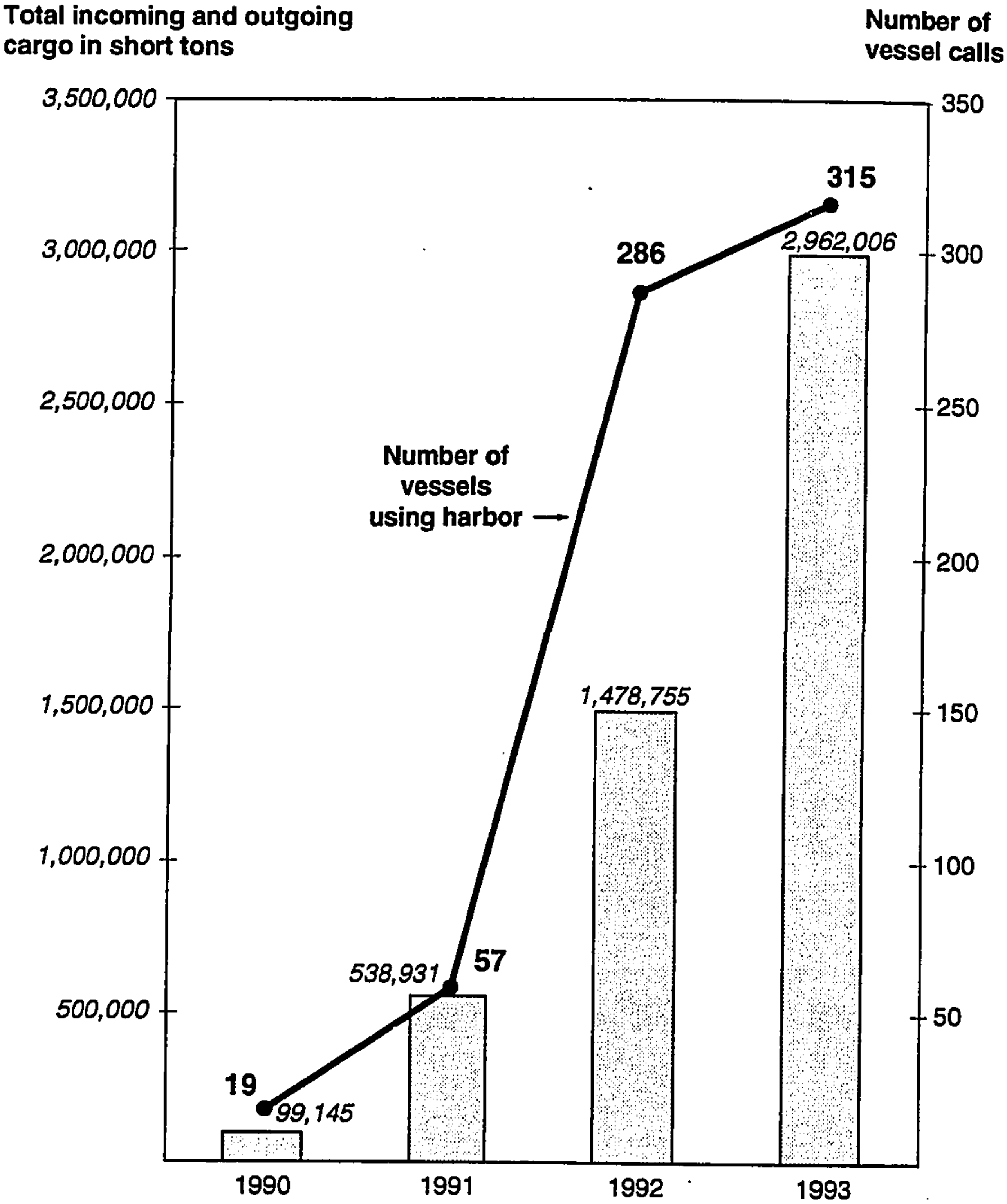
Finally, expanding the harbor basin now, while the adjacent areas are relatively undeveloped, will have fewer impacts than if this work is deferred. Given the trend of development on the Ewa Plain, the adjacent areas will be further developed in the future, thereby increasing the severity of construction impacts on adjacent areas in the future.



Source: State Department of Transportation, 1991.

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Barbers Point Harbor 2010 Master Plan Configuration
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 1-2

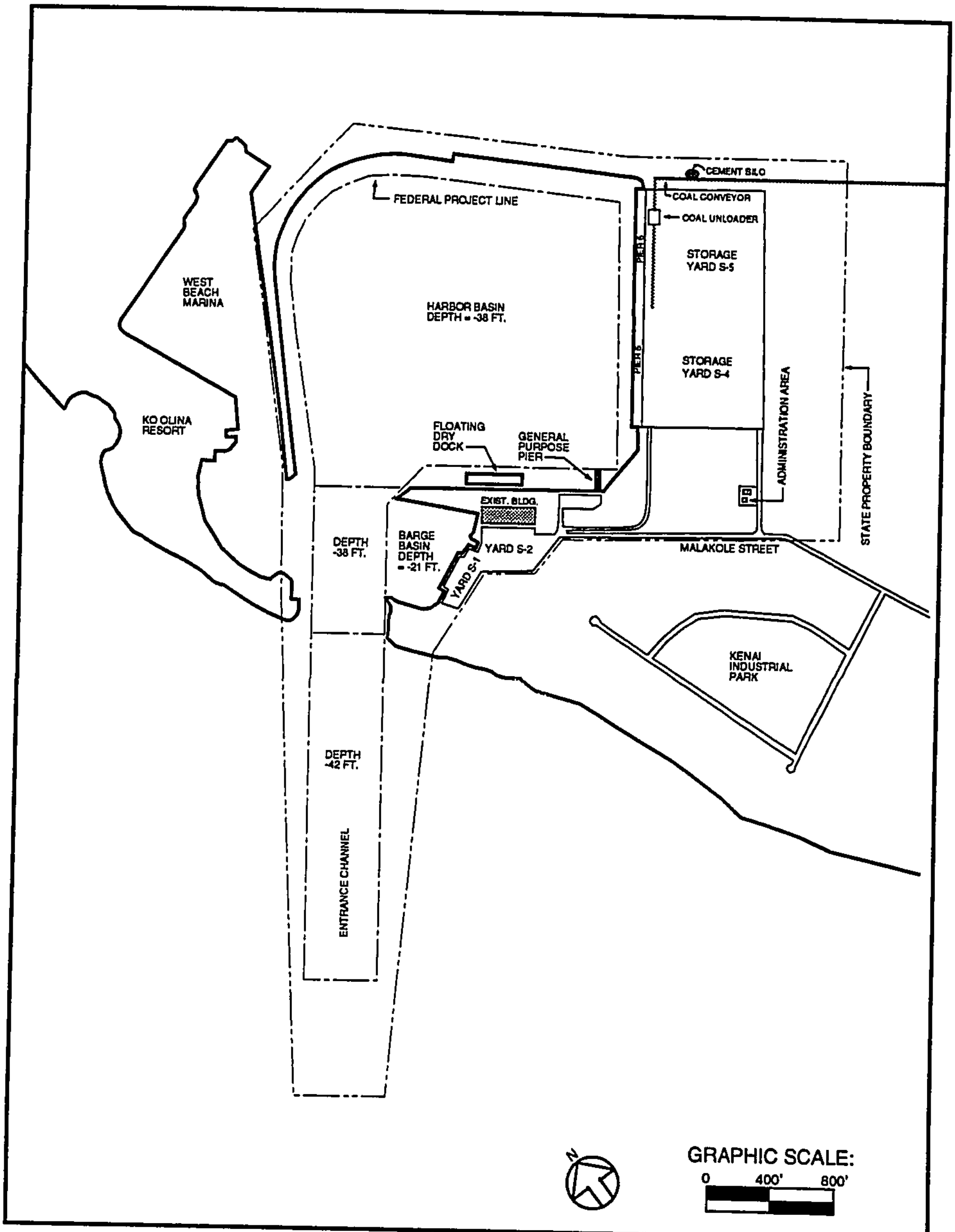


Source: State Department of Transportation, June 1994

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Usage of Piers 5 & 6, 1990-1993
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE I-3

In summary, the proposed capacity improvements at Barbers Point Harbor, together with improvements at Honolulu Harbor, are necessary to permit the handling of cargo volumes projected for Oahu and the State. The need for Barbers Point Harbor was identified in the 1978 EIS and subsequent studies have reaffirmed the evolving needs of the harbor. The 2010 Master Plan for Honolulu Harbor (1986) described how Barbers Point Harbor is a complementary, supplemental facility to Honolulu Harbor, and the Honolulu Waterfront Master Plan (1989) went beyond this to propose specific port facility relocations from Honolulu Harbor to Barbers Point Harbor. Actual growth in tonnage and number of vessel calls at the harbor have demonstrated the growing demand for port facilities at Barbers Point. Therefore, the continued development of Barbers Point Harbor is warranted and necessary to keep pace with growing demands.



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Existing Harbor Layout

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

JOB H.C. 1823

Final Supplemental Environmental Impact Statement

FIGURE 2-1

CORRECTION

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

In summary, the proposed capacity improvements at Barbers Point Harbor, together with improvements at Honolulu Harbor, are necessary to permit the handling of cargo volumes projected for Oahu and the State. The need for Barbers Point Harbor was identified in the 1978 EIS and subsequent studies have reaffirmed the evolving needs of the harbor. The 2010 Master Plan for Honolulu Harbor (1986) described how Barbers Point Harbor is a complementary, supplemental facility to Honolulu Harbor, and the Honolulu Waterfront Master Plan (1989) went beyond this to propose specific port facility relocations from Honolulu Harbor to Barbers Point Harbor. Actual growth in tonnage and number of vessel calls at the harbor have demonstrated the growing demand for port facilities at Barbers Point. Therefore, the continued development of Barbers Point Harbor is warranted and necessary to keep pace with growing demands.

CHAPTER 2

PROJECT DESCRIPTION

2.1 HISTORY OF BARBERS POINT HARBOR

In 1958 Congress authorized a feasibility study for a deep-draft harbor at Barbers Point, Oahu. In 1961, the first marine facility at the site, a channel and harbor for barges, was constructed. In 1979 Congress authorized improvements to the barge facility so that the harbor could function as a deep-draft port, and appropriated construction funds.

The dredging of the deep-draft harbor was jointly pursued by the federal government (U.S. Army Corps of Engineers--ACOE) and the State of Hawaii. Significant milestones included the following:

- 1982: the ACOE awarded the construction contract;
- 1984: the Hawaii State Legislature appropriate funds for piers and storage yards;
- 1986: the dredging was completed, and the project was transferred to the State;
- 1988: the Hawaii State Legislature appropriated additional funds for piers and storage yards, and construction of Piers 5 and 6 and Storage Yards S-4 and S-5 began; and
- 1990: Piers 5 and 6 and Storage Yards S-4 and S-5 were completed, and the harbor became fully operational in July.

The harbor currently occupies about 310 acres of fast (above water) and submerged lands (see Figure 2-1), and consists of:

- an entrance channel 450 feet wide, 4,280 feet long, and 38 to 42 feet deep[1] (this entrance channel serves not only the harbor, but also the West Beach Marina, which is not yet completed);
- a deep-draft harbor basin approximately 2,300 feet by 1,800 feet, and 38 feet deep;
- a barge basin approximately 600 feet by 400 feet, and 21 feet deep;

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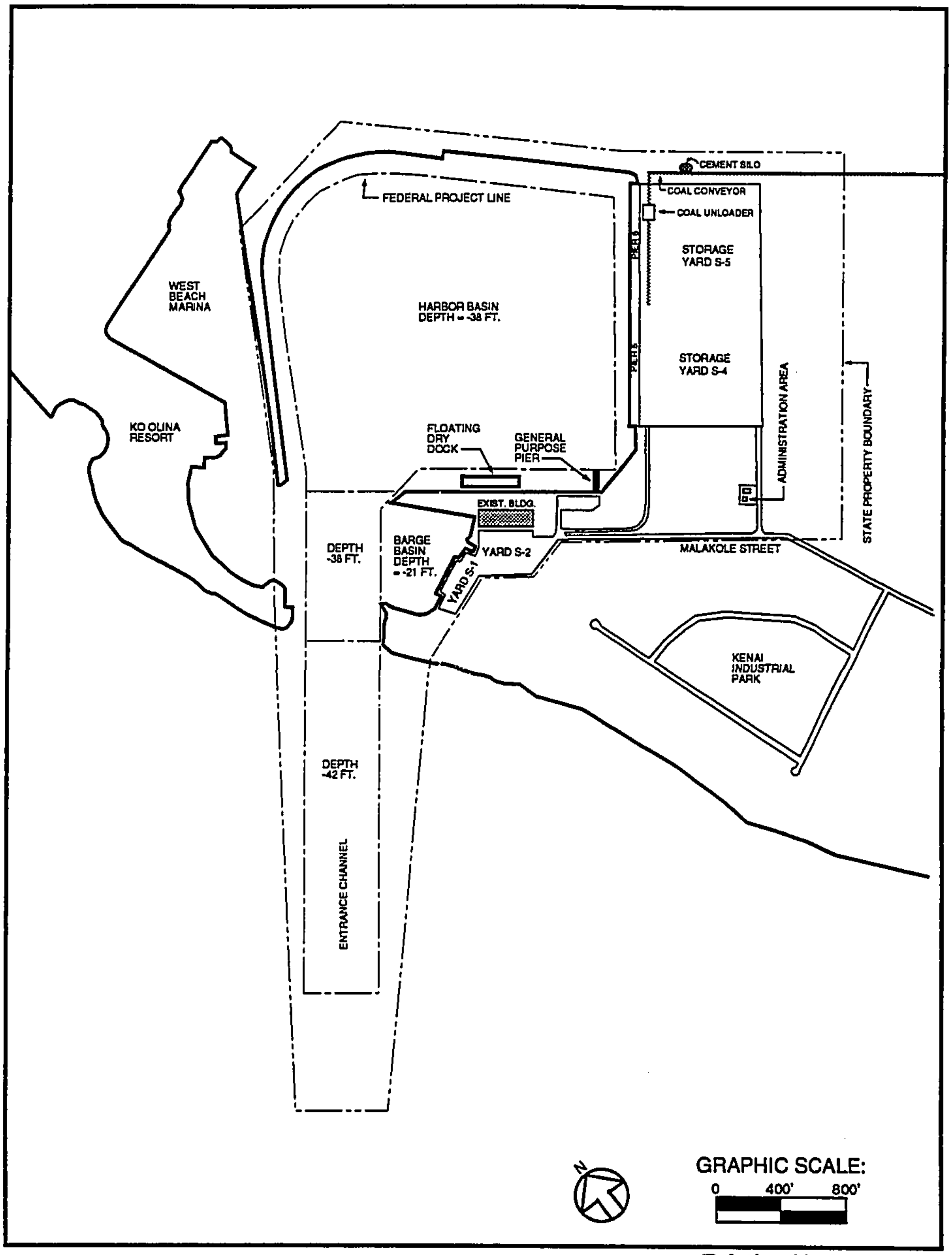
1 Unless otherwise stated, all elevations and depths provided in this Final SEIS are with respect to "mean lower low water--mllw."



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Existing Harbor Layout
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-1

- a 250-foot long barge pier, with adjacent Storage Yards S-1 and S-2 totaling approximately 5 acres in size;
- Piers P-5 and Pier P-6, which form a continuous wharf approximately 1,600 feet long;
- Storage Yards S-4 and S-5, landward of Piers P-5 and P-6, which total approximately 30 acres;
- a general purpose pier approximately 150 feet long by 15 feet wide; and
- an administration building.

In addition to the work addressed in this Final SEIS, the State is currently proceeding with construction activities for Storage Yard S-3 (approximately 5.5 acres) and a transit cargo shed (36,000 square feet). Construction of this project is expected to be completed by the end of 1995.

The U.S. Army Corps of Engineers has initiated preliminary technical and cost/benefit analyses for the deepening of Barbers Point Harbor entrance channel and the harbor basin within the federal project limits. This Final SEIS does not address this possible federal project.

2.2 PROJECT LOCATION AND LAND OWNERSHIP

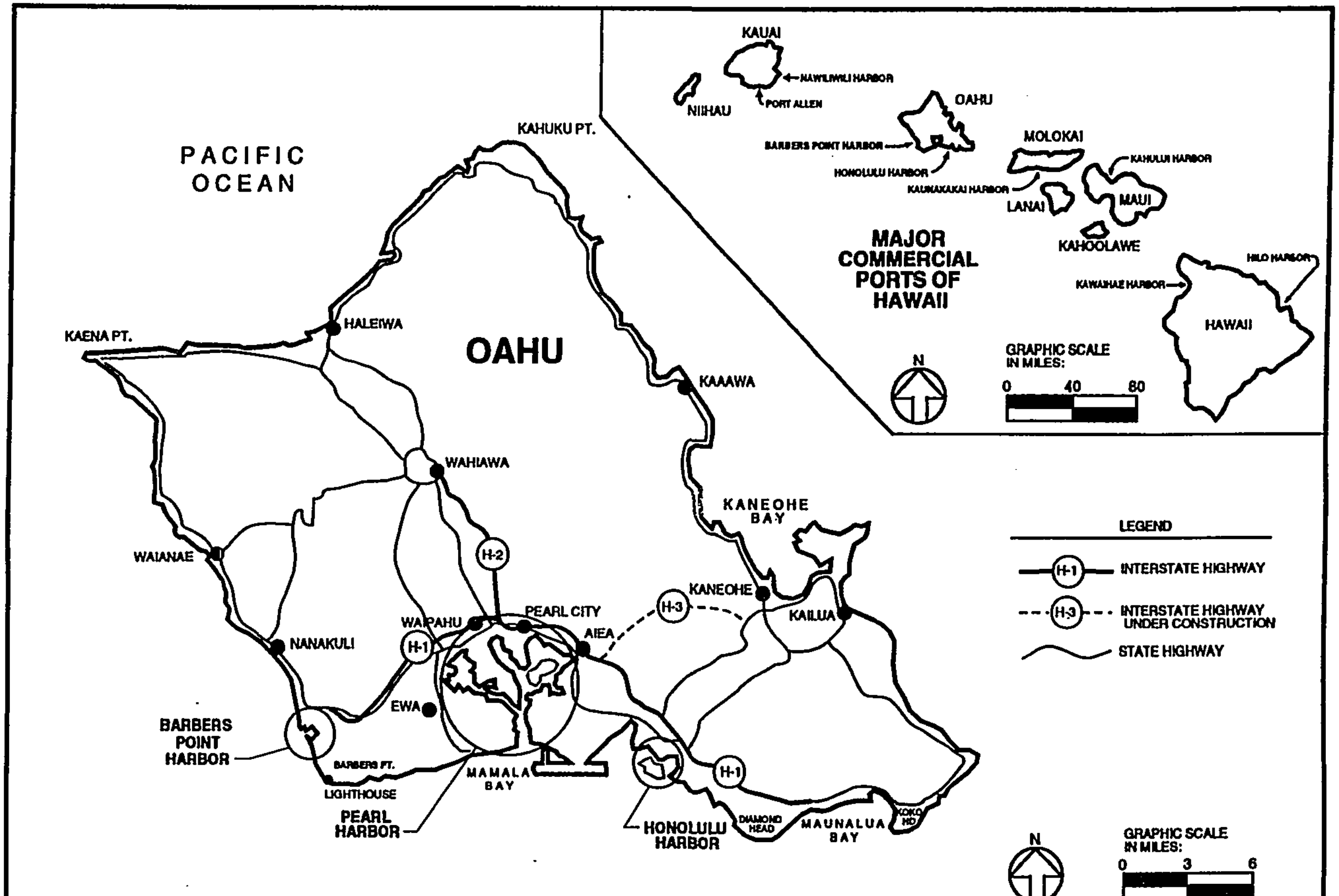
2.2.1 Project Location

Figure 2-2 shows the harbor's location in relation to other commercial ports on Oahu and in the State. Figure 2-3 locates the harbor more precisely on Oahu.

The harbor is located along the southern portion of Oahu's Waianae Coast, approximately two miles north-northwest of the Barbers Point lighthouse and 15 miles due west of Honolulu Harbor. The harbor is served by Interstate Highway H-1 and Farrington Highway, and is located about 20 road miles from downtown Honolulu. The harbor is located within the Ewa region of Oahu.

2.2.2 Land Ownership

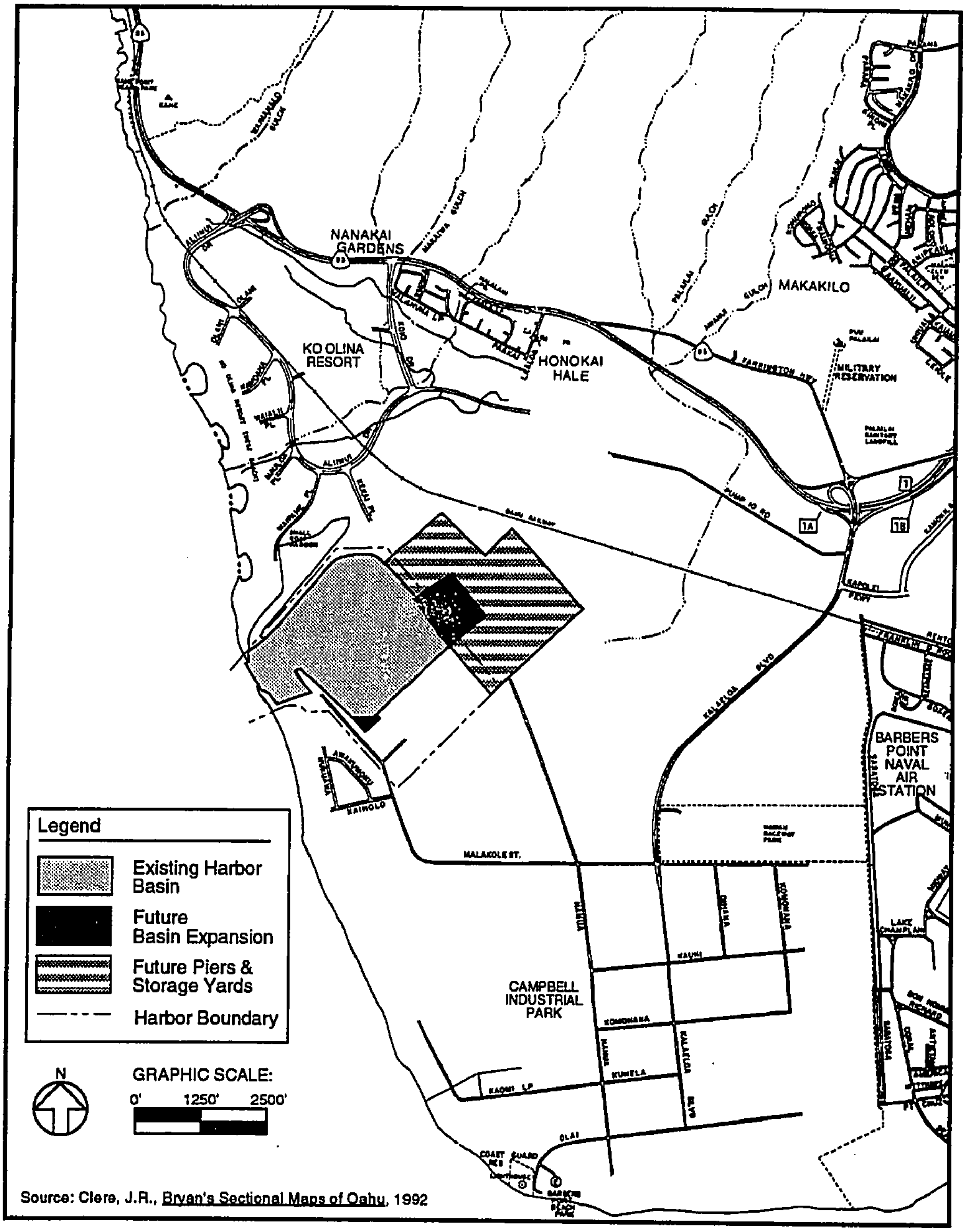
Figure 2-4 shows land ownership in the project area. Much of the project will be constructed on State lands (Tax Map Key 9-1-14:24, First Taxation Division of the City and County of Honolulu) and the balance of the project will be constructed on adjacent lands presently



Source: Department of the Army, 1976. (Adapted)

PARSONS
BRINCKERHOFF
QUADE &
DOUGLAS, INC.

Commercial Ports of the State
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-2



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Barbers Point Harbor Vicinity Map
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
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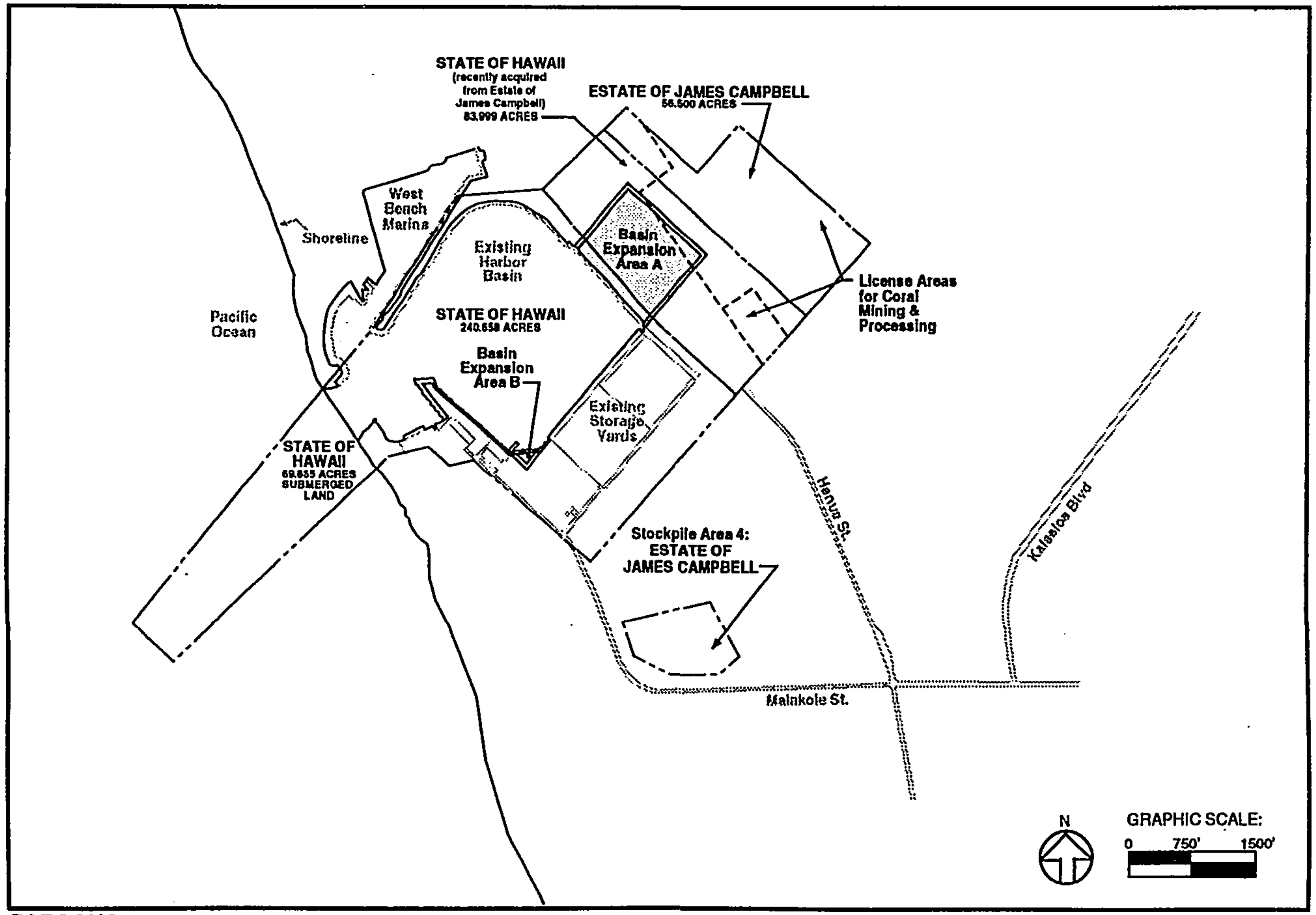
FIGURE 2-3



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Barbers Point Harbor Land Ownership
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-4

owned by The Estate of James Campbell (The EJC) (a portion of Tax Map Key 9-1-14:2).

The EJC and the State have reached agreement to transfer the necessary EJC lands to State ownership. The total acreage being transferred from The EJC to the State will be 140.5 acres. The land has been divided into two parcels; one 56.5 acres and the other approximately 84 acres. The transfer of the 84-acre parcel was completed in late 1994, and the 56.5-acre parcel will be transferred to the State in 1995.

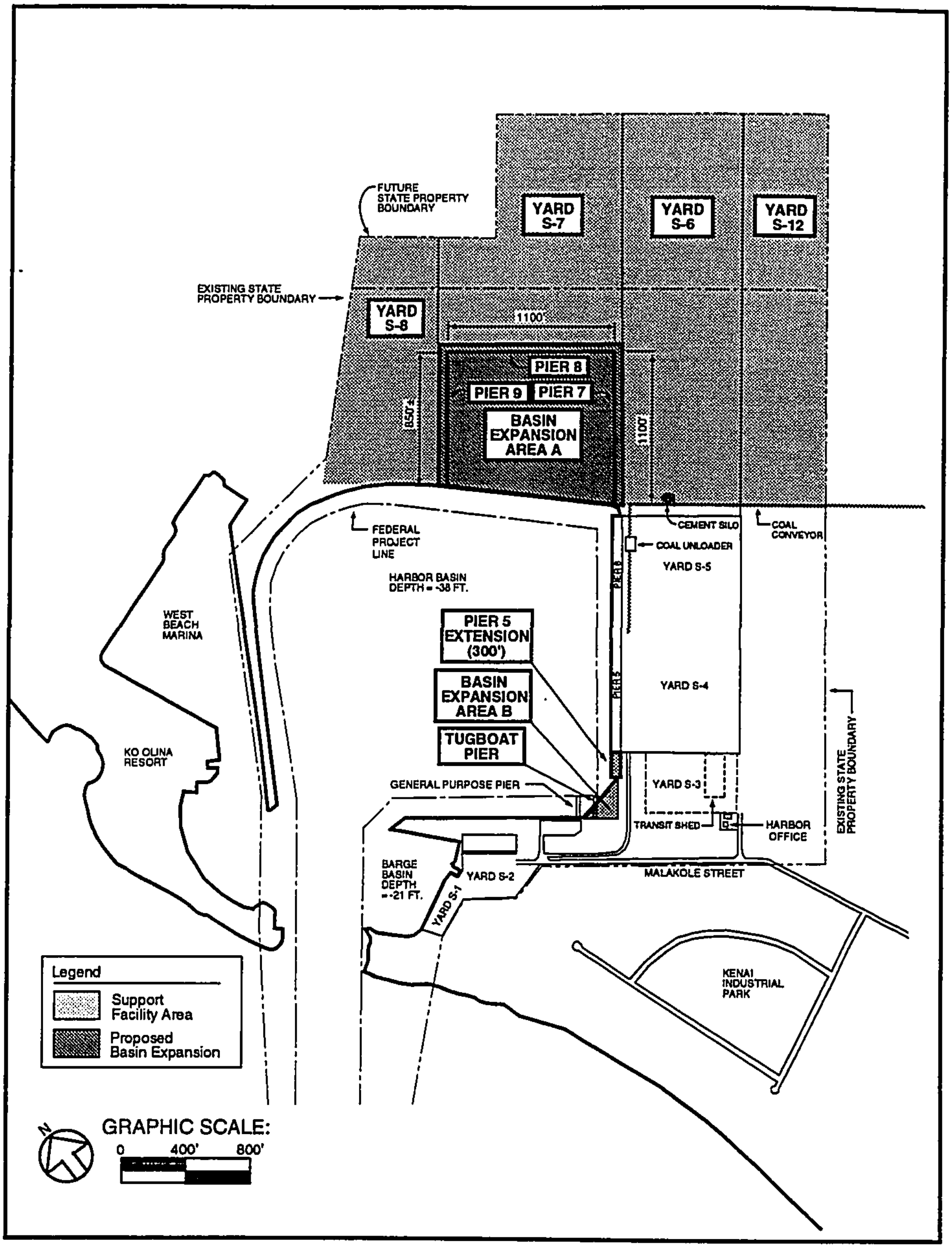
Portions of the properties mauka of the basin are currently occupied by commercial entities that have existing agreements with The EJC. Grace Pacific Corporation has an agreement to process and sell coral from existing stockpiles, and the Hawaiian Cement Corporation has an agreement to remove coral from specified areas. These agreements will remain in force after the acquisition of the parcels by the State.

The EJC owns Stockpile Area 4 and negotiations with the State for its use are on-going. Stockpile Area 1 is on State property. Stockpile Area 2 and a portion of Stockpile Area 3 are located within the 84 acres recently acquired by the State from The EJC. The rest of Stockpile Area 3 is within the 56.5 acres to be transferred from The EJC to the State.

2.3 DESCRIPTION OF THE PROPOSED ACTION

The work addressed by this Final SEIS ("the proposed action") consists of the following six elements (see Figure 2-5):

(1) extension of the harbor basin by approximately 1,100 by 1,100 feet along the northeast margin (Basin Expansion Area A);
(2) removal of a triangular area of land measuring approximately 230 by 280 feet in the south corner of the basin (Basin Expansion Area B);
(3) construction and operation of a tugboat pier (Tugboat Pier);
(4) construction and operation of additional piers for general cargo ships (General Cargo Piers 7, 8, 9 and Pier 5 Extension);
(5) construction and operation of storage yards and other support facilities (Yards S-6, S-7, S-8, and S-12); and
(6) acquisition by the State of 140.5 acres necessary for Expansion Area A and the adjacent facilities from The Estate of James Campbell, and reclassification of this acreage's State land use designation from "Agricultural" to "Urban".



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Elements of the Proposed Action

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

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FIGURE 2-5

2.3.1 Expansion Area A

Expansion Area A involves the creation of an approximately 1,100 by 1,100 foot basin (about 25 acres), 38 feet deep (-38 feet mean lower low water--mllw), adjacent to the existing harbor basin. A typical section of the expansion is shown in Figure 2-6. A 20-foot wide strip along the shoreline of the basin will be excavated to -45 feet mllw to avoid damaging the substructure of future piers should the harbor basin ever be deepened (the deepening of the basin is not addressed in this Final SEIS). Rip-rap will be placed along the shoreline as warranted for shoreline stabilization.

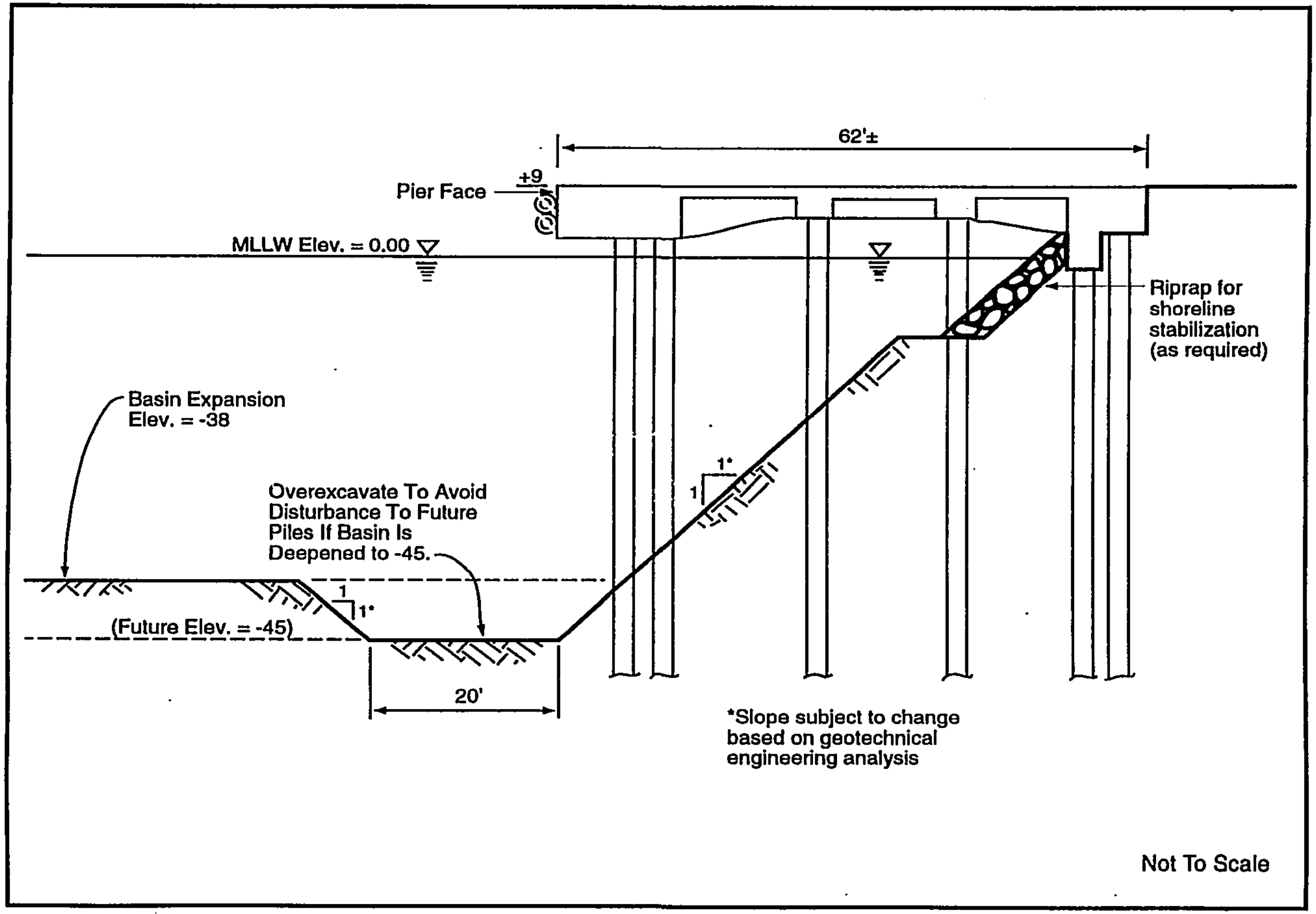
Approximately 450,000 cubic yards of dry material and 1,820,000 cubic yards of wet material will be removed to expand the basin (a total volume of approximately 2.3 million cubic yards). Material removed will consist of coralline limestone, coral sands and gravel, and clay.

2.3.2 Expansion Area B

A triangular area of land measuring approximately 230 feet by 280 feet (approximately 0.7 acres) will be removed from the south corner of the basin. Although the original harbor planning included removing this land, the need to maintain access between the barge harbor and the new harbor basin limited the construction actually performed. Land exchanges have now been concluded to allow construction of this corner of the basin to the original design. This expansion will allow the construction of a tugboat pier and the extension of Pier 5, as illustrated in Figure 2-7. Approximately 50,000 cubic yards of primarily coralline limestone materials will be removed. Rip-rap will be placed as required for stabilization.

2.3.3 Tugboat Pier

After the construction of Expansion Area B, a pier 150 feet long by 15 feet wide will be constructed for tugboat docking 125 feet from the existing general purpose pier and approximately 150 feet from the basin edge (see Figures 2-7 and 2-8). The concrete deck will be 7 feet above mllw.



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Typical Section Along Shoreline In Proposed Expansion Area
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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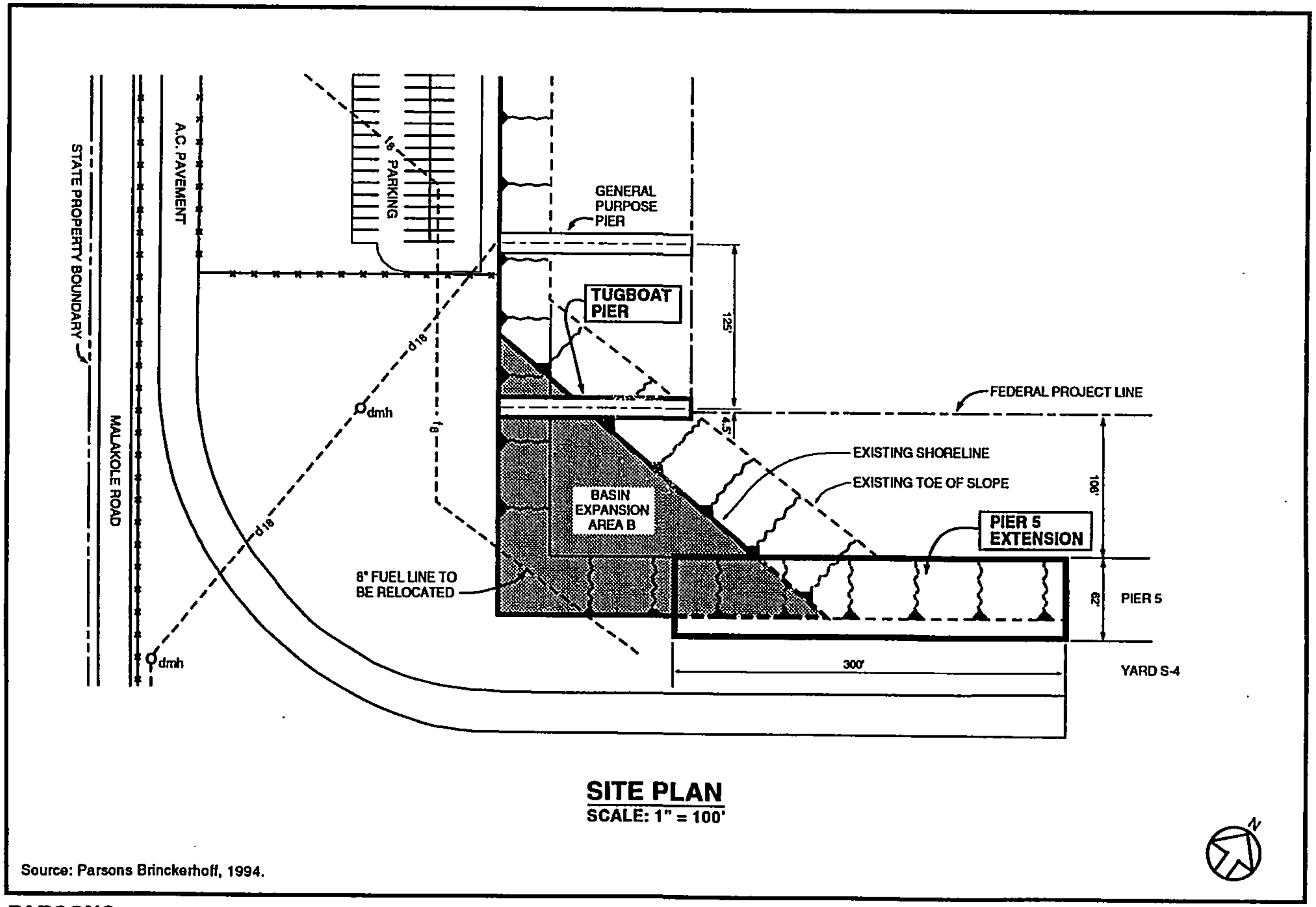
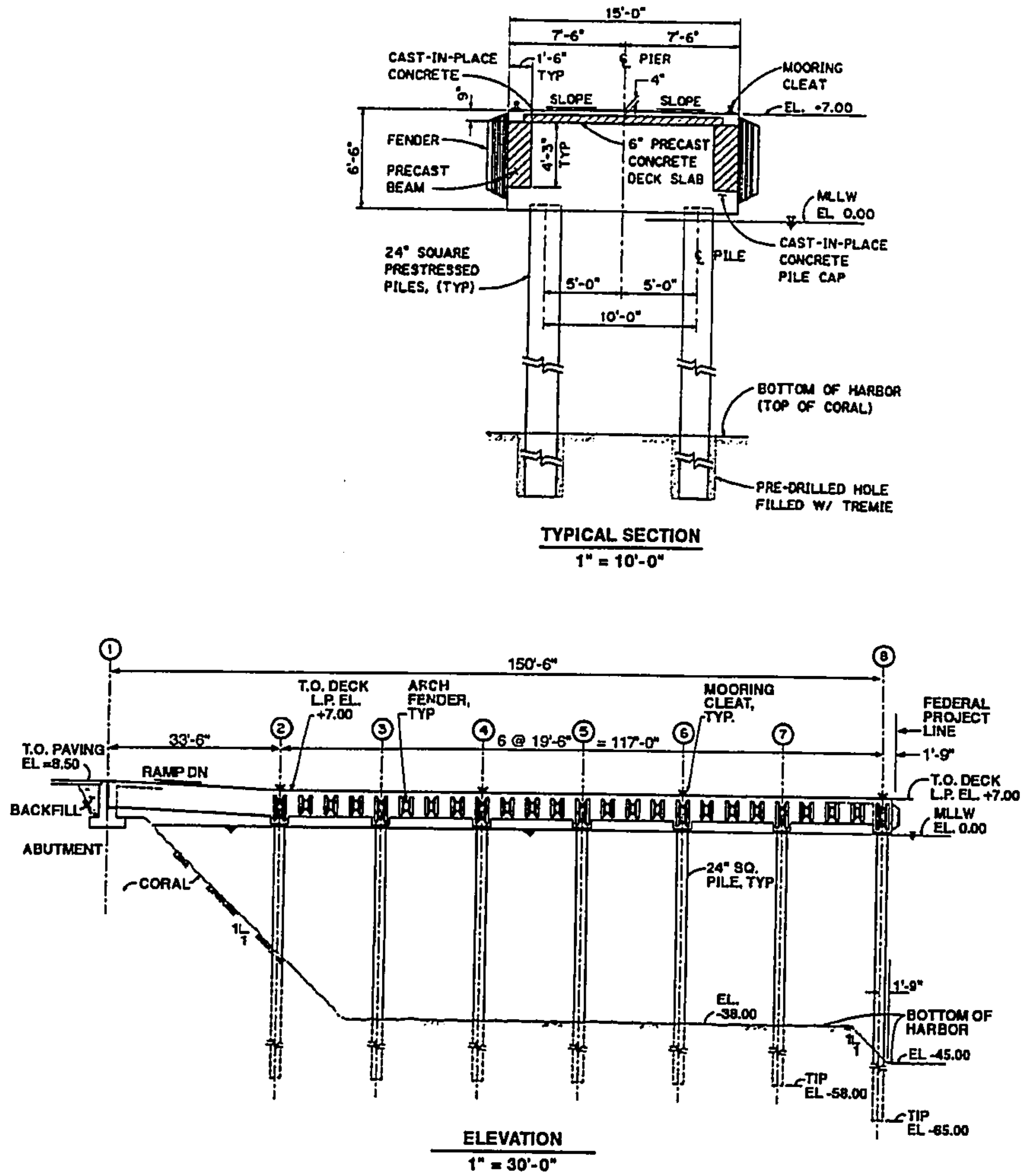
Final Supplemental Environmental Impact Statement
FIGURE 2-6



Source: Parsons Brinckerhoff, 1994.

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Site Plan: Basin Expansion Area B, Tugboat Pier, and Pier 5 Extension
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-7



Source: Parsons Brinckerhoff, 1994.

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Tugboat Pier Conceptual Plan
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-8

2.3.4 General Cargo Piers

Marginal wharves (Piers 7, 8 and 9, see Figure 2-5) will be constructed around the periphery of Expansion Area A. Pier 5 will also be extended after completion of Expansion Area B. Figure 2-6 shows a section through a typical cargo pier. The pier deck will be 9 feet above mllw. The piers will be equipped with mooring bitts and fenders.

Construction of the marginal wharves will provide about 3,350 linear feet of berthing space for general cargo ship loading and unloading as follows:

Pier	Approximate Pier Length (Feet)
7	1,100
8	1,100
9	850
5 Extension	300

2.3.5 Storage Yards and Support Facilities

Approximately 134 acres of additional storage yards will be constructed by grading and paving the land surrounding the expanded harbor basin (see Figure 2-5). These areas will support cargo handling and temporary storage activities. The approximate size of the proposed storage yards are shown below:

Storage Yard	Approximate Area (Acres)
S-6	44
S-7	33
S-8	24
S-12	33

Additional support facilities will include transit cargo sheds. Sheds will be used for the temporary storage of weather-sensitive cargo.

2.3.6 Land Acquisition and State Land Use Reclassification

Two land parcels originally owned by The EJC are being transferred to State ownership, as described in Section 2.2.2. Upon the completion of the transfers, SDOT will request from the Governor the right to use and develop the area, and an executive order allowing SDOT to lead development activities will be issued. The SDOT has also initiated redesignation of both parcels from their present State land use classification of "Agriculture" to "Urban."

2.4 FUTURE HARBOR OPERATIONS

The purpose of this section is to present an overview of how Barbers Point Harbor will operate after completion of the proposed action. The proposed action will allow the cargo handling capacity of the harbor to increase and certain piers to assume new functions. Tonnage through Barbers Point Harbor is expected to increase as shippers choose the harbor because of its location near developing Ewa destinations such as Campbell Industrial Park, the Kapolei Business Park, and the growing communities in Ewa. Furthermore, since land in Ewa is less expensive than Honolulu, Barbers Point Harbor will be attractive for cargoes needing temporary storage space, such as automobiles.

Cargo forecasts are contained in the Barbers Point Harbor Modification Study, Island of Oahu, Hawaii, Final Report (1991) and the 2010 Master Plan for Barbers Point Harbor (1991). While market conditions will control the rate at which the projected tonnage will materialize, the types of activities and berthing requirements described below are expected at the harbor in the future.

Barbers Point Harbor is expected to handle the following types of cargoes:

- general and neobulk cargoes: containers, lumber, heavy-lift machinery, automobiles;
- dry bulk cargoes: coal, limestone, ash, desulphurization by-products, grain and feed, cement, sand, clinker, scrap iron, building materials; and
- liquid bulk cargoes: gasoline, diesel fuel, fuel oil, naphtha.

The 2010 Master Plan for Barbers Point Harbor (1991) projected future berthing requirements from cargo projections. The Master Plan estimated that by 1995, the harbor would need to accommodate a total of 697 vessel days at berth (six working days for car carriers, 187 working days for dry bulk ships, 97 working days for dry bulk barges, 326 working days for liquid-bulk tankers, and 81 days for liquid bulk barges), or 37 percent more than the 1991-92 level. Even if this level of port activity is not reached by 1995, it is not too far off given the rate of tonnage increase demonstrated between 1991 and 1993.

Proposed Piers P-7, P-8 and P-9 will provide approximately 3,050 additional feet of wharf to accommodate some of these cargoes and the projected berthing requirements, and the proposed Storage Yards S-6, S-7, S-8, and S-12 will provide about 134 acres of additional cargo storage. As general cargo piers, Piers P-7, P-8 and P-9 could efficiently handle the general and neobulk cargoes, and with the provision of suitable equipment, some of the dry bulk cargoes as well.

The Honolulu Waterfront Master Plan (1989) and the Piers 19 to 35 Master Plan (in preparation) recommend relocating certain cargoes, such as dry bulks, to Barbers Point Harbor. Dry bulk cargo may be handled at Piers P-5 to P-9, although moisture-sensitive powders, such as cement, may be limited to Pier P-6 which has an existing pneumatic handling system.

Piers P-3 and P-4 are proposed to become dedicated petroleum piers to handle the volumes of gasoline, diesel fuel, fuel oil, naphtha, and jet fuel that are expected in the future. Texaco reported that it planned to export from Barbers Point Harbor 15,000 barrels of gasoline and diesel fuel twice a month to the neighbor islands within the next ten years (Barbers Point Harbor Modification Study, Island of Oahu, Hawaii, Final Report, 1991). Hawaiian Electric reported that it planned to export up to five million barrels per year of no. 6 fuel oil, no. 2 diesel and low sulfur fuel oil to the neighbor islands for electric generation (Barbers Point Harbor Modification Study, Island of Oahu, Hawaii, Final Report, 1991).

The kinds of cargo handling equipment needed at the harbor in the future could include shoreside mobile cranes, gantry cranes, straddle lifts, short-haul tractors, diesel tractors, forklifts and dry-bulk unloaders. (Noise impacts from this type of equipment are addressed in Section 5.10.)

Traffic volumes to and from the harbor facility will increase as a result of increased cargo volumes. (Traffic impacts are addressed in Section 5.12.)

2.5 CONSTRUCTION OPERATIONS

To evaluate the project's construction impacts, the construction methods and equipment likely to be used must be considered. Although the exact method and details of the construction will be determined by the construction contractor in compliance with the State's plans and specifications, the methods described in this section are the options most likely to be considered by the contractor.

2.5.1 Material Removal

Methods of removal of the material were evaluated by Ogden Beeman and Associates. The report, Barbers Point Harbor Basin Expansion: Description of Excavation and Disposal Alternatives (1994) describes three excavation methods:

- blasting and mechanical excavation;
- hydraulic dredging; and
- mechanical excavation without blasting.

Blasting with subsequent excavation and removal of the material is the method used in 1982-85 to construct the existing harbor. The second method, excavation by cutterhead, pipeline dredge of the submerged material, is a common technique for removing underwater materials and was proposed by one contractor for the previous project. The third method, mechanical breaking and subsequent removal, is used when blasting is not possible. These three methods are described below.

Common to all three methods is the ripping of material above the water level by tractor-dozers and bulldozers and removal by truck to a stockpile (possible stockpile areas are addressed in Section 2.5.2). Also, to minimize turbidity in the existing harbor basin, Expansion Area A would be excavated behind a berm of material that would be left in place to separate the expansion area from the existing harbor. This enclosure berm would be removed at the end of the project.

2.5.1.1 BLASTING AND MECHANICAL EXCAVATION

This method is the one used for the original harbor excavation and basic procedures used this time would be similar to those used for the prior project. However, there would be several important differences because of the close proximity of:

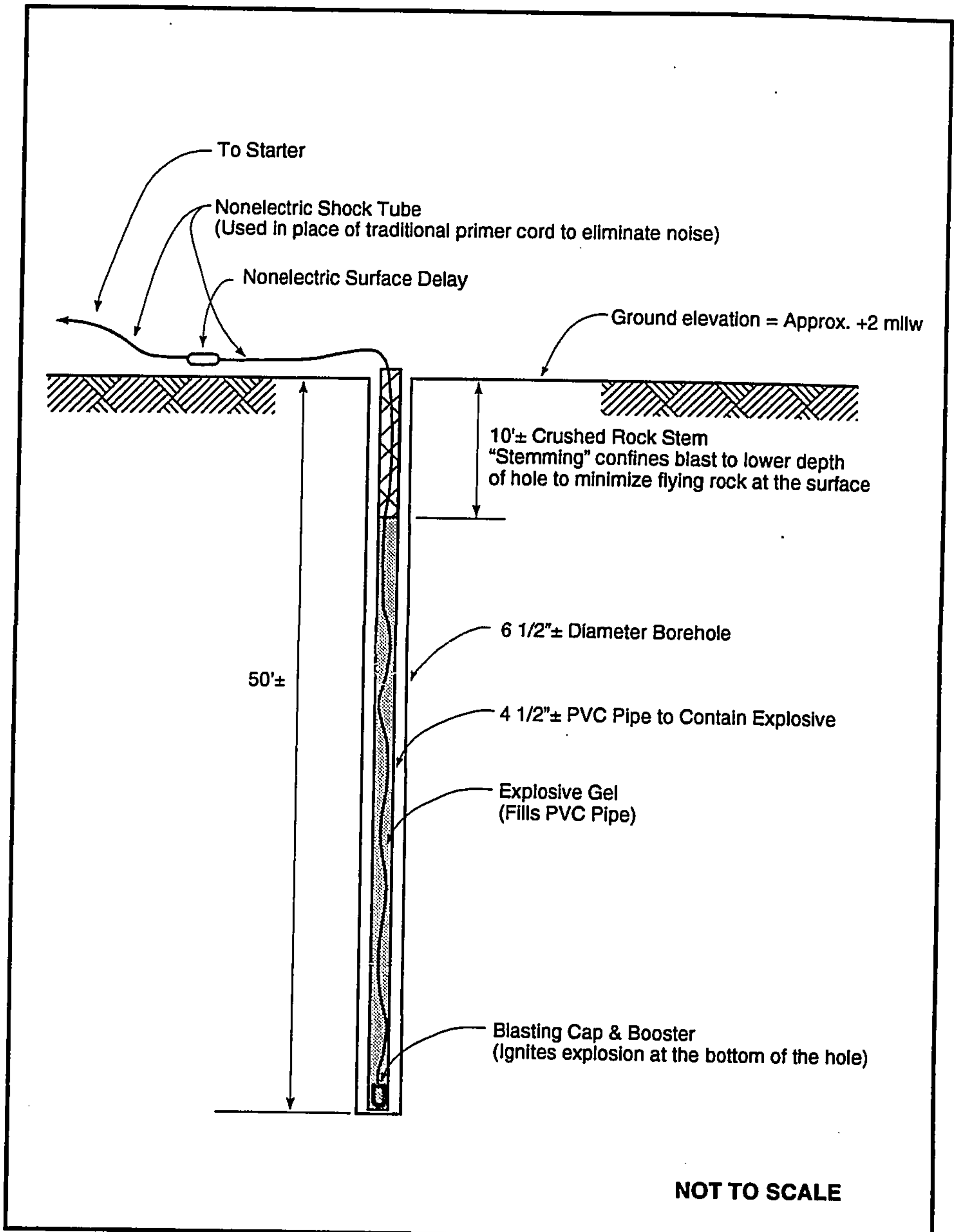
- existing harbor facilities, such as the piers, coal unloader and conveyor system, cement silo, and rock processing equipment; and
- residential neighborhoods, a luxury hotel and resort, and the industrial park tenants.

Because these nearby areas must be protected from damage and unacceptable vibrations, the size of explosive charges must be much smaller than used previously, and more extensive controls, monitoring and quality control measures would be specified.

Operations would begin with the ripping and removal of material by bulldozers down to the water table (approximate elevation +2 feet mllw). Materials would be loaded onto off-highway trucks by front end loaders and taken along established haul roads to designated stockpile areas. Excavation from +2 feet to the finish grade of -38 feet (and -45 feet along the shoreline) would occur by drilling and blasting. A pattern of blast holes would be drilled into the coral, with the optimum pattern to be determined after a program of test blasting. (The optimum pattern is the most efficient pattern the meets the requirements of minimal noise and vibration.) Typically, there would probably be only one blast per day in the late afternoon. Rock flying over the ground surface during blasting would be minimized by stemming the top of the blast holes and by detonating the explosive charges at the bottom of the hole (see Figure 2-9). The blast would fracture the coral, the fractured material would be removed by backhoe, clamshell, and/or dragline, and then be hauled by truck to the stockpile. Materials excavated by this method would have commercial value and may be used for road base, cement, structural fill, and aggregate.

Total construction time for this method is estimated to be 21 months (based on a nine-hour day and a six-day work week). The preliminary cost estimate for this excavation method is $15 million.

The primary environmental concern associated with this method is the noise and vibration associated with the blasting, which would be mitigated by limiting the size of the blasts (by controlling the amount of powder per "delay"), conducting excellent quality control, and scheduling blasting only during the day. Noise and vibration impacts are addressed in detail



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Typical Blasting Hole
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-9

in Sections 5.10 and 5.11, and Appendix A-1. Other impacts associated with this method include:

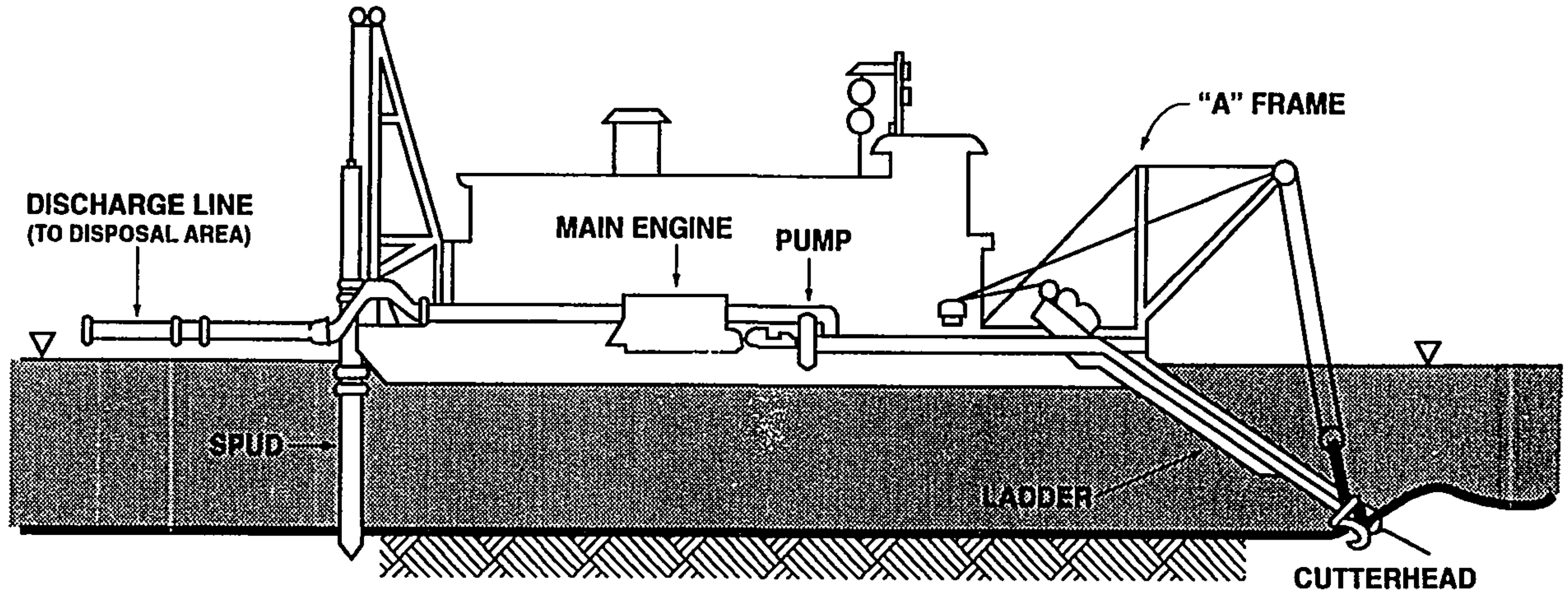
- dust emissions from haul roads and stockpiles, which would be mitigated by watering (see Section 5.13); and
- water turbidity, which would increase during the removal of the enclosure berm. Water quality impacts are discussed in more detail in Section 5.6 and Appendices A-2 and A-3.

2.5.1.2 HYDRAULIC DREDGING

Hydraulic dredging is a commonly used method for removing underwater materials. When the dredging vessel is equipped with a suitable cutterhead (the tool used to fracture material), the removal of hard materials such as the coralline limestone at Barbers Point Harbor is possible. A cutterhead dredge is shown in Figure 2-10. During dredging operations, pumps on the dredging vessel draw the fractured material by suction into a pipeline as a water slurry. The slurry is then pumped via pipeline to the material stockpile area. Dikes would contain the slurry within the stockpile area while the solids settle out. Much of the water would be absorbed by the porous coral limestone substrate at the disposal site. The remaining water would be returned via pipeline or spillway to Expansion Area A, where it would be contained by the enclosure berm and eventually recycled into the intake pipeline as the cutterhead continues to remove material.

As with the other excavation methods, material from the original ground level down to the water table would be removed by ripping with bulldozers. The hydraulic dredge would then begin cutting into the excavation area from the harbor side. The sequence is illustrated in Figure 2-11. To minimize turbidity in the existing harbor, the excavation would begin with a shallow draft cut to allow the dredging vessel to float into the expansion area. Full depth excavation would follow, with the shallow draft cut and berm left intact between the new excavation and the harbor. Removal of the berm would be the final step, after completion of all other excavation in the expansion area.

Dredging would occur 24 hours a day to maximize the productivity of the dredging vessel. Lighting at night would be necessary for operations to proceed. The construction time with this method is estimated to be 19 months (based on a six-day work week). The preliminary cost estimate for this method is $20 million.



Not To Scale

Source: Ogden Beeman & Associates, Inc., 1994.

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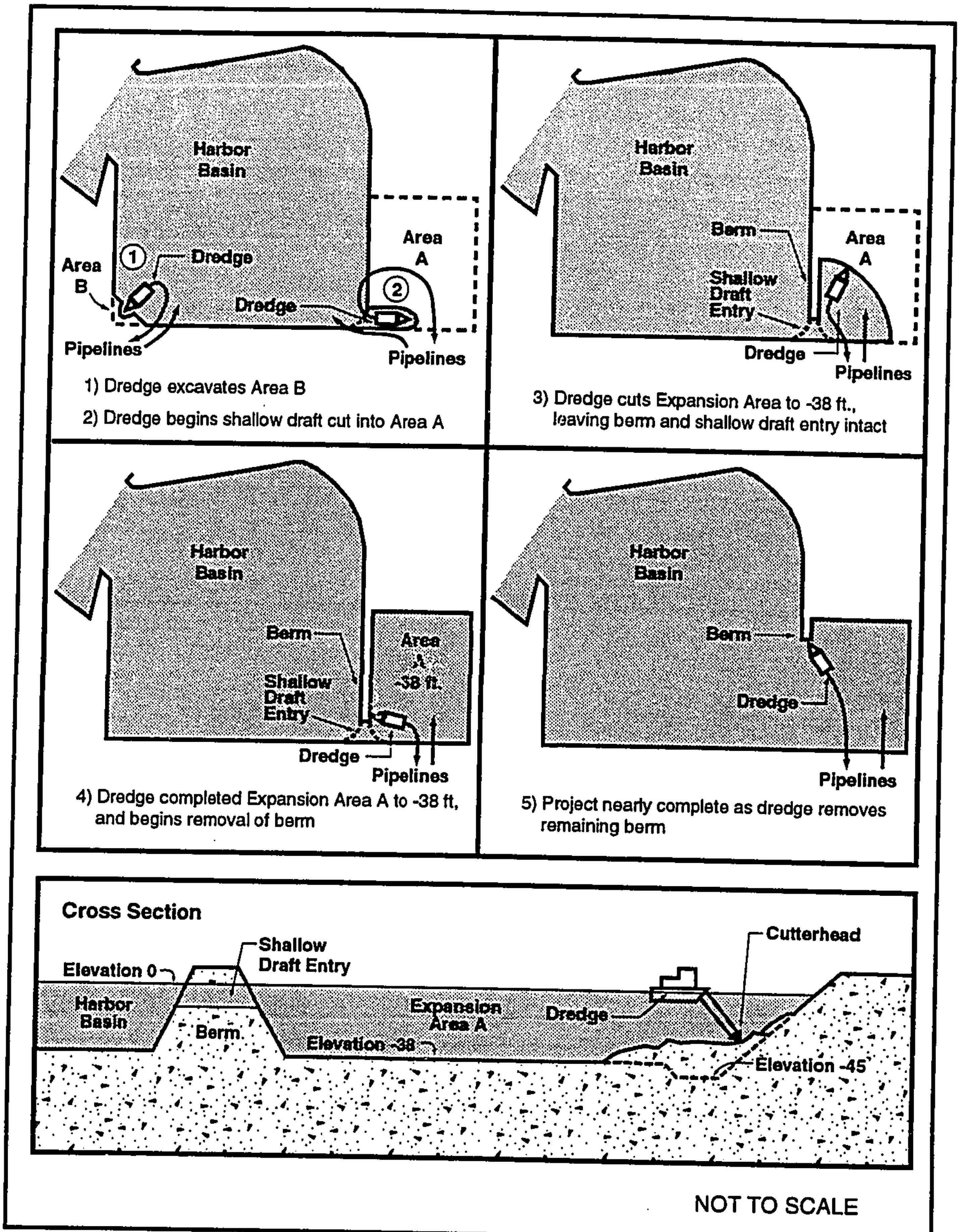
Illustration of a Hydraulic Dredge
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-10



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Work Sequence of Hydraulic Dredging
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 2-11

The primary environmental concerns associated with this method are turbidity and noise associated with 24-hour operations. Turbidity would be minimized by appropriate sizing of the settlement ponds at the stockpile area to allow sufficient time for the solids to settle (residence time), and by discharging the return water in the expansion area where it would be separated from the main harbor by the enclosure berm. As the settlement ponds fill with solid material toward the end of the job, a shorter work day may be necessary to achieve sufficient settlement of solids. When dredging Expansion Area B and removing the berm at Expansion Area A, a silt curtain could be deployed at the point of return water discharge to direct any remaining turbidity towards the bottom of the water column, minimizing the dispersion of turbidity. Turbidity dispersion is discussed in more detail in Section 5.6 and Appendix A-3.

Noise associated with 24-hour operations would be minimized by establishing a monitoring program to enforce adherence to noise standards to be included in the project specifications. Noise impacts are discussed in detail in Section 5.11 and Appendix A-1.

Although hydraulic dredging is presently viewed as a less favorable construction method due to the need for larger stockpiling and settlement pond areas, it is a feasible method and has therefore been retained in the *Final SEIS*. If the material is removed by hydraulic dredge, its value would be reduced. The rock would be pulverized and there would be limited opportunity during the dredging process to segregate the less valuable clay from the coral limestone. The higher salt content of dredged material may also reduce its value for future marketing.

2.5.1.3 MECHANICAL EXCAVATION WITHOUT BLASTING

Mechanical excavation without blasting was investigated because the blasting method is known to generate concerns. Therefore, it became important to determine the feasibility and potential impacts of this alternative method. While the West Beach Marina, adjacent to Barbers Point Harbor, was constructed without blasting, the maximum depth of that excavation was only -16 feet, in contrast to the proposed depth of -38 feet (-45 feet in some areas) for the harbor expansion. The feasibility of this method at Barbers Point Harbor is related to the required depth of the cut and the limited number of machines which can exert sufficient force to fracture hard coral material at the required depths.

It was assumed that this method would proceed as follows. Augers capable of drilling 24 to 36 inch diameter holes would create a pattern of holes to the required depths in the substrate ("swiss-cheesing") to weaken it. The weakened rock would then be fractured, ripped and excavated by a large backhoe, dragline, and/or clamshell bucket and loaded directly onto off-highway trucks for hauling to designated stockpile areas. Materials excavated by this method would have commercial value and may be used for road base, cement, structural fill, and aggregate.

As with the other methods, material from the original ground level to the water table would be removed by bulldozers. An enclosure berm would be left to isolate the expansion area from the existing harbor. Upon completion of the expansion area, the auger drills would "swiss cheese" the enclosure berm prior to its removal.

The construction time for this method is estimated to be 25 months (based on a nine-hour day and a six-day work week). The preliminary cost estimate for this method is $20 million.

Environmental concerns associated with this method include dust emissions from haul roads and stockpiles and water turbidity associated with removal of the enclosure berm. Dust can be mitigated by watering (air quality impacts are addressed in more detail in Section 5.13). Turbidity is discussed in detail in Section 5.6 and in Appendix A-3. It should also be noted that this construction method would take longer than the other two, and therefore its associated impacts would occur over a longer period of time.

2.5.2 Stockpiling of Removed Material

The work will produce approximately 2.3 million cubic yards of material consisting of coral sand/gravel, coral limestone, clay with coral, clay, and sand. Applying a bulking factor of 10 percent, stockpiles capable of storing 2.5 million cubic yards will be necessary. Approximately 0.5 million cubic yards will be dry material removed from above the water level. The remainder (2.0 million cubic yards) will come out as wet material by one of the three methods described above.

The amount of land required for stockpiling will depend on the construction method and the available disposal site, as follows:

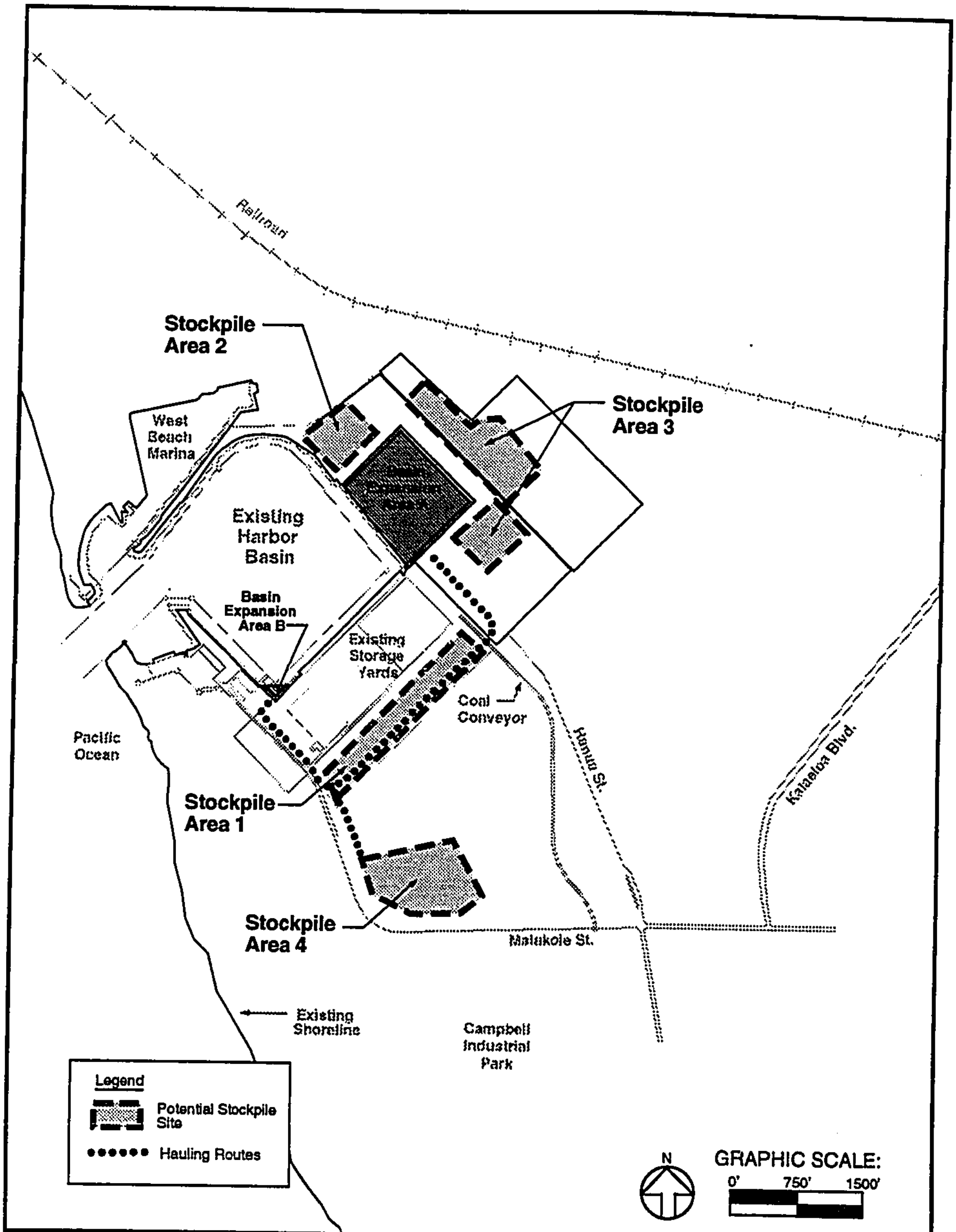
- If the work is accomplished by blasting or mechanical fracturing, the material could be accommodated on a total of 45 acres at either Stockpile Areas 1, 2, and 3 or Stockpile Areas 1, 2 and 4 (assuming a stockpile height of 40 feet, which was the maximum permitted stockpile height during the previous harbor excavation).

- Hydraulic dredging would require a disposal area of 72 acres, which could be accommodated on Stockpile Areas 1, 2, 3 and 4 (containment dikes would be limited to a maximum height of 20 feet).

The locations of proposed upland stockpile areas are shown in Figure 2-12. None of these proposed sites are located in environmentally sensitive areas. Land ownership and use of the sites is as follows:

Stockpile Area	Land Ownership	Land Use
1	State of Hawaii	Currently vacant. Previously used for stockpiling material excavated from Storage Yards S-4 and S-5.
2	State of Hawaii (recently acquired from The EJC)	Currently vacant. Previously used for stockpiling material excavated from the harbor basin.
3	The EJC and the State of Hawaii (The EJC recently transferred ownership of part of the land to the State; remainder to be transferred in 1995)	Currently vacant. Previously used for surface mining of coral limestone.
4	The EJC	Currently vacant. Previously used for stockpiling material excavated from the harbor basin.

Another option would be for the construction contractor to remove some or all of the material for use or disposal at an approved location not listed above. The impacts of this option are not addressed in this Final SEIS.



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Expansion Areas and Potential Stockpile Areas
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 2-12

2.5.3 Construction of Shoreside Facilities

Construction of piers, storage yards, and support facilities will occur by standard methods. Piles will be driven by a floating pile driver or crane barge. Precast concrete deck elements or cast-in-place concrete pile caps and decks will be required. Backhoes or a clamshell dredge will be used. Short-term construction impacts will include the following:

- noise from construction equipment and operations, particularly pile driving;
- dust;
- rainfall runoff contributing to increased turbidity in the harbor; and
- increased traffic due to movement of construction materials and workers.

Appropriate construction specifications and compliance with applicable environmental standards governing noise, air pollution, and water pollution will minimize the construction impacts.

2.6 THE USE OF PUBLIC FUNDS AND PUBLIC LANDS

2.6.1 Public Funds

The total cost of land acquisition, project design, and construction of the proposed action will be approximately $155 million. The projects will be fully State-funded. The expenditure of funds will occur from fiscal years 1993 to 2011. Individual project budgets and schedules are shown in Figure 2-13.

2.6.2 Public Lands

Although portions of the project will be built within the existing Barbers Point Harbor boundary, most of the harbor expansion will occur on two parcels. The State recently acquired one of the parcels from The EJC and is in the process of acquiring the other. Parcel boundaries and work areas are illustrated in Figure 2-4.

Figure 2-13

STATE SPONSORED
CAPITAL IMPROVEMENT PROGRAM TO YEAR 2011
BARBERS POINT HARBOR

(in thousands of dollars)

PROJECT	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Dredging Piers P-7/8/9, Corner & Tug Pier	1,800	30,000																	
Pier 7 (1,000LF), Pier 5 (300LF)			1,000			17,000													
Storage Yard S-6 (10 AC/8AC)						500	6,000			500	6,000								
Pier 9 (1,000LF)														1,500	20,000				
Pier 8 (1,000LF)								1,500	17,000										
Shed #2												750	9,000						
Storage Yard S-8 (25 AC)																1,500	18,000		
Storage Yard S-7 (8 AC)										600	5,000								
Land Acquisition (56.5 AC)	6,000																		
Storage Yard S-9, 12																		1,000	10,000
TOTAL	7,800	30,000	1,000			17,500	6,000	1,500	17,000	1,100	11,000	750	9,000	1,500	20,000	1,500	18,000	1,000	10,000

Source: Harbors Division, State Department of Transportation (adapted), rev. 9/9/94.

Note: This figure includes only those Barbers Point Harbor Projects included in the proposed action of this Draft SEIS.

2.7 PROJECT SCHEDULE

Design and construction of the elements of the proposed action is programmed to occur from 1993 to 2011, as shown in Figure 2-13. Planning and design for Expansion Areas A and B and the tugboat pier commenced in 1993. These projects have been designated "Job H. C. 1823, Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu." The environmental process, development of detailed plans and specifications, and selection of a construction contractor is projected to occur in 1994 and 1995. The acquisition by the State of 140.5 acres is presently underway, and the State land use redesignation process and issuance of a Governor's Executive Order authorizing the use and development of the land are expected to be completed in 1995. Construction is expected to commence in late 1995 and last for two years. Construction of the marginal wharves, storage yards, and support facilities will follow completion of the basin expansion according to the State capital improvements funding program. Construction of individual storage yards will follow construction of the adjacent piers to provide complete functional units.

CHAPTER 3

ALTERNATIVES CONSIDERED

This chapter presents alternatives which were considered but rejected from further consideration.

3.1 NO-BUILD ALTERNATIVE

One alternative would be to not proceed with the proposed action, leaving Barbers Point Harbor in its present configuration. This alternative is called the "no-build." With this alternative, there would not be additional piers and storage yards to accommodate the projected cargo volumes and types (see Chapter 1). The harbor would not be able to accommodate the increasing number of vessels, and demurrage and other penalty fees would become substantial, contributing to increased business costs for shippers and the cost of living for Hawaii residents. The harbor's utility as a facility supplemental to Honolulu Harbor and the port closest to leeward Oahu destinations would diminish.

The no-build alternative has been rejected from further consideration because:

- the goals of the project would not be achieved (see Chapter 1);
- State and City and County development policies would not be implemented (see Chapter 4); and
- the State would lose the favorable terms under which it could acquire from The EJC some of the land required for harbor expansion (see Chapter 1).

3.2 ALTERNATIVE HARBOR SITES

Another alternative to the proposed action would be to construct the additional facilities at a different site.

The Revised Environmental Impact Statement for Barbers Point Deep-Draft Harbor on Oahu (1978) discussed alternative harbor sites on Oahu. The alternative sites considered were Pearl Harbor and Kaneohe Bay.

These alternative sites were rejected in 1978, and the basis for their rejection remains valid. Pearl Harbor was eliminated as a potential commercial harbor site due to security and safety reasons and significant dredging impacts, which could cause adverse impacts on the groundwater system around Pearl Harbor. In addition, maintenance of the desired harbor depths would be difficult and expensive because of the silt-bearing streams that enter the harbor.

Kaneohe Bay would neither meet Oahu's future harbor needs nor be an economically feasible commercial port. A commercial harbor at Kaneohe Bay would require significant overland hauling of goods and materials to Honolulu and leeward Oahu. In addition, filling of reef areas to create land for harbor-related structures would be necessary.

Honolulu Harbor is not an appropriate site for the facilities proposed for Barbers Point Harbor because Honolulu Harbor does not have the available space, and the needed facilities are not consistent with the development goals for Honolulu Harbor as described in the Honolulu Waterfront Master Plan (1989).

Therefore, the alternative of developing the facilities proposed for Barbers Point Harbor at another site has been rejected from further consideration because:

- there is no other harbor site available to accommodate the proposed improvements; and
- at Barbers Point Harbor, the new facilities will adjoin an existing commercial harbor with room for expansion and suitable infrastructure already in place.

3.3 ALTERNATIVE CONSTRUCTION METHODS

One construction method was considered in addition to the three methods that are addressed in detail in this Final SEIS. This method would involve dewatering Expansion Area A so that the water level would be below the bottom of the excavation, and material could be removed under dry conditions. This alternative was eliminated from further consideration because:

- it would have a much larger impact on the groundwater regime in the area;
- it is doubtful that dewatering could be achieved due to the porous nature of the limestone; and
- it appears to have no advantages over the other three methods.

The other feasible construction methods are addressed in Chapter 2.

3.4 ALTERNATIVE USES AND DISPOSAL OPTIONS FOR REMOVED MATERIALS

As described in Chapter 2, materials removed from the expansion areas will be stockpiled for reuse at upland sites near the harbor. The following alternatives were considered and have been rejected from further consideration:

- Transporting the material upon its removal to the Reef Runway at Honolulu International Airport: Although SDOT needs fill material for projects proposed at the airport, and a stockpile area at Reef Runway may be available to store the material until it is needed, these projects have not yet completed the environmental review process, and environmental approval of the stockpile area at Reef Runway has not yet been obtained. Therefore, this alternative was found to be unworkable.

- Transporting the material upon its removal to Kakaako: The Hawaii Community Development Authority (HCDA) needs fill for its proposed Kapalama Development and Kakaako Waterfront Beach Park, but because funding for transportation and/or stockpiling the material is unavailable, this alternative was rejected.

- Ocean disposal: This alternative was considered but rejected because the material has commercial value for use as road base, cement, fill, and aggregate.

CHAPTER 4

RELATIONSHIP OF THE PROPOSED ACTION TO EXISTING LAND USE AND DEVELOPMENT PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

4.1 LAND USE

4.1.1 Existing Harbor Land Use

Barbers Point Harbor presently includes the following facilities:

State Department of Transportation Facilities

- an entrance channel 450 feet wide, 4,280 feet long, and 38 to 42 feet deep; [1]
- a harbor basin that is approximately 2,300 feet by 1,800 feet wide and 38 feet deep;[1]
- Piers P-5 and P-6 which form a continuous wharf approximately 1,600 feet long;
- Storage Yards S-4 and S-5, backland of Piers P-5 and P-6, which total approximately 30 acres of concrete paved storage area and are used to store and handle dry-bulk and general cargoes, and petroleum products;
- a 21 feet deep barge basin, a barge pier approximately 250 feet long, and Storage Yards S-1 and S-2 (approximately 5 acres in size) which are adjacent to the harbor entrance;
- a 150 feet long general purpose pier near the south corner of the basin; and
- an administration building.

Privately Owned Facilities

- Marisco Ltd. floating dry dock and ship repair facilities, located on the southwestern side of the basin;
- pneumatic loading system and cement storage silo on Pier P-6;

1 The harbor entrance channel and most of the basin are maintained by the U.S. Army Corps of Engineers.

- Hawaii Pacific Industries Inc. dry-bulk unloader and enclosed conveyor system connecting Pier 6 with the Applied Energy Services-Barbers Point, Inc. (AES-BP) co-generation electric power plant in Campbell Industrial Park; and
- BHP Hawaii, Chevron, Texaco, and Hawaiian Electric Company petroleum pipelines.

The coal unloader and conveyor are currently used to handle coal shipments (2010 Master Plan for Barbers Point Harbor, 1991). The system can also unload and deliver dry-bulk products directly onto trucks at the harbor facility. The pneumatic loader system pumps certain dry-bulk products onto vessels. This system is presently used to pump cement from a silo onto the Hawaiian Cement, Inc. barge Punapau. Other dry-bulk cargoes handled at the harbor include cement clinker, sand and gypsum.

The petroleum pipelines at Piers P-5 and P-6 handle diesel, gasoline, fuel oil, naphtha and jet fuel. The pipelines are used to load ships and barges serving the neighbor islands.

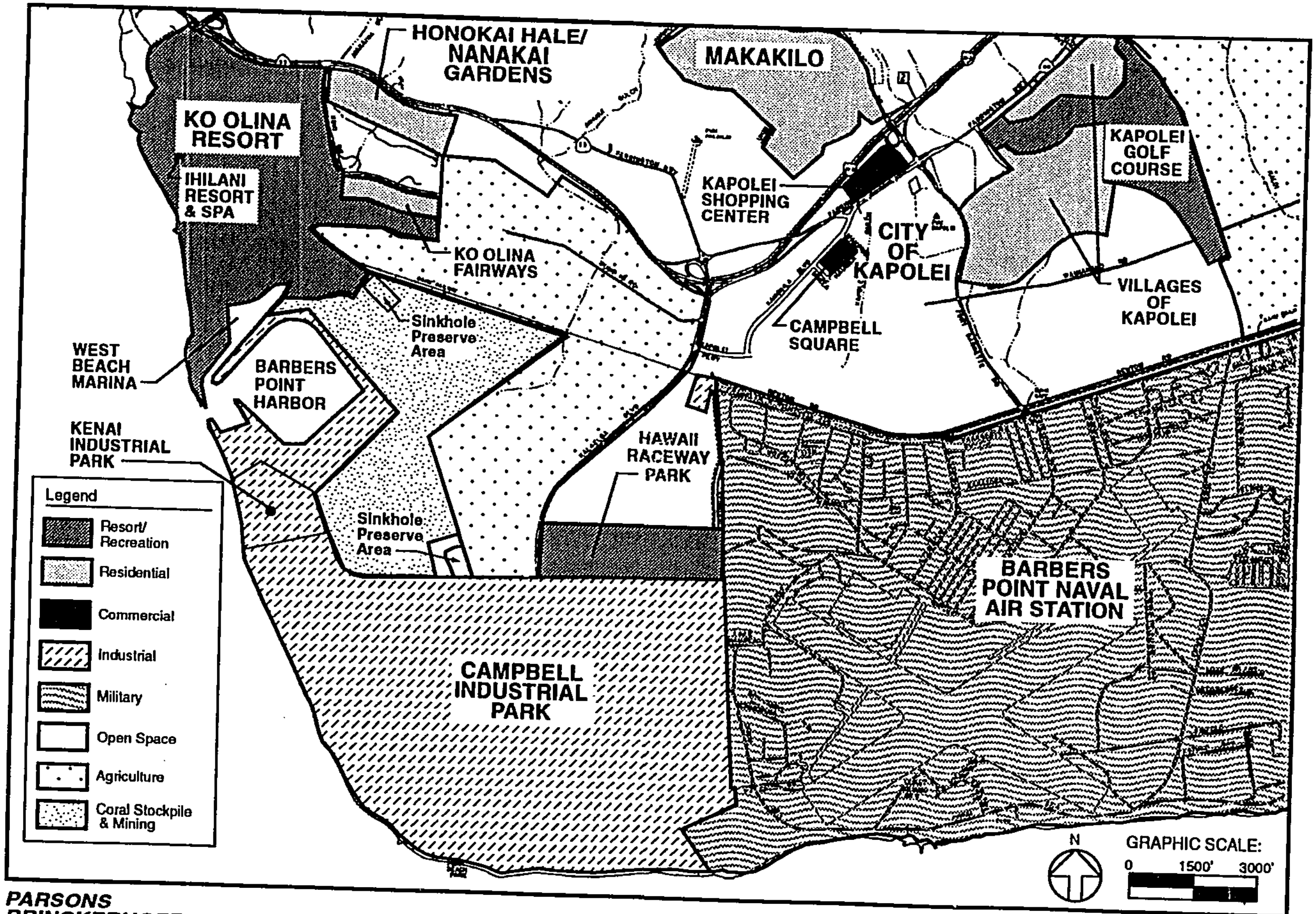
Scrap iron, equipment and vehicles are handled at the harbor although they constitute a small percentage of the total cargo tonnage.

4.1.2 Surrounding Land Uses

The existing land uses in the general vicinity of Barbers Point Harbor are shown in Figure 4-1.

Immediately north of Barbers Point Harbor is the new Ko Olina Resort. The resort is in a partial state of completion and presently consists of four artificial sandy lagoons, a golf course and accompanying club house, a marina which shares the same entrance as Barbers Point Harbor, and Ko Olina's first hotel, the Ihilani Resort and Spa which opened in late 1993. Ko Olina Fairways, a residential complex, is presently under construction.

Coral limestone processing occurs immediately mauka and to the south and east of Barbers Point Harbor where coral from the construction of the main harbor basin is stockpiled. The stockpiled material is processed and sold by Grace Pacific Corporation. Mauka of the existing stockpile is a coral limestone surface mining operation run by Hawaiian Cement. A 40-foot wide historic railroad right-of-way is located about 200 feet mauka of the nearest area of proposed work.



PARSONS
BRINCKERHOFF
QUADE &
DOUGLAS, INC.

Existing Land Use
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 4-1

Further mauka of the project site, along Farrington Highway, are the contiguous residential communities of Honokai Hale and Nanakai Gardens. Nanakai Gardens, developed in the mid-1960s, contains 130 single-family units and Honokai Hale, developed in the early 1970s, contains 160 single-family units (Barbers Point Harbor Expansion Social Impact Assessment, 1993).

Northeast of the project site is Makakilo, a 25-year-old residential community on a ridge overlooking the Ewa plain. This community consists of almost 3,000 residential units. The majority of these units are single-family, although there is a significant number of multi-family, low and medium density units. Makakilo also contains two elementary schools, three neighborhood parks, and a small commercial retail center.

Sugar cane lands are located to the north and east of the harbor. Cane production in this area is in its final years and some of these lands are already zoned for industrial development.

Campbell Industrial Park is located south of the harbor. Approximately 188 businesses are situated on 1,367 acres, and current employment is estimated at 3,500 persons (Barbers Point Harbor Expansion Social Impact Assessment, 1993). Major tenants include the Chevron and BHP petroleum refineries, a concrete manufacturing plant, H-Power resource recovery facility, a coal-fired co-generation power plant, large building supply yards, and Hawaii Raceway Park. The 66-acre Kenai Industrial Park was recently constructed on land immediately south and adjacent to the harbor. Its 34 lots are not yet occupied.

The Barbers Point Naval Air Station is located to the east of Campbell Industrial Park. This station is 3,672 acres in size and is used to support Naval aviation activities and units (Barbers Point Harbor Expansion Social Impact Assessment, 1993).

On land northeast of the project site the first residential developments of the Villages of Kapolei (over 500 homes) have recently been completed. Most of them are already occupied. The Kapolei Shopping Center, completed in 1993, has 134,500 square feet of leaseable space and can house 34 tenants. Longs Drug Stores and the largest Safeway branch in Hawaii are anchor tenants (Pacific Business News, August 9, 1993). Kapolei's first office complex, Campbell Square, was completed in 1993 and has 125,000 square feet of office space. This complex houses The EJC's corporate operations.

Sites in the vicinity of Barbers Point Harbor to be preserved for special purposes include:

- the historic railroad right-of-way;
- a fenced sinkhole preserve area containing archaeological sites immediately mauka of Barbers Point Harbor;
- another fenced sinkhole preserve area on Malakole Street to the east of Barbers Point Harbor;
- a fenced preserve area for a small colony of the endangered plant *Achyranthes splendens*, located just makai of Malakole Street, less than 1/2 mile from the project site; and
- a 100-foot building setback along the property line of the 84-acre parcel to serve as a buffer between the Ko Olina Resort and the harbor.

4.1.3 Proposed Land Use Developments

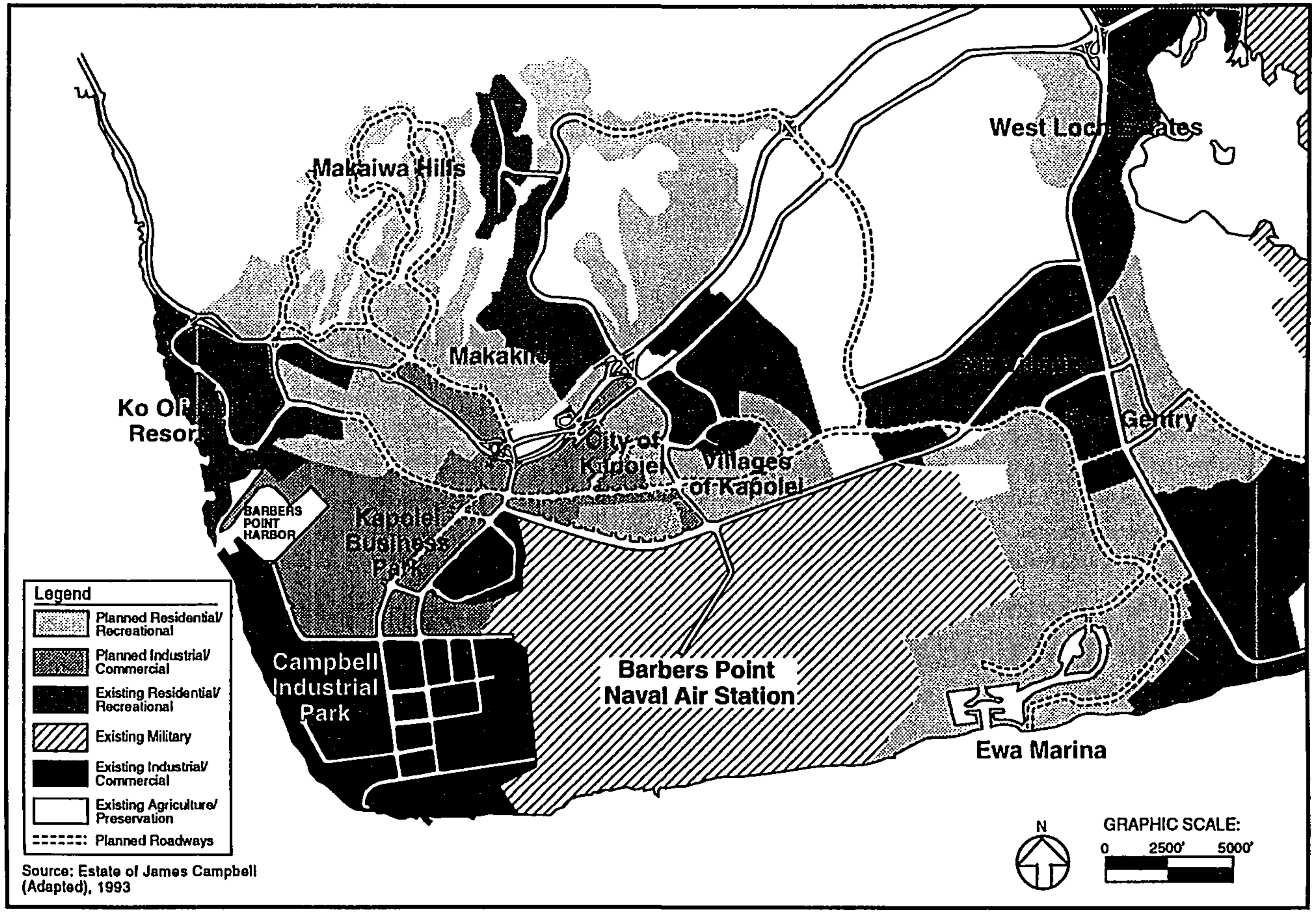
There are many proposed developments in the vicinity of Barbers Point Harbor. The entire Ewa plain is undergoing dynamic change, centered on the developing City of Kapolei. New and proposed developments are illustrated in Figure 4-2.

The EJC is currently developing the Kapolei Business Park on parcels immediately east of Barbers Point Harbor. Infrastructure improvements for the first increment of approximately 135 acres to be used for light industrial purposes have been completed (Kapolei/Ewa Project Update, The Estate of James Campbell, Third Quarter 1993). The total size of the proposed business park will be approximately 800 acres, and the park will consist of waterfront industrial, intensive industrial and commercial land uses.

Southeast of the harbor is The Estate of James Campbell's future 63-acre Maritime Industrial Subdivision.

To the north of Barbers Point Harbor the Ko Olina Resort encompasses 1,000 acres. In addition to the Ko Olina Fairways, the golf course, marina, and the Ihilani Resort and Spa, the 640 acre first phase includes the following facilities which are yet to be developed:

- 5,200 residential apartments;
- 18 acres of commercial space; and
- additional hotels totaling 4,000 rooms.



PARSONS
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Kapolei Area Long Range Master Plan
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 4-2

A second phase may include an additional 3,500 residences and a second golf course (Barbers Point Harbor Expansion Social Impact Assessment, 1993).

East of Barbers Point Harbor and encompassing approximately 890 acres, the city of Kapolei is expected to be the nucleus of a master-planned community in the Ewa plain. It will evolve over time to include several million square feet of office and retail space and several thousand residential units. The State and the City and County of Honolulu are committed to locating offices and services in Kapolei. Some of the planned projects in Kapolei include:

- the Kapolei Regional Park;
- schools;
- a pedestrian mall;
- the Kapolei Town Center;
- a child care facility; and
- community parks.

The Barbers Point Naval Air Station (BPNAS) is scheduled for closure in 1997 (Pacific Business News, August 9, 1993). A Barbers Point Naval Air Station Reuse Committee, comprised of representatives of the City and County of Honolulu, the State, federal agencies and the community, was formed to recommend future land uses for the base. Some of the possible lead agencies and land uses include:

- the State Department of Transportation - Airports Division, for general aviation use of the existing air field;
- the United States Navy, for housing and recreational use;
- the United States Army, for housing and a sewage treatment plant;
- the Federal Aviation Administration, for maintenance of existing navigational facilities;
- the United States Coast Guard, for continued operation of their air station;
- the National Park Service, for land exchange purposes;
- the U.S. Postal Service, for new facilities serving the rapidly growing Ewa-Makakilo-Kapolei community;
- the City and County of Honolulu, Department of Wastewater Management, for expansion of the Honouliuli Wastewater Treatment Plant; and
- the Board of Water Supply for a desalination plant.

Other planned developments in the vicinity of Barbers Point Harbor include the expansion of the Makakilo community and Makaiwa Hills. The expansion of Makakilo would involve approximately 2,800 additional homes in the area of Palalai Gulch. Makaiwa Hills is a 2,000-acre project located on a ridge north of the Barbers Point Harbor, mauka of Farrington Highway. Current plans include 4,100 new residential units, a commercial retail center, and public facilities to support this community.

4.1.4 Probable Land Use Impact

The areas to be affected by the proposed action do not have existing structures.

The 140.5-acre area to be used for Expansion Area A, the new piers and storage yards, and Stockpile Areas 2 and 3, is presently used for stockpiling and coral mining and processing operations. The affected parties have agreed that portions of the stockpile will be removed to make way for the basin expansion. Coral mining operations will not be impeded by the proposed construction. A coral processing plant, operated by Grace Pacific, located within the 84-acre parcel, will not be affected by the excavation. However, it is located on the site of future storage yards and will have to be relocated when these yards are constructed.

The area to be used for Expansion Area B and the tug pier is unoccupied.

The location to be used for Stockpile Area 1 is presently vacant. The use of this area as a stockpile area will not affect any existing activities, but will affect the future construction of storage yards proposed for this area. Stockpiled material will need to be removed or relocated before the storage yards could be constructed.

The location to be used for Stockpile Area 4 was recently used for stockpiling and is now vacant. Additional stockpiles in this area will have no impact on the present utilization of this parcel. However, since this parcel is designated for industrial use by the Ewa Development Plan, its use for stockpiling may impede future development opportunities. The possible use of this parcel for stockpiling is being coordinated with the parcel owner, The EJC.

As described in Section 4.1.5, "Mitigation Measures," the proposed action will not affect land use and future development at Ko Olina Resort.

The proposed harbor improvements are likely to have beneficial impacts on Kapolei Business Park, Kenai Industrial Park, and the proposed Maritime Industrial Park. Appropriate businesses could take advantage of the expanded port facility to reduce transportation costs from Honolulu Harbor. For example, AES-BP reported that Barbers Point Harbor provides the least cost means for delivering coal to their co-generation facility (Barbers Point Harbor Modification Study, Island of Oahu, Hawaii, Final Report, 1991). In addition, the proposed improvements are compatible with and supportive of the existing, industrial land uses at Campbell Industrial Park.

The improvements at Barbers Point Harbor will not affect land use decisions at BPNAS, the City of Kapolei, and other residential and commercial development sites in Ewa. These developments will proceed regardless of improvements to Barbers Point Harbor since they are driven by the island-wide demand for housing and commercial development.

4.1.5 Mitigation Measures

To mitigate the incompatibility of a port facility with a resort, a landscape and building set-back buffer has been established between the 84-acre parcel and Ko Olina (see Figure 4-3).[2]

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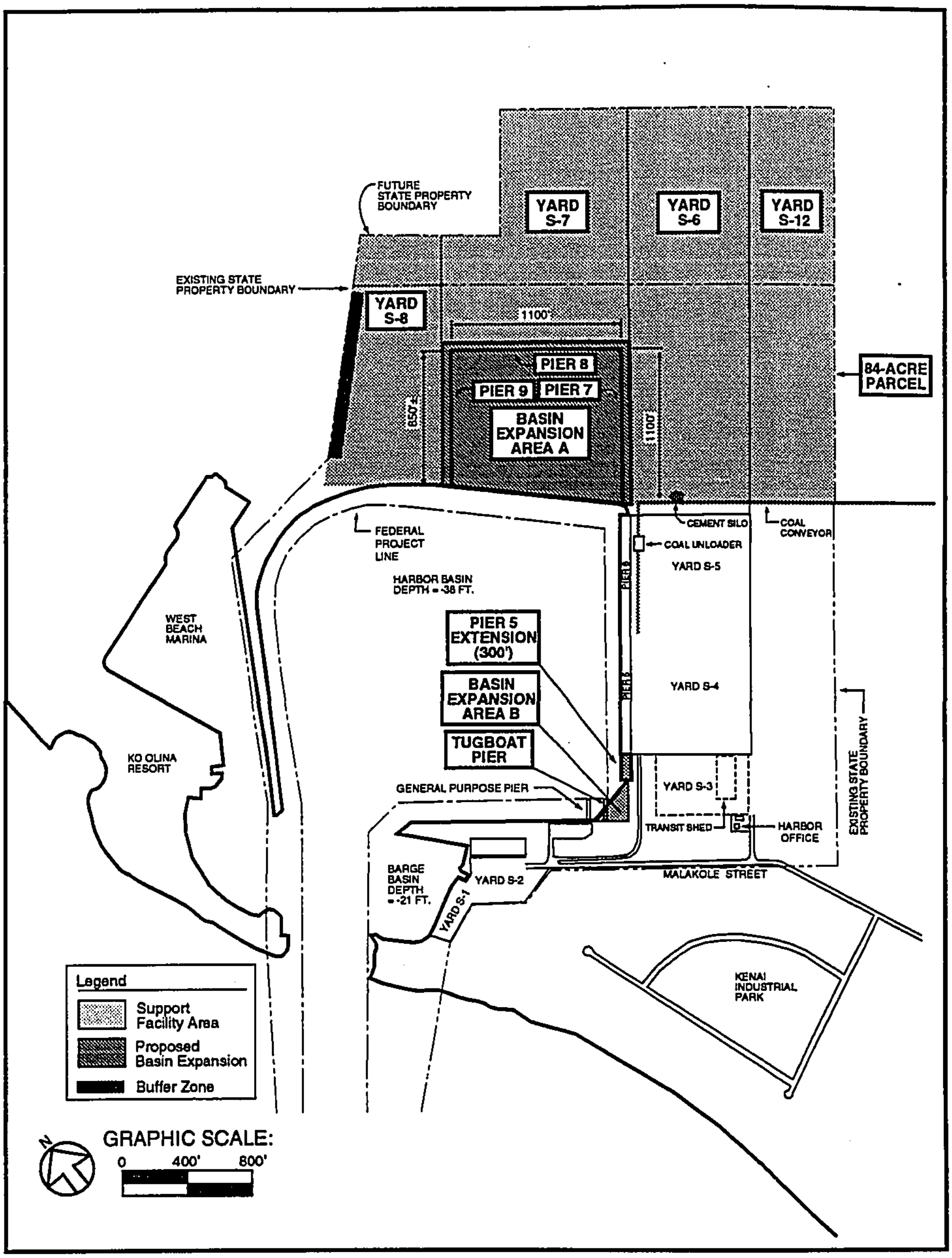
2 The State Department of Transportation and the Department of General Planning of the City and County of Honolulu reached a formal agreement in 1990 on the 84-acre parcel that:

> "(the SDOT) agree(s) to provide a 50-foot strip of landscaping along the northwest boundary of the parcel and establish a 100-foot building setback from the northwest property line to contribute to a buffer area between the Ko Olina Resort and the harbor." (State Department of Transportation, 1994)



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Buffer Zone Along 84-Acre Parcel
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 4-3

4.2 GOVERNMENTAL PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

4.2.1 Federal Plans

The Barbers Point Harbor Modification Study, Island of Oahu, Hawaii, Final Report (1991), prepared by the United States Army Corps of Engineers, reported in a preliminary assessment of the engineering feasibility, costs, and physical requirements of possible future modifications to enable Barbers Point Harbor to service vessels larger than those for which the harbor was originally designed.

Several alternatives for widening and deepening the Barbers Point Harbor entrance channel and basin were considered, including the deepening of the basin to 41 or 45 feet. All of the alternatives include a 1,100 feet by 1,100 feet basin expansion (Expansion Area A). To ensure compatibility with any future basin deepening, construction plans for Expansion Areas A and B would include provisions to accommodate possible future basin deepening to 45 feet, although this future deepening is not addressed in this Final SEIS.

At present, the ACOE is continuing to study possible improvements to the entrance channel and harbor basin, actions that are not addressed in this Final SEIS.

4.2.2 State Plans and Policies

4.2.2.1 HAWAII STATE PLAN

As set forth in Hawaii Revised Statutes, Chapter 226, the Hawaii State Planning Act consists of broad goals and objectives. Policies applicable to the Barbers Point Harbor improvements are listed below.

Objectives and Policies for the Economy in General:

- Increased and diversified employment opportunities to achieve full employment, increased income and job choice, and improved living standards for Hawaii's people. (Sec. 226-6-(a)-1)
- A steadily growing and diversified economic base that is not overly dependent on a few industries. (Sec. 226-6-(a)-2)
- Foster greater cooperation and coordination between the government and private sectors in developing Hawaii's employment and economic growth objectives. (Sec. 226-6-(b)-9)
- Stimulate the development and expansion of economic activities which will benefit areas with substantial or expected employment problems. (Sec. 226-6-(b)-10)

The proposed improvements to Barbers Point Harbor will provide jobs for residents of Ewa, central Oahu, the leeward coast, and the rest of the island. Even though Ewa is experiencing rapid population growth, the employment base of this region remains limited. In addition to direct employment at the harbor, the proposed improvements will encourage businesses that would benefit from proximity to port facilities to locate near the harbor, and therefore provide a broader choice of employment for Ewa residents.

The harbor improvements are being promoted through a cooperative and coordinated effort involving both the State and the private sector to improve the operational efficiency and capacity of the harbor. The proposed improvements will also support private sector efforts to develop employment centers near the harbor.

Objectives and Policies for the Economy--Agriculture:

- Assure the availability of agriculturally suitable lands with adequate water to accommodate present and future needs. (Sect. 226-7-(b)-6)

While portions of the project site are designated Agricultural by the State, these areas have not been used for agricultural purposes. The agricultural areas are not included in any of the Agricultural Lands of Importance to the State of Hawaii (ALISH) classifications. Neither are these areas considered important agricultural lands under the Land Evaluation and Site Assessment (LESA) system. The soil is coral outcrop, which is not suitable for crop production.

Objectives and Policies for the Physical Environment--Land Based, Shoreline, and Marine Resources:

- Prudent use of Hawaii's land-based, shoreline, and marine resources. (Sec. 226-11-(a)-1)
- Ensure compatibility between land-based and water-based activities and natural resources and ecological systems. (Sec. 226-11-(b)-2)
- Take into account the physical attributes of areas when planning and designing activities and facilities. (Sec. 226-11-(b)-3)
- Encourage the protection of rare or endangered plant and animal species and habitats native to Hawaii. (Sec. 226-11-(b)-6)
- Pursue compatible relationships among activities, facilities, and natural resources. (Sec. 226-11-(a)-8)

Expansion of the existing Barbers Point Harbor is the most prudent way of satisfying the need for ship berthing and cargo handling space while minimizing impacts to the shoreline and marine resources. Impacts associated with developing the necessary port facilities at a new location will be avoided.

Chapter 5 contains detailed information on the proposed action's effects on the natural environment and mitigation measures that will be employed, but generally, the proposed action will not have a major effect on natural resources.

Objectives and Policies for Facility Systems--Transportation:

- Provide for improved accessibility to shipping, docking, and storage facilities. (Sec. 226-17-(b)-4)
- Encourage transportation systems that serve to accommodate present and future development needs of communities. (Sec. 226-17-(b)-6)
- Increase the capacities of airport and harbor systems and support facilities to effectively accommodate transshipment and storage needs. (Sec. 226-17-(b)-8)
- Encourage the development of transportation systems and programs which would assist statewide economic growth and diversification. (Sec. 226-17-(b)-9)

Chapter 1 discusses the need for capacity improvements at Barbers Point Harbor. The proposed harbor improvements will increase cargo handling capacity and allow construction of dedicated fuel and tug piers. The proposed improvements will provide an additional 3,350 linear feet of piers and 134 acres of storage yards. The proposed action will support the rapidly growing Ewa region by providing improved port services and decreasing overland transportation costs for cargoes destined for Ewa and leeward Oahu that must presently be hauled from Honolulu Harbor.

4.2.2.2 STATE TRANSPORTATION FUNCTIONAL PLAN

State Functional Plans are the primary guidelines for implementing the Hawaii State Plan. While the Hawaii State Plan establishes long-term objectives, the State Functional Plans focus on shorter-term actions. Relevant policies and implementing actions are listed below.

Objective I.A: Expansion of the transportation system.

- Policy I.A.1: Increase transportation capacity and modernize transportation infrastructure in accordance with existing master plans and laws requiring accessibility for people with disabilities.
  - Implementing Action I.A.1.c: Barbers Point Harbor -- Piers, yards, sheds, land acquisition, and improvements in FY 92-93: $20 million.

Objective I.D.: Identification and reservation of lands and rights-of-way required for future transportation improvements.

- Policy I.D.1: Identify, reserve and/or acquire land for future transportation improvements.
  - Implementing Action I.D.1.a: Reserve land/rights-of-way for anticipated improvements in the following areas/facilities:
    - Barbers Point Harbor ($5.6 million) for future harbor expansion.

Discussion

The proposed action is consistent with the above objectives and actions. Barbers Point Harbor's cargo handling capacity will increase, and the proposed action will allow the subsequent construction of additional facilities, such as a dedicated fuel pier. The proposed action will require 140.5 acres of land from The Estate of James Campbell.

4.2.2.3 HONOLULU WATERFRONT MASTER PLAN

The Honolulu Waterfront Master Plan (1989) called for such improvements to Barbers Point Harbor as the deepening of the entrance channel and the construction of new slips and backland storage yards. The Plan also recommended the relocation of certain waterfront industrial activities such as the grain and sugar terminals from Honolulu Harbor to Barbers Point Harbor.

The proposed action is in conformance with the Honolulu Waterfront Master Plan recommendation to construct new slips and backland storage yards at Barbers Point Harbor.

4.2.2.4 2010 MASTER PLAN FOR BARBERS POINT HARBOR

The 2010 Master Plan for Barbers Point Harbor (1991) was generated through a planning process in which representatives of government agencies, local community boards, users of the harbor and other members of the maritime community provided input in four areas of port facilities: general cargo, dry-bulk cargo, liquid-bulk cargo, and facilities.

The 2010 Master Plan concluded that the harbor's facilities will become oversubscribed. The report recommended:

- the acquisition of an additional 56.5 acres of land;
- the expansion of the harbor basin by dredging additional berths;
- the removal of the fast land in the south corner of the basin to extend Pier P-5 by an additional 400 feet;
- construction of facilities to accommodate smaller support vessels;
- construction of a dedicated fuel pier;
- construction of a control tower to coordinate traffic between Barbers Point Harbor and West Beach Marina;
- construction of a transit shed for sheltering cargo and to house customs personnel, tugboat crews and shipping agents;
- construction of a new harbor entrance; and

- perimeter lighting to permit vessel movement after dark.

The proposed action implements the following recommendations of the 2010 Master Plan for Barbers Point Harbor:

- acquisition of additional land;
- expansion of the harbor basin by dredging new berths;
- excavation of the south corner; and
- construction of the tug pier.

4.2.2.5 HAWAII STATE LAND USE CONTROLS

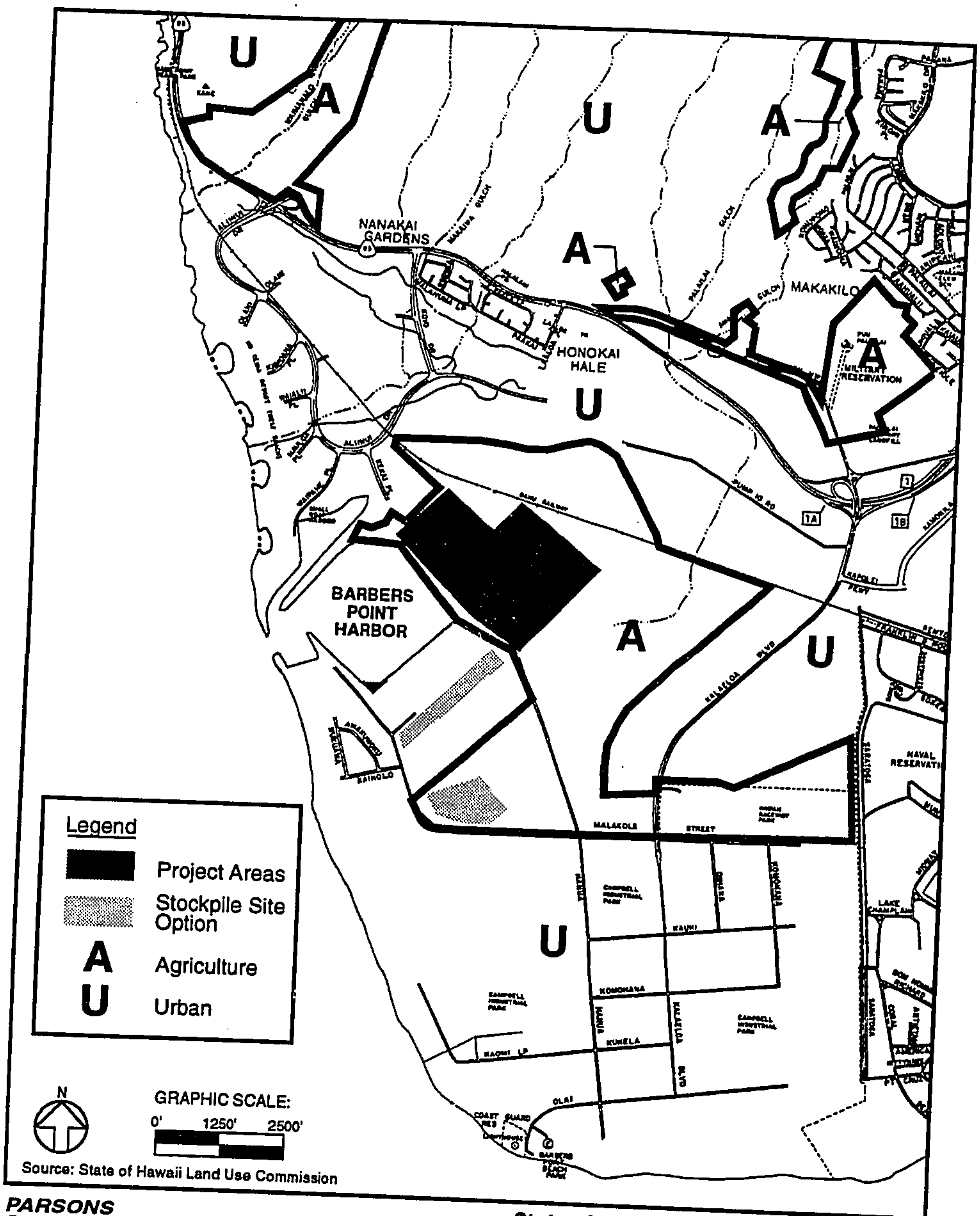
The State of Hawaii classifies all land into four districts: Urban, Agriculture, Rural and Conservation. Changes to boundaries of any conservation district and other districts greater than 15 acres must be approved by the State Land Use Commission (SLUC). Changes to boundaries of districts other than conservation districts of less than 15 acres can be approved by the county land use authority.

Figure 4-4 displays the State land use district boundaries in the vicinity of Barbers Point Harbor. Expansion Area A and the new piers and storage yards are located within an Agriculture district. The tug pier and Basin Expansion B are located within an Urban district. Proposed stockpile areas are located within both Agriculture and Urban districts.

Discussion

The construction of Expansion Area A and the new piers and storage yards will require the redesignation of Agriculture land to Urban by the SLUC. This redesignation process is for both 84- and 56.5- acre parcels will be initiated in 1995.

Temporary stockpiling on sites 2-4 in Agricultural Land will be allowable with a special use permit from the SLUC. Development of the tug pier, work in Expansion Area B, and stockpiling on site 1 is consistent with the existing Urban designation of these areas.



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

State of Hawaii Land Use Classifications
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 4-4

4.2.2.6 COASTAL ZONE MANAGEMENT PROGRAM

The objectives and policies of the Hawaii Coastal Zone Management (CZM) Program, as set forth in Chapter 205A, Hawaii Revised Statutes, are set for the protection and management of Hawaii's valuable coastal areas and resources. Chapter 205A outlines controls, policies and guidelines for development within an area along the shoreline referred to as the Special Management Area (SMA). These policies are administered by the counties. The SMA boundaries were designated by the 1975 Shoreline Protection Act. Figure 4-5 displays the SMA boundary in the vicinity of the harbor. Only the area to be used for Expansion Area B and the tug pier falls within the SMA boundary.

Discussion

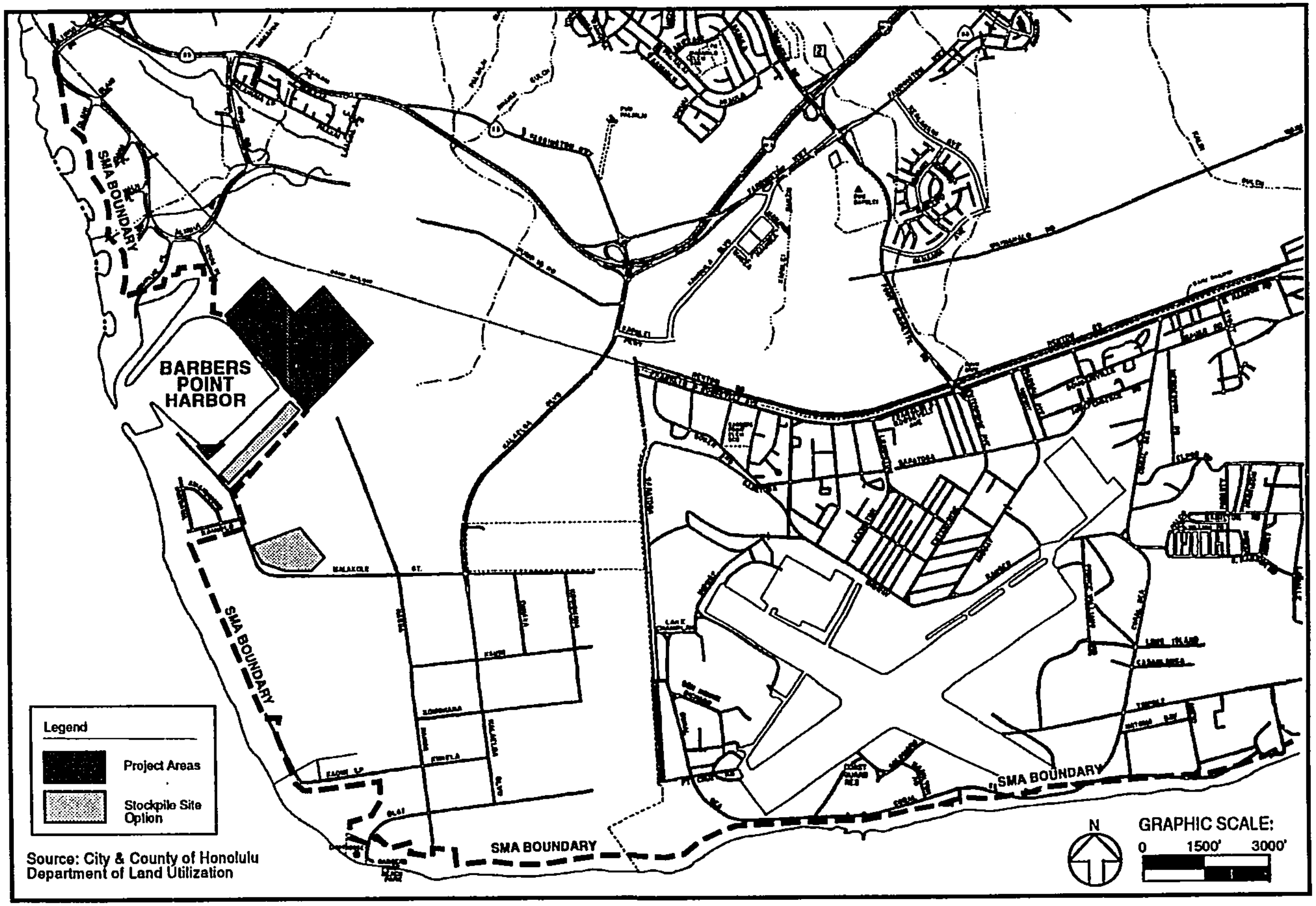
Barbers Point Harbor is exempt from the SMA regulatory mechanism. Nonetheless, the proposed action conforms with the objectives and policies of the Hawaii Coastal Zone Management Program as discussed below:

- Recreational Resources: Provide coastal recreational opportunities accessible to the public.

  Conformity: Barbers Point Harbor is a commercial harbor and is therefore not available for public recreational activities. Public access to the ocean shoreline is available via Malakole Street and through the parking lot adjacent to the barge harbor. The proposed action will not affect this public access point.

- Historic Resources: Protect, preserve, and where desirable, restore those natural and man-made historic and pre-historic resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

  Conformity: Archaeological and historic resource impacts are discussed in detail in Chapter 6. Archaeological surveys have been performed, and the expansion area boundaries were modified to avoid important sites recommended for preservation. Archaeological impacts will therefore be minimal. There will be no impact on the historic railroad mauka of the harbor.



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Special Management Area (SMA)
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 4-5

- Scenic and Open Space Resources: Protect, preserve, and where desirable, restore or improve the quality of coastal scenic and open space resources.

  Conformity: The land that will be affected by the proposed action has been used for surface mining, stockpiling and processing of coral limestone minerals, and therefore has no value as either a scenic or open space resource. Visual impacts are addressed in detail in Chapter 6 and will be minimal.

- Coastal Ecosystems: Protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems.

  Conformity: Probable impacts on coastal waters and marine biology are discussed in Chapter 5. With the implementation of mitigation measures, impacts will be minimal.

- Economic Uses: Provide public or private facilities and improvements important to the State's economy in suitable locations.

  Conformity: Barbers Point Harbor is the most appropriate location for the additional port facilities proposed in this Final SEIS. This topic is addressed in more detail in Chapter 1 (need for more facilities), Chapter 3 (alternative locations for the facilities), and Chapter 6 (economic impacts).

- Coastal Hazards: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, and subsidence.

  Conformity: The harbor configuration provides a safe haven from storm waves, although tsunami precautions include putting vessels in harbors to sea. A drainage master plan will be developed to ensure the proper discharge of stormwater runoff.

- Managing Development: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

  Conformity: The SDOT has consulted with and will continue to involve the maritime community, area residents and other interested parties in the development of Barbers Point Harbor. SDOT has initiated a public outreach program to keep area residents informed about Barbers Point Harbor development plans.

4.2.3 City and County Plans and Policies

4.2.3.1 GENERAL PLAN OF THE CITY AND COUNTY OF HONOLULU

The General Plan, Objectives and Policies (1992) states broad objectives and policies for the overall physical and economic development of the island. The General Plan envisions Kapolei, Makakilo, West Beach, and other areas in the Ewa region as Oahu's secondary urban center, including a second deep-water harbor to complement Honolulu Harbor.

The following objectives and policies of the General Plan appear pertinent to the proposed harbor improvements:

Population

Objective C: To establish a pattern of population distribution that will allow the people of Oahu to live and work in harmony.

Policy 2: Encourage development within the secondary urban center at Kapolei and the Ewa and central Oahu urban-fringe areas to relieve developmental pressures in the remaining urban-fringe and rural areas and to meet housing needs not readily provided in the primary urban center.

The proposed action supports the development of the secondary urban center by providing an expanded port facility in proximity, thereby contributing to the reduction of transportation costs for goods which support economic growth in leeward Oahu.

Transportation and Utilities

Objective A: To create a transportation system which will enable people and goods to move safely, efficiently, and at a reasonable cost; serve all people, including the poor, the elderly, and the physically handicapped; and offer a variety of attractive and convenient modes of travel.

Policy 13: Facilitate the development of a second deep-water harbor to relieve congestion in Honolulu Harbor.

The proposed action implements this policy.

Physical Development and Urban Design

Objective C: To develop a secondary urban center in Ewa with its nucleus in the Kapolei area.

Policy 2: Encourage the development of a major residential, commercial, and employment center within the secondary urban center at Kapolei.

Policy 3: Encourage the continuing development of Barbers Point as a major industrial center.

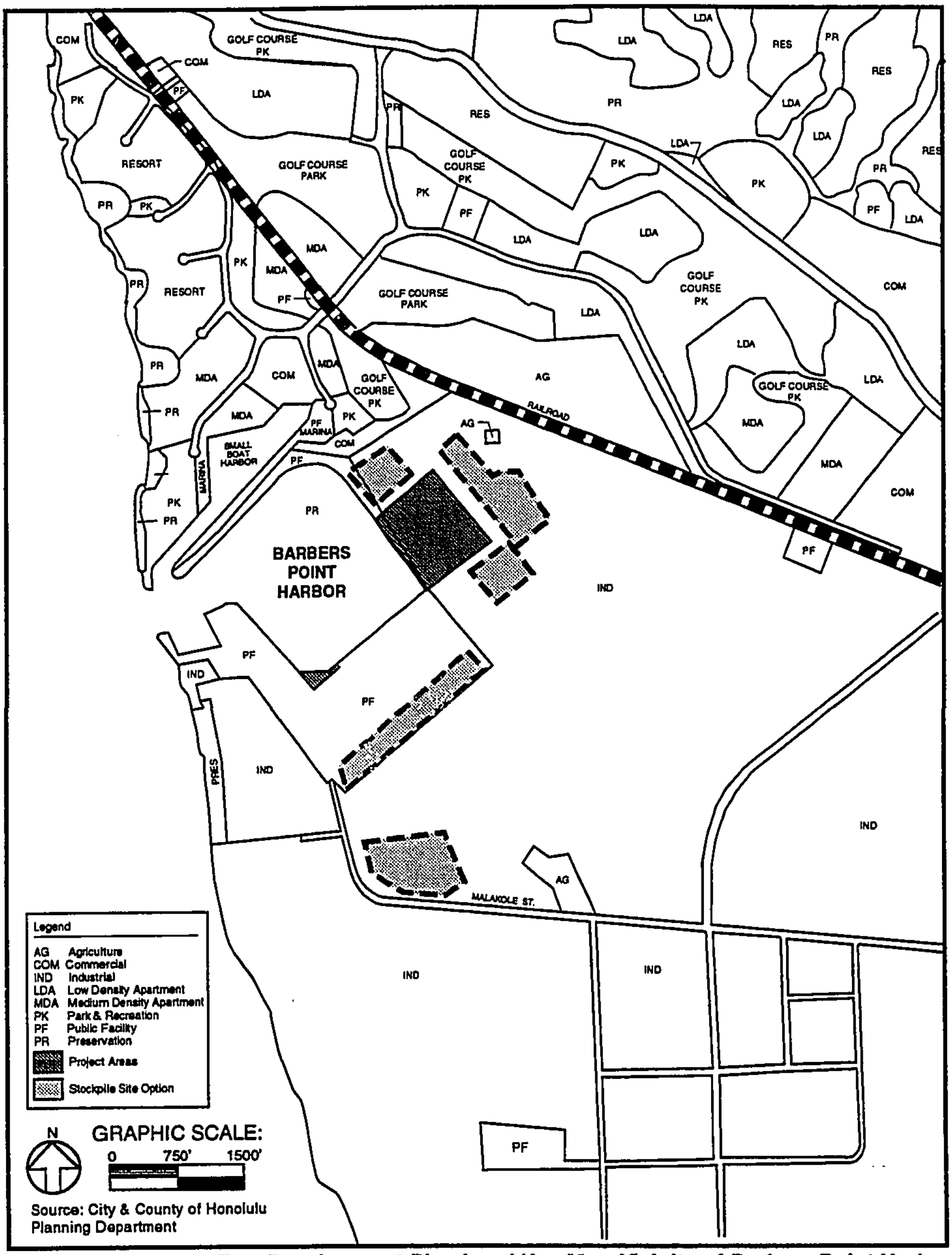
Policy 5: Cooperate with the State and federal governments in the development of a deep water harbor at Barbers Point.

The proposed action supports development in Ewa and Kapolei by providing direct and indirect employment opportunities through the continuing development of Barbers Point as an industrial center.

4.2.3.2 EWA DEVELOPMENT PLAN

The Ewa Development Plan area encompasses the region from Kahe Point to the West Loch of Pearl Harbor. According to the Ewa Development Plan Land Use Map (see Figure 4-6), the areas to be used for Expansion Area A and the additional piers and storage yards are designated "industrial." The proposed tug pier and Expansion Area B are located in areas designated for "public facility." The stockpiles are located in areas designated "industrial." The proposed action conforms with these designations.

The City and County of Honolulu Planning Department is currently revising the Ewa Development Plan. Final recommendations for revisions are expected to be proposed for adoption in late March, 1995.



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Ewa Development Plan Land Use Map-Vicinity of Barbers Point Harbor

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

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FIGURE 4-6

4.2.3.3 ZONING

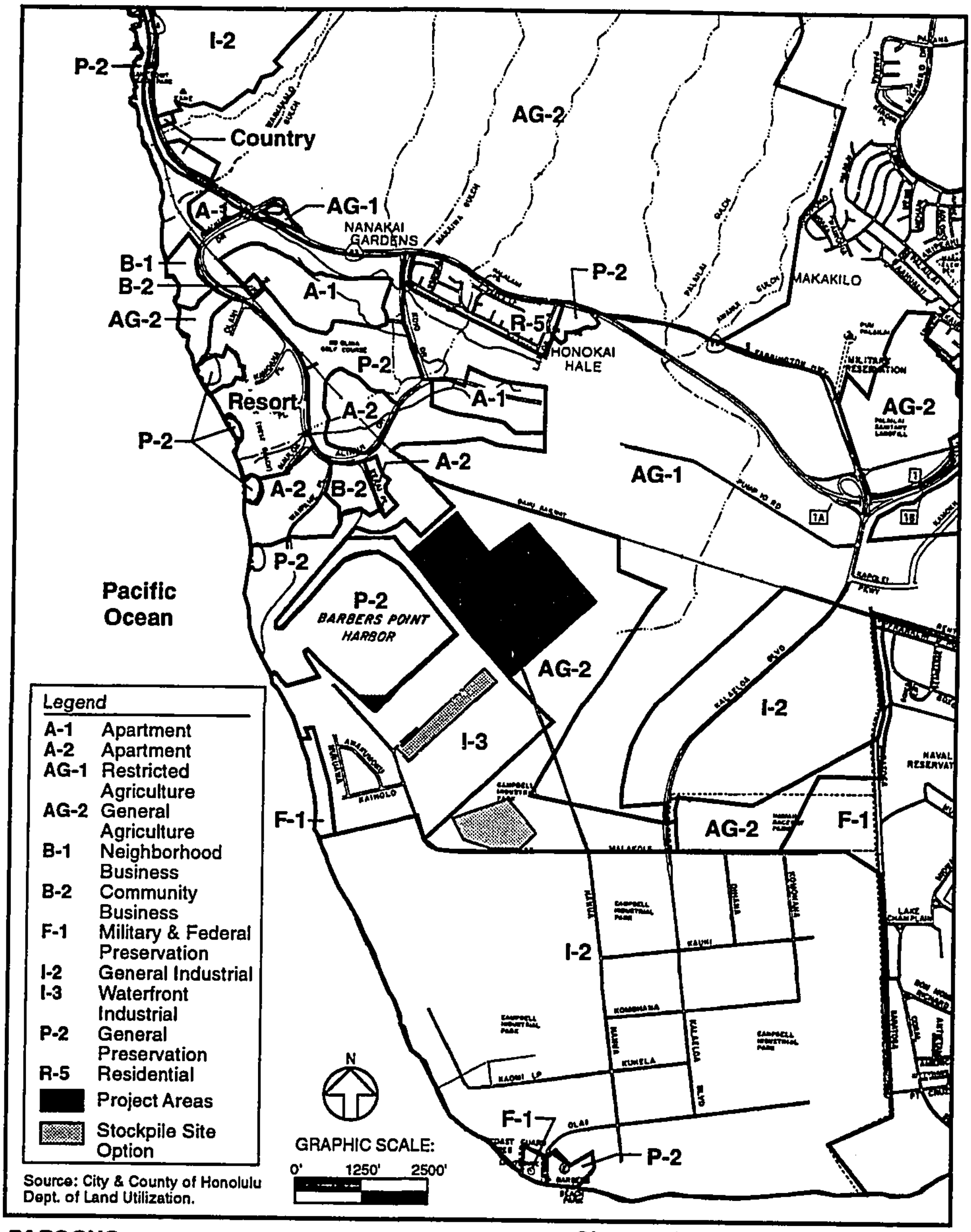
The City and County of Honolulu Department of Land Utilization (DLU) administers the Zoning Ordinance. Figure 4-7 displays the City and County of Honolulu zoning districts in the vicinity of the harbor. Expansion Area A, the proposed piers and storage yards, Expansion Area B and the proposed tugboat pier are located on lands currently zoned AG-2, General Agriculture, and I-3, Waterfront Industrial. Stockpile areas are located on land zoned AG-2 and I-3, Waterfront Industrial.

While not required for the construction of the harbor improvements addressed in this Final SEIS (see Section 4.3), SDOT intends to seek rezoning of both the 84- and 56.5-acre parcels following approval from the SLUC to reclassify this land from Agriculture to Urban. Stockpiling on AG-2 lands may require a conditional use permit from the DLU.

4.3 PERMITS AND APPROVALS REQUIRED

Applicable permits and approvals that may be required for the proposed action include:

(1) Department of the Army Permit (issued by the U.S. Army Corps of Engineers);
(2) Section 401 Water Quality Certification (issued by the State Department of Health);
(3) Coastal Zone Management Consistency Certification (issued by the Office of State Planning);
(4) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Construction Activity (issued by the State Department of Health);
(5) State land use designation change from "agriculture" to "urban" (issued by the State Land Use Commission);
(6) Noise Variance if hydraulic dredging, which would require 24-hour operations, is selected (issued by the State Department of Health); and
(7) Water Use Permit from the State Department of Land and Natural Resources.



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City and County of Honolulu Zoning
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 4-7

According to the provisions of Chapter 266-2(b) of the Hawaii Revised Statutes, SDOT is exempt from county approvals for work pertaining to the construction of a commercial harbor:

> "Notwithstanding any law or provision to the contrary, the Department of Transportation is authorized to plan, construct, operate, and maintain any commercial harbor facility in the State, including, but not limited to, the acquisition and use of lands necessary to stockpile dredged spoils, without the approval of county agencies."

The following City and County regulatory requirements are therefore not applicable to the work proposed in this Final SEIS:

(1) Compliance with City and County zoning;
(2) Special Management Area permit; and
(3) Grading, Grubbing and Stockpiling permit.

Even though these City and County approvals are not necessary, SDOT intends to seek City and County zoning changes subsequent to the State land use redesignation, and the proposed work is consistent with and complies with the policies governing the Special Management Area.

CHAPTER 5

PHYSICAL ENVIRONMENT

5.1 CLIMATE

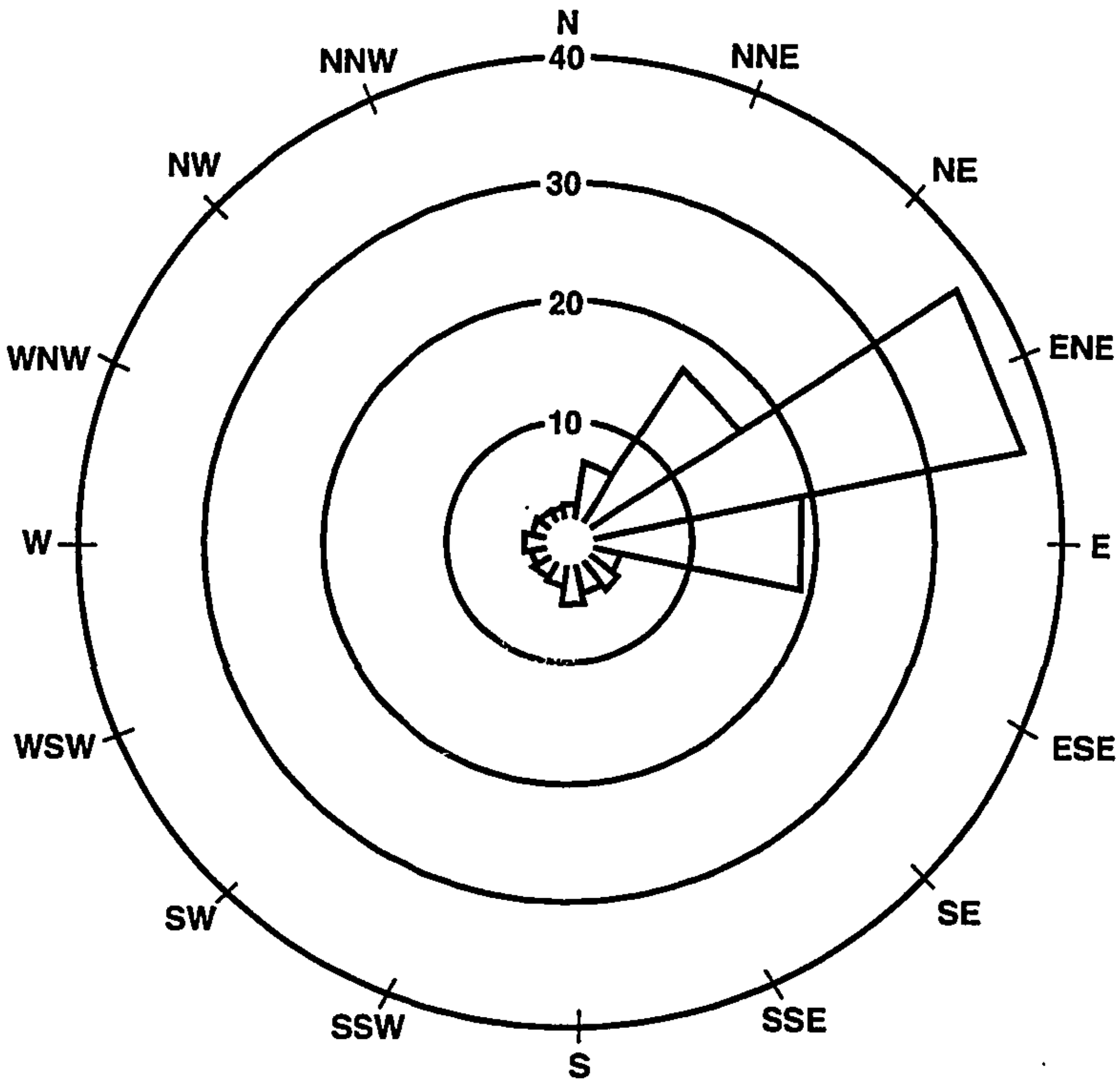
The climate of the project site, warm and dry, is typical for the Ewa plains. Trade winds from the northeast occur much of the time, with occasional Kona winds. Temperature ranges from the high 60s (Fahrenheit) to the low 90s. Rainfall is light, with an average annual precipitation of about 20 inches.

5.1.1 Winds

Hawaii lies within the belt of northeasterly trade winds generated by a semi-permanent Pacific high pressure cell to the north and east. Oahu's Koolau and Waianae Mountain Ranges are oriented almost perpendicular to the trade winds, which accounts for much of the variation in the local climate of the island (<u>Air Quality Study for the Proposed Barbers Point Harbor Expansion Project</u>, 1992). The proposed project is located along the coast on the leeward side of the Koolaus and at the southern end of the Waianaes.

Surface winds at the project site are likely to be very similar to those recorded at Barbers Point Naval Air Station (BPNAS). Long-term wind data (Figure 5-1) collected at BPNAS indicates that the east to northeasterly trade winds prevail. Winds from the south occur only a few days each the year, usually during the winter, in association with Kona storms. Wind speeds average about 10 knots (12 mph) and usually vary between 5 and 15 knots (6 and 17 mph).

Wind speeds were predicted for model hurricane scenarios in <u>Hurricane Vulnerability Study for Honolulu, Hawaii, and Vicinity, Volume 1: Hazard Analysis</u> (1985). For a scenario depicting the most probable hurricane, maximum sustained wind speeds of 65 knots with gusts up to 90 knots can be expected. During the worst case hurricane, maximum sustained winds might reach 100 knots with gusts up to 120 knots.



Source: "Monthly and Annual Wind Distribution/Pasquill Stability Classes, STAR Program, Barbers Point Hawaii, 1/72-12/76, 8 Observations/Day", U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service, National Climatic Center, Asheville, NC.

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Annual Wind Rose, Barbers Point
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 5-1

5.1.2 Temperature

Temperature in Hawaii varies with elevation, distance inland and exposure to the trade winds. Average temperatures at locations near sea level are generally warmer than those at higher elevations. Areas exposed to trade winds tend to have the least temperature variation, while inland and leeward areas often have the most. Long-term temperature data have been collected at Barbers Point at the U.S. Magnetic Observatory. The average annual daily minimum and maximum temperatures recorded are 66°F and 84°F, respectively. The extreme minimum temperature on record is 48°F, and the extreme maximum is 94°F.

5.1.3 Rainfall

Rainfall in Hawaii is highly variable depending on elevation and location with respect to the mountains and trade winds. Barbers Point is one of the driest areas on Oahu due to its location leeward and near sea level. Average annual rainfall in this area of Oahu amounts to about 20 inches, but may vary from less than 10 inches during a dry year to more than 30 inches during a wet year. Most of the rainfall usually occurs during the winter months. Monthly rainfall may vary from as little as a trace to as much as 15 inches or more.

Annual and monthly rainfall averages do not properly reflect the rain that could occur during a major storm or hurricane. During a hurricane, rainfall amounts could reach 30 inches in 24 hours (Hurricane Vulnerability Study for Honolulu, Hawaii, and Vicinity, Volume 1: Hazard Analysis, 1985).

5.2 TSUNAMIS

5.2.1 Existing Conditions

Tsunamis occur as a series of waves that strike a coastline, and the waves decrease in height with time. The larger waves usually occur within the first hour with both wave height and wave period, the time between waves, changing as the incoming waves decay. Typically, tsunami wave periods are between 10 and 15 minutes (Summary of Technical Input for the West Beach Marina Concept Development, 1979). Tsunami wave periods are important in relation to the resonance time for a standing wave in the harbor. If these periods are similar, resonance may occur during a tsunami, causing severe surge and flooding within the harbor.

Tsunami wave heights for the harbor area were recorded in 1946, 1952, 1957 and 1960 (Tsunami Wave Runup Heights in Hawaii, 1976). They ranged up to 20 feet in 1946 four miles north of Nanakuli. The mean wave height for the four tsunamis was approximately 11 feet (Environmental Conditions Anticipated in Two Lagoons and a Marina for the Proposed West Beach Development, and the Potential Impact of These Facilities on the Project Coastal and Nearshore Ocean Environment, 1979).

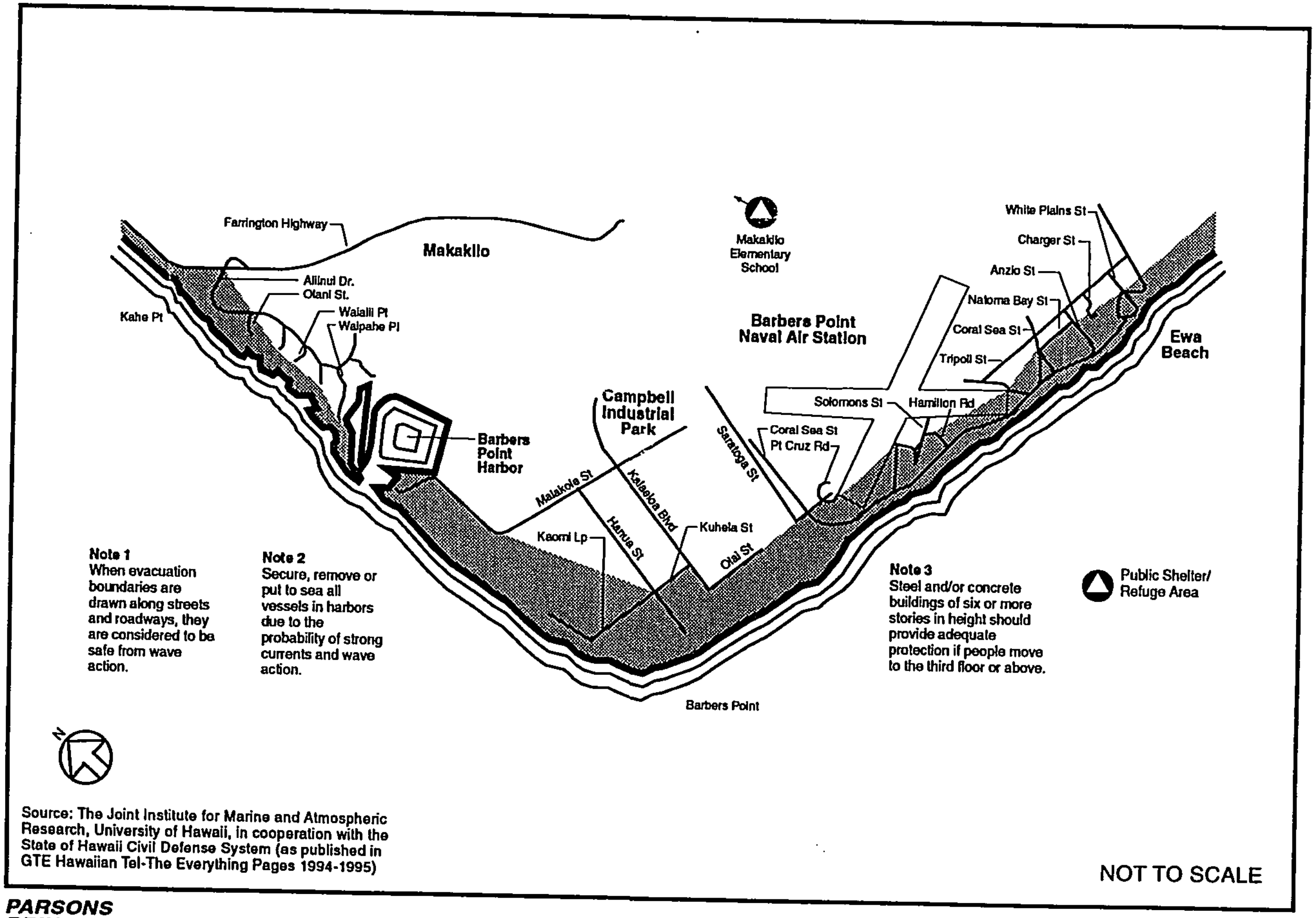
The U.S. Army Engineer Waterways Experiment Station produced a numerical model (Tsunami Response of Barbers Point Harbor, Hawaii, 1982) describing the effects of tsunamis of varying characteristics on the original harbor. They concluded that Barbers Point Harbor is well located because the area has relatively small open coast tsunami amplitudes. However, in the event of a tsunami:

- flooding of the onshore port facilities could occur under many circumstances;
- strong currents in the area close to the harbor mouth will put ships at risk; and
- large horizontal water movements may produce surging forces on moored ships and cause maneuvering problems for ships under way.

Tsunami run-up on land is a function of bathymetry, tidal elevation, wave conditions existing at the time of the tsunami, topography, slope and surface roughness. The Oahu Civil Defense Tsunami Evacuation Map for the Barbers Point Harbor vicinity is shown in Figure 5-2. The exact zones of potential tsunami inundation around Barbers Point Harbor have not been defined by the Oahu Civil Defense. However, a series of maps in Tsunami Response of Barbers Point Harbor, Hawaii (1982) shows potential flooding at the harbor. Flooding is shown to depend on both the topography of the area and the incident wave characteristics and is discussed in more detail in section 5.4, "Surface Hydrology, Drainage and Flood Hazard."

5.2.2 Probable Impact of Proposed Action

Construction of the storage yards will require the existing grades of the area mauka of the harbor to be reduced in elevation prior to being paved. Therefore, because the proposed



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Tsunami Evacuation Map
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 5-2

action will reduce these elevations and extend the harbor shoreline further inland, the potential inundation areas around the harbor will be increased. An increase in harbor size will affect current patterns and surge in the harbor and channel. Although the general tsunami hazards as described in Tsunami Response of Barbers Point Harbor, Hawaii (1982) will continue, the responses modeled by the Army Corps of Engineers will change slightly due to the harbor expansion. The new piers, storage yards and sheds could be affected by flooding as described in section 5.4, "Surface Hydrology, Drainage and Flood Hazard."

5.2.3 Mitigation Measures

Damage from tsunamis will be minimized by following Oahu Civil Defense evacuation procedures. Preparation measures would include the evacuation of ships and personnel and the removal of vehicles, containers, and other cargo from the flood prone areas (Tsunami Response of Barbers Point Harbor, Hawaii, 1982). The piers, wharves and storage yards will be designed and operated in accordance with potential for tsunami flood inundation.

5.3 TOPOGRAPHY AND SOILS

5.3.1 Existing Conditions

The project area is located on the Ewa plain, an emergent ancient coral-algae calcareous reef formed during the Pleistocene Period. The Ewa plain extends from sea level at the coastline to an elevation of about 100 feet three to five miles inland. The plain is composed of calcareous material which has been modified, consolidated, and cemented by dissolution, rain, air and other weathering factors to form a hard but extremely permeable surface. The rock is classified predominantly as coral limestone or coral limestone breccia. Alluvium, consisting of muds and clays eroded from the Waianae volcanics, is interlayered with these limestones.

A geotechnical exploration program has been performed for the basin expansion and tug pier consisting of thirteen separate soil borings. The borings revealed that the material to be removed will consist of coral sand/gravel, coral limestone, clay with coral, clay and sand.

At the project site, natural elevations range from approximately 10 feet above mean sea level (msl) near the basin to approximately 60 feet above msl near the northeast boundary. The site is generally flat with an average slope of one-half percent to five percent. Stockpiles of material from the original harbor excavation form 30- to 40-foot high mounds. Material is withdrawn from the stockpiles for processing at a rate dependent on local demand for construction materials. Over most of the site, original ground elevations have been reduced by the surface mining of coral limestone, which has been ongoing since 1959.

Soils within the project area are designated by the U.S. Department of Agriculture (USDA) Soil Conservation Service as Coral Outcrop (CR). Coral Outcrop consists of coral or cemented calcareous sand with a thin layer of friable red soil material in cracks, crevices, and depressions. Coral Outcrop is unsuitable for cultivating crops.

Additional information on soils and topography at the project site can be found in the <u>Revised Environmental Impact Statement for Barbers Point Deep-Draft Harbor on Oahu</u> (1978) and <u>Barbers Point Harbor Expansion: Impact on Agriculture</u> (1991).

5.3.2 Probable Impact of Proposed Action

The harbor expansion will remove approximately 2.3 million cubic yards of material to create a 25-acre body of water. Approximately 134 acres of land will be graded at a one percent slope inland from the shoreline and paved for cargo handling and storage.

When the removed material is stockpiled at upland sites, the topography at these sites will be altered until the material is depleted.

Construction of the tugboat pier and marginal wharves will have little impact on soils and topography.

5.3.3 Mitigation Measures

The stockpiles will temporarily affect the topography. They will remain in place until all the material is withdrawn.

5.4 SURFACE HYDROLOGY, DRAINAGE AND FLOOD HAZARD

5.4.1 Existing Conditions

According to the Revised Environmental Impact Statement for Barbers Point Deep-Draft Harbor on Oahu (1978), surface water runoff in the area occurs when water from the Waianae Range discharges onto the plain. There are no perennial streams draining to the ocean. The runoff is absorbed by the porous coral substrate so that most of the discharge never reaches the ocean by overland flow. During extreme rainfalls, however, some water can drain into the harbor.

Runoff generated on the site and from adjacent areas drains overland toward the harbor and onsite depressions. Heavy rains usually associated with Kona storms transport large quantities of lateritic silt to the nearshore area, but prevailing advective forces appear to transport such material out of the immediate area within several days.

Harbor Storage Yards S-4 and S-5 have storm drainage systems consisting of trench drains, collection pipes, and outlet structures which collect runoff during storms and discharge it into the harbor.

The natural drainage patterns east of the harbor were altered by stockpiling and coral mining activities near the harbor. As a result, runoff generated by heavy storms in upland areas now flows uncontrolled in the harbor vicinity and can enter the surface waters. The EJC proposes to construct a large drainage channel as an element of the Kapolei Business Park which will collect stormwater runoff and discharge it to the ocean.

According to the Flood Insurance Rate Map (FIRM), the project area has been classified as Zone D, indicating that flood hazards are undetermined in the area. However, the potential depths of overland flooding as the result of a tsunami were derived for the harbor in Tsunami Response of Barbers Point Harbor, Hawaii (1982) and coastal inundation resulting from a hurricane was assessed in the report Leeward Oahu Hurricane Vulnerability Study, Determination of Coastal Inundation Limits (1993). The hurricane scenarios are described in Hurricane Vulnerability Study for Honolulu, Hawaii, and Vicinity, Volume 1: Hazard Analysis (1985).

Shoreline profiles were used to determine inundation limits around Barbers Point Harbor in Leeward Oahu Hurricane Vulnerability Study, Determination of Coastal Inundation Limits (1993). Coastal storm wave inundation limits were modeled at the profile locations and then these elevation points were connected to form the inundation limit lines (Figure 5-3). Inundation limits in the vicinity of the harbor for both a worst case and a probable hurricane are shown. The maximum predicted stillwater levels in Barbers Point Harbor resulting from the worst case hurricane are less than the elevations of the harbor marginal wharves, and therefore the study predicts no hurricane flooding inland of the wharves.

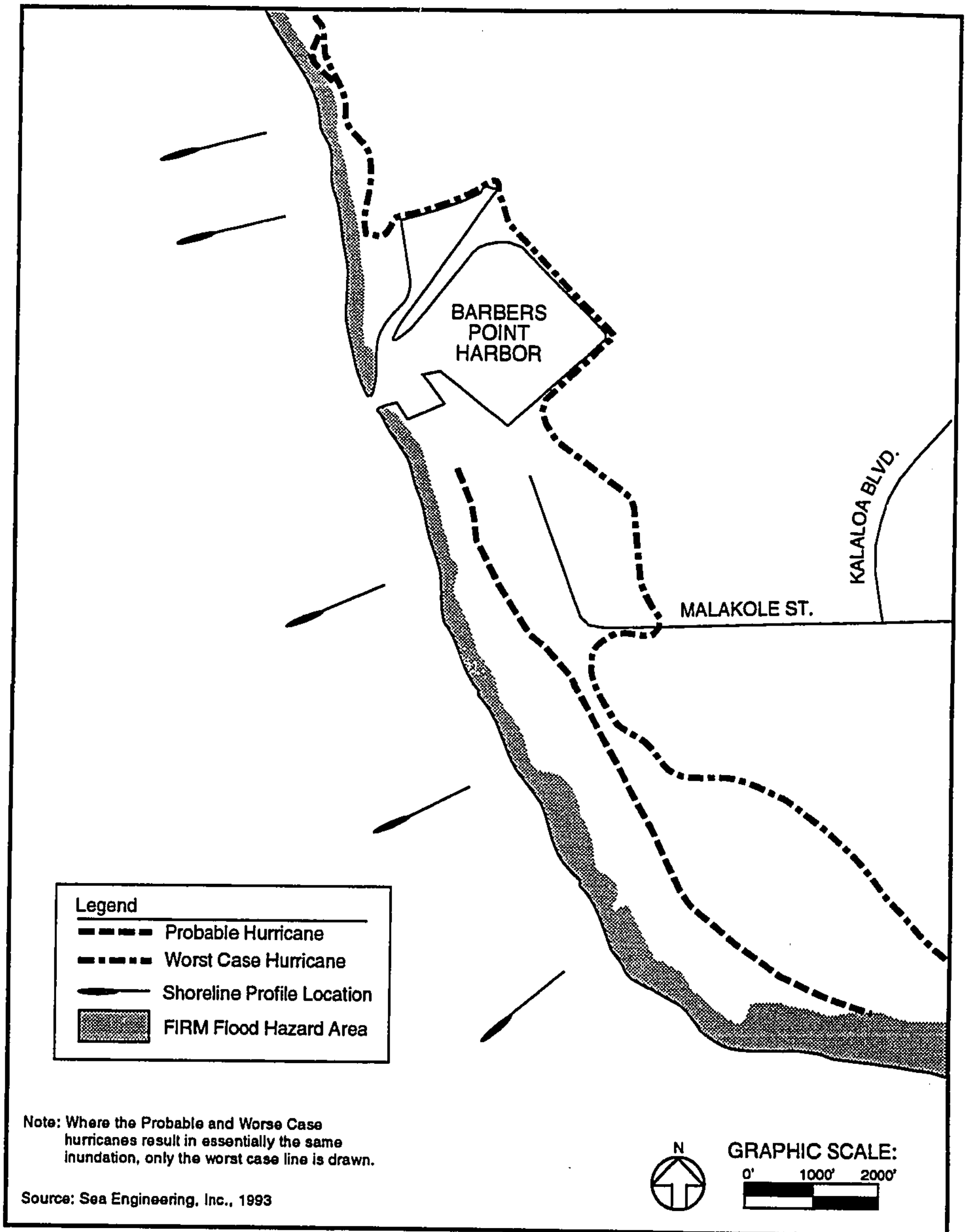
Potential flooding as a result of a tsunami is discussed Tsunami Response of Barbers Point Harbor, Hawaii (1982). The model used a variety of incident wave amplitudes, periods and land elevations to produce a series of maps showing the maximum depths of overland flooding. For land elevations which approximate the existing harbor elevations, the maximum depth of overland flooding around the harbor perimeter ranged from 0 to 3 feet depending on the characteristics of the tsunami.

5.4.2 Probable Impact of Proposed Action

The proposed harbor expansion will alter the drainage of the project site as portions of the existing fastland become a part of the water body while others will be paved to create storage yards. The paving of 134 acres of storage yards will increase the volume of runoff. A Drainage Master Plan will be prepared during the initial design phase of the project to ensure that the storm drainage systems for the storage yards are properly sized.

Local drainage patterns will be altered at the stockpile areas. Runoff volume from the stockpiles will not exceed the volume generated under existing conditions, and may decrease due to absorption of rainfall into the stockpiles.

Although the report, Tsunami Response of Barbers Point Harbor, Hawaii (1982), does not consider the expansion area in the model, the inclusion of this additional area together with the



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Coastal Inundation Limits
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 5-3

West Beach Marina area (which was also not considered in the study) would tend to decrease the amplitude of harbor oscillations and therefore decrease the depth and extent of flooding. However, because existing grades of the area mauka of the harbor will be reduced in elevation, and the harbor shoreline will be moved further inland, the extent of overland flooding due to tsunami will increase in the vicinity of the expansion area.

The new harbor shoreline will alter the coastal storm wave inundation limits from those shown in Figure 5-3. However, the new configuration would not indicate an increase in the predicted harbor water levels and therefore no increase in flooding due to hurricanes would be expected.

5.4.3 Mitigation Measures

Construction sites over five acres in area are subject to regulation under the National Pollution Discharge Elimination System (NPDES) permit system, administered in Hawaii by the State Department of Health (DOH).

A Best Management Practice (BMP) plan will be included in an NPDES permit application to DOH requesting coverage of the proposed action under the General Permit for Stormwater Discharges from Construction Activities. Methods of runoff, erosion and sediment control at the project site will be proposed in the BMP plan. Contract specifications will require the contractor to control runoff from the project site and the stockpile areas.

Harbor facilities will be designed and constructed with attention to potential flooding as a result of a tsunami.

5.5 GROUNDWATER

Detailed discussions of groundwater conditions and hydrogeological impacts of the proposed harbor expansion are found in Hydrogeological Impacts, Proposed Expansion of the Barbers Point Harbor (1993) and Groundwater Resources and Sustainable Yield Ewa Plain Caprock Aquifer (1988). These reports form the basis of this discussion. The first reference may be found in this Final SEIS as Appendix A-5.

5.5.1 Existing Conditions

The Ewa plain is composed of terrestrial alluvium, such as clay and mud eroded from the Waianae Mountains, and coral limestone deposited during periods when the area was covered by the ocean. This wedge of sediments and sedimentary rock is referred to as "caprock". In geologic cross-section (Figure 5-4), layers of limestone alternating with terrestrial clays and muds rest on volcanic basement. Limestone layers in the caprock are referred to as aquifers because they are porous enough to contain groundwater. The terrestrial clays and muds are aquicludes. They have low permeabilities and prevent the flow of groundwater between the limestone aquifers.

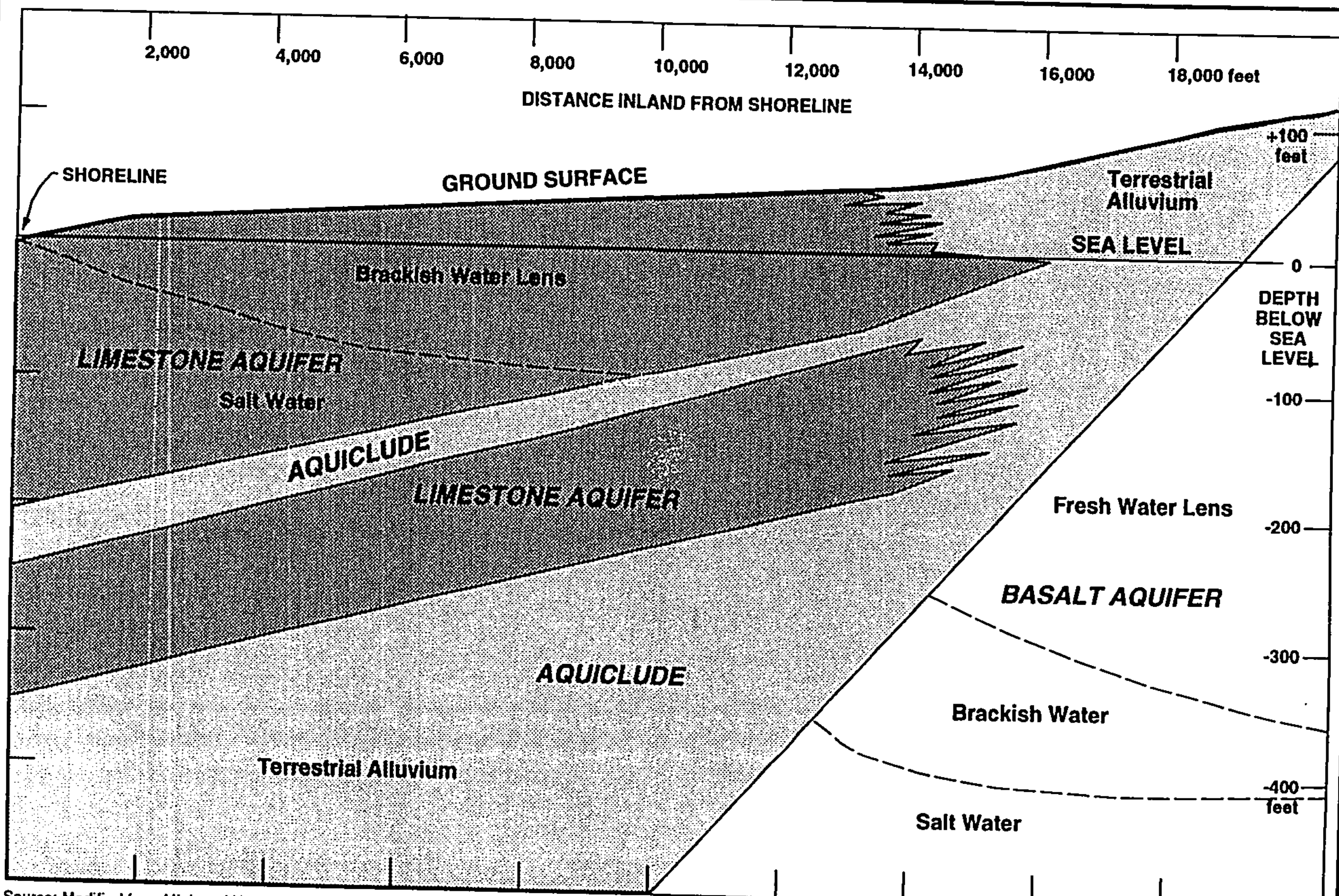
At Barbers Point Harbor shoreline, the caprock layer is approximately 250 feet thick. The upper-most limestone layer in the caprock contains brackish groundwater. This groundwater has a salinity greater than 1,000 milligrams per liter (mg/l) chloride, which is too brackish for most irrigation purposes. There are wells in the area, however, which pump groundwater from this upper-most limestone aquifer for industrial purposes such as cooling and washing coral aggregates. One well supplies brackish groundwater to the State of Hawaii -- The Estate of James Campbell pilot desalination plant. The remaining limestone aquifers in the caprock contain groundwater of approximately seawater salinity.

Below the caprock, is the Waianae Basalt Aquifer which supplies potable water from wells approximately four miles from the project site.

Recharge of groundwater in the caprock aquifers comes from several sources:

Direct infiltration from rainfall and runoff onto the Ewa plain. In the Ewa plain, rainfall is less than 20 inches per year, of which perhaps one fourth infiltrates into the groundwater.

Leakage of groundwater from the Waianae basalt aquifer. Interaction between the groundwater in the Waianae aquifer and the groundwater in the caprock is restricted to a low rate of upward seepage from the basalt into the lower caprock sediments.



Source: Modified from Mink and Yuen, 1993

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Ewa Plain Caprock, Geologic Cross Section
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 5-4

Groundwater occurrence and behavior in the upper-most limestone aquifer near the harbor is not influenced by this weak interaction.

Infiltration from irrigation. Sugar cane in the Ewa plain requires substantial irrigation. Much of this irrigation water filters into the ground to recharge the upper-most limestone aquifer.

5.5.2 Probable Impact of the Proposed Action

The harbor expansion will be excavated into the upper-most limestone aquifer in the caprock to a depth of 38 feet below mllw (45 feet mllw along the perimeter of the basin). At the harbor, the upper-most limestone aquifer is greater than 60 feet in thickness. The excavation will not affect the aquiclude that separates the limestone aquifers in the caprock.

In order to understand the effect the original harbor had on groundwater and the potential effects the proposed action could have, the hydrologic system of the upper-most limestone aquifer in the caprock was simulated with a numerical model. The computer program employed was Aquifem-Salt 2-D Finite Element and is described in more detail in Appendix A-5. To account for uncertainty in many of the parameters and the changes in land use occurring in the Ewa plain, numerous scenarios were modeled to insure that the impact analysis bracketed realistic conditions.

Construction of the original harbor extended the coastline 3,000 feet inland of the natural coast and modified the groundwater flow in the upper-most limestone aquifer. Groundwater levels, measured as hydraulic head in surrounding wells, were reduced. The 1-foot head contour, a line which connects all the points that have a hydraulic head of 1 foot, moved from its natural position 4,000 feet inland to 6,000 feet inland. Groundwater flow into the harbor doubled when compared to the undisturbed coastline to a rate of about 1 million gallons per day (mgd).

Major changes in land use have occurred since the original harbor was constructed. Less sugar cane is grown on the Ewa plain and the cane fields are irrigated by drip irrigation instead of furrow irrigation. Furrow irrigation used large quantities of water which partially recharged the upper-most limestone aquifer. Some of this irrigation water came from the upper-most limestone aquifer but much of it was also pumped from the Waianae basalt aquifer. In addition to recharging the upper-most limestone aquifer, the irrigation water kept the salinity low by constantly adding fresh or low salinity water. Conversion to drip irrigation in the early 1980s reduced the amount of water recharging the upper-most limestone aquifer. The groundwater in the upper-most limestone aquifer near the harbor became too salty for irrigation purposes. The conversion to drip irrigation also reduced the flow of groundwater into the harbor by about 0.3 mgd.

The numerical model predicts that if sugar cane production were to continue as it occurs today, the harbor expansion will have minor effects on groundwater flow. Flow into the harbor after the expansion will remain about 0.7 mgd and the 1-foot head contour will move 300 feet inland from its current location.

However, land use changes in the Ewa plain are continuing and in a few years it is expected that there will be no recharge from sugar cane irrigation. The current quality of the groundwater in the caprock aquifers is already too saline for irrigation, but when recharge from irrigation ceases, the groundwater will become even saltier. The model predicts that groundwater levels will be reduced to the point where the hydraulic head will not reach a level of 1.0 foot near the harbor. Groundwater flow into the harbor will decrease by approximately half from 0.7 mgd to 0.3 or 0.4 mgd. Infiltration of water used for golf course irrigation may replace a small amount of the lost sugar cane irrigation recharge.

In summary, the harbor expansion will not affect the Waianae basalt aquifer or any of the other aquifers that contain potable groundwater resources on Oahu. It will have a slight effect on the upper-most limestone aquifer in the caprock but this will not affect the utility of this resource for industrial cooling and coral washing. The groundwater impact associated with the termination of sugar cane irrigation will be much greater than the impact associated with both the original harbor and the proposed harbor expansion.

5.6 COASTAL WATERS

Numerous studies of the physical parameters, water quality, and marine biological characteristics of the coastal waters around Barbers Point Harbor have been conducted during recent years. These studies include pre- and post-construction surveys associated with the initial harbor development during the 1980s and the more recent development of the Ko Olina resort immediately adjacent to Barbers Point Harbor.

To supplement these existing studies and address specific issues associated with the current proposed action, three studies were performed in 1993 and 1994. They are:

- Barbers Point Deep-Draft Harbor Proposed Harbor Expansion, Marine Environmental Assessment, by Oceanic Institute (OI) Consultants, Inc.;
- Barbers Point Harbor Turbidity Investigations, by Sea Engineering, Inc.; and
- Survey of Ciguatera: Barbers Point Harbor and Channel Entrance, by Dr. Yoshitsugi Hokama, Ph.D., Asian Pacific Research Institute.

This section is based on these studies. For further information, the original reports may be found in Appendices A-2, A-3, and A-4.

5.6.1 Physical Setting

5.6.1.1 EXISTING CONDITIONS

The mean tidal range between mean lower low water (mllw) and mean higher high water is 1.9 feet. Mean sea level is 0.8 foot above mllw. The maximum tidal range is 4.0 feet.

Nearshore currents in the Barbers Point region are complex, highly variable and dependent upon a matrix of meteorological and oceanographic conditions prevailing at the time of measurement. In general, reversing tidal currents dominate the nearshore coastal waters with the primary direction of flow parallel to the shore and bottom contours. Flood tide currents flow predominantly to the southeast and ebb tide currents typically flow to the northwest. However, this is not always the case, and switches in the ebb and flood tide current directions occur relatively often and unpredictably.

Bathymetric studies indicate a broad, gently sloping limestone shelf extending from approximately 2,000 to 4,500 feet offshore. At an average depth of approximately 40 feet, the slope descends at a steeper angle. Further seaward at greater depths is a large gently sloping sand flat.

Concern over wave oscillation or surge conditions within the harbor increased after an accident in 1988 in which two vessels sustained damage attributed to harbor surge while relatively calm conditions prevailed in the harbor. Model studies of proposed harbor modifications were conducted by the U.S. Army Corps of Engineers Waterways Experiment Station, Coastal Engineering Research Center (CERC), Vicksburg, Mississippi between September 1990 and June 1992 (Physical and Numerical Model Studies of Barbers Point Harbor, Oahu, Hawaii, 1994). Wave oscillations were simulated by use of a numerical computer model, HARBD, and correlated with a physical model and wave measurements from the existing harbor. These studies documented that the harbor experiences natural resonance modes which cause standing waves to occur under certain long period ocean wave conditions. These standing waves can strain ships' mooring lines such that they may require adjustment to avoid damage.

5.6.1.2 PROBABLE IMPACT OF THE PROPOSED ACTION

The proposed action will add a new area to the harbor basin thereby changing its shape. The existing harbor with the proposed Expansion Area A was one of eight scenarios evaluated by the CERC, whose study concluded that expanding the harbor basin improved surge conditions in the harbor over existing conditions. There will be no other impact associated with the proposed action on the physical conditions of the coastal waters.

5.6.2 Water Quality

5.6.2.1 STATE WATER QUALITY STANDARDS

All coastal waters of the State of Hawaii have been divided into water quality and effluent limitation segments by the State Department of Health through Section 303(e) of Public Law 92-500, Federal Water Pollution Control Act of 1972. Barbers Point Harbor and the coastal waters in front of the harbor are designated Class "A" by the State Department of Health.

Harbors and marinas are allowable uses within Class "A" waters. Barbers Point Harbor is classified as a marine embayment for purposes of the State water quality standards.

The State Department of Health established the following numerical water quality criteria for open coastal waters and marine embayments:

	Water Quality Standards (WQS)	
	Open Coastal Waters	**Embayment**
• turbidity	0.20 NTU	0.40 NTU
• ammonia nitrogen (NH_4)	0.14 μM	0.25 μM
• nitrite + nitrate (NO_2 + NO_3)	0.25 μM	0.36 μM
• total nitrogen (TN)	7.86 μM	10.71 μM
• total phosphorus (TP)	0.52 μM	0.65 μM
• chlorophyll a (CHL)	0.15 μg/L	0.50 μg/L

Concentrations are expressed in μM (microgram-atoms per liter); μg/L is micrograms per liter. Turbidity is expressed as nephelometric turbidity units, or NTUs.

5.6.2.2 EXISTING CONDITIONS

Comprehensive water quality data were collected by OI Consultants in January 1994.

The physical structure of the water in the harbor and the adjacent nearshore area was determined from vertical profiles of temperature, salinity, and turbidity (as percent transmission) taken at 14 stations within the harbor and entrance channel, and at 12 nearshore water quality stations. Water quality samples were taken from various depths at 12 offshore stations and three stations within the harbor. A total of eleven physio-chemical parameters and one biological parameter were measured. The parameters are divided into four main categories:

1) physical water quality parameters:
   - temperature,
   - salinity, and
   - dissolved oxygen;

2) measures of suspended material:
   - turbidity and
   - total suspended solids;

3) algal nutrients and other biological indicators:
   - nitrate + nitrite,
   - ammonium,
   - phosphate,
   - silicate,
   - total nitrogen, and
   - total phosphorous;

4) biological parameter:
   - chlorophyll a.

Results of the vertical profile survey are summarized as follows:

- Temperature was generally vertically uniform and varied little within the harbor, ranging from 23.4° to 23.6°C.
- Temperatures in the nearshore stations were warmer than the inshore or harbor stations, ranging from 23.8° to 24.3°C.
- Salinity within the harbor was generally uniform at 34.8 parts per thousand (ppt) with the exception of the station closest to the rear corner of the harbor, which showed a significant decrease in salinity, especially near the surface. This reflects a strong influx of brackish water near this station.
- Salinity gradually increased along the harbor axis, with vertical gradients reflecting the outflow of lower salinity water in the upper 5 m of the channel. Salinity was uniform at 35.1 ppt in the nearshore and outer channel stations.
- Turbidity levels were highly variable within the harbor, ranging from 30 percent to 80 percent transmission.
- Outer channel and nearshore stations had turbidity ranging from 87 percent to greater than 95 percent transmission.

A comparison of the geometric means of the measured water quality data with corresponding State standards follows:

	Harbor		Nearshore	
Parameter	State WQS	Sample	State WQS	Sample
turbidity (NTU)	0.40	1.29*	0.20	0.30*
ammonia nitrogen (μM)	0.25	0.98*	0.14	0.58*
nitrate + nitrite (μM)	0.36	2.78*	0.25	0.73*
total nitrogen (μM)	10.71	10.55	7.86	7.21
total phosphorus (μM)	0.65	0.54	0.52	0.47
chlorophyll a (μg/L)	0.50	0.45	0.15	0.20*

* = exceeds State water quality standard

Relationships between water quality parameters suggest the following sources of the high nutrient and turbidity levels observed in the harbor and nearshore waters:

- groundwater is probably the primary source of nitrate;
- the observed levels of ammonium are probably the result of biological activity of marine organisms; and
- observed turbidity levels are the result of both suspended living phytoplankton and non-living particulate material (resuspended from the bottom of the harbor by boat traffic or from the ocean bottom by wave action.) The predominant effect is from non-living particulates.

Two major construction projects have potentially affected the water quality of Barbers Point Harbor and the adjacent waters: the expansion of the barge terminal to the Deep-Draft Harbor, and construction of the shoreline lagoons and marina at the Ko Olina Resort immediately north of the harbor. The time frames for these two construction projects, and the water quality studies associated with each, are summarized in Figure 5-5. The figure also presents the timing of two major storm events which had significant impacts on the nearshore marine environment.

Water quality monitoring was conducted by AECOS, Inc. before, during and after construction of the Deep-Draft Harbor. Preconstruction measurements showed considerable variability in nearshore turbidity, with apparent dependence on factors such as sea conditions, distance

Figure 5-5

WATER QUALITY SURVEYS FOR DEVELOPMENT OF THE BARBERS POINT HARBOR AND THE KO OLINA RESORT, WEST BEACH, OAHU

Water Quality Surveys - Barbers Point Harbor		
October - November 1975	Water quality survey of original harbor	ECI, 1975
January 1980	Severe winter storm	
August - October 1982	Preconstruction water quality surveys	AECOS, 1982
November 1982	Hurricane Iwa	
February - April 1983	Channel augering Water quality surveys	AECOS, 1986
May - August 1983	Channel dredging Water quality surveys	AECOS, 1986
September 1983 - June 1984	Channel dredging, harbor excavation Water quality surveys	AECOS, 1986
July 1984 - April 1985	Harbor excavation	
April - July 1995	Berm removal, final harbor dredging Water quality surveys	AECOS, 1986
August - November 1985	Post-construction Water quality surveys	AECOS, 1986
Water Quality Surveys - Ko Olina Resort		
November 1979	Water quality survey	Bienfang & Brock, 1980
January 1980	Severe winter storm	
November 1982	Hurricane Iwa	
August 1987 - December 1989	Construction of lagoons and marina Monthly water quality monitoring	S.E.A., 1987 - 1989
February - December 1990	Post-construction Monthly water quality surveys	S.E.A., 1990
April 1990	Post-construction water quality surveys	OIC, 1990

Source: OI Consultants, Inc., Barbers Point Deep Draft Harbor Proposed Harbor Expansion, Marine Environmental Assessment, (July 1994).

from shore, and proximity to the barge terminal entrance. The mean values of turbidity measured at the harbor entrance and in the nearshore waters were 3.3 NTU and 1.3 NTU respectively. The mean ambient turbidity exceeded the State water quality criteria of 0.2 NTU by a considerable amount, and exceedences occurred virtually constantly prior to the construction of the original Barbers Point Harbor.

Post-construction measurements showed ambient turbidity in the adjacent coastal waters to be 1.2 NTU and 1.3 NTU at the surface and the bottom respectively, and Final Report, Water Quality Monitoring Study, Barbers Point Deep Draft Harbor, Oahu, Hawaii (1986) concluded that a return to pre-construction levels of turbidity was suggested by these results.

Other water quality and turbidity measurements in the project vicinity include a series of measurements made between 1980 to 1990 for the West Beach/Ko Olina Resort development. These data also show that nearshore coastal water turbidity equals or exceeds the State criteria of 0.2 NTU essentially all the time.

In December 1993, Sea Engineering made a series of turbidity measurements in the harbor vicinity. The results (geometric mean in NTU) are summarized as follows:

Harbor Basin	Harbor Entrance	Nearshore Waters (<18')	Mid-Reef Waters (18'-30')	Offshore Waters (<30')
1.32	0.72	0.59	0.30	0.23

Sea Engineering noted high natural variability in turbidity within the harbor basin and the nearshore waters. Inside the harbor, ship movements produce localized and temporary increases in turbidity by stirring up bottom sediment. Outside the harbor, wave action often results in elevated turbidity in shallow waters. On two field investigation days, the surface turbidity in the harbor basin increased by 0.8 NTU over the course of the day for no apparent reason.

5.6.2.3 PROBABLE SHORT-TERM IMPACT OF PROPOSED ACTION

The proposed harbor excavation will cause an increase in the inorganic particulate material suspended in the harbor waters and discharged to the adjacent nearshore marine waters. Because most of the excavation (Expansion Area A) will be done behind an enclosure berm (see Chapter 2), the critical event for water quality will be the excavation and removal of the berm.

To evaluate this condition, Sea Engineering, Inc. (SEI) conducted numerical model studies of the levels of suspended sediment created, the rates of transport through the harbor and out to the ocean, and the distribution of this material in the nearshore environment. Data from previous harbor dredging projects were used to calibrate a predictive model for the proposed harbor expansion.

It is not known at this time what construction method described in Chapter 2 will be utilized. Clamshell dredging typically produces the greatest suspended solids concentration. If clamshell dredging can be shown to result in acceptable turbidity impacts, then other reasonable dredging operations, such as the use of a backhoe, dragline or hydraulic dredge, would also be acceptable.

The model estimates the spread and centerline concentration of a plume of suspended solids affected by:

- transport and mixing in a uniform current flow; and
- particle settling.

The modeling is done in two steps:

- Step 1 calculates the change in turbidity within the harbor basin and estimates a concentration at the harbor mouth; and
- Step 2 calculates plume dilution and transport by coastal currents to estimate the impacts on the nearshore water quality.

The initial concentrations and plume widths are based on data collected during the original Barbers Point Harbor construction monitoring and other data on dredging. Current speeds in the harbor are derived from field measurements and represent likely average speeds over the entire flood and ebb tidal cycles. The 0.05 ft/sec speed is representative of average, long duration flow across the harbor, and the 0.1 ft/sec current speed is representative of the highest, or worse case, flow across the harbor basin.

The model results indicate that with a current speed of 0.05 ft/sec, the plume would not exceed 0.13 NTU above ambient at the harbor mouth. Even with a worst case 0.1 ft/sec current the plume would reach the harbor mouth with an estimated turbidity of about 0.8 NTU above ambient. This potential increase in turbidity should be evaluated with respect to the natural variability in turbidity that has been documented in the harbor and coastal waters. For example, the average 1982 pre-construction turbidity at the harbor mouth was 3.3 NTU, about five times greater than the measurements made during this study.

In conclusion, the model predictions are within the limits of variability typically found in the harbor and the nearshore coastal waters. Therefore, the proposed action is not expected to generate unacceptable levels of turbidity.

Short-term water quality impacts from the construction of the piers and storage yards are similarly expected to be acceptable and within the natural limits of variability.

5.6.2.4 PROBABLE LONG-TERM IMPACT OF PROPOSED ACTION

Potential long-term adverse impacts could result from the accidental release of contaminants such as oil and gasoline during the refueling of vessels. Low levels of hydrocarbon contaminants do not appear to adversely affect algal, invertebrate or fish populations within marinas or harbors. Although increased vessel traffic could increase the potential of oil spills, oil spill response procedures have been developed for Barbers Point Harbor.

The discharge of vessel sewage is regulated by State and federal regulations and raw sewage cannot be directly discharged in harbor and nearshore waters.

Although harbor turbidity will increase more frequently because of expanded vessel traffic, these increases are within the natural variability already experienced in the harbor. At the greater depths outside the harbor, ship movements will resuspend less bottom sediment than in the harbor and vessels should not cause turbidity to increase beyond the range of natural variability in near-shore marine waters.

The development of storage yards and storm drainage systems will increase the potential of shoreside contaminants to enter the harbor.

The existing groundwater influx and tidal flushing of the harbor will not be changed by the harbor expansion. These processes will continue to flush the limited amount of pollutants that might be introduced into the harbor into ocean waters where they will undergo further dispersion, weathering and degradation.

5.6.2.5 MITIGATION MEASURES

The primary water quality mitigation measure during construction of the harbor expansion will be the enclosure berm that will separate Expansion Area A from the harbor. Water quality monitoring will be performed during removal of the berm and construction of Expansion Area B. Should turbidity levels become excessive, silt curtains could be deployed to contain the suspended particulate matter. Erosion control measures will be employed during construction. Portable toilets will be provided for construction workers.

Hawaii's oil spill response planning is carried out by the Office of Hazard Evaluation and Emergency Response of the Department of Health. This agency is responsible for writing and enforcing the State's oil spill contingency plan, as well as for promulgating administrative rules for HRS 128D, the Environmental Response Act.

The Clean Islands Council[1] maintains a vessel and oil spill clean-up equipment at Barbers Point Harbor. Each company using the harbor has a Harbor User Plan which details the procedures to respond to an oil spill. As vessel traffic increases, the Clean Islands Council will refine their procedures and equipment.

5.6.3 Marine Biology

5.6.3.1 EXISTING CONDITIONS

According to the OI study in 1994 (see Appendix A-2), marine biological surveys of the area between Barbers Point and Kahe Point identified complex benthic communities and high coral cover areas which have been considered for nomination as a Marine Life Conservation District.

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[1] The Clean Islands Council is a regional cooperative formed in compliance with the Oil Pollution Act of 1990 that buys and maintains oil spill clean-up equipment.

The impacts of the first harbor expansion were documented in technical reports describing the pre-construction, construction and post-construction water quality and marine biological conditions. Baseline conditions and impacts associated with the construction of the Ko Olina lagoons and marina were also documented.

Construction-related impacts on the benthic communities have ranged from insignificant to severe. The most damage was associated with the dredging of the harbor entrance channel. Natural events such as Hurricane Iwa and winter storms have had as great or greater impact.

Between January and March 1994, OI Consultants surveyed the bottom substrate, coral species, fish and invertebrates outside the harbor entrance to compare with the prior survey data. Three biotopes (areas with distinct physical and biological characteristics) were found in the nearshore waters 1,500 m on either side of the harbor entrance channel and offshore to depths of 20 m:

- the shallow inshore limestone bench;
- the limestone plate with extensive beds of living and dead coral at depths of 6 to 10 m; and
- the deep (15+ m) limestone plate covered with a thin algal-sand mat.

The shallow limestone bench generally had less than six percent live coral, with *Porities lobata* being the dominant species. Extensive sand patches and a thin sand layer covering the limestone were found south of the harbor channel; little sand was observed north of the channel. *Echinometra mathaei*, a rock boring sea urchin was the dominant invertebrate. The number of fish was highly variable. Most of the fish were from the labrid family which includes the saddleback wrasse, *Thalassoma duperrey*; the acanthurid family, mainly *Acanthurus nigrofuscus* (lavender tang) and *A. triostegus* (convict tang); and the pomacentrids, mainly *Chromis vanderbilti* (blackfin chromis) and *Abudefduf imparipennis* (brighteye damselfish). Macroalgae were predominantly a very short, filamentous red alga.

The substrate at the mid-depth (7-8 m) was limestone plate with interspersed beds of live and dead coral. South of the entrance channel a thin layer of sand covered the limestone. Sand layers or deposits were not seen north of the channel. Live coral coverage averaged about 25 percent, with *Porities lobata* as the dominant species. The fish in the area were mainly from the acanthurid, pomacentrid and labrid families. Invertebrates were scarce. Macroalgae were more abundant and species-rich at the mid-depth stations.

Further offshore at 14 m, the bottom substrate was limestone covered with a thin sand-algal mat. The bench sloped sharply down from 14 m to a sand and rubble bottom at 30 m. Coral covered an average of six percent of the bottom substrate. Large schools of *Lutjanus kasmira* (bluestripe snapper), *Parupeneus multifasciatus* (manybar goatfish), *Chaitondon miliaris* (milletseed butterflyfish) and *Acanthurus livaceous* (orangeband surgeonfish) were observed. Tubeworms (*serpulorbis variabilis*) were found and red filamentous algae covered 60 - 100 percent of the bottom along the transect lines.

In addition to depth-related differences in fish populations and benthic community distributions, there were differences at the same depth on the north and south sides of the entrance channel. Corals and fish tended to be more abundant and species-rich to the north of the channel. There was also a difference in the distribution of sand between stations to the north of the harbor entrance channel, where little sand was present, and to the south, where the bottom was covered with sand or sand-macroalgal mats.

5.6.3.2 PROBABLE SHORT-TERM IMPACT OF PROPOSED ACTION

The majority of the material to be removed is behind the existing harbor shoreline. The removal of existing shoreline will kill organisms which have settled there. Due to the turbid nature of the harbor waters and the strong groundwater influx, however, corals have not become established in this area. The new shoreline will provide three times the habitat area for colonization as presently exists.

The primary potential impact to marine biological communities will derive from elevated turbidity and increased sedimentation rates. Elevated turbidity will have no lasting effect on highly mobile resident fish populations. Benthic populations of stony corals, macroalgae and macroinvertebrates, on the other hand, cannot move. However, these communities inhabit areas which periodically experience naturally high levels of turbidity and sedimentation. They have developed mechanisms, such as entrapping the sediment with mucous, to cope with these events provided they are short-term. The increase in sedimentation rate which was projected under the worse case conditions in the Sea Engineering, Inc. model are less than one tenth the rates which coral have been shown to tolerate without significant impact.

Although adverse effects on the fish population occurred during the original expansion of the harbor in the early 1980's, no substantial adverse effects on marine ecology are expected from this project. During the original expansion of the harbor, fish mortality was associated with blasting of the harbor entrance channel. The blasting occurred offshore to create a deeper harbor entrance. Fish mortality is not expected in this project since construction blasting will occur onshore, not in the water. Almost all of the material to be removed is onshore material behind the existing harbor shoreline. In addition, due to present activity in the harbor, fish populations are low compared to those outside the harbor entrance.

5.6.3.3 PROBABLE LONG-TERM IMPACT OF PROPOSED ACTION

There will be no significant adverse impacts to the marine ecology due to the proposed excavation and subsequent construction of shoreside facilities because long-term water quality impacts are expected to be minimal.

5.6.4 Ciguatera Toxin

Ciguatera fish poisoning is caused by the marine dinoflagellate, *Gambierdiscus toxicus*, which is found in association with certain red or brown algae. *G. toxicus* can cause poisoning in humans when fish containing the toxin is eaten. Herbivorous fish graze on the algae, and humans can eat either the herbivorous fish or carnivorous fish which have eaten infected herbivores.

Ciguatera fish poisoning has been reported more frequently in recent years for two reasons:

- there is an increase in knowledge and awareness of the public to fish poisoning; and
- there is an increase in *G. toxicus* that come from the discharge of contaminated ship ballast, and *G. toxicus* may also attach to the hulls of ships coming from areas where it is endemic.

Increases in ciguatera poisoning have been noted especially on the leeward side of the Hawaiian Islands, and particularly in the Waianae area of Oahu.

Although there is a perception that ciguatera poisoning may be associated with coastal construction activities, this perception has no clear scientific support. While it was reported in studies at Tuvalu in the Pacific that the development of channels and small boat harbors resulted in a small increase in *G. toxicus* in areas where they had existed prior to development, large increases only occur following massive destruction of reefs after hurricanes and other natural forces.

5.6.4.1 EXISTING CONDITIONS

Ciguatera surveys conducted during the construction of Barbers Point Harbor in 1982-83 showed no increases in toxicity or outbreaks of poisoning. In the years following completion of the harbor excavation in 1985, there have been no reported outbreaks of ciguatera poisoning at Barbers Point Harbor.

In January 1994, Barbers Point Harbor and areas offshore of the entrance channel were surveyed for ciguatera fish poisoning. The survey included the collection and analysis of 130 fish of various species, and the collection and classification of algae samples. No *G. toxicus* was found. This suggests that ciguatera toxins do not occur within Barbers Point Harbor and its entrance. This finding is consistent with measured physical parameters. Water temperatures within the harbor (less than 25°C) and groundwater intrusion are not conducive to *G. toxicus* growth.

Immunological test results showed the presence of toxins unrelated to ciguatoxin, but at low levels that would not cause outbreaks of toxicity in humans.

5.6.4.2 PROBABLE IMPACT OF THE PROPOSED ACTION

The lack of *G. toxicus* in Barbers Point Harbor and nearby coastal waters indicates that ciguatera poses no serious problem at Barbers Point Harbor because:

- *G. toxicus* do not thrive in turbid waters;
- water temperatures within the harbor (less than 25°C) are not conductive for *G. toxicus* growth;
- areas experiencing groundwater influx are not conducive to *G. Toxicus*; and
- during the original harbor development, no increase in toxicity or outbreaks were noted.

No ciguatera outbreaks should therefore occur as a result of the proposed construction.

Since ciguatera has been related to the ballast and hulls of ships containing *G. toxicus*, an increase in ciguatera could occur if ships come from areas of the Pacific where ciguatera is endemic. Although the proposed action will increase the number of vessels using Barbers Point Harbor, the extent of contaminated vessels using Barbers Point Harbor is not known. In any case, the habitat of Barbers Point Harbor is not conducive to *G. toxicus* that may be introduced by arriving ships.

5.6.4.3 MITIGATION MEASURES

A post-construction ciguatera survey similar to the pre-construction survey will be conducted following completion of the project. In case of any reported outbreak, the SDOT will assist the State Department of Health to protect the public health and safety by putting up warning signs and taking other steps.

5.7 TERRESTRIAL BIOLOGY

This section describes the upland biological conditions in the area which will be affected by the proposed action. Endangered and threatened species are discussed in Section 5.8.

5.7.1 Existing Conditions

5.7.1.1 FLORAL

A comprehensive botanical survey of 524 acres, including the harbor, shoreside facilities and some of the proposed stockpile areas was performed prior to construction of the Barbers Point Harbor (Revised Environmental Impact Statement for the Barbers Point Harbor Deep-Draft Harbor on Oahu, 1978). Kiawe forest and scrublands were found in the undisturbed areas, while the more disturbed land areas were classified as wasteland and koa-haole scrub. Actively used areas included sugar cane fields and the quarry. Two endangered species were found (see Sections 5.8.4 and 5.8.5).

In 1992, a botanical survey was made of the 140.5 acres of land to be acquired by the State for the proposed action (Botanical Survey for Proposed Barbers Point Harbor Expansion, Ewa District, Oahu, 1992). The study reported that approximately 90 percent of the study area was greatly disturbed, containing a flat-topped coral stockpile along the length of the 84-acre parcel and an active mining operation in large parts of the 84-acre and 56.5-acre parcels. Vegetation was sparse, and there were barren piles of coral with some scattered soil.

The only relatively undisturbed area is a narrow strip of kiawe forest along the eastern boundary of the 56.5-acre parcel. The kiawe trees (*Prosopis pallida*) range from 18 to 25 feet tall. A foot or two of reddish-brown soil covers the old corralline substrate in most places. Where the tree cover is less dense and where there is soil, the ground cover consists of patches of Guinea grass (*Panicum maximum*), bristly foxtail (*Setaria verticillata*), and shrubs of wild basil (*Ocimum gratissum*). On areas with coral outcropping and shallow soil, the vegetation tends to be sparser and Chinese violet (*Asystasia gangetica*) is more common.

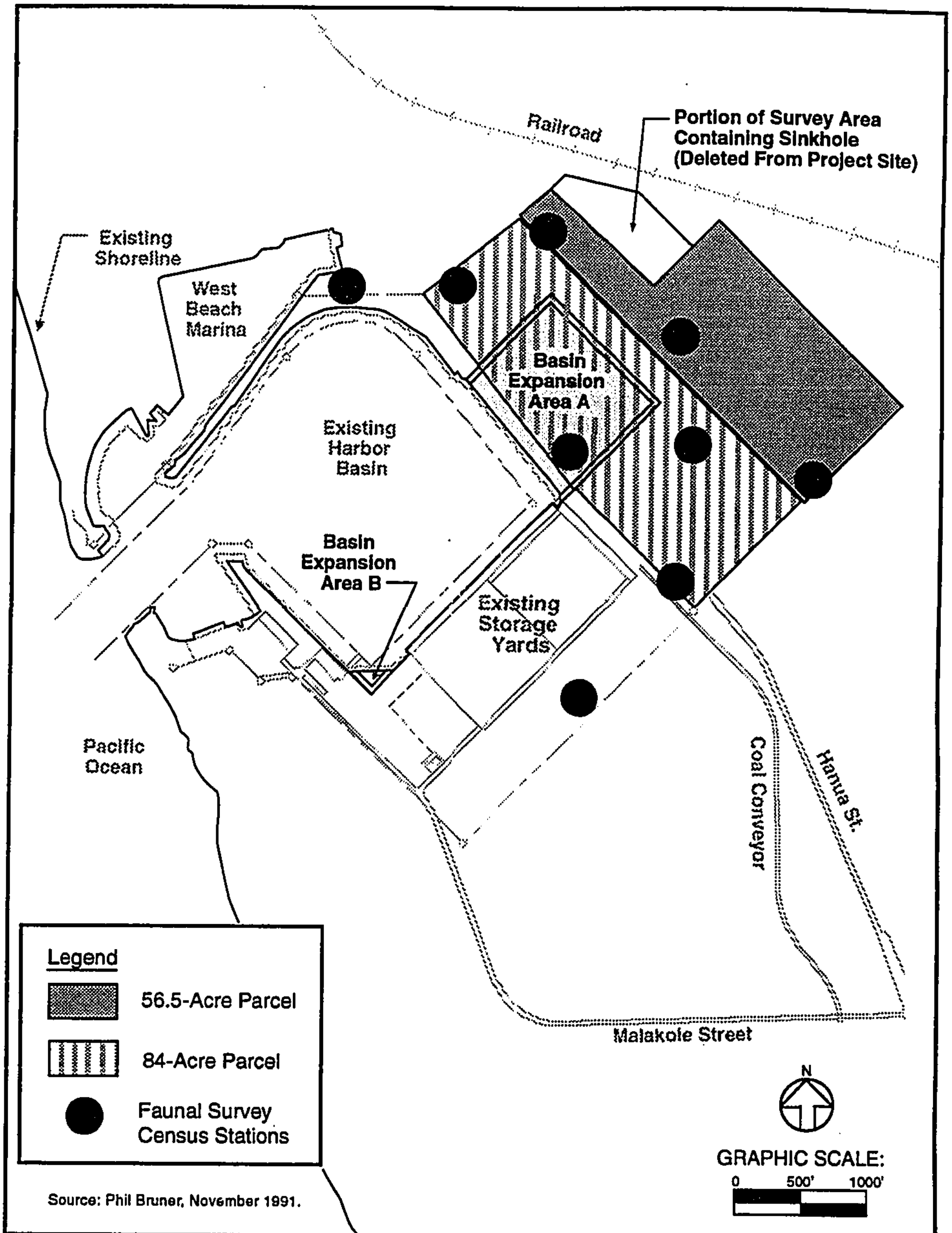
Species observed in the disturbed areas are tree tobacco (*Nicotiana glauca*), pluchea, klu (*Acacia farnesiana*), saltbush (*Atriplex suberecta*), *Achyranthes aspera*, buffel grass (*Cenchus ciliaris*), swollen finger grass (*Chloris barbata*), golden crownbeard, and radiate finger grass (*Chloris radiata*).

Due to the presence of natural sinkholes of possible archaeological and palentological significance, the 56.5-acre parcel described in the 1992 survey was reconfigured. The reconfiguration added approximately 11 new acres to compensate for deletion of the sinkhole sites. The 11 acres is a portion of the property which was the subject of a botanical survey in 1989 (<u>Botanical Survey for Proposed Barbers Point Harbor Expansion, Ewa District, Oahu</u>, 1992). The study reported no endangered or threatened species and little of botanical interest or concern.

5.7.1.2 FAUNAL

A faunal survey was conducted recently for the proposed action (<u>Letter Report of a Faunal Survey of Lands Proposed for an Expansion of Barbers Point Harbor, Ewa, Oahu</u>, 1991). Figure 5-6 shows the area of the field survey and the location of census stations.

Figure 5-7 lists all the species recorded in the survey. The only native species found on the property was the Pacific Golden Plover (*Pluvialis fulva*). This common migrant species can be found on lawns and open fields as well as shoreline habitat. The Pueo, an endemic and endangered species, may forage in this area on occasion. Several species which could occur at the site but were not recorded during the survey include: Barn Owl (*Tyto alba*), Short-eared Owl or Pueo (*Asio flammeus sandwichensis*), Ruddy Turnstone (*Arenaria interpres*), Japanese Bush-warbler (*Cettia diphone*), White-rumped Shama (*Copsychus malabaricus*), Red Avadavat (*Amandava amandava*) and Chestnut Mannikin (*Lonchura malacca*). This site contains the



Source: Phil Bruner, November 1991.

PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

Location of Faunal Survey Census Stations
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 5-6

Figure 5-7
RELATIVE ABUNDANCE OF BIRDS AT THE PROPOSED BARBERS POINT HARBOR EXPANSION SITE, EWA, OAHU

Common Name	Scientific Name	Relative Abundance*
Cattle Egret	*Bubulcus ibis*	R = 3
Spotted Dove	*Streptopelia chinensis*	C = 6
Zebra Dove	*Geopelia striata*	C = 8
Common Myna	*Acridotheres tristis*	U = 4
Red-vented Bulbul	*Pycnonotus cafer*	C = 8
Northern Mockingbird	*Mimus polyglottos*	R = 1
Northern Cardinal	*Cardinalis cardinalis*	U = 2
Red-crested Cardinal	*Paroaria coronata*	U = 4
Japanese White-eye	*Zosterops japonicus*	C = 7
Eurasian Skylark	*Alauda arvensis*	R = 4
House Sparrow	*Passer domesticus*	C = 6
House Finch	*Carpodacus mexicanus*	C = 8
Java Sparrow	*Padda oryzivora*	R = 1
Common Waxbill	*Estrilda astrild*	C = 9
Nutmeg Mannikin	*Lonchura punctulata*	R = 9

Notes:

*Relative abundance = number of individuals observed during walking survey or frequency on 8-minute counts in appropriate habitat.

C = Common (5-10) on 8-minute counts.

U = Uncommon (less than 5) on 8-minute counts.

R = Recorded but not on 8-minute counts (number which follows is the total recorded over the course of the entire survey).

Source:

Phill Bruner, Letter Report on Faunal Survey of Land Proposed for an Expansion of Barbers Point Harbor, Ewa, Oahu, November 15, 1991.

usual mix of introduced birds that will be expected in a second growth lowland habitat on Oahu. No unexpected species were recorded.

The only feral mammals recorded were the small Indian Mongoose (*Herpestes aurpounctatus*) and cats.

The survey noted that the sinkhole found on the property may be an important source of vertebrate bones. With the possible exception of the sinkhole, the property does not possess any unique or special qualities for wildlife. The project site was subsequently reconfigured to exclude the sinkhole.

The Hawaiian stilt, a waterbird species listed on the federal endangered species list, is discussed in section 5.8.3.

5.7.2 Probable Impact of Proposed Action

5.7.2.1 FLORAL

The proposed harbor expansion is not expected to have a significant negative impact on floral resources because work will occur on previously disturbed areas. Mixed weeds, kiawe trees and koa-haole shrubs will be removed on the undeveloped portions of the 56.5-acre site. These are regionally abundant floral resources.

5.7.2.2 FAUNAL

The proposed harbor expansion is not expected to have a significant negative impact on the faunal communities because the work will occur in previously disturbed areas and the faunal resources to be affected are abundant in the region. Individuals could relocate to adjacent, similar habitat.

5.7.3 Mitigation Measures

The 56.5-acre parcel has been reconfigured to exclude sinkholes which may contain vertebrate bones. Because of the lack of significant impact, no additional mitigation measures are proposed.

5.8 THREATENED AND ENDANGERED SPECIES

5.8.1 Green Sea Turtles (*Chelonia mydas*) - Threatened Species

5.8.1.1 EXISTING CONDITIONS

Green sea turtles are found throughout State of Hawaii waters but their distribution has been reduced in recent years due to loss of breeding sites and foraging areas.

Summary of Observations on the Green Sea Turtle Population in the Area Affronting the West Beach Project Site (1990) surveyed green sea turtles off Ko Olina before, during and after construction of their artificial lagoons. Before construction, they were observed making extensive use of a ledge 60 feet deep and over 1 kilometer offshore as a daytime resting place. While surveys were not performed at night, early morning shoreline surveys found turtles foraging for macroalgae off the shoreline bench (Post-construction Surveys of Nearshore Water Quality and Biota at West Beach, Oahu, 1990). Early in the construction phase, Brock observed that the turtles had moved from the deeper offshore ledge to a resting place in shallower water only 250 m offshore of the construction activities. Later during construction, the turtles dispersed along the coast off Ko Olina Resort within about 400 m of the shore, and maintained this distribution for the remaining 13-month lagoon construction period. Brock observed a decrease in size from adults to juveniles during the study period, but attributed this to reproductive migration patterns. He concluded that no significant impacts to the turtle population had resulted from the Ko Olina lagoon construction.

Nearshore surveys in the Barbers Point Harbor vicinity conducted in 1977 prior to harbor construction 1977 and recent surveys in 1994 encountered no green sea turtles.

5.8.1.2 PROBABLE IMPACT OF PROPOSED ACTION

No significant construction related impacts are anticipated because:

- The proposed action will take place along the internal harbor shoreline 3,000 feet or more from the natural shoreline.
- Although excavation and dredging will result in a temporary increase in turbidity, model studies indicated that worst case turbidity increases will be within the natural range of variability.
- Although blasting could transmit noise and vibration to the water, charges would be detonated on shore, not in the water, and therefore noise and vibration in the marine environment would be minimal.
- Shielding would be placed around night lighting employed for hydraulic dredging to avoid attracting sea turtles.

As shipping traffic increases in the future, collisions between ships and turtles could occur. However, due to the slow speeds of vessels entering and exiting the harbor, the probability of a collision is low so no significant long-term impacts are anticipated.

The National Marine Fisheries Service is involved in the evaluation of the impact of the proposed action on this species.

5.8.1.3 MITIGATION MEASURES

To ensure that there are no direct impacts to green sea turtles which may enter the harbor and approach the construction areas, project specifications will require construction personnel to monitor turtles which might venture into the harbor basin. Lights would be shielded to avoid attracting sea turtles.

5.8.2 Humpback Whale (*Megaptera novaeagliae*) - Endangered Species

5.8.2.1 EXISTING CONDITIONS

North Pacific humpback whales are the second most depleted endangered cetacean in the Pacific. During the months of November to May, humpback whales migrate from Alaskan waters to the major mating, calving and calf rearing grounds off Maui. Humpback whales are regularly observed off the south shore of Oahu. Surveys have shown that humpback whales and most other small whales seldom come into waters within the 100 fathom contour off Oahu. The 100 fathom contour is just under one mile offshore of the harbor.

5.8.2.2 PROBABLE IMPACT OF PROPOSED ACTION

No significant negative impact to the humpback whale is expected because of the distance of whale migration areas from the project site.

The National Marine Fisheries Service is involved in the evaluation of the proposed action on this species.

5.8.2.3 MITIGATION MEASURES

Since no significant impacts are anticipated, mitigation measures will not be necessary.

5.8.3 Hawaiian Stilts (*Himantopus mexicanus knudseni*) - Endangered Species

5.8.3.1 EXISTING CONDITIONS

Hawaiian stilts have been observed at two locations in the vicinity of the project:

- The birds have established nesting areas in a pond at the Chevron Refinery in Campbell Industrial Park. This pond is located about one mile from Expansion Area B, the nearest proposed excavation area.
- The U.S. Fish and Wildlife Service (FWS) has observed small numbers of Hawaiian stilts using the artificial ponds created by the coral crushing and sand washing operation located about 1,500 feet from Expansion Area A. The FWS monitored use of these ponds by Hawaiian stilts during the 1994 stilt breeding season (March through August). No nesting was observed.

There are no known Hawaiian stilt habitats within the project boundaries or at any of the proposed material stockpile areas.

5.8.3.2 PROBABLE IMPACT OF PROPOSED ACTION

The existing stilt habitats described above will not be affected by the proposed action. It is noteworthy that the stilts have established themselves in areas of heavy industrial activity.

Hawaiian stilts have been reported to use sinkholes when it rains. The project will not affect any sinkholes.

Hawaiian stilts were seen in sedimentation ponds during the dredging of the Ko Olina lagoons. If Expansion Areas A and B are constructed by hydraulic dredging, sedimentation ponds will be constructed that may attract the stilts.

The stilts appear adapted to ongoing industrial activities in Campbell Industrial Park and the coral processing areas. Therefore the stilts are not expected to be disturbed by the proposed work. For example, construction noise is not expected to affect the Hawaiian stilts since noise measurements taken near the Chevron Refinery pond measured approximately 66 dBA[2], with occasional peaks reaching 70 dBA. Estimated harbor expansion construction noise levels are on the order of 45 dBA, far below the existing noise levels at the Chevron pond. (Noise and vibration impacts are discussed in Sections 5.11 and 5.12.)

If blasting occurs, the charges will be small to avoid damage to existing structures in the immediate vicinity and avoid annoyance to nearby residential areas. The Honokai Hale/Nanakai Gardens residential areas are located approximately 3/4 mile from the excavation area, closer than the Hawaiian stilt habitat at the Chevron Refinery. Therefore, blasting vibrations would be in the "just perceptible" range and have no negative impact on the Hawaiian stilts. Also, blasting would usually be scheduled only once a day during the late afternoon. Such intermittent, short duration activity is not expected to disrupt the nesting habits of the Hawaiian stilt.

No significant long-term negative impact on the stilts is expected because the project would not affect the existing stilt nesting areas.

The FWS is involved in the evaluation of the proposed action on this species.

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2 The overall noise level is expressed in units called A-weighted decibels (dBA).

5.8.3.3 MITIGATION MEASURES

The FWS would be notified of any Hawaiian stilt activity which may occur if settlement ponds are used for the hydraulic dredging construction method.

5.8.4 *Achyranthes splendens* - Endangered Species

5.8.4.1 EXISTING CONDITIONS

Achyranthes splendens var. *rotundata* is a shrub 1.6 to 6.6 feet tall. This plant is currently listed as a federally endangered species whose range is restricted to the Ewa and Kaena regions of Oahu.

A population of 65 *Achyranthes splendens* var. *rotundata* is in a half-acre fenced preserve across Malakole Street and approximately 1,000 feet away from the boundary of Barbers Point Harbor (Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata*, 1994). The surrounding land has been cleared of vegetation and is planned for industrial land uses. The U.S. Fish & Wildlife Service published a Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata* (1994) with an ultimate goal of downlisting and then delisting the plant. The Recovery Plan proposed a buffer zone of 30-50 meters around the existing population.

A botanical survey was made in January 1992 of the 140.5-acre project site (Botanical Survey for Barbers Point Harbor Expansion, Ewa District, Oahu, 1992). The survey reported that "no threatened and endangered or rare species occur on the project site."

5.8.4.2 PROBABLE IMPACT OF THE PROPOSED ACTION

The location map of endangered plants at Barbers Point Harbor (Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata*, 1994) was examined and the project area does not overlap with any plant locations identified by the U.S. Fish and Wildlife Service. No material will be disposed on top of plants. No mitigation measures will be needed.

The FWS is involved in the evaluation of the proposed action on this species.

5.8.5 *Chamaesyce skottsbergii* - Endangered Species

5.8.5.1 EXISTING CONDITIONS

The endangered 'Akoko, *Chamaesyce skottsbergii*, is a perennial shrub. This plant is listed as a federally endangered species, and is found in the Ewa plain on Oahu and northwestern Molokai.

A population of *Chamaesyce skottsbergii* was found in the original Barbers Point Harbor site. Relocation and recovery efforts helped protect a portion of the population in the Barbers Point Naval Air Station (Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata*, 1994).

A botanical survey was made in January 1992 of the 140.5-acre project site (Botanical Survey for Barbers Point Harbor Expansion, Ewa District, Oahu, 1992). The survey reported that although *Chamaesyce skottsbergii* once occurred in the area of the harbor, it has since been removed as a result of several transplant programs.

5.8.5.2 PROBABLE IMPACT OF THE PROPOSED ACTION

The location map of endangered plants at Barbers Point Harbor (Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata*, 1994) was examined and the project area does not overlap with any plant locations identified by the U.S. Fish and Wildlife Service. No material will be disposed on top of plants. No significant negative impact from the proposed action is expected, so no mitigation measures will be necessary.

The FWS is involved in the evaluation of the proposed action on this species.

5.9 HAZARDOUS AND SOLID WASTE MATERIALS

5.9.1 Existing Conditions

This section reports the results of a baseline condition investigation for the 140.5-acre project site and the stockpile areas.

Environmental database searches by government agencies and an independent consultant were requested for any environmental citations within the study area.

5.9.1.1 AGENCY RECORD REVIEW

The government agencies who keep relevant environmental monitoring records were contacted in December 1993 to review their records. The agencies contacted were:

- The U.S. Environmental Protection Agency (EPA)
- The U.S. Geological Survey (USGS)
- State Department of Health (DOH)
- State Department of Land and Natural Resources (DLNR)
- Honolulu Fire Department (FD)
- Hawaiian Electric Light Company (HECO)

The agency responses were as follows:

EPA:	nothing to report within the study area.
USGS:	nothing to report within the study area.
DOH:	nothing to report within the study area.
DLNR:	nothing to report on the groundwater monitoring wells within the study area.
FD:	nothing to report within the study area.
HECO:	8 non-PCB (polychlorinated biphenyls, a hazardous material) transformers within the study area, and 2 non-PCB pole mounts (a can-sized mount sitting on top of utility pole).

In summary, the agency record review did not document any hazardous material release or spill within the study area.

5.9.1.2 ENVIRONMENT DATABASE SEARCH

An independent consultant conducted an environmental database search for the study area. The database search involved a review of federal and State environmental databases to identify environmental citations within the project site. Fourteen current federal and State environmental databases, listed below, were reviewed:

- National Priorities List (NPL) Superfund Sites;
- NPL Superfund Potentially Responsible Parties (PRP);
- Comprehensive Environmental Response, Compensation and Liability Information System Sites (CERCLIS);
- Resource Conservation and Recovery Act (RCRA) Corrective Action;
- RCRA D Landfills;
- RCRA Facilities (All Categories);
- Superfund Amendments and Reauthorization Act (SARA) of 1986 III Facilities;
- Emergency Response Notification System (ERNS) Spills;
- Facility Index Data System (FINDS) Facilities;
- Permitted Clean Air Sites;
- National Pollutant Discharge Elimination System (NPDES) Permit Compliance System (PCS);
- State Landfills;
- Leaking Underground Storage Tanks (USTs); and
- Registered USTs.

The review did not find any environmental citations within the study area.

5.9.1.3 EXPANSION AREA GEOTECHNICAL BORING RESULTS

A geological test boring program was conducted in 1993. Soil samples were taken from three deep borings (-100 feet) in Expansion Area B and nine deep borings (-75 feet) in Expansion Area A. None of the borings showed signs of soil contamination.

5.9.1.4 FUEL PIPELINE

Texaco owns an underground, 8-inch fuel pipeline that runs from Campbell Industrial Park to the barge terminal at Barbers Point Harbor. About 80 feet of the fuel pipe crosses Expansion Area B and will require relocation prior to construction. There is no indication of leakage from the pipeline. Soil samples taken from the deep boring about 50 feet away from the pipe did not show any signs of soil contamination.

In conclusion, there are no documented hazardous waste contamination incidents within the study area.

5.9.2 Probable Impact of Proposed Action

The proposed harbor expansion and future support facilities will be built in areas where no environmental citations have been reported. The excavated materials will not be considered solid waste since they have commercial value and will be stockpiled for reuse.

The expanded harbor and new shoreside facilities will handle more ships and cargoes. Additional shipping activity might increase the potential for accidental or unauthorized discharges of waste and hazardous materials in the harbor area.

5.9.3 Mitigation Measures

Proper safety and material handling rules will be followed during the fuel pipeline removal and the harbor operational phase. Oil spill emergency response procedures have been and will continue to be followed.

5.10 TRAFFIC

The contents of this section are based primarily on the Traffic Impact Assessment Report for Barbers Point Harbor Expansion (1992).

5.10.1 Existing Conditions

The only vehicular access to Barbers Point Harbor is via the H-1 Freeway, Kalaeloa Boulevard, and Malakole Street (see Figure 5-8). Access from the H-1 Freeway to Kalaeloa Boulevard is made through the Palailai Interchange. Malakole Street intersects with Kalaeloa Boulevard at the entrance to Campbell Industrial Park. There are existing truck hauling routes to the stockpiling and coral processing areas mauka of the harbor. These hauling routes are used by Hawaiian Cement and Grace Pacific for their operations.

Existing traffic counts taken in November 1991 show that the weekday commuter peak period generally occurs between 6:00 to 8:00 a.m. in the morning, and 3:00 to 5:00 p.m. in the

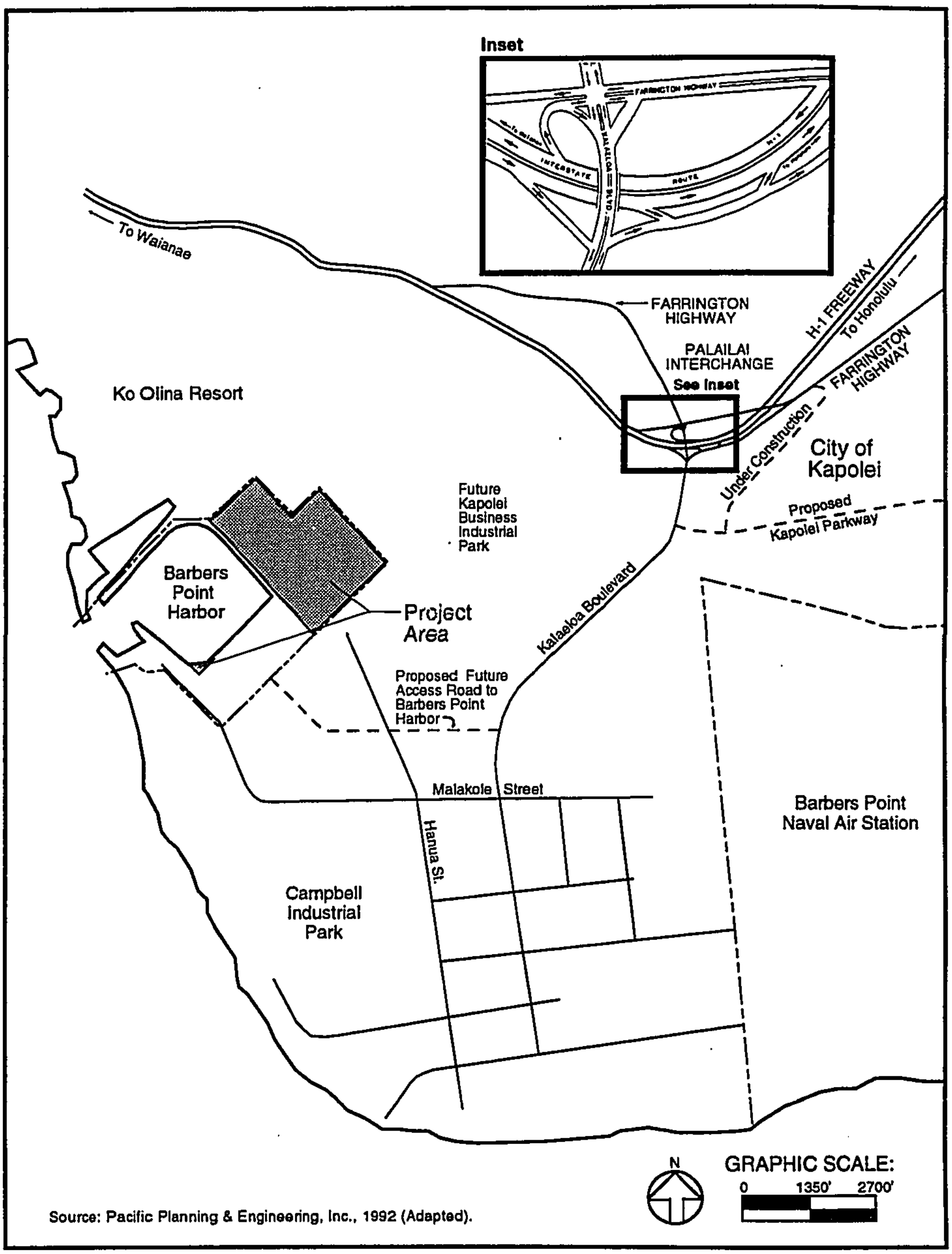

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FIGURE 5-8

afternoon. The existing traffic counts were used as the baseline condition to estimate future traffic volumes. The following traffic problems were noted during the field survey:

- On the Waianae bound off-ramp to Kalaeloa Boulevard, a queue of vehicles extended onto the H-1 Freeway for a 10 to 15 minute period of the morning peak hour.
- Large trucks traveling southbound, turning right from Kalaeloa Boulevard to Malakole Street, were observed making wide turns, occasionally using the adjacent through lane.
- During the afternoon peak hour, queues of 10 to 15 vehicles formed along Malakole Street (west bound).
- Trucks exiting Malakole Street onto or across Kalaeloa Boulevard will sometimes block the intersection or cause traffic to slow considerably while the trucks cleared the intersection.

5.10.2 Probable Impact of Proposed Action

Projections of future traffic without the proposed action were based on the Oahu Regional Transportation Plan (1991) and traffic projections for the Ko Olina Resort, the Kapolei Business Park, and other developments in the area. Projections of future traffic conditions with the proposed action were made by adding the traffic generated by the expanded harbor to the projected traffic that was calculated without the proposed action. It was estimated that there will be 478 additional trips generated in both the morning and afternoon periods by the proposed action.

Figure 5-9 summarizes the results of the analysis of roadway facilities that serve Barbers Point Harbor. These roadway facilities include:

- the segments of the H-1 Freeway at the Palailai Interchange;
- ramps at the Palailai Interchange affected by the project;
- the intersection of Kalaeloa Boulevard and Malakole Street; and
- the future intersection of Kalaeloa Boulevard with a proposed future access to Barbers Point Harbor.

The figure uses level-of-service (LOS) to grade the existing traffic conditions and the traffic conditions for the year 2005 with and without the project. There are six grades of LOS, measured from 'A' to 'F'. LOS 'A' generally represents free flow of traffic, where individual

Figure 5-9

TRAFFIC IMPACT ANALYSIS SUMMARY

[measured in Level-of-Service (LOS)]

	Existing Traffic 1992		Without Project 2005		With Project 2005	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
H-1 Freeway: East of Palailai Interchange						
Waianae Bound	B	B	D	C	D	D
Honolulu Bound	A	B	B	E	B	E
H-1 Freeway: West of Palailai Interchange						
Waianae Bound	A	C	B	F	B	F
Honolulu Bound	B	A	E	D	F	D
Waianae Bound Off-Ramp						
Freeway Before Off-Ramp	B	A	D	C	D	D
Diverge Lane	F*	B	F	D	F	F
Waianae Bound On-Ramp						
Freeway After On-Ramp	A	C	B	F	B	F
Merge Lane	C	C	C	F	C	F
Honolulu Bound Off-Ramp						
Freeway Before Off-Ramp	B	A	E	D	F	D
Diverge Lane	C	A	F	C	F	D
Weaving Areas at Palailai Interchange						
Weaving Section	B	D	D	F	D	F
Non-Weaving Section	B	D	D	F	D	F
Intersection of Kalaeloa Blvd. and Malakole St. (unsignalized)						
Kalaeloa Blvd.						
Mauka Bound - LT	D	A	E	A	E	A
Makai Bound - LT	A	D	C	F	C	F
Malakole St.						
Honolulu Bound - LT/TH/RT	F	F	F	F	F	F
Waianae Bound - LT/TH/RT	C	E	F	F	F	F
Intersection of Kalaeloa Blvd. and the Future Harbor Access Road (unsignalized)						
Kalaeloa Blvd.						
Mauka Bound - LT	N/A	N/A	E	B	E	C
Future Harbor Access Road						
Honolulu Bound - LT/RT	N/A	N/A	F	F	F	F

* Results of the analysis indicate LOS D conditions during the morning peak hour. However, field observations indicate LOS F conditions dur a 10 to 15 minute period of this hour.

Source:
Pacific Planning & Engineering, Inc., Traffic Impact Assessment Report for Barbers Point Harbor Expansion, July 2, 1992.

users are virtually unaffected by the presence of other users. LOS 'F' generally means that the amount of traffic exceeds the capacity of the facility.

In summary, the proposed action in the year 2005 will impact traffic conditions along Kalaeloa Boulevard and the H-1 Freeway. With or without the project, however, the highway system in the project vicinity will need improvement to accommodate the traffic to be generated by other developments in the Ewa region.

5.10.3 Mitigation Measures

The intersection of Kalaeloa Boulevard with Malakole Street is in the process of being modified and signalized. This will mitigate some local traffic impacts at this intersection. Traffic signals should also be placed at the future intersection of Kalaeloa Boulevard and the proposed second access road to Barbers Point Harbor.

In order to mitigate the collective adverse impacts from projected traffic of other developments in the area, the following types of improvements are recommended in the Ewa Region Highway Transportation Master Plan (1997 and 2005 Roadway Concepts) (1992):

- Construction of the East-West Parkway;
- Construction of additional ramps to the Palailai Interchange;
- Widening H-1 Freeway at certain locations;
- Relocation or deletion of the connection of Farrington Highway to Kalaeloa Boulevard;
- Widen Kalaeloa Boulevard to six lanes and signalize the intersections of Kalaeloa Boulevard with Malakole Street and the future second harbor access road; and
- Construction of a second access to Campbell Industrial Park.

These mitigation measures were proposed to meet regional travel demands. Their implementation is not part of this project.

5.11 NOISE

This section is based on detailed analyses of the noise impacts of the proposed action provided in the following reports:

- Acoustical Study of Barbers Point Harbor Expansion, Darby & Associates, July 9, 1992
- Noise and Vibration Impact Assessment, Parsons Brinckerhoff, 1994 (see Appendix A-1)

5.11.1 Noise Standards and Criteria

Applicable noise control is established by the following regulations:

- "Chapter 43 - Community Noise Control for Oahu," Department of Health, State of Hawaii Administrative Rules, Title 11, November 6, 1991

These rules specify the noise levels that shall not be exceeded at the property line more than 10 percent of any 20-minute period. The specified noise limits vary depending on the land use and time of day. Where the allowable noise level between two adjacent zoning districts differ, the lower level usually applies. .

Where new land uses are initiated, however, the noise limits are governed by the existing adjacent land use. The initiation of a new use is established by the date of rezoning of the parcel supporting the new use.

The rules have the following exemptions:

1. Boat whistles, horns, hovercrafts, and boats operating in any harbor;
2. Backup alarm devices on trucks and other construction vehicles installed in accordance with the Society of Automotive Engineers Handbook (1979); and
3. Vehicular noise covered under Chapter 42, Vehicular Noise Control for Oahu.

The following rules concerning construction noise are applicable if a permit has been issued by DOH:

1. Construction activities are limited to daytime hours between 7:00 a.m. and 6:00 p.m.;
2. Construction activity is not allowed on Sundays and specified public holidays;
3. Construction noise in excess of 95 dBA at or beyond the property line of the construction site is prohibited except between 9:00 a.m. and 5:30 p.m. on weekdays; and
4. Construction activity generating less than 95 dBA is allowed on Saturdays between 9.30 a.m. and 5.30 p.m.

DOH may grant a variance to these standards in certain cases.

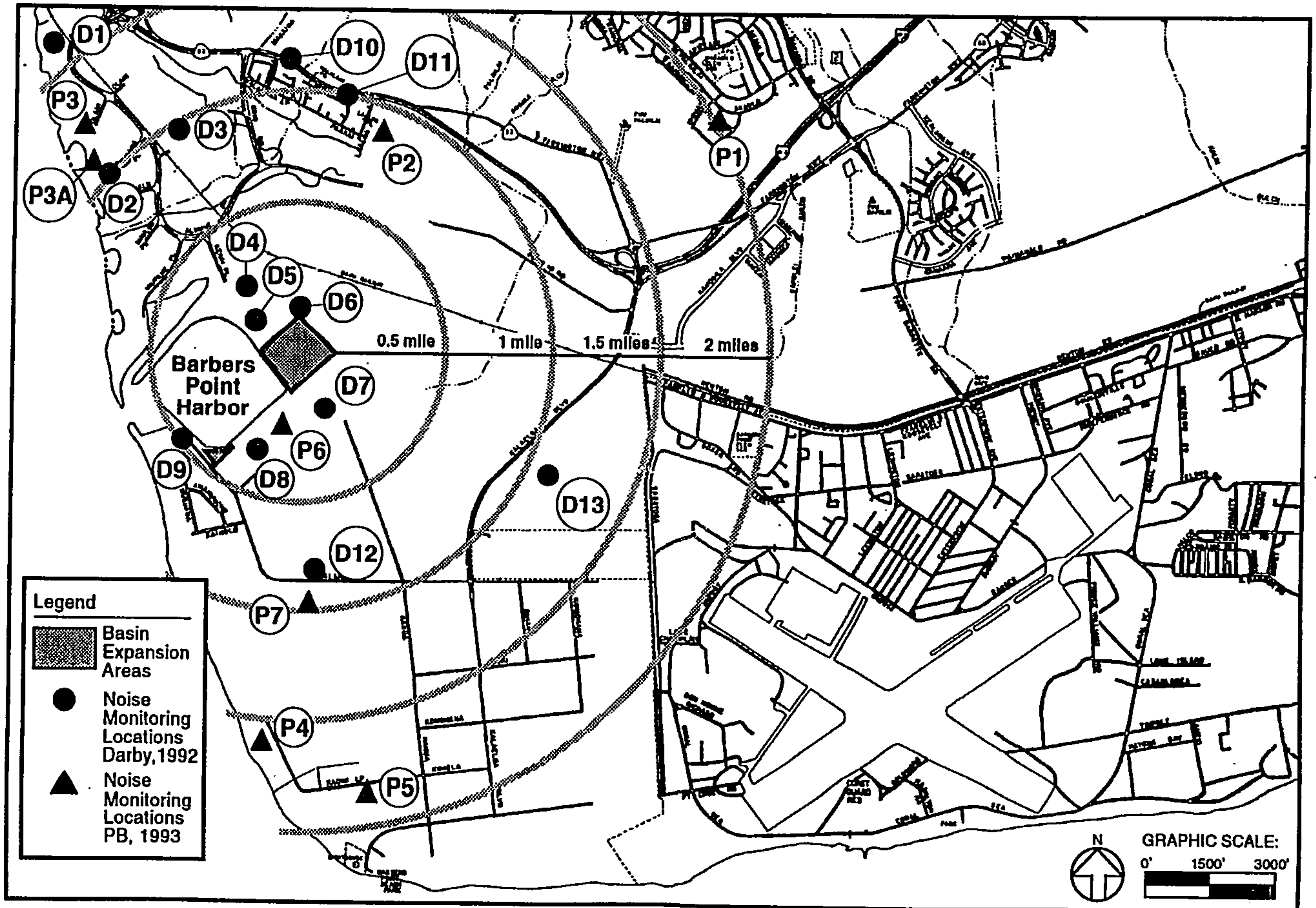
- "Chapter 42 - Vehicular Noise Control for Oahu," Department of Health, State of Hawaii, Administrative Rules, Title 11, November 6, 1981, and "Section 3.11 Noise Regulations," Land Use Ordinance (LUO), City and County of Honolulu, October 22, 1986

The LUO criteria differ from those of the DOH in that they use octave band sound levels instead of A-weighted decibel levels, and no temporal factor is involved. LUO noise regulations are theoretically enforced by the Building Department, but since they do not have a noise measurement capability, noise complaints are usually handled by the DOH.

5.11.2 Existing Conditions

Land use conditions at Barbers Point Harbor and adjacent properties are described in detail in Section 4.1. Ambient noise levels at selected locations in the vicinity of the proposed action were measured by Darby & Associates in November 1991, and by Parsons Brinckerhoff in November 1993. The monitoring locations are shown in Figure 5-10. The ambient noise measurement results are shown in Figure 5-11. Existing and potential noise sensitive locations include the following:

- Ko Olina Resort - Average noise levels measured at various locations within the resort range from 47 to 70 dBA, with the lowest occurring at night and the highest influenced by aircraft noise. When construction resumes at Ko Olina, internal noise levels will increase



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Noise Monitoring Locations
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FIGURE 5-10

Figure 5-11
AMBIENT NOISE MEASUREMENT SUMMARY

Measurement Number	Location	dBA Leq Average	dBA L_{90} Low	dBA L_{10} High	dBA L_1 Peak
Measurements by Darby & Associates, November 1991					
D1	Ko Olina Restaurant (Paradise Cove) Near Malakole St. Guard Station	51	48	58	73
D2	Ko Olina Visitor Center	52	49	53	59
D3	Golf Course Club House	56	48	59	66
D4	Cul-De-Sac Ko Olina	66	47	62	84
D5	N.W. Corner of Project Site	55	49	55	68
D6	Middle of Project Site	63	59	70	84
D7	S.W. Corner of Project Site	58	42	67	86
D8	Pier 5 Barbers Point Harbor	59	57	60	61
D9	Pier 3 Barbers Point Harbor	64	55	67	72
D10	Nanakai Gardens	50	36	60	78
D11	Konokai Hale	58	45	71	84
D12	Malakole Street	64	NM	NM	NM
D13	Kalaeloa Boulevard	68	NM	NM	NM

Measurement Number	Location	Day dBA Leq	Day dBA L_{90}	Day dBA L_{10}	Day dBA L_1	Night dBA Leq
Measurements by Parsons Brinckerhoff, November 1993						
P1	Akaawa Street, Makakilo	54	48	54	67	45
P2	Laaloa St., Honokai Hale	54	49	58	63	43
P3	Ko Olina Resort near Ihilani Hotel	47	44	48	54	NM
P3A	Ko Olina Visitor Center	70	53	72	83	47
P4	Refinery Pond -- Hawaiian Stilt Nesting Areas	66	63	68	71	NM
P5	Generation Plant	71	65	72	82	NM
P6	At Harbor approximately 150 ft from unloading ship	66	63	68	75	NM
P7	Refinery on Malakole Street	74	57	76	87	NM

Sources: Adapted from Darby and Associates, 1991; Parsons Brinckerhoff, 1993.

Note:
NM = Not measured.

significantly. When completed, the resort will also experience increased noise levels due to greater volumes of internal traffic. Ko Olina resort will also be impacted by the sounds from the portions of Barbers Point Harbor which were zoned for Waterfront Industrial (I-3) use prior to the resort zoning.

- Nanakai Gardens and Honokai Hale - The closest portions of these residential communities are located approximately 3/4 mile from the basin expansion site. Ambient noise is dominated by traffic noise from Farrington Highway. Measured average noise levels were 50-58 dBA during the day and 43 dBA at night.

- Makakilo Located over 1.5 miles from the project site, ambient noise levels within this residential community were measured at 54 dBA during the day and 45 dBA at night.

- Industrial and Business Parks - Campbell Industrial Park, Kenai Industrial Park, and the proposed Maritime Industrial Park and Kapolei Business Park are industrial land uses which could generate considerable noise on their own. Existing traffic noise Leq was measured at 68 dBA and 64 dBA near Kalaeloa Boulevard and Malakole Street, respectively. The measured Leq near the Chevron refinery and the co-generation power plant were 74 dBA and 71 dBA, respectively.

- Barbers Point Harbor - Average ambient noise measurements at the harbor and at the project site ranged from 55-66 dBA. At the project site, the dominant noise sources are the quarry and the mineral processing facilities. At the harbor, cargo handling is the dominant source.

- Hawaiian Stilt Nesting Area - Noise measurements were recorded adjacent to a pond within the Chevron Refinery which is a known nesting habitat for the endangered Hawaiian stilt. The primary noise source is an adjacent, intermittent waste flare at the refinery. The Leq was measured at 66 dBA.

5.11.3 Probable Impact of Proposed Action

5.11.3.1 PROBABLE IMPACT DURING CONSTRUCTION

Construction noise is generated by construction equipment operating at the site, blasting and the movement of construction materials. Noise levels from construction equipment can range from less than 70 dBA at 50 feet for stationary pumps to peaks of over 100 dBA at 50 feet for pile drivers.

Construction operations for this project are described in Section 2.5. Construction will be carried out in several phases, each of which will have its own mix of equipment and noise characteristics. Therefore, the total noise from the construction site will depend on the methods being employed during each stage of the process.

Of particular interest is the construction of Expansion Areas A and B, for which three methods are possible (see Chapter 2). The first alternative involves blasting and subsequent removal of the fractured material. Blasting produces an air pressure wave transmitted outward into the surrounding area. This pressure wave consists of audible sound that can be heard, and concussion or subaudible sound which cannot be heard. Generally, air blast is an annoyance problem which usually does not cause damage. Blasting, if used, is expected to occur only once per day and would be limited to a few minutes in duration.

Blasting noise levels and air blast overpressures are known to vary over a wide range depending on how well the charge is confined within the blast hole. For this project, construction specifications would require the use of noiseless shock tube leads, detonation of charges from the bottom of the hole, and stemming the charges at the top of the hole to eliminate or minimize surface noise. With these precautions, it is expected that noise levels due to blasting would be minimal. No mitigation of blasting noise would be required.

The second alternative, hydraulic dredging, could have the highest total mechanical power of the three methods, depending on the size of dredge used. Hydraulic dredging equipment would generate a total noise level about three dBA higher than the noise produced by the construction equipment of the blasting method. Only at site P2 in Honokai Hale would projected noise levels from hydraulic dredging exceed existing levels. The increase of one dBA at this location would not be perceptible.

The third method, mechanical excavation without blasting, would use auger drilling to weaken the material before excavation. The impacts from this method would be confined to noise generated by construction equipment. Since the total mechanical horsepower of this method is roughly the same as the blasting method, total noise impact from both methods' construction equipment would be very similar.

The estimated construction noise levels generated by equipment used with either the blasting or mechanical excavation methods lies in the range of 45 to 52 dBA, as shown in Figure 5-12. The noise levels shown on this figure are lower than the existing noise levels which were recorded (Figure 5-11).

The effect of wind direction on the propagation of noise is not considered in this analysis even though previous observations have shown that noise from the construction site is more perceived during occasional Kona winds than during the more prevalent trade winds. It is expected that during most of the year the trade winds would prevail and as a result, the noise that propagates to the residential areas would be less than the estimate. It should be noted that under conditions of temperature inversion sound can travel greater distances due to reflections from the upper air layers, and noise levels would increase at greater distances from the source. However, temperature inversions usually occur at night when most people are indoors and construction will probably not be occurring.

5.11.3.2 PROBABLE IMPACT DURING HARBOR OPERATIONS

Tugboats will be required to maneuver ships in the harbor. During this process noise will be created by tugboat and ship engines, and the horn or whistle signals which are used in the docking or departure sequence. All of these noises are presently generated at the harbor, but will occur more frequently with increased vessel traffic. Noises required for navigation within the harbor are exempt from DOH noise criteria.

The use of heavy cargo cranes, forklifts, other motorized vehicles, dry-bulk conveyors, refrigerated containers, and other equipment will be sources of noise within the project site. Noise levels from these types of activities were measured at the Fort Armstrong and Sand

Figure 5-12

ESTIMATED CONSTRUCTION EQUIPMENT NOISE AT SENSITIVE RECEPTORS

Mechanical Excavation with or without Blasting

Sites No.	Site Description	Land Use	Distance from Construction Sites (feet)	Estimated Noise Level Leq(1hr)(dBA)
P1	Akaawa Street, Makakilo.	Residential	9,300	45
P2	Laaloa St., Honokai Hale	Residential	4,000	52
P3	Ko Olina Resort @ Ihilani Hotel	Resort	6,000	48
P3A	Ko Olina Visitor Center	Resort	5,200	50
P4	Pond @ fence about 250 ft from flare	Industrial	7,000	47
P5	Co-Generation Plant, Kaomi Loop	Industrial	8,500	45
P7	Refinery on Malakole Street	Industrial	4,300	51
P8	Corner of Franklin D. Roosevelt Ave. & Saratoga St.	Military Residential	7,000	47
P10	Kaaoao Pl., near Honokai Hale	Residential	5,100	50
P11	Farrington Hwy., near Nankai Gardens	Residential	5,500	49
P12	Kohupono Pl., Makakilo	Residential	8,900	45
P13	Ko Olina Golf Course	Golf Course	4,200	52
P14	Ko Olina Resort, near Mauloa Pl.	Resort Beach	4,100	52
P15	Campbell Industrial Park	Industrial	6,000	48
P16	Ko Olina Fairways	Residential	2,600	55
P17	Lagoon No.4	Recreational	1,000	64

Source:
Parsons Brinckerhoff, Noise and Vibration Impact Assessment, 1994.

Island terminals in Honolulu Harbor. These measurements are summarized in Figure 5-13. The probable impacts from these noise sources are:

- Ko Olina Resort - During the daytime under trade wind conditions, Ko Olina will be in a cross-wind position to the noise sources at the piers and yards. Noise from cranes on ships at the closest pier where unloading will occur (Pier P-8) could cause sound levels of 48 to 53 dBAs at the Ko Olina golf course and on the lanais in the closest apartments in Ko Olina. During Kona winds and on nights when it is calm and there is a thermal inversion, causing sound to refract (bend) over obstacles, noise levels of 55 to 60 dBA from the cranes could be experienced at the same locations. Backup alarms on forklifts, tractors and trucks may be audible in Ko Olina during quiet nights. These signals, which must be distinctly audible in the noisy work area, are also exempt from DOH regulations. Similarly, diesel powered tractors will be audible (particularly if operating in Yard S-8 nearest to Ko Olina) and are exempt from DOH Chapter 43 noise regulations if the truck meets the noise limits in DOH Chapter 42, Vehicular Noise Control.

  Any non-exempt motorized vehicle in the northern Pier P-8 area which is noisier than about 75 dBA at 100 feet could exceed the allowable nighttime 50 dBA noise limits if it is not shielded effectively by a ship or building. For example, a diesel powered gantry crane at Pier P-8 could cause 60 dBA on quiet nights at high-rise lanais in Ko Olina, exceeding the DOH regulations.

  Noise from the dry dock operation, if relocated to Pier P-9, should be inaudible or muted due to shielding by the dry dock structure and from the large building expected to be located relatively close to the activity.

- Nanakai Gardens, Honokai Hale and Ko Olina Fairways - During normal trade wind conditions, these communities will be upwind of the project and normal harbor activities should be inaudible.

  Under certain non-trade wind conditions and/or thermal inversions, harbor activities may be audible, but traffic noise from Farrington Highway and normal ambient sounds generated by a developed community will provide a masking effect.

- Campbell Industrial Park and Other Proposed Business/Industrial Parks - Industrial parks should not be impacted by noise from harbor operations since industrial land uses

Figure 5-13

HARBOR OPERATIONS NOISE MEASUREMENT SUMMARY

(noise levels at a distance of approximately 100 feet)

Activity	Measured Level (dBA)
Sand Island Cargo and Container Facility (November, 1991)	
Loading/Unloading Container Ship - Gantry Cranes	79-84
Moving Containers and Placing Them on Trailers - Straddle Lift*	71-74
Hauling Containers on Trailers	71-82
Refrigerated Storage of Perishable Goods	65
Loading or Unloading of Liquid Cargo	65
Container Ship Waiting to be Loaded or Unloaded	74
Loading an Automobile Barge	74
Moving of Dry-Bulk Cargo - Conveyor System	70
Fort Armstrong Container Facility (August, 1988)	
Incoming & Outgoing Trucks	70-80
Loading & Unloading by Forklift	76-82
Reverse Beep Alarm from Forklift*	76-80
Heavy Forklift	73-80

Source: Adapted from Darby and Associates, 1992.

Note:
* Backup alarms are exempt from Department of Health noise regulations.

generate considerable noise of their own and it is most likely that noise sensitive spaces such as offices will be air-conditioned, thereby reducing their sensitivity to outdoor noise.

5.11.3.3 PROBABLE IMPACT OF TRAFFIC NOISE

Existing and future traffic noise levels were calculated using a PC version of the Federal Highway Administration (FHWA) traffic noise prediction model, Stamina 2.0. Future traffic volumes used in the analysis were extracted from the Traffic Impact Assessment Report for Barbers Point Harbor Expansion (1992). The results, which are summarized in Appendix A-1, Figure 7, show noise increases from zero to two dBA when future conditions with and without the project are compared. Increases less than five dBA are considered to be insignificant when the projected noise levels are below FHWA Noise Abatement Criteria. The results also indicated that traffic noise abatement measures may be warranted in the future for the Nanakai Gardens and Honokai Hale subdivisions, even without the increase attributed to the harbor expansion.

5.11.4 Mitigation Measures

Construction noise is not expected to perceptively exceed existing noise levels at nearby locations. However, there are a number of measures that could be implemented to mitigate construction noise impacts. They include the following:

- Use temporary sound barriers;
- Position equipment to reduce noise emissions;
- Install effective silencers or mufflers on all equipment;
- Limit operation hours allowing the use of back-up alarms and public address systems;
- Maintain all equipment such that parts of vehicles and loads are secure against rattling and banging;
- Limit equipment idling on site;
- Implement effective community relations to alert the public about possible noisy construction activities; and
- Continuously monitor noise levels.

The exact types and locations of future harbor equipment are unknown at this time, and unmitigated noise from harbor operations could affect nearby residential areas. To avoid undesirable impacts the following measures could be used:

- Set back distances, i.e., locate the noisier operations as far away as possible from sensitive locations such as Ko Olina Resort;
- Use sound barriers. Significant attenuation can be provided by ships, storage sheds, cargo containers and other obstructions if located between the noise source and the noise sensitive location;
- Limit crane engine noise by using cranes with motors low to the ground to maximize the effects of shielding;
- Equip straddle lifts, forklifts, and short-haul tractors with adequate mufflers and keep exhaust stacks as low to the ground as possible;
- Limit noise associated with automobile unloading by securing and cushioning ramps against rattling, and limiting speeds on the ramps;
- Supply noise disclosures for commercial areas on adjacent properties to discourage open-air cafes and non-air-conditioned buildings; and
- Provide acoustic treatments and/or hearing protection devices for workers in high noise exposure areas.

Because future traffic noise levels associated with the proposed action are predicted to be nearly the same as the future noise levels without the improvements, no traffic noise mitigation measures are proposed.

5.12 VIBRATION

Appendix A-1, Noise and Vibration Impact Assessment, presents detailed information on the vibration impact analysis. This section is based on that report.

5.12.1 Vibration Measurements and Standards

Construction activities such as rock blasting and pile driving produce seismic waves, which are actually ground vibrations. The faster the vibration, the greater the energy being transmitted through the ground. A seismograph is commonly used to measure vibration velocities, typically in inches per second. The peak particle velocity is the maximum velocity with which the particles vibrate. It is a direct measure of the energy carried by the seismic waves.

The potential effects of vibration on structures and persons in the vicinity would fall into one of the following categories:

1. no perceptible effects at the lowest levels of vibration;
2. low rumbling sounds and perceptible vibration at moderate levels; and
3. architectural and/or structural damage at the higher levels.

The criteria for acceptable vibration fall into two categories, one for structural integrity and the other for human sensitivity. Vibration criteria for structural integrity have been firmly established and are widely accepted. The criteria for human sensitivity and annoyance depend on many subjective factors and are not as readily available.

In the absence of State and local guidelines for construction vibration, the criteria selected to evaluate these effects have been compiled from international standards. The project vibration criteria, in terms of peak particle velocity, for the three categories above are the following:

1. imperceptible --less than 0.005 inch/second (in/sec);
2. just perceptible vibration--less than 0.025 in/sec; and
3. no architectural or structural damage--less than 0.3 in/sec.

5.12.2 Existing Conditions

Existing peak ground vibration levels were measured at one typical structure in each of the following areas: Makakilo, Honokai Hale, and Ko Olina Resort. The measurements indicate that peak daytime ground vibration velocity levels ranged between 0.003 and 0.004 in/sec which is below the threshold of perception. These levels are generally due to road traffic.

5.12.3 Probable Vibration Impact

This analysis focuses on the impacts that would occur if blasting is selected as the construction technique, since the vibration impacts of the other methods would be significantly less.

The structures nearest to the construction site are the dry bulk unloader, the cement silo, the coal conveyer and the piers. Blasting at the construction site, with the specified maximum peak vibration velocity of less than 0.3 in/sec, would be highly perceptible. However, blasting is likely to occur only once per day and the immediate harbor vicinity is not considered a sensitive area for human annoyance. There is no likelihood of structural damage because the 0.3 in/sec peak vibration velocity is a safe level for the most vulnerable of structures.

When the new residences at Ko Olina Fairways are occupied, the nearest residences would be approximately 1/2 mile from the blasting. At this location, the estimated peak vibration velocity levels would be less than 0.03 in/sec. At such low vibration velocity levels, ground vibration would be in the "just perceptible" range. These low vibration levels would not be strong enough to cause even minor damage to structures. In summary, by meeting a criterion of 0.3 in/sec close in, annoyance would be avoided in residential areas further away. Recreational areas within the Ko Olina Resort, such as the nearby portions of the golf course and shoreline lagoon no. 4, would experience vibrations in the clearly perceptible range, but these vibrations would not cause any damages.

Construction equipment including bulldozers, loaded trucks, jackhammers, augers for drilled shafts, and earth movers will generate peak vibration velocity levels that will be less than project criteria vibration levels beyond 50 feet. Therefore, vibrations from construction equipment will not damage harbor structures nor will they cause an annoyance in residential areas.

5.12.4 Mitigation Measures

No mitigation measures are required for construction vibrations associated with hydraulic dredging or for excavation without blasting. If blasting is the excavation method, the following mitigation measures would be appropriate:

- Specify vibration limits in contract documents of 0.30 in/sec to protect adjacent structures and 0.03 in/sec to minimize annoyance at potentially affected residential areas.
- Specify appropriate blasting quality control measures to ensure adequate control of the process.
- Specify that the contractor retain a qualified blasting consultant to provide a plan and initiate blasting work, including the supervision of initial test blasting to establish effects and baseline conditions.

- Monitor vibrations at sensitive locations throughout the construction period.
- Conduct pre-construction structural integrity inspections of sensitive structures in the vicinity.
- Inform people living and working in the vicinity about the construction method, probable effects, quality control measures, precautions to be used, and the channels of communication available to them.

5.13 AIR QUALITY

A detailed discussion of the air quality impacts of the proposed action is found in Air Quality Study for the Proposed Barbers Point Harbor Expansion Project (1992). The following information is primarily based on that report.

5.13.1 Ambient Air Quality Standards

Ambient concentrations of air pollution are regulated by both national and State ambient air quality standards (AAQS). National AAQS are specified in Section 40, Part 50 of the Code of Federal Regulations (CFR), while State AAQS are defined in Chapter 11-59 of the Hawaii Administrative Rules. National AAQS are stated in terms of primary and secondary standards. National primary standards are designed to protect the public health with an "adequate margin of safety." National secondary standards, on the other hand, define levels of air quality necessary to protect the public welfare from "any known or anticipated adverse effects of a pollutant." In contrast to the national AAQS, State AAQS are given in terms of a single standard that is designed to "protect public health and welfare and to prevent the significant deterioration of air quality."

Figure 5-14 summarizes both the national and State AAQS. Each regulated air pollutant has the potential to create or exacerbate some form of adverse health effect or to produce environmental degradation when present in sufficiently high concentrations for prolonged periods of time. The State Air Pollution Control Regulations also prohibit visible emissions at the property line of fugitive dust from construction activities.

5.13.2 Existing Conditions

Present air quality in the project area is mostly affected by air pollutants from vehicular, industrial, natural and agricultural sources.

Figure 5-14

SUMMARY OF STATE OF HAWAII AND NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Units	Average Time	Maximum Allowable Concentration		
			National Primary	National Secondary	State of Hawaii
Particulate Matter[b]	ug/m^3	Annual	50	50	50
		24 Hours	150 [a]	150 [a]	150 [a]
Sulfur Dioxide	ug/m^3	Annual	80	---	80
		24 Hours	365 [a]	---	365 [a]
		3 Hours	---	1300 [a]	1300 [a]
Nitrogen Dioxide	ug/m^3	Annual	100	100	70
Carbon Monoxide	ug/m^3	8 Hours	10 [a]	---	5 [a]
		1 Hour	40 [a]	---	10 [a]
Ozone	ug/m^3	1 Hour	235 [a]	235 [a]	100 [a]
Lead	ug/m^3	Calendar Quarter	1.5	1.5	1.5

Notes:
[a] Not to be exceeded more than once per year
[b] Particles less than or equal to 10 microns aerodynamic diameter

Source:
B.D. Neal & Associates, Air Quality Study for the Proposed Barbers Point Expansion Project, July 1992, and Barry Neal, August 1994.

Kalaeloa Boulevard, passing near the project area on the east, is the only access road to Campbell Industrial Park and presently carries moderate levels of vehicle traffic during peak traffic hours. Malakole Street intersects with Kalaeloa Boulevard and currently provides the only access to the harbor. Emissions from vehicles using these roadways tend to be carried toward the ocean by the prevailing east-northeast winds.

Several sources of industrial air pollution are located to the south and southeast of the harbor at Campbell Industrial Park. Major industries operating at the park include two oil refineries, the H-Power plant, a co-generation power plant which uses coal transported from the harbor via a dry-bulk unloader and conveyer, a cement plant and others. Most of the time prevailing winds carry emissions from these industries away from the harbor.

Air pollution from agriculture originates from sugar cane operations to the north and northeast of Barbers Point Harbor, upwind of the project area. Smoke and dust from the harvesting of the cane fields may affect the harbor on occasion, although most of the nearby cane fields may be displaced quite soon.

Natural sources of air pollution, such as from the ocean (sea spray), plants (aero-allergens), wind-blown dust, and volcanic emissions from the island of Hawaii, may also affect the harbor and surrounding area. These sources cannot be quantified very accurately.

The State Department of Health (SDOH) operates a network of air quality monitoring stations at various locations on Oahu. However, each station does not monitor the full complement of air quality parameters. Figure 5-15 shows the annual summary of air quality measurements that were made nearest to the project site for each of the regulated air pollutants for the period 1985 through 1989. Nitrogen dioxide, which is no longer being recorded by SDOH, was last monitored during the early and mid 1970s at Barbers Point. The annual mean values were found to vary from 11 to 29 $\mu g/m^3$ and meet the State and national standards.

Although the recorded data indicates that AAQS are currently being met, it is likely that nearby agricultural and industrial emissions occasionally reduce air quality. Sugar cultivation in the vicinity of the Barbers Point Harbor is likely to cause occasional elevated levels of both carbon monoxide and particulate matter. Industrial emissions of particulate matter, sulfur dioxide and nitrogen oxides probably also degrade air quality during periods of onshore winds.

Figure 5-15

ANNUAL SUMMARIES OF AIR QUALITY MEASUREMENTS FOR MONITORING STATIONS NEAREST BARBERS POINT HARBOR

Parameter / Location	1985	1986	1987	1988	1989
Sulfur Dioxide / Barbers Point					
No. of 24-Hr. Samples	59	57	53	59	54
Range of 24-Hr. Values (ug/m^3)	10-48	<5-10	<5-13	<5-19	<5-20
Average Daily Value (ug/m^3)	24	<5	5	<5	<5
No. of State AAQS Exceedances	0	0	0	0	0
Particulate / Pearl City					
No. of 24-Hr. Samples	27	60	51	-	59
Range of 24-Hr. Values (ug/m^3)	8-24	17-65	20-61	-	16-48
Average Daily Value (ug/m^3)	15	29	34	-	30
No. of State AAQS Exceedances	0	0	0	-	0
PM-10 / Barbers Point					
No. of 24-Hr. Samples	9	52	46	56	58
Range of 24-Hr. Values (ug/m^3)	10-26	7-66	10-40	10-48	10-44
Average Daily Value (ug/m^3)	20	26	21	24	26
No. of State AAQS Exceedances	N/A	N/A	N/A	N/A	N/A
Carbon Monoxide / Downtown Honolulu					
No. of Days of 1-Hr. Samples	342	348	345	360	323
Range of Daily Max. 1-Hr. Values (ug/m^3)	0.0-10.4	0.2-13.5	0.3-11.1	0.2-10.4	0.3-7.8
Average Daily Max. 1-Hr. Value (ug/m^3)	1.5	2.2	1.7	1.7	1.9
No. of State 1-Hr. AAQS Exceedances	1	3	1	1	0
No. of Days of 8-Hr. Samples	246	213	228	-	-
Range of Daily Max. 8-Hr. Values (ug/m^3)	0.1-4.4	0.3-4.7	0.3-3.9	-	-
Average Daily Max. 8-Hr. Value (ug/m^3)	1.3	1.4	1.2	-	-
No. of State 8-Hr. AAQS Exceedances	0	0	0	-	-
Ozone / Sand Island					
No. of Days of 1-Hr. Samples	341	346	342	362	342
Range of Daily Max. 1-Hr. Values (ug/m^3)	8-198	10-88	4-84	0-94	0-96
Average Daily Max. 1-Hr. Value (ug/m^3)	43	39	38	13	15
No. of State AAQS Exceedances	3	0	0	0	0
Lead / Downtown Honolulu					
No. of 24-Hr. Samples	58	57	57	-	-
Range of 24-Hr. Values (ug/m^3)	0.0-0.3	0.0-0.2	0.0-0.2	-	-
Average Quarterly Value (ug/m^3)	0.2	0.0	0.0	-	-
No. of State AAQS Exceedances	0	0	0	-	-

Source:
B. D. Neal & Associates, Air Quality Study for the Proposed Barbers Point Harbor Expansion Project, July 1992.

5.13.3 Probable Short-Term Impact of Proposed Action

There are two potential types of air pollution emissions which could impact air quality during construction: (1) fugitive dust from vehicle movement, soil excavation, and stockpiling; and (2) exhaust emissions from on-site construction equipment. Fugitive dust emissions from construction activities are difficult to estimate because the potential for their generation varies greatly depending upon the type of soil, the amount and type of earthmoving activity, the moisture content of exposed soil in work areas, and the wind speed. Although the Barbers Point Harbor basin expansion will require the excavation of over 2 million cubic yards of material, the potential for dust problems from the excavated material itself will be minimized by the fact that most of the material will be excavated from below the water table in a wet condition. The excavated area itself will be under water below about +2 feet mllw. During the original harbor excavation, water dripping from trucks hauling the wet material also minimized dust on the hauling roads. Dust will be a greater concern at the material stockpile areas because the tropical climate will dry out the material. Past experience has shown that the coralline limestone material becomes somewhat cemented as it dries, thus minimizing dust from the stockpiles although subsequent rehandling of the material could create dust.

Some of the dredged material may cause unpleasant odors. Residents of Hanakai Hale and Nanakai Gardens reported in a survey for the Barbers Point Harbor Expansion Social Impact Assessment (1993) that they objected to the smell of the dredged materials from the previous basin expansion. During the previous basin expansion, the stockpiles included organic-rich material removed from the channel and shoreline. The excavated material for the proposed expansion will contain much less organic matter to decay and produce odors. The hot dry climate of the area will rapidly dry the material which will diminish the odor problem. The prevailing winds from the east-northeast would also help with the potential odor problem, and would also blow fugitive dust away from residential and sensitive areas.

On-site mobile and stationary construction equipment will emit air pollutants from engine exhausts. Some of the large construction equipment, such as bulldozers, backhoes, and trucks, are diesel powered, and therefore emit higher concentrations of nitrogen oxides than gasoline-powered equipment. The standards for nitrogen dioxide are set on an annual basis and are not likely to be violated by short-term construction activities. Carbon monoxide emissions from diesel engines, on the other hand, are low and should be relatively insignificant compared to vehicle emissions on nearby roadways.

5.13.4 Probable Long-Term Impact of Proposed Action

Industrial sources of air pollution associated with a port facility include vessels entering and leaving the harbor and docked along the piers, cranes used for loading and unloading cargo, motorized vehicles used for cargo servicing, liquid-bulk loading and unloading operations and the dry-bulk unloader and conveyer system. Figure 5-16 displays approximate emissions for five pollutants which could emanate from various Barbers Point Harbor activities for the year 2010. Emission estimates given in this figure should be considered order-of-magnitude only due to the lack of detailed information on harbor operations 16 years into the future. For liquid- and dry-bulk operations, it is assumed that one-half the total material handled through the harbor would be associated with the harbor expansion.

Figure 5-16 also displays defined significant emission rates for the five air pollutants. Emissions below the significant levels are considered minor enough that any air quality impacts are likely to be small. Emissions above the significant levels generally indicate that an air quality analysis or a more detailed examination of those emissions may be warranted. As shown in Figure 5-16, the emissions from normal port operations could exceed the significant emission rates for particulate matter, nitrogen oxides and hydrocarbons. Sufficient details are not currently available to prepare quantitative air quality impact analyses, but it is likely that the Department of Health will require such analysis of industrial operations endeavoring to expand operations at the harbor. However, due to the prevailing wind pattern, a high percentage of the time the emissions from harbor activities will be carried out to the sea.

The proposed action will increase motor vehicle traffic on nearby roadways, potentially adversely affecting the ambient air quality in the project vicinity. Motor vehicles with gasoline-powered engines are significant sources of carbon monoxide. In order to evaluate the ambient air quality impacts from the increase in expected traffic, the EPA computer model MOBILE 4.1 was used to estimate the ambient carbon monoxide concentrations along the roadways leading to and from the project. Three scenarios were used for comparison--1991, present conditions, and year 2005 with and without the proposed action.

The computer modeling results are displayed in Figure 5-17 for three key intersections (see Figure 5-8 for the locations of the intersections in relation to the harbor). The worst-case 1-hour morning and afternoon ambient concentrations, and the worst-case 8-hour carbon monoxide concentrations are presented in the figure. Also included in the figure are the State and National AAQS for carbon monoxide.

Figure 5-16

APPROXIMATE BARBERS POINT HARBOR AIR POLLUTION EMISSIONS FOR YEAR 2010 AND SIGNIFICANT AIR POLLUTION EMISSION RATES

[tons/year]

Emission Source	Partic-ulates	Sulfur Dioxide	Nitrogen Oxides	Carbon Monoxide	Hydro-Carbons
Tug/Tow Boat Operations	N/A	N/A	40	10	5
Ships On-Berth	N/A	2	8	4	1
Diesel Cranes	3	2	40	8	3
Motorized Cargo Equipment	4	4	60	13	5
Ferry Operations	N/A	N/A	20	6	2
Crude Oil Import	nil	nil	nil	nil	150
Refined Oil Import	nil	nil	nil	nil	250
Dry-Bulk Import/Export	200	nil	nil	nil	nil
Total	207	8	168	41	416
Significant Air Pollution Emission Rates (State of Hawaii)	25	40	40	100	40

Note:

N/A indicates no estimate available but emissions will likely be negligible.

Sources:

1) B.D. Neal & Associates, Air Quality Study for the Proposed Barbers Point Expansion Project, July 1992.

2) State of Hawaii, Hawaii Administrative Rules, Title 11, Department of Health, Chapter 60, Air Pollution Control.

Figure 5-17

ESTIMATED 1-HOUR AND 8-HOUR CARBON MONOXIDE CONCENTRATIONS AT KEY INTERSECTIONS

[milligrams per cubic meter]

	1991 Existing Conditions		2005 No-Build		2005 Build	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Worst-Case 1-Hour Ambient Air Quality Conditions						
Kalaeloa Blvd. and Malakole St.[a]	13.0	18.6	6.1	5.0	6.3	5.1
Kalaeloa Blvd. and Future Access Road[b]	2.5	1.8	5.2	5.1	7.6	5.3
Palailai Interchange[c]	3.2	8.4	1.7	10.0	2.4	11.5
Hawaii State AAQS	10.0		10.0		10.0	
National AAQS	40.0		40.0		40.0	
Worst-Case 8-Hour Ambient Air Quality Conditions						
Kalaeloa Blvd. and Malakole St.[a]	9.3		3.0		3.2	
Kalaeloa Blvd. and Future Access Road[b]	1.2		2.6		3.8	
Palailai Interchange[c]	4.2		5.0		5.8	
Hawaii State AAQS	5.0		5.0		5.0	
National AAQS	10.0		10.0		10.0	

Notes:

[a] 2005 scenarios with or without the project include roadway improvements recommended in project traffic study. These include signalization and added laneage.

[b] 1991/present scenario assumes through traffic only on Kalaeloa Blvd. at the location of the proposed future access road; 2005 scenarios with or without the project assume signalized intersection.

[c] Occurs near intersection of Kalaeloa Blvd. and Farrington Hwy.; 2005 assume no improvements.

Source:

B.D. Neal & Associates, Air Quality Study for the Proposed Barbers Point Expansion Project, July 1992.

With or without the project, the predicted carbon monoxide concentrations at the intersections of Kalaeloa Boulevard and Malakole Street, and Kalaeloa Boulevard and the future access road will meet the State AAQS, even though present 1991 conditions at the Kalaeloa Boulevard and Malakole Street intersection exceed the State AAQS. The projected reduced concentrations are due to the effects of older, more polluting vehicles leaving the State's roadways during the intervening 15 years and to the roadway improvements that were assumed to occur. It is expected that with or without the project, carbon monoxide concentrations at the Palailai Interchange will meet the national AAQS but will not meet the State AAQS. No highway improvements were assumed at this location.

5.13.5 Mitigation Measures

During construction, the contractor must comply with the State Air Pollution Control Regulations which prohibit visible emissions of fugitive dust from construction activities at the property line. Thus, an effective dust control plan will be essential. In spite of the wet material which will be excavated, it is likely that a frequent watering program will be necessary to keep barren areas and haul roads from becoming significant sources of dust. Dust abatement measures at the stockpile area will vary depending on the construction method. If the hydraulic dredging method is used, the stockpile area would be a sedimentation pond covered with water. Dust abatement would probably be unnecessary until after completion of dredging. With other construction methods the pile will dry out. Based on past experience the coralline limestone material will tend to become cemented as it dries out. If this natural cementing is not sufficient to control dust, a crusting agent may be used to cement the surface. Other possible dust mitigation measures could include covering the stockpiles with erosion control mats or erecting wind screens.

It is unlikely that traditional erosion control measures such as hydromulch seeding can be used successfully either on stockpiled material or on barren soil areas. Low rainfall to sustain growth, the porous nature of the material, the lack of soil nutrients, and high salt content are not favorable for plant growth. Landscape planting of the stockpiles was attempted on the original harbor excavation project, but was later abandoned due to lack of success in establishing the plants.

A large percentage of emissions from harbor activities will likely be carried offshore because of the prevailing winds, and therefore, should not cause significant impacts to adjacent sensitive properties. Hydrocarbon emissions from petroleum handling could be mitigated by requiring the use of vapor recovery systems and/or restricting ship ballasting while in port. Emissions from particulate matter from dry-bulk handling could be reduced through the use of either dust suppression or dust collection systems. The DOH will require industries locating at the harbor to commit to specific emission controls when applying for a Permit to Construct and/or a Permit to Operate.

To mitigate traffic-related air pollution, it is recommended that improvements to the roadways leading to the harbor be made which will increase roadway capacities, and reduce traffic congestion, and therefore, reduce excess vehicular emissions. The promotion of transportation demand management strategies, such as buses, carpools, bicycling, and adjusting work hours, could also alleviate traffic congestion and reduce emissions.

CHAPTER 6

SOCIAL ENVIRONMENT

6.1 ARCHAEOLOGICAL, HISTORIC, AND CULTURAL CHARACTERISTICS

This section addresses the archaeological, historic, and cultural characteristics of the areas that will be affected by the following proposed action:

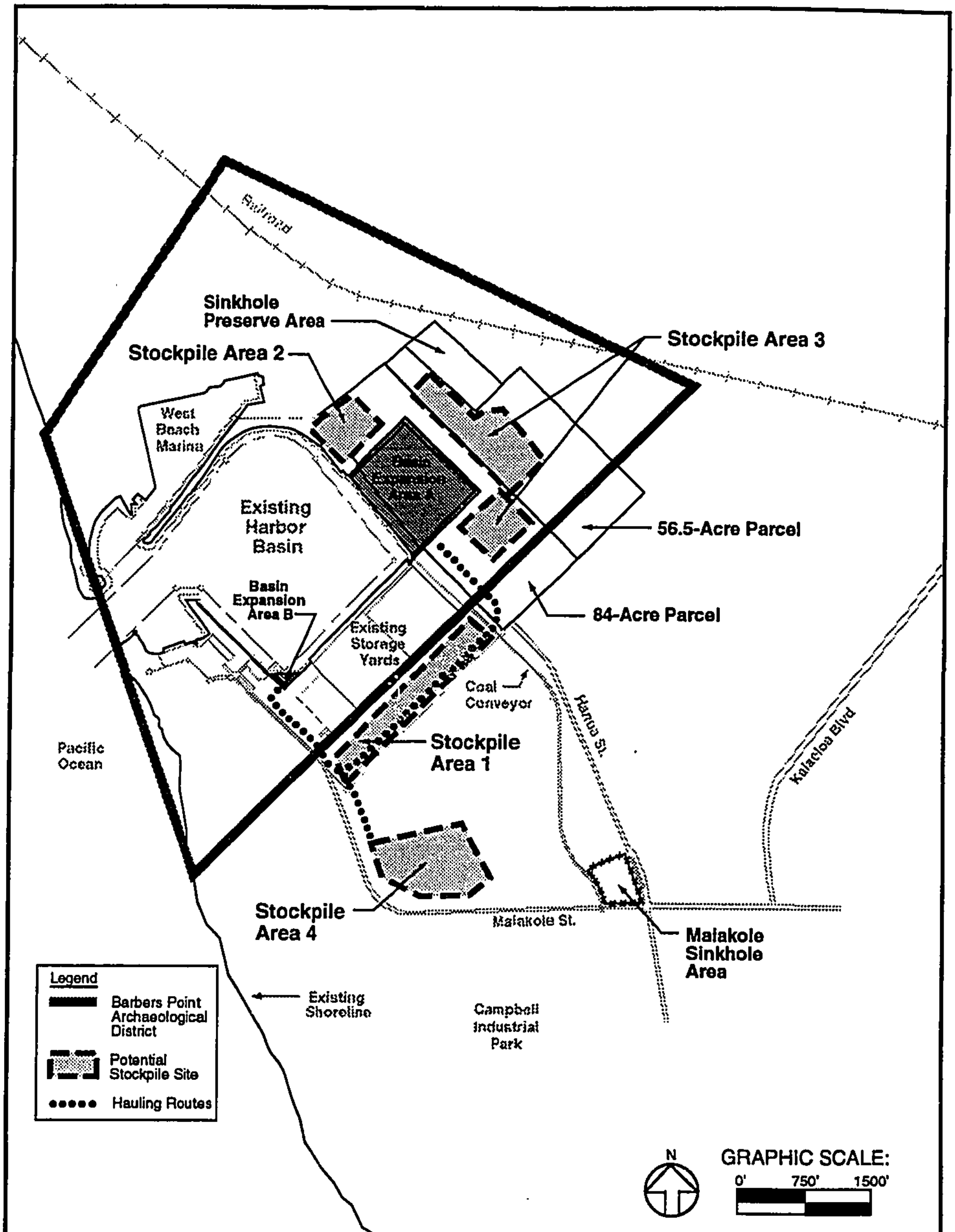
- the 84-acre parcel recently acquired from The EJC which includes Expansion Area A, Stockpile Area 2, part of Stockpile Area 3, and portions of the future paved storage yards;
- the 56.5-acre parcel to be acquired from The EJC which includes portions of Stockpile Area 3 and the future paved storage yards;
- Expansion Area B;
- a narrow strip of State lands along the southwest edge of the 84-acre parcel;
- Stockpile Areas 1 and 4; and
- the proposed haul routes.

These areas are shown in Figure 6-1.

6.1.1 Existing Conditions

Archaeological reports were the primary sources of information used in this analysis. The State Historic Presentation Division (SHPD) produced a draft archaeological site map that indicates the location of sinkholes and other archaeological features at Barbers Point in January 1994. This map, however, is preliminary and is currently undergoing agency review.

The Barbers Point Archaeological District is shown in Figure 6-1. The district was established by the SHPD in the late 1970s to facilitate the archaeological review of Barbers Point Harbor construction. The district is eligible for the National Register of Historic Places, but has not been officially listed on either the National Register or the Hawaii Register. Some of the project area (Stockpile Areas 1 and 4 and portions of the haul routes) will be outside of the archaeological district.



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Archaeological District at Barbers Point Harbor

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

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FIGURE 6-1

An historic railway to the north of the proposed harbor expansion traverses the archaeological district. The railway is listed on the National Register and, according to the SHPD, is of significant historic value. The Oahu Railway and Land Company (OR&L) constructed the 36-inch narrow-gauge steel rails on a raised roadbed of mixed material from 1889 to 1899. The 13-mile Nanakuli-Honouliuli right-of-way is:

- a well-preserved remnant and the longest remaining continuous stretch of the 175 miles of track laid by OR&L that had a tremendous effect on the economic development of Oahu and the State of Hawaii;
- the longest stretch of continuous railroad in Hawaii; and
- one of longest stretches of narrow-gauge railroad track in place in the United States.

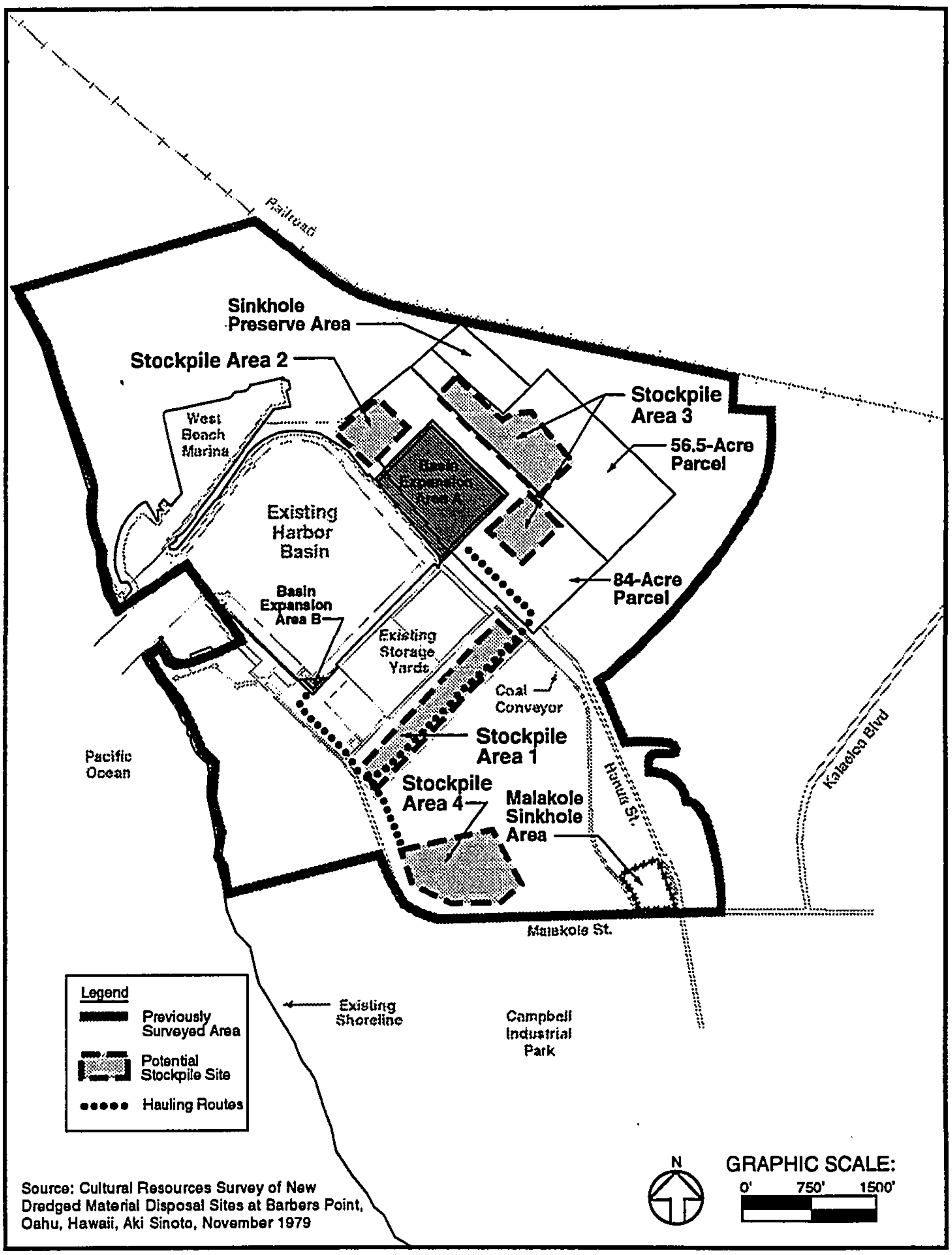
The 40-foot railroad right-of-way is never closer than 200 feet from the nearest area of proposed work and will not be affected by the proposed action.

In the early 1970s, two reconnaissance studies documented the presence of 30 archaeological sites in the area. The area was resurveyed between 1976 and 1979, as described below, and these survey areas are shown in Figure 6-2.

The earliest documented "archaeological survey" in the area, <u>A Report on Cultural Resources Survey at Barbers Point, Island of Oahu</u> (1976), was prepared for the U.S. Army Corps of Engineers, Pacific Ocean Division for the construction of the Barbers Point Harbor and was reviewed by the SHPD. The scope of the report included a historic and cultural summary of the study area and a cultural resources survey of the lands within and adjacent to the proposed harbor site. The survey area encompassed approximately 900 acres of The EJC lands.

The report noted physical evidence of extensive prehistoric utilization of the area. Ninety-two sites were recorded, including simple stone mounds and modified limestone sinkholes. When Barbers Point Harbor and its port facilities were constructed, most of these archaeological and cultural sites were destroyed.

When a new disposal site for the harbor construction was planned, a subsequent report entitled <u>Cultural Resources Survey of New Dredged Material Disposal Sites at Barbers Point, O'ahu, Hawai'i</u> (1979) was prepared for the U.S. Army Corps of Engineers. The survey area



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Previously Surveyed Area at Barbers Point Harbor
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
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FIGURE 6-2

encompassed approximately 80 acres of Campbell Industrial Park. The report identified and surveyed all cultural features, and located, identified, and tested paleontological sites.

The archaeological fieldwork located and recorded 40 sites, including site complexes, discrete structural forms, modified natural features, and remnant features. The paleontological survey located and identified 505 unmodified sinkholes. With the exception of sinkholes near Malakole Street which were subsequently fenced in for protection, all of these sites were buried under material removed during the harbor expansion. Consequently cultural and paleontological resources that once existed in the area have been destroyed except for the "Malakole sinkholes" which will not be disturbed by the proposed project.

84-Acre Parcel

The 84-acre parcel contains Expansion Area A, Stockpile Area 2, a portion of Stockpile Area 3, and future paved storage yards. While archaeologically significant sites were documented here, they no longer exist because of the previous harbor construction. According to the SHPD (correspondence dated August 17, 1989), archaeological recovery activities were completed for the 84-acre parcel under two contracts, Studies in Natural History and Human Settlement at Barbers Point, Oahu (1978) and A Report on Cultural Resources Survey at Barbers Point Island of Oahu (1976).

An Archaeological Assessment for the Proposed Barbers Point Harbor Expansion, (84 acres) Honouliuli, Ewa, Oahu (July 1993, revised January 1994), however, was subsequently prepared for the 84-acre parcel because the 1976 report stated, "it is possible that a number of sites were missed due to dense vegetation and portions of unclarified project boundaries." Further work was therefore recommended for the 84-acre parcel.

A field inspection conducted in January 1994 determined that no archaeological sites or deposits remain in the survey area. This archaeological conclusion is documented in the Preliminary Planning and Environmental Assessment Proposed Barbers Point Harbor Expansion, Ewa, Oahu, Hawaii (February 1994).

Expansion Area B

This expansion area was surveyed in the Archaeological and Paleontological Salvage at Barbers Point, Oahu (March 1978). The area no longer contains archaeological sites because of the prior harbor expansion.

Strip of State Lands

The narrow strip of State lands along the southwest edge of the 84-acre parcel contains no archaeological resources. Previous harbor expansion activities have destroyed any sites that may have existed.

56.5-Acre Parcel

The 56.5-acre parcel contains a portion of Stockpile Area 3 and future paved storage yards. Coral mining activities have operated in and around this parcel since the 1950s.

Since the late 1970s, inventory survey standards have become more strict, and the SHPD expressed a concern that sites (possibly including Hawaiian burials) not identified in previous studies could be concentrated in natural sinkholes. Therefore, the 56.5-acre parcel (see mitigation discussion below) was resurveyed.

The Archaeological Inventory Survey of the Proposed Barbers Point Harbor Expansion (revised September 1994) investigated an area that contained the 56.5-acre parcel. The scope of work included a survey and site inventory, limited subsurface testing, research on historical and archaeological background, and preparation of a report.

Thirty-seven archaeological sites were found in the area including habitation sites, sinkholes, mounds, walls, and various miscellaneous structures associated with historic occupation. According to the SHPD, 34 of the 37 sites "are significant because they are excellent examples of their representative site types and for the information on Hawaiian history and prehistory that they have yielded and are likely to yield."

Of the 37 sites recorded during the inventory survey, eight were classified as no longer significant and therefore require no further work. These are listed in Figure 6-3. Twenty-four sites were recommended for data recovery and are listed in Figure 6-4.

Figure 6-3

ARCHAEOLOGICAL RESOURCES RECOMMENDED FOR NO FURTHER WORK

State Site Number	Formal Site Type	Interpreted Function	Significance Determination
50-80-12-4905	Mound	Military	D
50-80-12-4914	Wall	Boundary	D
50-80-12-4915	Midden scatter	Historic/Modern-kiawe harvesting	D
50-80-12-4916	Sink	undetermined	D
50-80-12-4918	Mound	Agriculture	D
50-80-12-4919	Mound	Agriculture	D
50-80-12-4923	Wall section (remnant)	Cattle containment	D
50-80-12-4924	Wall section (remnant)	Cattle containment	D

Source: Cultural Surveys Hawaii, Archaeological Inventory Survey of the Proposed Barbers Point Harbor Expansion, revised September 1994.

Notes:
SIGNIFICANCE DESIGNATION
D - Site may be likely to yield information important in prehistory and history

Figure 6-4

ARCHAEOLOGICAL RESOURCES RECOMMENDED FOR DATA RECOVERY

State Site Number	Formal Site Type	Interpreted Function	Significance Designation
50-80-12-4893	Sink	Safety filling	D
50-80-12-4894	Enclosure	Temp. habitation	D
50-80-12-4895	Mounds	Agriculture	D
50-80-12-4897	Complex Circular mounds Linear mounds	Agriculture	D
50-80-12-4898	Mounds	Agriculture	D
50-80-12-4899	Enclosure	Temp. habitation	D
50-80-12-4900	Complex Sinks Wall	Agriculture	D
50-80-12-4901	Complex Modified outcrop Sinks	Agriculture	D
50-80-12-4902	Complex Wall Mound	Agriculture Enclosure remnant Undetermined	D
50-80-12-4903	Complex Sink Sink Rectangular enclosure Mound Mound	Perm. habitation; agriculture Undetermined Undetermined Seasonal habitation Agriculture Agriculture	D
50-80-12-4904	Complex Mound Mound Mound/barbed wire	Agriculture; military Agritulture Agritulture Military	D
50-80-12-4906	Sink	Undetermined	D
50-80-12-4907	Complex Sink Sink Sink Sink Sink	Undetermined-one has cat skeleton	D

Figure 6-4

ARCHAEOLOGICAL RESOURCES RECOMMENDED FOR DATA RECOVERY (continued)

State Site Number	Formal Site Type	Interpreted Function	Significance Designation
50-80-12-4908	Sink	Military	D
50-80-12-4909	Sinks	Undetermined; Military	D
50-80-12-4910	Sink complex	Agriculture	D
50-80-1-4911	Complex Enclosure Mound Mound Mound	Agricutlrure	D
50-80-12-4912	Complex Enclosure Enclosure	Temp. Habitation	D
50-80-12-4913	Complex Mound Mound	Agriculture	D
50-80-12-4917	Complex C-shaped enclosure Irregular-shaped enclosure Sinks Mound Mound Mound Mound Mound L-shaped wall Mound Mound Sinks	Agriculture	D
50-80-12-4920	Enclosure	Temp. habitation	D
50-80-12-4921	Complex Mound Soil-filled Sink Sink	Agriculture Agriculture Undetermined Undetermined	D

Figure 6-4

ARCHAEOLOGICAL RESOURCES RECOMMENDED FOR DATA RECOVERY
(continued)

State Site Number	Formal Site Type	Interpreted Function	Significance Designation
50-80-12-4922	Sink	Undetermined	D
50-80-12-9548	Complex	Animal enclosure; poss. habitation	D
	L-shaped wall	Enclosure remnant	
	Wall	Enclosure remnant	
	Paved area	Poss. habitation	

Source: Cultural Surveys Hawaii, Archaeological Inventory Survey of the Proposed Barbers Point Harbor Expansion, revised September 1994.

Notes:
INTERPRETED FUNCTION
Temp. - Temporary
Poss. - Possible

SIGNIFICANCE DESIGNATION
D - Site may be likely to yield information important in prehistory or history

The remaining five archaeological sites were recommended for partial or complete preservation, as listed in Figure 6-5. In correspondence dated October 18, 1994, the SHPD emphasized the significance of three of the five sites, including a burial cave, a large sinkhole, and a temporary habitation and agriculture complex.

Stockpile Area 1

Potential Stockpile Area 1 was surveyed in A Report on Cultural Resources Survey at Barbers Point Island of Oahu (1976). This area no longer contains archeological sites because of the prior harbor construction.

Stockpile Area 4

This area no longer contains archaeologically significant sites because of the prior harbor construction and material stockpiling.

Haul Routes

The haul routes are shown in Figure 6-1. All segments of the haul routes have been surveyed in earlier studies. Archeological resources along the haul routes have been destroyed by the prior harbor expansion or coral mining activities.

6.1.2 Probable Impact of Proposed Action

84-Acre Parcel

A letter from SHPD dated August 17, 1989 indicates that "archaeological data recovery was finished, and development of the parcel will have no adverse effect on significant historic sites."

In addition, the Preliminary Planning and Environmental Assessment, Proposed Barbers Point Harbor Expansion, Ewa, Oahu, Hawaii (February 1994) stated that, "it has been conclusively determined that no archaeology is extant within the project area."

Figure 6-5

ARCHAEOLOGICAL RESOURCES RECOMMENDED FOR PRESERVATION

State Site Number	Formal Site Type	Interpreted Function	Significance Designation
Site 50-80-12-4896	Complex Sink Sink	Temp. habitation/ agriculture	CD
Site 50-80-12-9545	Fenced Sinkhole	Habitation	CD
Site 50-80-12-9546	Wall	Cattle containment	D
Site 50-80-12-9617	Complex Platform Remnant	Temp. habitation	D
Site 50-80-12-9633	Cave	Burial	CDE

Source: Cultural Surveys Hawaii, Archaeological Inventory Survey of the Proposed Barbers Point Harbor Expansion, revised September 1994.

Notes:
INTERPRETED FUNCTION
Temp. - Temporary

SIGNIFICANCE DESIGNATION
C - Site is an excellent example of a site type
D - Site may be likely to yield information important in prehistory or history
E - Site has cultural significance; probable religious structures and/or burial present

Expansion Area B

Since this area does not have existing archaeological sites, there will be no archaeological impacts.

Strip of State Lands

Since the narrow strip of State lands along the southwest edge of the 84-acre parcel does not have existing archaeological sites, there will be no archaeological impacts.

56.5-Acre Parcel

The Archaeological Inventory Survey of the Barbers Point Harbor Expansion (revised September 1994) describes archaeological resources within an area that contains the 56.5-acre parcel. The sites recommended for preservation comprise the best examples of sites within the project area, and represent examples of the kinds of prehistoric and historic activities that took place in the study area, including agriculture, habitation, cattle containment, a human burial, and human use of now extinct avifauna.

The final configuration of the 56.5-acre parcel was subsequently established so that it does not contain any sites recommended for preservation (see mitigation discussion below).

Stockpile Area 1

Since this area does not have existing archeological sites, there will be no archaeological impacts.

Stockpile Area 4

Since this area does not have archeological resources, there will be no archaeological impacts.

Haul Routes

Since all segments of the proposed haul routes do not have archaeologically significant sites, there will be no impacts.

6.1.3 Mitigation Measures

Mitigation measures will not be required for the 84-acre parcel, Expansion Area B, the narrow strip of State land along the southwest edge of the 84-acre parcel, Stockpile Areas 1, and 4, and the proposed haul routes. Previously existing archaeological resources in these areas have been destroyed by the construction of Barbers Point Harbor, its shoreside facilities, stockpiled materials, coral mining activities, or sugar cane cultivation.

The Archaeological Inventory Survey of the Barbers Point Harbor Expansion (revised September 1994) described the presence of archaeological resources within an area that contains the 56.5 acre parcel. The SHPD has reviewed the inventory survey, in accordance with the requirements of 36 CFR Part 800 and the Advisory Council on Historic Preservation (ACHP), and concurs with the report's recommendations for preservation and data recovery.

To avoid those sites recommended for preservation, the 56-5-acre parcel was configured so that it does not contain the five sites recommended for preservation. Recommended data recovery will, however, still be required at those sites that remain within the parcel and that will be potentially affected by the proposed project. An archeological mitigation plan will address data recovery, analysis, and testing procedures of significant sites remaining within the 56.5-acre parcel. Mitigation fieldwork will entail data recovery of those qualified sites according to the mitigation plan. The SHPD will review both the fieldwork and written report. Pending revisions, the mitigation plan will be accepted by the SHPD and implemented by SDOT.

If archaeological resources are inadvertently discovered during construction, work will stop immediately and SHPD officials will be notified.

6.2 RECREATION

6.2.1 Existing Conditions

The locations of some of the recreational resources in the vicinity of Barbers Point Harbor are shown in Figure 6-6. Six parks are located within a six-mile radius of the harbor:

- Nanakuli Beach Park;
- Kahe Point Beach Park;
- Makakilo Community Park;
- Mauka Lani Neighborhood Park;
- Barbers Point Beach Park; and
- Oneula Beach Park.

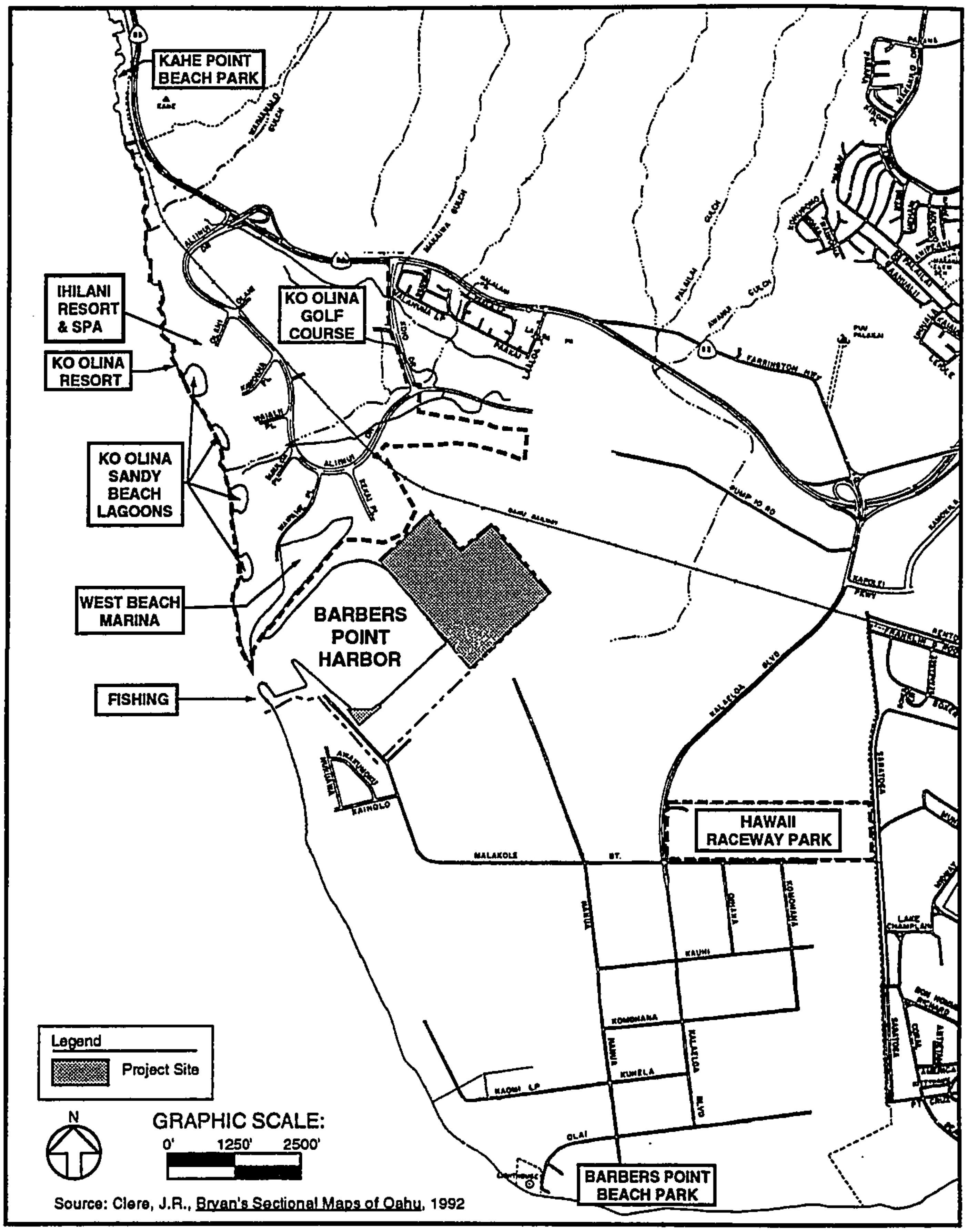
Other recreational facilities include:

- the Kapolei Golf Course;
- Hawaii Raceway Park (located at the entrance to Campbell Industrial Park); and
- Ko Olina Resort (located north of Barbers Point Harbor), which includes four sandy beach lagoons, a golf course, a marina (that shares the same entrance channel as the harbor), and the Ihilani Resort and Spa.

Planned recreational facilities include:

- a Marine Life Conservation District between Barbers Point Harbor and Kahe Point Beach Park;
- community parks in Kapolei Village as residential growth occurs;
- the Makakilo Golf Course; and
- further development of Ko Olina Resort, which could include another golf course, more hotels and resort development.

The shoreline near the harbor entrance can be accessed via Malakole Street, which ends at a parking lot adjacent to the barge pier, and is presently used for fishing.



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Locations of Recreational Resources and Facilities
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Final Supplemental Environmental Impact Statement
FIGURE 6-6

6.2.2 Probable Impact of Proposed Action

There are no recreational activities occurring at areas that will be directly affected by the proposed action, and therefore no recreational resources will be displaced. The proposed action will not affect existing shoreline access at the harbor entrance.

Noise, vibration, air and water quality impacts from the construction and operation of the proposed action are addressed in Chapter 5. Based on the analyses in these sections, recreational resources will not be affected by the project.

At some point, however, when levels of commercial shipping and recreational boating have increased, there could be some vessel traffic interference because West Beach Marina uses Barbers Point Harbor's entrance channel.

6.2.3 Mitigation Measures

Since there will be no displacement, access or other impacts to recreational resources from this project, no mitigation measures are needed at this point. However, to mitigate possible conflicts between harbor operations and West Beach Marina, vessel traffic mitigation such as described in the 2010 Master Plan for Barbers Point Harbor (1991) may be needed at some point. Such mitigation is not warranted at present and is not included as part of this project.

6.3 VISUAL

6.3.1 Existing Conditions

The major viewsheds of Barbers Point Harbor are:

- from Farrington Highway, although the kiawe forest somewhat blocks the view of the harbor and the existing stockpile; and
- from Honokai Hale, Nanakai Gardens, Ko Olina Fairways and some parts of Makakilo.

The harbor cannot be seen from many of the presently developed areas of Ko Olina Resort because of the design of the resort.

Barbers Point Harbor has an industrial appearance including cranes, paved areas, vessels, stockpiles and mining operations. It is immediately adjacent to the refineries at Campbell Industrial Park that also present an industrial appearance. Some of the industrial areas have high intensity illumination at night. Some portions of the partially completed Ko Olina Resort also have the visual appearance of a construction site.

6.3.2 Probable Impact of Proposed Action

The construction and operation of the harbor improvements are not expected to have an adverse visual impact because the existing harbor already has an industrial appearance, and these new activities will be immediately adjacent to the existing port development. Expanded port activities and new stockpiling are consistent with the existing views and appearance of other uses planned for the harbor area, such as new industrial subdivisions.

Details of the nighttime illumination of the proposed storage yards have not yet been developed.

Since the harbor area already has stockpiles and an overall industrial appearance, visual impacts from additional stockpiles will be minimal. Visual impacts will decrease as material is withdrawn from the stockpiles, and at some point the stockpiles will no longer exist.

6.3.3 Mitigation Measures

The 40-feet limitation on stockpile height (see Chapter 2) will help minimize visual impacts. Landscaping of the stockpiles is a mitigation measure that was considered but rejected. A previous attempt at landscaping the stockpiles failed because the material has a high salt content and because of its coarse nature, does not hold water. Imbedding planters in the stockpile and then maintaining them would not be practical.

The impacts of nighttime illumination of the storage yards on residential areas will be mitigated through proper design of the lighting system, including height and number of lighting standards and the use of appropriate shielding.

6.4 SOCIO-ECONOMIC CONDITIONS

6.4.1 Existing Conditions

In 1990 the Ewa district had a resident population of 42,983 according to the General Plan, Objectives and Policies (1992).

Between 1980 and 1990, the Ewa district experienced an average annual growth rate of 1.7 percent while Oahu experienced only a 0.9 percent average annual growth rate. Ewa's rapid population growth is likely to continue since this region has been designated in government plans for further urbanization.

Figure 6-7 displays certain characteristics of occupied housing units in Ewa. In 1990, there were 11,734 housing units in the Ewa Development Plan area, with a 2.6 percent vacancy rate, lower than the rate for Oahu which was 5.8 percent.

The communities nearest the project site are currently Honokai Hale/Nanakai Gardens and Makakilo. Ko Olina Fairways is scheduled for occupancy in February 1995. The Barbers Point Harbor Expansion Social Impact Assessment (1993) states that approximately 1,200 persons resided in Honokai Hale/Nanakai Gardens in 1990. According to the 1990 census, 9,922 persons lived in Makakilo. There were approximately 3,300 housing units in Makakilo and in Honokai Hale/Nanakai Gardens. Owner-occupancy in these communities is higher than the Oahu average.

Figure 6-7

CHARACTERISTICS OF OCCUPIED HOUSING UNITS IN EWA DEVELOPMENT PLAN AREA, 1990

	Oahu	Total Ewa	Makakilo Census Tract		Ewa to Honokai Hale Census Tract	Naval Air Station	West Loch Census Tract	Ewa Beach & Iroquois Point Census Tract		
			86.03 [1]	86.04	86.98		87.98 [2]	83.01	83.02	84
Total Occupied Units	281,683	11,434	1,947	1,026	1,333	1,313	219	1,513	1,387	2,696
Owner-occupied	52.0%	53.5%	69.1%	80.0%	65.3%	0.4%	81.7%	0.5%	80.5%	65.6%
Renter-occupied	48.0%	46.5%	30.9%	20.0%	34.7%	99.6%	18.3%	99.5%	19.5%	34.4%
Persons per room										
1.00 to 1.50 [3]	8.2%	10.9%	6.5%	9.6%	17.5%	4.6%	13.7%	3.9%	23.3%	11.5%
1.51 or more [4]	8.2%	8.5%	3.1%	8.4%	17.9%	1.5%	5.5%	0.5%	18.5%	10.9%
Persons per unit	3.02	N/A	N/A	3.91	4.14	2.71	3.77	3.75	4.83	3.58
Persons in Occupied Units	802,338	41,818	5,869	4,015	5,517	3,559	826	5,676	6,699	9,657
As % of Total Population	95.9%	97.3%	99.4%	100.0%	99.9%	78.6%	100.0%	98.1%	100.0%	99.8%

Source: U.S. Bureau of Census, 1991; taken from Earthplan, Barbers Point Harbors Expansion Social Impact Assessment, 1992.

Notes:

(1) The information presented for census tract 86.03 excludes Block Group 1, which is Kunia Village.
(2) This information is for the West Lock area only and excludes the Waipahu portion of this census tract.
(3) Indicates 'mildly crowded' conditions.
(4) Indicates 'very crowded' conditions.

6.4.2 Probable Socio-Economic Impact

Regardless of the harbor expansion, the Barbers Point Harbor Expansion Social Impact Assessment (1993) predicted that the Ewa district is expected to experience:

- continued creation of distinct, new communities;
- efforts to retain identity/characteristics of existing communities;
- evolution of Ewa's regional identity;
- population and cultural diversification;
- competition for public, particularly recreational, facilities;
- shift in employment patterns and increased job competition; and
- introduction of a visitor industry.

These changes will occur as:

- sugar cultivation ends;
- new residential, industrial and commercial developments are constructed;
- *resort development continues; and*
- a major military installation closes.

Although sugar cultivation has been the major land use in Ewa for the last 100 years, Oahu Sugar Company, Ewa's only operating sugar company, recently announced that it will be terminating its operations. There are plans to convert large portions of sugar land in central Oahu to diversified agriculture.

While BPNAS is scheduled to close in 1997, a wide variety of the new land uses have been proposed at BPNAS. New uses have not yet been determined, so the number of new jobs to be created is not yet known. Suggested uses range in their degree of labor intensity.

The City and County of Honolulu has designated the Ewa region as the island's secondary urban center. The focus of this secondary urban center is the City of Kapolei. Continued development of residential housing in Makakilo, Kapolei and other areas such as Ewa Marina is expected. By 2010, the population in Ewa is expected to be approximately 119,000 to 130,000, triple its 1990 population (General Plan, Objectives and Policies, 1992).

New employment opportunities include:

- The Ko Olina Resort, which includes substantial acreage still available for development;
- Campbell Square, Kapolei's first office complex which was completed in 1993;
- the Kapolei Business Park, which is being presently being developed and contains land zoned for industrial and maritime industrial purposes;
- smaller industrial developments such as the 63-acre maritime industrial subdivision located southwest of the harbor, and the Kenai Industrial Park;
- the Kapolei Shopping Center which has 134,500 square feet of leaseable space; and
- planned commercial and office developments in Kapolei, such as a pedestrian mall, movie theaters, banks, restaurants, and City and State offices.

6.4.2.1 ECONOMIC IMPACT OF CONSTRUCTION

The proposed action will not have an effect on existing agricultural or other employment since agricultural activities do not occur on any of the directly affected areas. Grace Pacific and Hawaiian Cement will continue their operations during construction of the harbor improvements.

Construction expenditures will have a beneficial impact on the local construction industry. Up to 28 jobs could be directly created during the construction of Expansion Areas A and B, and an average of 70 jobs (Barbers Point Harbor Expansion: Impact on Employment, 1992) could be directly created during the construction of new piers and storage facilities. A larger number of jobs will be indirectly created during the construction phase.

The coral material which will be removed from Expansion Areas A and B also has a value. The primary uses include:

- road base;
- cement;
- structural fills; and
- aggregate.

6.4.2.2 SOCIAL IMPACT DURING CONSTRUCTION

Residents in Honokai Hale and Nanakai Gardens reported physical damage to their homes and personal stress during the original construction of the harbor. They also objected to the smell of and dust from the removed material. Noise, vibration and air quality impacts from the project are expected to be minimal and acceptable (see Chapter 5) and the related social impacts are expected to be insignificant.

6.4.2.3 ECONOMIC IMPACT DURING HARBOR OPERATIONS

Beneficial economic impacts are expected during harbor operations, including direct maritime expenditures, port-related job creation, and the development of new businesses near the harbor. A partial list of port expenditures is given in Figure 6-8. While some of these revenues will accrue to the State (e.g., wharfage and facility charges), others will flow to private businesses.

Harbor operations will require support businesses to supply ships, handle cargoes and provide other services. An employment impact analysis prepared for the SDOT (Barbers Point Harbor Expansion: Impact on Employment, 1992) estimated that at full operation, the proposed action will generate about 460 jobs with annual salaries ranging from $25,000 to over $75,000 (based on an employment multiplier of about 4 jobs per acre), and about 500 jobs could be created indirectly (based on about 1 indirect job per direct job).

Harbor improvements will also encourage certain businesses to locate near the harbor. For example, Barbers Point Harbor greatly influenced AES-BP's decision to locate its coal co-generation plant in Campbell Industrial Park. Employment levels of 3.5 persons per acre could be expected for heavy and waterfront industrial business activities. According to a market assessment report prepared for The EJC, Barbers Point Harbor will influence demand for up to 60 acres of maritime industrial land by the year 2010 thus creating 210 jobs. The proposed improvements will represent approximately 60 percent of the harbor's future capacity, so the improvements could create 126 of the 210 jobs. The Kapolei Business Park, the maritime industrial park and Kenai Industrial Park (see Figure 4-1) will be possible locations for this marine-related industry.

Figure 6-8

TYPICAL PORT INDUSTRY DIRECT EXPENDITURES

- Navigational services
- Expenses to meet government requirements
- Supplies
- Bunkers
  - Oil
  - Water
- Minor repairs
- Stevedoring
- Equipment rental
- Container stuffing
- Terminal charges
- Storage and facilities charges
- Wharfage
- Warehousing
- Reefer storage
- Drayage
- Inland transport
  - Trucking
  - Rail
  - Barge
- Export packing
- Agency commissions
- Freight forwarders
- Customs house brokerage
- Banking and insurance
- Other professional services
- Crew expenditures

Source: U.S. Department of Transportation, Maritime Administration, Revised Port Economic Impact Kit, 1981.

6.4.2.4 IMPACT TO STATE AND COUNTY FINANCES

The State is acquiring 140.5 acres for this project from The EJC. State acquisition of this land will decrease real property tax revenues since these lands will become tax-exempt. However, The EJC is planning to develop the Kapolei Business Park adjacent to the harbor and is changing the zoning of approximately 552 acres from agriculture to industrial and commercial. Since industrial and commercial districts generate far more property tax revenue than agricultural land, an increase in property taxes from lands that will become the business park is expected and will more than offset the loss of 140.5 acres from the property tax base.

The expansion of the harbor will stimulate harbor-related business enterprises and increase employment in the Ewa area. Increased business activities will result in higher State tax revenues in the form of excise, individual and corporate income taxes.

Harbor improvements will permit a higher level of shipping activity and therefore increase port user fees paid to the State.

6.4.3 Mitigation Measures

To mitigate potential social impacts on Honokai Hale/Nanakai Gardens and Ko Olina Fairways, construction impacts will be minimized. Noise, vibration and air quality impacts are discussed in Chapter 5. A program of community awareness is also planned so that residents are kept informed (see Chapter 13).

Since no negative economic impacts are expected from the proposed action, no economic mitigation measures are proposed.

CHAPTER 7

PUBLIC SERVICES

The information on public utilities in this chapter is based on the Preliminary Engineering Report for the Proposed Barbers Point Harbor Expansion prepared by Engineering Concepts, Inc., September 1993.

7.1 WATER SUPPLY

7.1.1 Existing Conditions

Barbers Point Harbor is currently served by a 20-inch Board of Water Supply (BWS) main in Malakole Street. There is one existing domestic water meter for the harbor. The water source is near Waipahu in the vicinity of Kunia Interchange. The Hoaeae Wells, Kunia Wells I and II, and the Waipahu Wells provide the water needed in the Ewa/Kapolei area.

The existing harbor facilities have a water allocation of 127,000 gallons per day (gpd) from the BWS. Present water usage is estimated by the SDOT to be approximately 20,000 gpd. Water at Barbers Point Harbor is used for shoreside facilities and to service vessels in port.

7.1.2 Probable Impact of Proposed Action

The potable water demand for the proposed pier and storage yard facilities can be estimated by the acreage of the shoreside facilities and a water use factor. A factor of 880 gpd per acre was used for the type of facilities proposed. This factor was based on actual water consumption for a comparable area within Honolulu Harbor. Based on approximately 134 acres of shoreside facilities, potable water use is estimated to be 118,000 gpd for the proposed action.

The ultimate water demand for the entire harbor will be 194,000 gpd based on a total land area of about 220.5 acres. The 20-inch existing water main to the harbor could accommodate this additional water demand. The water supply system will have to be extended to the proposed shoreside facilities.

7.1.3 Mitigation Measures

The SDOT will apply for the additional water allocation as warranted with future expansion improvements.

7.2 WASTEWATER

7.2.1 Existing Conditions

There are no existing wastewater facilities on the sites of the proposed action. Wastewater within the existing harbor is generated at three comfort stations--one operated by SDOT and the others by its tenants. Disposal of wastewater from the SDOT comfort station is by onsite seepage pit. One tenant-operated comfort station utilizes a septic tank and the other utilizes a holding tank for wastewater disposal. The harbor does not presently provide facilities for vessels to discharge wastewater. When necessary, the ship's agent makes arrangements for a tank truck to receive vessel wastewater.

The Honouliuli Wastewater Treatment Plant (WTP) is the nearest treatment facility, located approximately four miles east of the harbor. An existing gravity interceptor sewer running parallel to the railroad right-of-way, mauka of the harbor, connects the Ko Olina Resort with the Honouliuli WTP. There are presently no sewers serving the harbor.

7.2.2 Probable Impact of Proposed Action

Use of septic tanks will be an interim method of wastewater treatment and disposal prior to connection of the harbor facilities to the municipal sewer system. The wastewater estimated to be generated by Barbers Point Harbor has been included in a Wastewater Management Master Plan for the proposed Kapolei Business Park submitted by The EJC and approved by the City Division of Wastewater Management in January 1992. Coordination between SDOT and The EJC will occur to ensure adequate capacity of the proposed Kapolei Business Park sewer system for wastewater from the harbor.

7.2.3 Mitigation Measures

In the interim, wastewater generated from the proposed action will be disposed of through a septic system. Eventually, wastewater from the harbor will be disposed of through the Kapolei Business Park sewer system, and treated at the Honouliuli WTP. Therefore, no mitigation measures need to be implemented.

7.3 POWER AND COMMUNICATIONS

7.3.1 Existing Conditions

Electricity to Barbers Point Harbor is currently provided by Hawaiian Electric Company (HECO) through a utility corridor along Malakole Street. An existing HECO substation is located adjacent to the railroad right-of-way and west of Kalaeloa Boulevard. GTE Hawaiian Telephone (HawTel) provides telephone service to the existing harbor facilities.

7.3.2 Probable Impact of Proposed Action

The proposed action will place additional demands on power and communication systems. The existing electrical and telephone lines will be extended to the areas of the proposed improvements. In order to accommodate development in the Ewa/Kapolei areas, HECO is planning to increase the electrical generating capacity of its Kahe Power Plant.

7.3.3 Mitigation Measures

Since HECO is committed to provide electrical power to all Ewa/Kapolei developments, including Barbers Point Harbor, no mitigation measures need to be implemented.

7.4 FIRE PROTECTION

7.4.1 Existing Conditions

Fire protection services to Barbers Point Harbor are presently provided from the Makakilo and Nanakuli Fire Stations. Ladder service is from the Waipahu Fire Station. A new fire station near the entrance to Campbell Industrial Park is scheduled to be in service in March 1995. This station will house an engine and ladder company.

A fire boat is moored at Honolulu Harbor and could be dispatched to Barbers Point Harbor if necessary.

Fire hydrants are located in Storage Yards S-4 and S-5 and additional fire hydrants will be installed in Storage Yard S-3.

7.4.2 Probable Impact of Proposed Action

The proposed action will allow Barbers Point Harbor to handle more cargo. This additional maritime activity might increase the potential for fire. With the new fire station located within a few minutes of Barbers Point Harbor, the Fire Department response time will be shortened. In addition, the City and County of Honolulu Fire Department reported in a letter dated October 26, 1994, that the proposed action will have no adverse impact to Fire Department facilities or services.

7.4.3 Mitigation Measures

All structures and cargo handling activities must conform to fire codes. Additional fire hydrants will be installed in the new storage yards. All on-site fire protection measures will be coordinated with the Fire Prevention Bureau at the City and County of Honolulu Fire Department.

CHAPTER 8

RELATION BETWEEN THE LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

For this project, the short-term uses of the environment are primarily associated with its construction phase impacts, as described in Chapters 5 and 6 and summarized in Chapter 10. The long-term enhancements of productivity are primarily related to improvements to Oahu's port and intermodal transportation system, which in turn will help support the State's economy and the State and City and County development plans for the Ewa plain, as discussed in Chapter 4.

8.1 SHORT-TERM USE OF THE ENVIRONMENT

The project will transform about 25 acres of land into a body of water, expanding the existing harbor basin. One hundred thirty-four acres of land surrounding the new basin area will be graded and paved for use as storage yards.

Although the proposed work will result in minor short-term adverse impacts (see summary in Chapter 10), performing the work at an existing harbor will minimize the adverse effects in comparison to constructing a new harbor. As discussed in Chapter 3, since Honolulu Harbor is unavailable for the proposed facilities, Barbers Point Harbor is the most appropriate location for them. The siting of these facilities at Barbers Point Harbor is consistent with the master plans for Barbers Point and Honolulu Harbors.

Construction of the project in accordance with applicable standards will assure that the adverse impacts will be minimized and acceptable.

Positive short-term impacts on the social environment will include the jobs created during the construction phase and the cash flow for materials purchased for construction.

8.2 ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed improvements to Barbers Point Harbor will enhance long-term productivity by:

- increasing the vessel berthing and cargo handling capacity of Barbers Point Harbor;
- facilitating the relocation of certain cargo handling activities from Honolulu Harbor as described in the Honolulu Waterfront Master Plan (1989);
- relieving existing and future congestion at Honolulu Harbor;
- increasing the capacity of Oahu's intermodal transportation system;
- supporting the planned growth in the Ewa plain (in conformance with State and City and County plans) by providing employment opportunities, increasing development opportunities near Barbers Point Harbor, and, in comparison to Honolulu Harbor, increasing the efficiency of transporting goods destined for leeward Oahu; and
- providing usable raw materials (limestone) for the production of cement, aggregate and other stone products.

Barbers Point Harbor provides all the elements conducive to harbor use. The site is physically suitable for harbor development, the population base in the area is growing and surrounding lands are used for industrial purposes. The proposed expansion will implement the next phase of the plan to establish a port closer to the growing number of cargo destinations in leeward Oahu. Together with Honolulu Harbor, the expanded Barbers Point Harbor will meet short- and long-term needs for additional maritime cargo handling capacity and realize significant overland haul benefits. In conclusion, the long-term productivity enhancements of the proposed action will exceed its short-term adverse impacts.

CHAPTER 9

ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WILL BE INVOLVED IN THE PROPOSED ACTION

Irreversible and irretrievable commitments of resources associated with the improvements to Barbers Point Harbor will include the transformation of approximately 25 acres of naturally occurring land into a water body used for harbor operations. The natural topography and character of much of the land to be affected by the proposed action was previously altered during the initial harbor construction. Most of the affected land is currently used for stockpiling material and coral mining.

The immediate area is already committed to harbor operations and industrial use. No agricultural operations will be affected by the proposed action. The biological resources which will be affected are minor, and the project boundaries have been reconfigured to avoid destruction of archaeological resources. The visual impact of the expanded harbor will conform with the current landscape. Efforts such as establishment of a buffer zone along the 84-acre parcel have been made to allow resort development to coexist with the harbor, and the harbor improvements are not expected to reduce the viability of the adjacent resort activities.

As with any construction activity, resources such as fossil fuels and construction materials will be irrevocably committed. In addition to the fuels and construction materials involved, approximately $155 million (Figure 2-13) will be committed to the project. Labor will be required for planning, engineering, and construction.

The operational phase will involve an irreversible commitment of utilities, such as water and electrical service.

CHAPTER 10

PROBABLE UNAVOIDABLE ADVERSE EFFECTS

Unavoidable adverse impacts that will result from the proposed action include the following:

Coastal Water Quality

Turbidity in the harbor and coastal waters will increase for a short time during the removal of the enclosure berm between Expansion Area A and the main harbor, and during the excavation of Expansion Area B. As discussed in Section 5.6.2.3, this increase will have minimal environmental impacts. The predicted turbidity levels are within the range of natural turbidity in the harbor and coastal waters.

Although turbidity will increase on occasion during the operation phase of the harbor because of increased vessel traffic, these increases will be within the variability already experienced in the harbor.

Accidental or unauthorized introduction of contaminates from vessels into the harbor and nearshore waters is a potential adverse impact. However, bacteria in illegally dumped sewage would be rapidly killed by the effects of salinity and sunlight. Low levels of hydrocarbon contaminants do not appear to adversely affect marine organisms within marinas and harbors. Should there be an oil spill, response procedures have been developed for Barbers Point Harbor. Tidal flows and groundwater influx would flush the limited amount of pollutants that might be accidentally introduced into the harbor into ocean waters where they would undergo further dispersion, weathering and degradation.

Drainage

The proposed paving of storage yards will increase the volume of runoff discharged to the harbor. This runoff could contain some contaminants, however, the proposed storm drainage system will be designed in compliance with applicable environmental regulations including the National Pollution Discharge Elimination System (NPDES).

Groundwater

Construction of Expansion Area A will modify the groundwater regime in the immediate vicinity of the harbor. As discussed in Section 5.5.2, this impact will be inconsequential. There will be no effect on either potable groundwater resources or on irrigation quality water. There will be minor impacts to the aquifer containing high salinity, brackish water which is used for industrial cooling and washing purposes, but the impact will be small, particularly in comparison to changes which will occur as a result of the termination of sugar cane irrigation.

Noise and Vibration

Construction noise and vibration will be perceived in proximity to the harbor, but as discussed in Sections 5.11.3.1 and 5.12.3, the peak velocity levels in residential areas would be limited to levels which would be "just perceptible." Peak vibration levels at the harbor would be limited to a level well below the level that would cause structural damage. A monitoring program would be conducted and modifications to construction procedures made to ensure that the level of vibrations remains within specified limits.

After the new facilities are constructed, there will be an increase in noise levels associated with a higher level of port activity. This noise will generally be inaudible to nearby residents or masked by traffic and other noise. Mitigation measures would keep noise within allowable limits. In industrial areas, there should be little impact because of existing noise levels.

Air Quality

Short term impacts will include air pollutant emissions from construction equipment and dust from construction areas. Dust generation and dispersion will be minimized by watering programs, windscreens or other dust abatement measures. Long-term air pollutant emission levels will increase because of the increased level of port operations, including vessel, equipment and traffic emissions. Most emissions will be carried offshore because of the prevailing wind direction, and will not affect adjacent properties.

Some of the dredged material may cause unpleasant odors. The hot, dry climate of the area will rapidly dry the material and diminish any odors, so this impact will be temporary should it occur. The prevailing winds will help disperse any odors offshore.

Traffic Impacts

There will be short-term traffic impacts associated with construction activities and long-term traffic impacts associated with an increased level of port activity. Regardless of this project, however, the roadway system in the vicinity will need improvement to accommodate the traffic generated by other developments in the Ewa region.

Visual Impacts

Material stockpiles will create visual impacts which are viewed as inconsequential given the industrial setting of the area. The stockpiles will be temporary and will eventually be depleted.

Botanical Impacts

Mixed weeds, kiawe trees and koa-haole shrubs will be removed from the undeveloped portions of the 56.5-acre parcel. These botanical resources are regionally abundant and their loss in this area is not viewed as significant.

Ciguatera Impacts

The proposed action will increase the number of vessels using Barbers Point Harbor. An increase in ciguatera could theoretically occur if ships come from areas of the Pacific where ciguatera is endemic. However, recent surveys and those conducted before and after the original harbor excavation documented no increase in ciguatera toxins at Barbers Point Harbor. Also, the relatively low temperatures, low salinity, and high turbidity levels of Barbers Point Harbor waters are not conducive to ciguatera growth.

Potential Tsunami Impacts

The proposed action will lower existing grades adjacent to the expansion area and could enlarge the potential inundation areas around the harbor. An increase in harbor size may affect current patterns and surge in the harbor and channel during a tsunami.

<u>Increased Demand for Water and Wastewater Disposal</u>

As discussed in Sections 7.1.2 and 7.2.2, demand for potable water and wastewater treatment will increase when the harbor is operational. The SDOT would request a water allocation when warranted.

The increased wastewater will temporarily be disposed through a septic system. Eventually wastewater from the harbor will be disposed through the Kapolei Business Park sewer system, and treated at the Honouliuli WWTP.

<u>Increased Need for Power and Communications</u>

The proposed action will place additional demands on power and communication utility systems. It is anticipated that the existing electrical and telephone lines will be extended to the areas of the proposed improvements. In order to accommodate development in the Ewa/Kapolei areas, HECO is planning to increase its electrical generating capacity.

CHAPTER 11

PROPOSED MITIGATION MEASURES

This chapter summarizes the mitigation measures that will be implemented to minimize the adverse impacts of the proposed action.

11.1 MITIGATION MEASURES THAT WILL BE IMPLEMENTED DURING CONSTRUCTION PHASE

11.1.1 Noise

Construction noise impacts will be mitigated by the following measures:

- Contract specifications for blasting would require the use of noiseless shock tube leads, detonation of charges from the bottom of the hole, and stemming the charges at the top of the hole to eliminate or minimize surface noise. With these precautions, it is expected that noise levels due to blasting would be minimal.
- Construction equipment will be equipped with mufflers in good working order and will comply with Department of Health and OSHA regulations for vehicular noise emissions.
- Although construction noise is not expected to exceed ambient levels in nearby sensitive areas, Section 5.11.4 lists additional mitigation measures which could be implemented.

11.1.2 Vibration

Vibration impacts due to blasting would be mitigated by the following measures:

- Specify vibration limits in contract documents of 0.30 inch/second (in/sec) to protect structures and 0.03 in/sec to minimize annoyance at potentially affected residential areas.
- Specify appropriate blasting quality control measures to ensure adequate control of the process.
- Specify that the contractor retain a qualified blasting consultant to provide a plan and initiate blasting work, including the supervision of initial test blasting to establish effects and baseline conditions.

- Monitor vibrations at sensitive locations throughout the construction period.
- Conduct pre-construction structural integrity inspections of sensitive structures in the vicinity.
- Inform people living and working in the vicinity about the construction method, probable effects, quality control measures and precautions to be used, and the channels of communication available to them.

11.1.3 Water Quality

Water quality mitigation measures that will be implemented during construction include:

- Expansion Area A will be excavated behind an enclosure berm to minimize turbidity within the main harbor and coastal waters;
- in the event that hydraulic dredging is used as the construction method, the return water will be discharged to Expansion Area A, behind the enclosure berm;
- a Best Management Practice (BMP) plan will be developed to control stormwater runoff, erosion and sediment from the stockpiles; and
- turbidity will be monitored during construction, and procedural modifications made to comply with requirements.

11.1.4 Air Quality

All construction activities must comply with the State Air Pollution Control Regulations which prohibit visible emissions of fugitive dust at the property line. To mitigate air quality impacts from construction and stockpiling activities, active work areas, unpaved haul roads and stockpile areas will be watered as necessary to control dust. If dust blowing from the stockpiles becomes a nuisance, a crusting agent could be used to cement the surface. Other possible dust mitigation measures include covering the stockpiles with erosion control mats or erecting wind screens. The direction of the prevailing winds will also minimize adverse impacts on adjacent areas.

11.1.5 Hazardous Waste

Appropriate regulations will be followed during the removal of the fuel pipeline within Expansion Area B. Hazardous materials generated during construction will be handled in accordance with all applicable requirements.

11.1.6 Archaeological Resources

The project site has been configured to avoid impacts to archaeological resources recommended for preservation. Some sites recommended for data recovery still remain within the area to be affected, however, and data recovery activities at these sites will occur. In addition, should there be any inadvertent discoveries of resources during construction, work will stop immediately and the SHPD will be notified.

11.1.7 Visual Impact

The stockpiles will be limited in height.

11.1.8 Ciguatera

A post-construction ciguatera survey similar to the pre-construction survey will be conducted following completion of the project. In case of any reported outbreak, the SDOT will assist the State DOH to protect the public health and safety by putting up warning signs and taking other steps.

11.1.9 Threatened and Endangered Species

To ensure that there are no direct impacts to green sea turtles which may enter the harbor and approach the construction areas, project specifications will require construction personnel to monitor turtles which might venture into the harbor basin. Shields will be placed around lights employed during hydraulic dredging to avoid attracting sea turtles.

The FWS will be notified of any Hawaiian stilt activity which may occur if settlement ponds (associated with the hydraulic dredging construction method) are constructed.

11.2 MITIGATION MEASURES THAT WILL BE IMPLEMENTED DURING OPERATIONAL PHASE

11.2.1 Water Quality

Increased use of the harbor will increase the chance of accidental spills of oil and other contaminants and the illegal discharge of sewage. Each company using the harbor has a Harbor User Plan that describes oil spill response procedures, and clean-up equipment is maintained by the Clean Islands Council. Discharge of sewage and other contaminants by vessels is regulated by both the State and federal government. The natural flushing of the harbor by tidal flows and groundwater influx will not be changed by the harbor improvements, and will move to the ocean small quantities of pollutants that might accidentally be introduced to the harbor.

11.2.2 Air Quality

Particular cargoes that will move across the new piers are not known at this time, so the specific air pollutant emissions that could be associated with handling these cargoes cannot be determined. However, air quality emissions from cargo handling will be controlled in accordance with requirements. For example, emissions of particulate matter from dry-bulk handling could be reduced through the use of dust suppression or dust collection systems.

To mitigate traffic-related air pollution, improvements to roadways approaching the harbor should be made (see Section 5.10.3). However, these mitigation measures are not proposed as part of this project.

11.2.3 Land Use

SDOT and the City and County of Honolulu have agreed to establish a buffer zone between the Ko Olina Resort and the 84 acres acquired from The EJC consisting of a 50-foot strip of landscaping along the northwest boundary of the parcel and a 100-foot building setback. The buffer will minimize the impact of the harbor on the resort.

11.2.4 Recreational Activities

Because Barbers Point Harbor and West Beach Marina share the same entrance channel, future levels of vessel traffic may warrant the development of a vessel traffic control system for the channel. However, this mitigation measure is not included in this project.

11.2.5 Drainage System

The storm drainage system for the storage yards will be properly sized and maintained. The EJC has proposed a large drainage channel as an element of the Kapolei Business Park which will intercept presently uncontrolled upland runoff in the harbor vicinity and discharge it to the ocean.

11.2.6 Noise

The exact types and locations of future harbor equipment are unknown at this time. The following measures could be used to mitigate noise due to harbor operations:

- set back distances;
- sound barriers;
- limits on motor heights for cranes ;
- maximize the effects of shielding;
- equip equipment with mufflers;
- keep exhaust stacks low to the ground;
- secure and cushion ramps against rattling;
- limit speeds;
- provide workers with hearing protection devices; and
- disclose noise conditions to discourage incompatible uses of adjacent properties.

11.2.7 Hazardous Waste

The expansion will increase the possibility of hazardous material cargoes moving through Barbers Point Harbor. All regulations pertaining to the handling of hazardous materials will be followed.

CHAPTER 12

SUMMARY OF UNRESOLVED ISSUES

SDOT's program of consultation meetings and the comments received on the EISPN and the Draft SEIS (see Chapters 13 to 15) have provided substantial input on issues and concerns relative to the proposed action. Most issues raised have been addressed in this Final SEIS, although some issues remain unresolved. These unresolved issues are listed below, along with a brief discussion regarding the resolution of the issue.

- The excavation method to be utilized. Since all three methods of excavation discussed in this Final SEIS are feasible with minimal environmental impacts, they will remain as options to the construction bidders on the project. Each bidder will submit a bid based on one method of excavation, and upon the State's evaluation of the bids, the method will then be determined through the selection of the lowest responsible bidder. It is expected that the selected method will be one of the three methods described in Chapter 2, all of which have been addressed in this Final SEIS. Appropriate environmental protection measures developed in the project design phase for the various construction methods will be specified in the construction bid documents.

- The particular stockpiling scheme to be utilized. Stockpile Areas 1, 2, and 3 are located on land that is now or is designated to become State property. Negotiations are underway with the owner of Stockpile Area 4 to secure its use for the project. In addition, it has been proposed that the construction contractor be allowed to remove some or all of the material if an acceptable site or use is available. This issue will remain unresolved until the bids of the contractors have been evaluated, and the winning contractor selected. This Final SEIS has addressed the environmental impacts of material disposal at Stockpile Areas 1, 2, 3 and 4. The environmental impacts of contractor disposal have not been addressed in this Final SEIS, and so if this method is selected, additional environmental studies may be necessary.

- Details of certain environmental monitoring programs to be undertaken. Specifications for the monitoring of noise, ground vibrations and water quality have not yet been developed. It is expected that the details of each monitoring program will be developed in consultation with the appropriate environmental agencies within the context of the environmental permitting process.

- The exact types and locations of future cargo handling equipment. Future cargo handling equipment will depend on future commercial operations which cannot be determined at this time. In the absence of precise information, typical equipment types have been assumed to evaluate potential environmental impacts in this Final SEIS.

- Installation of State Civil Defense siren warning devices. Appropriate siren devices will be installed at Barbers Point Harbor. Discussions have been held between the SDOT and the State Department of Defense on the number and location of the devices.

SDOT is aware of concerns regarding the proposed project, and will continue to work with residents and businesses in the area, agencies and interest groups so that the final project plans meet the project objectives and are responsive to public and agency concerns.

CHAPTER 13

AGENCY CONSULTATIONS AND PUBLIC OUTREACH

Many agencies, organizations, and individuals have been consulted about this project. This consultation and public outreach has occurred through:

- meetings and correspondence;
- publication of a Supplemental Environmental Impact Statement Preparation Notice (SEISPN) in the OEQC Bulletin on April 8, 1994;
- distribution of an Environmental Assessment (EA) of the project to approximately 30 agencies and other interested parties in April, 1994;
- a public information and education program that includes newsletters, video, and other public communications about the project; and
- publication of a Draft Supplemental Environmental Impact Statement on September 13, 1994 with a 45-day public comment period (refer to Chapter 15).

SDOT is committed to continuing this consultation process so that concerns are adequately addressed.

13.1 MEETINGS

Meetings have been held with the following government agencies, private organizations, and neighborhood and citizens' groups:

Federal Agencies
- U.S. Army Corps of Engineers, Honolulu District (ACOE)
- Department of the Interior, Fish & Wildlife Service (FWS)
- Department of Commerce, National Marine Fisheries Service (NMFS)

State Agencies
- Department of Health (DOH), Clean Water Branch
- Department of Land and Natural Resources (DLNR):
    - Aquatic Resources Division
    - Land Management Division

    - State Historic Preservation Division (SHPD)[1]
    - Commission on Water Resource Management
- Office of State Planning, Coastal Zone Management
- University of Hawaii, Environmental Center

Private Organizations
- West Beach Estates
- The Estate of James Campbell
- Grace Pacific Corporation
- Hawaiian Cement
- Barbers Point Harbor Users Group

Community Associations
- Honokai Hale/Nanakai Gardens Community Association
- Villages of Kapolei Community Association
- Makakilo Community Association
- Ewa Neighborhood Board

One purpose of these meetings was to identify concerns regarding the project. Relevant concerns that were raised at the meetings have been addressed in this Final SEIS.

13.2 PUBLICATION AND DISTRIBUTION OF THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (SEISPN) AND ENVIRONMENTAL ASSESSMENT (EA)

In addition to the publication of the SEISPN in the OEQC Bulletin in April 1994, parties that participated in meetings were sent a copy of the SEISPN and an Environmental Assessment (EA) that was prepared for the project.

The following groups and individuals were also sent the SEISPN and EA in April 1994, and were asked to comment on the project:

State Legislators
- The Honorable Paul Oshiro

[1] Consultation with the SHPD was accomplished through correspondence in lieu of a meeting as suggested by the SHPD.

- The Honorable Annelle Amaral
- The Honorable Henry Peters
- The Honorable Lehua Fernandes Salling
- The Honorable Brian Kanno
- The Honorable James Aki

City and County of Honolulu
- The Honorable John Desoto
- Department of Land Utilization

Citizen Groups and Citizens
- Ahahui Siwila O Kapolei
- Alan Ziegler, zoologist

13.3 PUBLICATION, DISTRIBUTION AND PUBLIC HEARINGS ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

A Notice of Availability of the Draft SEIS was published in the Office of Environmental Quality Control Bulletin on September 23, 1994. Copies of the Draft SEIS were distributed to those agencies and organizations included on the List of Parties Reviewing Draft SEIS and Final SEIS (Appendix A-7). In addition, copies of the Draft SEIS could be reviewed at the Office of Environmental Quality Control (OEQC) Library, the State Main Library, all regional libraries, and the branch libraries located in west Oahu. More than 80 documents were distributed before the initiation of the 45-day public review period, which ended on November 7, 1994.

During the public comment period public hearings were held on October 13 and 19, 1994. A press release for the October 19, 1994 hearing was issued, and radio and television stations and the wire service received it. Notices of the hearing appeared in the October 9 and October 18 Advertiser, and the October 17 Star Bulletin. In addition, 6,137 newsletters ("In the Leeward Loop") were sent out to the residents and businesses of Kapolei, Makakilo, Honokai Hale and Nanikai Gardens with a notice of the October 19 hearing.

Written and oral comments received during the public comment period, and responses to substantive comments, are presented in Chapter 15. The sign-in sheets for both public hearings are reproduced in Appendix A-9.

CHAPTER 14

REPRODUCTIONS OF ALL SUBSTANTIVE COMMENTS ON THE SEISPN AND RESPONSES AND A LIST OF THOSE WHO HAD NO COMMENT ON THE SEISPN

14.1 PARTIES THAT COMMENTED ON THE SEISPN

Parties that responded to the SEISPN or other communications with written comments pertaining to the project are:

- Department of the Interior, Fish & Wildlife Service (FWS)
- Department of Commerce, National Marine Fisheries Service (NMFS)
- Department of Land and Natural Resources (DLNR)
    - William W. Paty, Chairperson
    - Aquatic Resources Division
    - Commission on Water Resource Management
    - State Historic Preservation Division
- Barbers Point Harbor User Group, c/o Waldron Steamship Co., Ltd.
- The Honorable Annelle Amaral
- Ahahui Siwila Hawai'i O Kapolei
- The Estate of James Campbell
- Alan Ziegler, Zoological Consultant

The letters are reproduced in Appendix A-6.

14.2 COMMENTS RECEIVED AND RESPONSES

The comments of the parties listed above are summarized below by subject. After each comment the commentator is identified and a reference is provided to the section of the Final SEIS where the comment is addressed. A response is provided if the comment is not addressed elsewhere in this document.

The comments have been divided into the following subjects:

- Archaeology;
- Excavated Material;
- Floodplains;
- Groundwater;
- Harbor Improvements;
- Ciguatera;
- Noise and Vibration;
- Water Quality;
- Existing Land Uses;
- Transportation / Access; and
- Visual.

14.2.1 Archaeology

Comment 1.1: An acceptable inventory survey report for the project's land will be needed to evaluate the potential effects on historic sites of alternative designs for the proposed project. (DLNR, State Historic Preservation Division)

Response: Archaeological aspects are discussed in Chapter 6.

Comment 1.2: Prior to reclassification of the project area, it should be concluded that a historic site inventory for the project location is complete. (DLNR, State Historic Preservation Division)

Response: Archaeological aspects are discussed in Chapter 6.

Comment 1.3: B6-22 has undergone only a relatively small amount of testing but this work was sufficient to show that this is an extremely valuable and important prehistoric Hawaiian site, and should eventually be much more extensively excavated. (Zoological Consultant, Alan Ziegler)

Response: The 56.5-acre parcel has been reconfigured to avoid Site B6-22.

Comment 1.4: Alternatives to stockpiling dredged material that minimize or eliminate potential effects to the eight-acre sinkhole parcel should be adopted. (DLNR, State Historic Preservation Division)

Response: The eight-acre sinkhole parcel will not be affected by the proposed action.

Comment 1.5: Without a commitment to preservation of the area around these sites, it is recommended that the land should not be re-classified. (DLNR, State Historic Preservation Division)

Response: Archaeological aspects are discussed in more detail in Chapter 6.

14.2.2 Excavated Material

Comment 2.1: The proposed uses of the excavated material as described in the project's Environmental Assessment (EA) are ambiguous and do not adequately explain whether the material would be sold, given, exchanged, discounted or through some other means becomes "*the responsibility of the contractor.*" (State Representative, Annelle Amaral)

Response: Alternative schemes for the material disposal are presented in Chapter 2.

Comment 2.2: The Barbers Point Harbor Location Map (that appeared in the EA) shows possible stockpile areas for excavated material and should be revised to incorporate existing land uses, as many cannot be relocated. (The Estate of James Campbell)

Response: Possible stockpile areas are described in Chapter 2; land use is discussed in Chapter 4.

Comment 2.3: Campbell Estate's comments regarding the map (that appeared in the EA) should not be interpreted as Campbell Estate agreement to store the excavated material on Campbell Estate property. (The Estate of James Campbell)

Response: SDOT is negotiating with Campbell Estate to obtain permission to use Campbell Estate lands, as described in Chapter 2, for stockpiling.

Comment 2.4: Stockpiles should be landscaped, especially on windward sides to control wind erosion. (DLNR, Aquatic Resources Division)

Response: Stockpiles will not be landscaped but dust control measures will be employed as discussed in Chapter 5.

14.2.3 Floodplains

Comment 3.1: Confirm on the flood maps that the project site as indicated is not within a flood plain or erosion-prone area. (The Estate of James Campbell)

Response: Flood hazard is discussed in Chapter 5.

14.2.4 Groundwater

Comment 3.2: Recommend that a study be made of any groundwater impact. (DLNR, Commission on Water Resources)

Response: Groundwater impact is discussed in Chapter 5. A study was made.

14.2.5 Harbor Improvements

Comment 4.1: Take all necessary actions to obtain approval of the proposed improvements to Barbers Point Harbor so a first class port that satisfies Hawaii's shipping needs is attained. (Barbers Point Harbor Users Group)

Response: Comment noted.

Comment 4.2: The Commission on Water Resource Management concurs with the EISPN that a Supplemental EIS is appropriate for this project. (DLNR, Commission on Water Resources Management)

Response: Comment noted.

Comment 4.3: Appreciation for the opportunity to comment on the basin expansion, pier and storage yard improvements at Barbers Point. ('Ahahui Siwila Hawai'i Kapolei)

Response: Comment noted.

Comment 4.4: The loss of available berthing space at Honolulu Harbor and the need to minimize delays and disruptions to the vessel operations further emphasizes the need for the expansion to Barbers Point Harbor. (Barbers Point Harbor Users Group)

Response: Comment noted; need for the project is discussed in Chapter 1.

14.2.6 Ciguatera

Comment 5.1: What is the impact that excavation and construction may have on ciguatera and other toxins in fish that may be transferred to humans? (State Representative, Annelle Amaral)

Response: Ciguatera and other toxins are addressed in Chapter 5.

Comment 5.2: At least one sampling station at the harbor and/or other appropriate sites should be established to provide baseline data on ciguatera and other toxins. (State Representative, Annelle Amaral)

Response: Ciguatera and other toxins are addressed in Chapter 5. Sampling at the harbor was performed and ciguatera was not found.

14.2.7 Noise and Vibration

Comment 3.1: The residents of Honokai Hale and Nanakai Gardens want mitigation of blasting, noise, dust, vibration and other disturbances connected with construction. (State Representative, Annelle Amaral)

Response: These impacts and the respective mitigation measures are addressed in Chapter 5. The mitigation measures are summarized in Chapter 11.

Comment 3.2: The proposed harbor basin expansion would bring construction closer to residential areas exposing them to shock waves from blasting. A blasting plan needs to be formulated because residents of the nearby Honokai Hale community complained of structural damage to their homes that resulted from shock waves created by the previous blasting. (DLNR, Aquatic Resources Division)

Response: Vibration impacts and mitigation are addressed in Chapter 5. Vibration will not cause structural damage and will be kept to low levels to minimize annoyance at residential areas.

Comment 3.3: During the excavation of the Barbers Point Harbor entrance channel, blasting attracted sharks that presumably fed on the dead fish. The presence of sharks coupled with heightened turbidity of harbor and coastal waters could present a public safety problem. (DLNR, Aquatic Resources Division)

Response: Sharks will not be attracted because, since all blasting would occur onshore, there will not be dead fish. This and possible turbidity impacts are addressed in more detail in Chapter 5.

14.2.8 Water Quality

Comment 7.1: Once project depth is obtained, before the fast land border (berm) is torn down, vacuuming of the basin expansion should be accomplished to remove fines and sediments to reduce the problems associated with resuspension. (DLNR, Aquatic Resources Division)

Response: The proposed construction techniques are discussed in Chapter 2. Vacuuming Expansion Area A before removing the closure berm is not proposed.

Comment 7.2: Long-term turbidity of the harbor basin needs to be addressed. (DLNR, Aquatic Resources Division)

Response: Long-term water quality is discussed in Chapter 5.

14.2.9 Transportation / Access

Comment 9.1: The northwest boundary of the proposed expansion would be very close to the existing OR&L railroad tracks. The Hawaii Railway Society has plans to run tours from the depot in Ewa to Ko Olina Resort. (State Representative, Annelle Amaral)

Response: There will be no impacts on the railway, as discussed in Chapter 6.

Comment 9.2: Show the overland pipe conveyor on the map and depict the location of the Campbell Estate's temporary access to the future Maritime Industrial subdivision. (The Estate of James Campbell)

Response: Comment was noted in relevant figures in Chapters 2 through 5.

14.2.10 Visual

Comment 10.1: Will the expansion of Barbers Harbor include the installation of large overhead lights similar to those at Honolulu Harbor that burn all night? This could be a disturbing factor to the residents of Honokai Hale and Nanakai Gardens and should be addressed early. (State Representative, Annelle Amaral)

Response: Visual impacts are discussed in Chapter 6.

14.3 PARTIES THAT DID NOT COMMENT ON THE SEISPN

Except the parties that commented on SEISPN, all others listed in Chapter 13 were mailed the SEISPN and the EA but did not submit comments.

CHAPTER 15

RESPONSES TO COMMENTS RECEIVED ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT AND PUBLIC HEARING TESTIMONY

15.1 PARTIES THAT COMMENTED ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

The following federal, State, City and County government agencies, private individuals and public organizations sent written comments or gave testimony at public hearings. Other agencies, as listed in Appendix A-6, "List of Parties Receiving the Draft SEIS and Final SEIS," received copies of the Draft SEIS but did not send written comments. Although the public comment period ended on November 7, 1994, comments received through December 13, 1994 are included in this list.

Federal:

- Department of the Navy
- Department of the Army
  - U.S. Army Corps of Engineers
- U.S. Department of the Interior
  - Fish and Wildlife Service

State:

- Department of Business Economic Development and Tourism
  - State Energy Office
  - Land Use Commission
- Department of Budget and Finance
  - Housing and Finance Development Corporation
- Department of Defense
  - Office of Civil Defense
- Department of Land and Natural Resources
  - State Historic Preservation Division
  - Division of Aquatic Resources
  - Division of Land Management
  - Division of Water and Land Development
- Department of Accounting and General Services
- Office of Environmental Quality Control
- Office of State Planning
- University of Hawaii Environmental Center
- Department of Health
  - Clean Air Branch
  - Office of Solid Waste Management
  - Clean Water Branch
  - Noise and Radiation Branch

City and County of Honolulu:

- Department of Housing and Community Development
- Department of Parks and Recreation
- Building Department
- Department of Public Works
- Police Department
- Board of Water Supply
- Planning Department

- Fire Department
- Department of Transportation Services

Public Organizations and Individuals:

- Friends for Ewa
- Honokai Hale/Nanakai Gardens Community Association
- Sierra Club Legal Defense Fund
- West Beach Estates
- Ka Lahui Hawaii
- The Estate of James Campbell, Residential/Resort Properties
- American Lung Association
- Meredith Monteville

15.2 RESPONSES TO COMMENTS RECEIVED DURING THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT COMMENT PERIOD

All written and oral statements received on the Draft SEIS during the review period have been reviewed and carefully considered. Approximately one-third of the letters received stated that the agency had no comments to make on the Draft SEIS.

Comments received on the draft covered a wide spectrum of topics and no single issue dominated the expressed concerns. Although it is not reflected by the volume of letters and testimony received, one of the major issues for the community is the type of construction method to be used to excavate the expansion area. Stockpiling of the excavated material is also an important community concern.

Other concerns are more clearly reflected by the number of letters received on the topic. Several reviewers felt that the effects on groundwater were not clearly or sufficiently explained, and that the potential flooding associated with tsunamis and hurricanes was inadequately described. Concerns about water circulation and water quality, especially in the event of an oil spill, were also voiced. Letters also addressed the issues of traffic, endangered wildlife, Ceded Lands, noise, storm water drainage, air quality, entrance channel use, surge conditions in the harbor, and archaeological resources. One letter questioned the need for the harbor and the use of public funds. Only one letter voiced clear opposition to the project.

Many of the other comment letters provided additional information on permits that could be required, agency responsibilities, present and future utilities, land use designations, services such as fire protection, and new developments.

The comment letters and transcribed oral comments are reprinted on the following pages. Substantive comments have been marked and responses to each substantive comment follow the letter in which the comment appears. Some comments required changes, corrections and additions to the draft; others asked for clarification of information presented. No written responses were made to comments that reflected opinions expressed, or did not identify a needed text clarification, correction or modification.

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860-5020

RECEIVED
OCT 18 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

5090(P)
Ser N4(23)/ 7467
OCT 13 1994

Mr. Rex D. Johnson
Office of Environmental Quality Control
220 South King Street, Fourth Floor
Honolulu, HI 96813

Dear Mr. Johnson:

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
FOR BASIN EXPANSION AND TUG PIER AT BARBERS POINT
HARBOR, OAHU AND FUTURE PIER AND STORAGE YARD IMPROVEMENT
AT BARBERS POINT HARBOR

Thank you for the opportunity to review the Draft Supplemental Environmental Impact Statement for Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu and Future Pier and Storage Yard Improvement at Barbers Point Harbor dated September 13, 1994.

The Navy has no comments to offer at this time and appreciates the opportunity to participate in your review process.

The Navy's point of contact is Mr. Stanford Yuen at 474-0439.

Sincerely,

STANFORD B.C. YUEN, P.E.
Facilities Engineer
By direction of
the Commander

Copy to:
Harbors Division
State Department of Transportation
Attn: Mr. Marshall Ando
79 South Nimitz Highway
Honolulu, HI 96813

Parsons Brinckerhoff Quade & Douglas, Inc.
Attn: Mr. David Atkin
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, HI 96813

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

October 21, 1994

REPLY TO ATTENTION OF

Planning Division

RECEIVED
OCT 24 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

Dr. David Atkin
Environmental Task Leader
Parsons Brinckerhoff
1001 Bishop Street, Suite 3000
Honolulu, Hawaii 96813

Dear Dr. Atkin:

Thank you for the opportunity to review and comment on the Draft Supplemental Environmental Impact Statement for Basin Expansion and Tug Pier at Barbers Point Harbor, Ewa, Oahu. The following comments are provided pursuant to Corps of Engineers authorities to disseminate flood hazard information under the Flood Control Act of 1960 and to issue Department of the Army (DA) permits under the Clean Water Act; the Rivers and Harbors Act of 1899; and the Marine Protection, Research and Sanctuaries Act:

a. A DA permit may be required if work is conducted in navigable waters of the U.S. Please contact our Regulatory Branch for further information at 438-9258.

b. We concur with the flood information provided on page 5-7 of the environmental impact statement.

Sincerely,

Ray H. Jyo, P.E.
Director of Engineering

Response to the U.S. Army Corps of Engineers

A DA permit is identified as a potential project requirement in section 4.3, "Permits and Approvals Required."

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE

Pacific Islands Ecoregion
300 Ala Moana Blvd, Room 6307
P.O. Box 50167
Honolulu, Hawaii 96850

In Reply Refer To: MEM

DEC 13 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Re: Draft Supplemental Environmental Impact Statement for Basin Expansion and Tug Pier at Barbers Point Harbor (Job H.C. 1823) and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Oahu, Hawaii

Dear Governor:

The U. S. Fish and Wildlife Service (Service) has reviewed the Draft Supplemental Environmental Impact Statement (DSEIS) for Basin Expansion and Tug Pier at Barbers Point Harbor (Job H.C. 1823) and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Oahu, Hawaii. The project sponsor is the Harbors Division of the Hawaii Department of Transportation (DOT). Project consultants for the DOT are Parsons Brinkerhoff Quade & Douglas, Inc (Parsons Brinkerhoff). The Service offers the following comments for your consideration.

The proposed project involves (a) expanding the existing harbor basin by excavating approximately 11 hectares (ha) [28 acres (ac)] of upland along its northeast margin (Expansion Area A) and approximately 0.6 ha (1.5 ac) of upland in its southeast corner (Expansion Area B); (b) constructing a new tugboat pier that is 46 meters (m) [150 feet (ft)] long in Expansion Area B; (c) extending existing Pier 5 by 91 m (300 ft) in the southeast corner of the existing basin; (d) constructing three new wharfs along the margins of Expansion Area A; and (e) constructing storage yards and other support features on approximately 54 ha (134 ac) of upland adjacent to Expansion Area A. A total of approximately 2.3 million cubic yards (yd^3) of sediments would be excavated to expand the harbor.

Service biologists met previously with representatives of Parsons Brinkerhoff to discuss potential project-related impacts to fish and wildlife resources. The Service provided information on federally endangered and threatened species in the project area and expressed concern for the protection of marine resources and water quality during and after project construction.

Although there are no known federally endangered Hawaiian stilt (*Himantopus mexicanus knudseni*) habitats within the project boundaries or at any of the proposed material stockpile areas, sedimentation ponds, which may attract stilts from nearby areas, would be constructed if Expansion Areas A and B are created by hydraulic dredging. The DSEIS includes a provision that the Service would be notified of any stilt activity that may occur at these ponds. Although the federally endangered plants, *Achyranthes splendens* and *Chamaesyce skottsbergii* var. *skottsbergii*, occur in the Ewa plain area, they are not present within the project boundaries, and no materials are to be stockpiled on top of the plants.

Although complex marine benthic communities and areas of high coral cover exist north of the harbor mouth, turbidity and sedimentation resulting from the project will be reduced by excavating Expansion Area A behind a berm that would be removed as a last step. Water quality monitoring would be performed during berm removal and construction of Expansion Area B, and silt containment devices would be deployed if turbidity levels become excessive. The majority of suspended sediments exiting the harbor mouth are expected to flow south toward an area where the bottom is covered with sand or sand-macroalgal mats. Oil spill emergency response procedures would be followed during construction.

In summary, the Service believes that the DSEIS adequately describes the existing terrestrial and marine resources at the project site and the potential project-related impacts to these resources. Based on the Service's review of the DSEIS and knowledge of the project site, no significant adverse effects to fish and wildlife resources are expected to result from the proposed work. Therefore, the Service would not object to the project as it is currently proposed.

The Service appreciates the opportunity to provide comments on the proposed project. If you have questions regarding these comments, please contact our Wetlands Branch Chief, Karen Evans, or Fish and Wildlife Biologist Michael Molina at 808/541-3441.

Sincerely,

for Brooks Harper
Field Supervisor
Ecological Services

cc: NMFS-PAO, Honolulu
EPA, Region IX, San Francisco
DAR, Hawaii
CZMP, Hawaii
CWB, Hawaii

U.S. Department of the Interior, Fish and Wildlife Service

No response required.

JOHN WAIHEE
GOVERNOR
JEANNE K. SCHULTZ
DIRECTOR
RICK EGGED
DEPUTY DIRECTOR
TAKESHI YOSHIHARA
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

Central Pacific Plaza, 220 South King Street, 11th Floor, Honolulu, Hawaii
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804 Telephone: (808) 586-2423 Fax: (808) 586-23

RECEIVED
SEP 29 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

September 29, 1994

David Atkin, Ph.D.
Environmental Task Leader
Parsons Brinckerhoff Quade
& Douglas, Incorporated
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, HI 96813

Dear Dr. Atkin:

Subject: Draft Supplemental Environmental Impact Statement (DSEIS) for Basin Expansion and Tug Pier at Barbers Point Harbor, Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa Oahu, Hawaii

This is to inform you that we have no comments on the subject Draft Supplemental Environmental Impact Statement (DSEIS).

Thank you for the opportunity to comment on the subject DSEIS.

Sincerely,

for Maurice H. Kaya
Energy Program Administrator

MHK/hkeis115

JOHN WAIHEE
GOVERNOR
JEANNE K. SCHULTZ
DIRECTOR
RICK EGGED
DEPUTY DIRECTOR
TAKESHI YOSHIHARA
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

Central Pacific Plaza, 220 South King Street, 11 th Floor, Honolulu, Hawaii
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804 Telephone: (808) 586-2423 Fax: (808) 586-2

RECEIVED
OCT 4 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

September 28, 1994

Mr. Brian Choy
Office of Environmental Quality Control
Office of the Governor
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Dear Mr. Choy:

The Department of Business, Economic Development & Tourism is pleased to submit the enclosed comments on the Draft Supplemental Environmental Impact Statement for the Basin Expansion and Tug Pier at Barbers Point Harbor, Future Pier, and Storage Yard Improvements at Barbors Point Harbor.

The comments were provided by the Land Use Commission. Questions regarding these comments may be directed to Esther Ueda, LUC Executive Officer at, 587-3826.

Thank you for the opportunity to comment.

Sincerely,

Jeanne K. Schultz

Enclosure

cc: David Atkin, Ph.D.
DOT, Harbors Division

JOHN WAIHEE
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813
Telephone: 587-3822

September 27, 1994

SUBJECT: Director's Referral No. 94-301-J
Draft Supplemental Environmental Impact Statement (DSEIS) for the Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu (Job H.C. 1823), and Future Pier and Storage Yard Improvements at Barbers Point Harbor

We have reviewed the DSEIS for the subject project, and have the following comments:

1) We confirm that Basin Expansion Area A, the site of the proposed piers and storage yards, and Stockpile Areas 2, 3, and 4, as shown on Figures 2-5 and 2-12, are located within the State Land Use Agricultural District. We also confirm that Basin Expansion Area B, the Tug Pier, and Stockpile Areas 1 and 5, as shown on Figures 2-5 and 2-12, are located within the State Land Use Urban District.

2) We understand that a petition to reclassify approximately 140.5 acres from the Agricultural District to the Urban District for Basin Expansion Area A and the adjacent facilities will be submitted to the Land Use Commission in the future.

3) The map of the State Land Use Districts (Figure 4-4) appears to incorrectly represent the Agricultural/Urban District boundary along the Oahu Railway and Nanakai Gardens. Additionally, the map does not reflect the urbanization of lands at Makaiwa Hills, which were reclassified under LUC Docket No. A92-687/Estate of James Campbell by Decision and Order dated October 28, 1993.

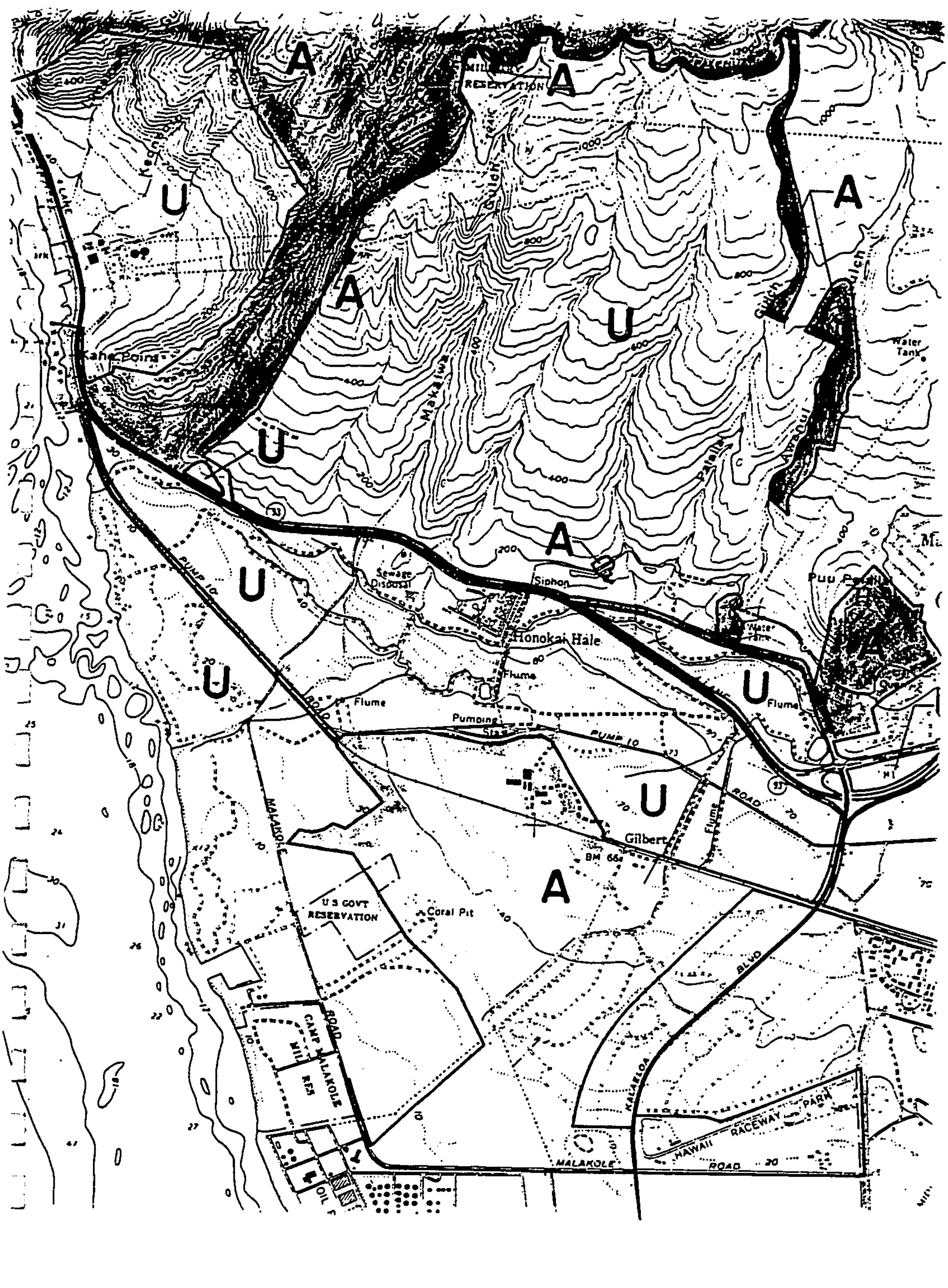
   We have attached a copy of a portion of the Commission's official map (quadrant O-6, Ewa) with the above referenced railway, gardens area, and petition area under Docket No. A92-687 highlighted in yellow for your reference.

4) For your information, a portion of the Barbers Point Harbor and the Stockpile Area 1 sites were reclassified to the Urban District under LUC Docket No. A78-449/D.P.E.D. by Decision and Order dated November 20, 1979.

We have no further comments to offer at this time.

EU:BS:th

att.



A
U
Kahe Point
Makaiwa
Water Tank
Sewage Disposal
Siphon
Honokai Hale
Flume
Pumping Sta
PUMP 10 ROAD
Gilbert
U S GOVT RESERVATION
Coral Pit
MALAKOLE ROAD
CAMP MALAKOLE MIL RES
HAWAII RACEWAY PARK
KALAELOA BLVD

Response to the Department of Business Economic Development and Tourism, Land Use Commission

Figure 4-4, "State of Hawaii Land Use Classifications," has been revised to reflect the Commission's official map.

JOHN WAIHEE
GOVERNOR

JOSEPH K. CONANT
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

IN REPLY REFER TO:
94:PPE/5204

October 7, 1994

TO: Governor, State of Hawaii
c/o Office of Environmental Quality Control

FROM: Joseph K. Conant
Executive Director

SUBJECT: Draft Supplemental Environmental Impact Statement (DSEIS) for the Basin Expansion and Tug Pier at Barbers Point Harbor, Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu

We have reviewed the subject DSEIS and have no comments to offer at this time. Enclosed is the subject document.

Thank you for the opportunity to comment.

Enclosure

c: ✓ Mr. David Atkin, Ph.D.
Environmental Task Leader
Parsons Brinckerhoff Quade & Douglas, Inc.

Mr. Marshall Ando
Harbors Division
Department of Transporation

HFDC

JOHN WAIHEE
GOVERNOR

MAJOR GENERAL EDWARD V. RICHARDSON
DIRECTOR OF CIVIL DEFENSE

ROY C. PRICE, SR.
VICE DIRECTOR OF CIVIL DEFENSE

RECEIVED
OCT 12 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

PHONE (808) 734-2161

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE DIRECTOR OF CIVIL DEFENSE
3949 DIAMOND HEAD ROAD
HONOLULU, HAWAII 96816-4495

October 11, 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

ATTENTION: The Honorable Rex D. Johnson
Director, Department of Transportation

Dear Sir:

Draft Supplemental Environmental Impact Statement (DSEIS); Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu, Job H.C. 1823 and
Future Pier and Storage Yard Improvements at Barbers Point Harbor

We appreciate this opportunity to comment on the DSEIS for Basin Expansion and Tug Pier at Barbers Point Harbor and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu, Hawaii; TMK Portion of 9-1-14:02 and Portion and 9-1-14:24.

1 State Civil Defense (SCD) does not have negative comments specifically directed at the DSEIS. However, the proposed area is not covered by any existing siren warning devices. We would like to propose that two sirens and siren support infrastructure be purchased and installed by the developer to help alert residents and workers of an impending or actual event that threatens the area. These sirens must be solar powered, have a minimum output of 121 DB @ 100 feet and be compatible with the existing civil defense siren warning system. The proposed sirens require a 250-foot radius buffer zone in which there are no residential buildings. The suggested location for the siren is at the northwest corner and southeast corner of the harbor as shown on a copy of Figure 1-2, page 1-5, of the Barbers Point Harbor 2010 Master Plan Configuration. The proposed site and the estimated coverage area for the siren is annotated in red.

Chapter 5, Physical Environment, page 5-1, needs to address the triple threat of high winds, storm driven surf/coastal inundation and torrential rains resulting from tropical cyclones/hurricanes. Specifically:

2 Page 5-1, paragraph 5.1, CLIMATE, subparagraph 5.1.1, Winds, does not address tropical cyclone/hurricane force winds.

3 Page 5.3, paragraph 5.1.3, Rainfall, does not address rainfall associated with tropical cyclone/hurricane force winds.

4 Page 5.3, paragraph 5.2, TSUNAMIS, subparagraph 5.2.1, Existing Conditions, subparagraph 5.2.2, Probable Impact of Proposed Action, and page 5-5, subparagraph 5.2.3, Mitigation Measures, address tsunami heights and tsunami run-ups, alteration of the existing grades, moving the harbor shoreline further inland (thereby increasing the inundation area around the harbor) and minimizing damage by following Oahu Civil Defense evacuation procedures. The design and operation of piers, wharves and storage yards in accordance with potential tsunami conditions need to be seriously evaluated in light of the alteration of the existing grades and moving the harbor shoreline further inland. Base flood elevations need to be established to provide appropriate design and construction data.

5 Page 5-6, paragraph 5.4, SURFACE HYDROLOGY, DRAINAGE AND FLOOD HAZARD, subparagraph 5.4.1, Existing Conditions, references the Flood Insurance Rate Map (FIRM) Zone "D," designation for the project area. With the alteration of the existing grades and increase in the inundation area around the harbor, base flood elevations need to be established so facilities can be properly designed and constructed.

6 Page 5-11, subparagraph 5.6.1, Physical Setting, and sub subparagraph 5.6.1.1., EXISTING CONDITIONS, and page 5-12, sub subparagraph 5.6.1.2, PROBABLE IMPACT OF THE PROPOSED ACTION, address the concern over wave oscillation or surge conditions within the harbor (and possible impact in the West Beach Marina). These concerns over a 1988 incident that occurred while relatively calm conditions prevailed in the harbor could be exacerbated even more under tropical cyclone/hurricane force wind and tsunami conditions.

Our SCD planners and technicians are available to discuss this further if there is a requirement. Please have your staff call Mr. Mel Nishihara of my staff at 734-2161.

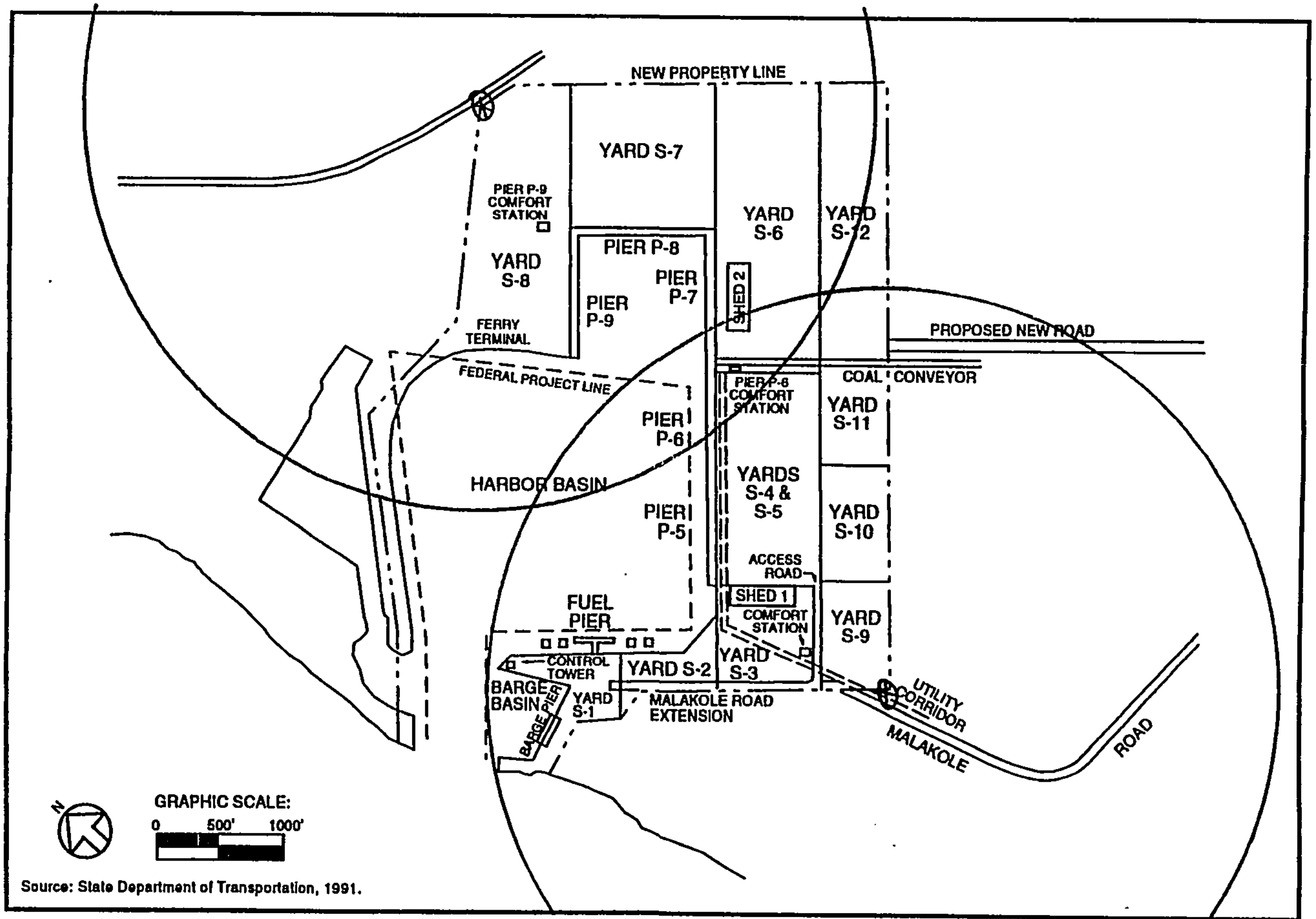
Sincerely,

ROY C. PRICE, SR.
Vice Director of Civil Defense

Enc.

c: Mr. Marshall Ando
Harbors Division
Department of Transportation

✓David Atkin, Ph.D.
Parsons Brinckerhoff Quade and Douglas, Inc.



PARSONS BRINCKERHOFF QUADE & DOUGLAS, INC.

eays:H:\bph\disk 9 9/12/94

Barbers Point Harbor 2010 Master Plan Configuration

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

JOB H.C. 1823

Draft Supplemental Environmental Impact Statement

FIGURE 1-2

Responses to the State Department of Defense, Office of Civil Defense

Response to Comment 1

Chapter 12, "Summary of Unresolved Issues," has been modified to reflect discussion between the SDOT and the State Department of Defense concerning installation of appropriate warning devices.

Response to Comment 2

Section 5.1.1, "Winds," has been updated to address hurricane force winds.

Response to Comment 3

Section 5.1.3, "Rainfall," has been updated to address rainfall during a hurricane.

Response to Comment 4

Section 5.4, "Surface Hydrology, Drainage and Flood Hazard," has been expanded to address these concerns. The potential extent of overland flooding as the result of a tsunami was modeled in Tsunami Response of Barbers Point Harbor, Hawaii (1982). The variability of flooding shown on these maps demonstrates the difficulty in assessing base flood elevations as a result of a tsunami. Harbor design and operation will take this potential flooding into consideration.

Response to Comment 5

Section 5.4, "Surface Hydrology, Drainage and Flood Hazard," has been expanded to include a discussion of coastal inundation from hypothetical worst case and probable hurricane scenarios as assessed in the report Leeward Oahu Hurricane Vulnerability Study, Determination of Coastal Inundation Limits (1993). Figure 5-3 shows that the coastal area around the harbor could be potentially inundated if there is a hurricane.

The report also assesses the increase in the elevation of surface water, termed stillwater rise, in the harbor during a hurricane. The report concluded that the stillwater rise for the model and worst case hurricane scenarios will not overtop the existing dock and land elevation around the Barbers Point harbor basin perimeter. The report does not take into account the harbor expansion area. However, the proposed action does not increase the entrance channel width or depth, only the harbor's interior area. The stillwater level will be approximately the same as the level predicted in the model scenarios, i.e. the stillwater rise will not overtop the proposed dock and land elevation around the Barbers Point harbor basin perimeter.

Response to Comment 6

The U.S. Army Corps of Engineers Waterways Experiment Station model (Physical and Numerical Model Studies of Barbers Point Harbor, Oahu, Hawaii, 1994) did not include tropical cyclone force winds or tsunami conditions. The U.S. Army Engineer Waterways Experiment Station had done an earlier study (Tsunami Response of Barbers Point Harbor, Hawaii, 1982) to address conditions in the harbor caused by a tsunami. Results from this report are discussed in section 5.2, "Tsunamis." Although the Hawaii Coastal Hazard Mitigation Planning Project (1993) does not address Barbers Point Harbor alone, it discusses the risks associated with tropical storms on Oahu. The report concludes that while hurricane threats in Hawaii are frequent, actual strikes are rare. In the event of a tropical cyclone or tsunami warning, vessels will be advised to leave the harbor as described under mitigation measures in section 5.2, "Tsunamis."

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED NOV 8 1994 PARSONS BRINCKERHOFF HONOLULU, HAWAII

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

KEITH W. AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

REF:OCEA:SKK

FILE NO.: 95-154
DOC. ID.: 5083

NOV - 4 1994

MEMORANDUM

TO: Dr. Bruce Anderson, Interim Director
Office of Environmental Quality Control

FROM: Keith W. Ahue, Chairperson
Board of Land and Natural Resources

SUBJECT: Draft Supplemental Environmental Impact Statement (DSEIS): Barbers Point Basin Expansion and Tug Pier, and Storage Yard Improvements, Ewa, Oahu, TMKs: 9-1-14: 2, por. 24

We have reviewed the DSEIS information for the subject project transmitted by Mr. David Atkin's letter dated September 21, 1994, and have the following comments:

Historic Preservation Division

The Historic Preservation Division (HPD) comments that the DSEIS correctly summarizes the status of historic preservation review for these projects at the time the DSEIS was prepared. HPD concurs that the proposed project activities in the 84-acre parcel, Expansion Area B, the narrow strip of State land along the southwest edge of the 84-acre parcel, Stockpile Areas 1, 4, and 5, and the proposed haul routes will have "no effect" on historic sites.

Recently, HPD completed their review of the Archaeological Inventory Survey of the Barbers Point Harbor Expansion (Hammatt et al. 1994) that was submitted to them by Mr. Chuck Ehrhorn of Campbell Estate.

Thirty-seven historic sites were found in the 56.5 acres parcel and sufficient information was collected to determine their significance. One site, 50-80-12-9633, a burial cave, is significant for its traditional importance as a resting place for Hawaiian ancestral remains, because it is an excellent example of this type of site, and for the information on Hawaiian history and prehistory that it has yielded and is likely to yield.

Two sites, 50-80-12-4896, a temporary habitation and agricultural complex, and -9545, a large sinkhole containing habitation structures, are significant because they are excellent examples of their respective sites types and for the information on Hawaiian prehistory and history that they have yielded and are likely to yield.

Thirty-four sites (listed in Table 3 on pages 131 and 132 of the inventory survey report) are significant for the information on Hawaiian prehistory and history that they have yielded and are likely to yield. Eight of these sites, 50-80-12-4905, a mound associated with military activities, -414, a boundary wall, -4915, refuse left by kiawe harvesters, -4916, a sinkhole that lacks any material of interest to Hawaiian history and prehistory, -4918 and -4919, rock mounds associated most likely with small scale horticultural activity, and -4923 and -4924, portions of cattle walls, have yielded their information and are "no longer significant."

The next step in the historic preservation review process for this project is preparation and submittal of an acceptable archaeological mitigation plan for the significant historic sites that will be adversely affected by the proposed project. HPD understands that this mitigation plan will be developed and implemented by the State Department of Transportation, Harbors Division.

Division of Aquatic Resource

The Division of Aquatic Resources (DAR) comments that the DSEIS addresses most of their comments previously forwarded on the preparation notice of this DSEIS. However, their concern on long-term turbidity of the harbor needs to be addressed. The DSEIS responded that the only impacts to water quality would be from oil/fuel pollution that might result from operations. DOT claims that the turbidity results (from ship maneuvering) are expected to be within the natural variability limits already existent for the harbor. While the DSEIS maintains that dredging-produced turbidity will be within the limits of natural turbidity and will not adversely impact the near-shore marine environment, turbid waters will continue to influence near-shore water quality in the future and may affect future proposed uses of the near-shore marine waters such as the Marine Life Conservation District proposed for off of the Ko Olina Development.

Division of Land Management

The Division of Land Management (DLM) comments that they have reviewed the DSEIS and understand that Department of Transportation (DOT) has reached an agreement with the Estate of James Campbell (EJC) to transfer necessary EJC land to the State. DLM will subsequently set aside these parcels to the DOT by Governor's Executive Order. DLM finds that the project has no significant or detrimental impact to DLNR State-owned land surrounding or near the project site and supports the proposed project as a necessary expansion of the harbor facilities which service the expanding Ewa Plain.

Division of Water and Land Development

The Division of Water and Land Development comments that the DSEIS should include the results of the U.S. Army Corps of Engineers study on tsunami events.

We will forward the comments of the Commission on Water Resource Management and our Historic Preservation Division as they become available.

We have no further comment to offer at this time. Thank you for the opportunity to comment on this matter.

Please feel free to call Steve Tagawa at our Office of Conservation and Environmental Affairs, at 587-0377, should you have any questions.

c: Marshall Ando, DOT Harbors Division
David Atkin, Parsons Brinckerhoff Quade & Douglas, Inc.

Response to Department of Land and Natural Resources, State Historical Preservation Division

The Final SEIS has incorporated descriptions of relevant archaeological resources, as described in the inventory survey. Section 6.1, "Archaeological, Historical and Cultural Characteristics," has been revised to reflect information in the cited report.

An archeological mitigation plan, subject to approval by the SHPD and the Advisory Council on Historic Preservation, is presently being developed and will be incorporated by the SDOT.

Response to Department of Land and Natural Resources, Division of Aquatic Resources

Sea Engineering monitored turbidity changes due to vessel traffic in the harbor and channel (refer to Appendix A-3, Figure II-1). Vessel movement caused an increase in turbidity, especially at depth, in the harbor. The turbidity plume was localized, dissipated within an hour and did not move out of the harbor basin. A similar set of before and after measurements was collected as a vessel exited the harbor. No change in turbidity was noted. In the harbor, ship movements will resuspend bottom sediment but outside the harbor, minimal sediment resuspension attributable to vessel traffic should be caused because of the greater water depth and natural currents and turbulence.

Department of Land and Natural Resources, Division of Land Management

No response required.

Response to Department of Land and Natural Resources, Division of Water and Land Development

Section 5.2, "Tsunamis," has been revised to include the U.S. Army Engineer Waterways Experiment Station study, Tsunami Response of Barbers Point Harbor, Hawaii (1982).

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

REF:HP-JK

OCT 18 1994

David Atkin
Environmental Task Leader
Parsons Brinckerhoff
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

LOG NO: 12843
DOC NO: 9410TD18

Dear Dr. Atkin:

SUBJECT: **Section 106 Review--Draft Supplemental Environmental Impact Statement (DSEIS) for Basin Expansion and Tug Pier, and Future Pier and Storage Yard Improvements at Barbers Point Harbor Honouliuli, `Ewa, O`ahu**
TMK: 9-1-14: por. 2, por. 24

Thank you for the opportunity to review this DSEIS, which correctly summarizes the status of historic preservation review for these projects at the time the DSEIS was prepared. We concur that the proposed project activities in the 84-acre parcel, Expansion Area B, the narrow strip of State land along the southwest edge of the 84-acre parcel, Stockpile Areas 1, 4, and 5, and the proposed haul routes will have "no effect" on historic sites.

Recently, we did complete our review of the Archaeological Inventory Survey of the Barbers Point Harbor Expansion (Hammatt et al. 1994) that was submitted to us by Chuck Ehrhorn of Campbell Estate. Thirty-seven historic sites were found in the 56.5 acre parcel and sufficient information was collected to determine their significance. One site, 50-80-12-9633, a burial cave, is significant for its traditional importance as a resting place for Hawaiian ancestral remains, because it is an excellent example of this type of site, and for the information on Hawaiian history and prehistory that it has yielded and is likely to yield. Two sites, 50-80-12-4896, a temporary habitation and agricultural complex, and -9545, a large sinkhole containing habitation structures, are significant because they are excellent examples of their respective site types and for the information on Hawaiian prehistory and history that they have yielded and are likely to yield. Thirty-four sites (listed in Table 3 on pages 131 and 132 of the inventory survey report) are significant for the information on Hawaiian prehistory and history that they have yielded and are likely to yield. Eight of these sites, 50-80-12-4905, a mound associated with military activities, -4914, a boundary wall, -4915, refuse left by kiawe harvesters, -4916, a sinkhole that lacks any material of interest to Hawaiian history and prehistory, -4918 and -4919, rock mounds associated most likely with small scale horticultural activity, and -4923 and -4924, portions of cattle walls, have yielded their information and are "no longer significant."

The next step in the historic preservation review process for this project is preparation and submittal of an acceptable archaeological mitigation plan for the significant historic sites that will be adversely affected by the proposed project. We understand that this mitigation plan will be developed and implemented by the State Department of Transportation, Harbors Division.

If you have any questions please call Tom Dye at 587-0014.

Very truly yours,

KEITH W. AHUE, Chairperson and
State Historic Preservation Officer

TD:jk

Response to Department of Natural Resources, State Historic Preservation Division

These comments from the State Historic Preservation Division were also sent with a letter from Keith W. Ahue, Chairperson, Board of Land and Natural Resources (see preceding letter).

(P)1912.4

OCT 21 1994

Governor
State of Hawaii
c/o Office of Environmental
  Quality Control
220 South King Street, 4th Floor
Honolulu, Hawaii

Gentlemen:

Subject: Barbers Point Harbor Basin Expansion and Tug Pier Draft Supplemental EIS

Thank you for the opportunity to review the subject document. We have no comments to offer.

If there are any questions, please have your staff contact Mr. Ralph Yukumoto of the Public Works Division at 586-0488.

Respectfully,

ROBERT P. TAKUSHI
State Comptroller

RY:jy
cc: State Department of Transportation, Harbors Division
✓Parson Brinckherhoff Quade & Douglas, Inc.
OEQC

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
220 SOUTH KING STREET
FOURTH FLOOR
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4185
FACSIMILE (808) 586-2452

BRUCE S. ANDERSON, Ph.D.
INTERIM DIRECTOR

RECEIVED
OCT 28 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

October 27, 1994

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

Dear Mr. Ando:

Subject: Draft Supplemental EIS Barbers Point Harbor Basin Expansion and Tug Pier, and Future Pier and Storage Yard Improvements

Thank you for the opportunity to review the subject document. We have no comments to offer.

Very truly yours,

for Bruce S. Anderson, Ph.D.
Interim Director

c: David Atkin

OFFICE OF STATE PLANNING
Office of the Governor
MAILING ADDRESS: P.O. BOX 3540, HONOLULU, HAWAII 96811-3540
STREET ADDRESS: 250 SOUTH HOTEL STREET, 4TH FLOOR
TELEPHONE: (808)587-2846, 587-2800
FAX: Director's Office 587-2848
Planning Division 587-2824

Ref. No. C-914

November 4, 1994

MEMORANDUM

TO: The Honorable John Waihee
Governor
State of Hawaii
c/o Office of Environmental Quality Control

SUBJECT: Draft Supplemental Environmental Impact Statement for the Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu, Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor

We have reviewed the referenced document and have the following comments. Although we do not oppose the proposed project, we have concerns that need to be addressed in the project's design to comply with the requirements of the Coastal Zone Management (CZM) law, Chapter 205A-2, Hawaii Revised Statutes.

1 One possible construction method for the expansion of the harbor involves hydraulic dredging. On page 2-19, "Dredging would occur 24 hours a day to maximize the productivity of the dredging vessel". Presumably, night lighting will be employed in order to continue construction during non-daylight hours. Night lighting may pose a hazard to green sea turtle (threatened species) navigation and nesting habits. As a threatened species, the welfare of the green sea turtle should be given special consideration, and efforts to preserve their habitat should be instituted.

Another is the use of explosives for excavation. On page 5-31 it is noted that, "Although blasting could transmit noise and vibration to the water, charges would be detonated on shore, not in the water, and therefore noise and

2 vibration in the marine environment would be minimal". Given the fact that humpback whales (endangered species) enter the waters off Oahu for calving and calf rearing purposes during the months from November to May, blasting should be scheduled to avoid disturbing these species. Preservation of coastal ecosystems with significant biological resources such as the green sea turtle and the humpback whale is a CZM policy, Chapter 205A-2 HRS.

3 An additional concern is the approximately 2.3 million cubic yards of coral limestone, coral sands and gravel that will be dredged and stockpiled for future use. The stockpiles of dredged material may contribute to a change in the nearshore water quality and salinity via dissolved salts suspended in runoff. A related CZM policy is to minimize disruption or degradation of coastal water ecosystems Chapter 205A-2 HRS. While mitigation measures are proposed to control turbidity and runoff, techniques to control potential salinity changes should also be considered.

If you have any questions, please contact Harold Lao at 587-2883.

Norma Wong

Norma Wong
Director

cc: Department of Transportation, Harbors Division
David Atkin

Responses to the Office of State Planning

Response to Comment 1

Sections 2.5.1.2, "Hydraulic Dredging," and 5.8.1, "Green Sea Turtles (*Chelonia mydas)* - Threatened Species," have been modified to address your concerns.

Response to Comment 2

Sound is attenuated by approximately 40 dB when it is transmitted from a solid medium to a water medium. The transmitted noise level would be nearly the same as the ambient noise level.

As noted in section 5.8.2 "Humpback Whale (*Megaptera novaeagliae*) - Endangered Species," the humpback whales' mating, calving and calf rearing grounds are primarily off Maui. Surveys have shown that humpback whales and most other small whales seldom come within the 100 fathom contour off Oahu. Since the 100 fathom contour is located just under one mile offshore of the harbor, and the major excavation site is located more than half a mile inland of the shoreline, no significant impact to the whale migration area is expected. The Barbers Point Harbor area is not known to be a site of frequent whale activity or important humpback whale habitat.

Should blasting be the selected construction method, blasting between November and May would be allowed.

Response to Comment 3

The stockpiles will be surrounded by berms to contain runoff which will percolate back into the porous coral material below. In any case, salinity associated with the excavated material will be residual sea salts deposited in the material by brackish groundwater while it is in-situ. Therefore, it is unlikely that there will be any degradation of coastal water quality associated with the return of these sea salts to the ocean from which they originated.

University of Hawai'i at Mānoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawai'i 96822
Telephone: (808) 956-7361 • Facsimile: (808) 956-3980

November 7, 1994
RE:0655

Honorable John Waihee
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Dear Governor Waihee:

Draft Environmental Impact Statement (DEIS)
Barbers Point Harbor Basin Expansion and Tug Pier,
and Future Pier and Storage Yard Improvements
Barbers Point, Oahu

The referenced project involves modifications to the Barbers Point Harbor in order to accommodate projected growth in the shipping industry. The proposed action includes expansion of the harbor basin in the northeast corner (1100 by 1100 feet - Expansion Area A) and removal of a triangular land area in the southern harbor corner (230 by 280 feet - Expansion Area B). In addition the project involves the construction and operation of a tugboat pier, three commercial piers, storage yards, and other port facilities. The existing Pier five will be extended an additional 300 feet. This project will require the acquisition of 140.5 acres of land by the State from the Estate of James Campbell and the reclassification of this land from "Agriculture" to "Urban".

The three options for the modifications to Expansion Areas A and B are blasting with mechanical excavation, hydraulic dredging, and mechanical excavation without blasting. About 2.5 million cubic yards of coral limestone rock will be removed in the expansion operation. The coral limestone rock will be stored in five stock piles on-site.

Our review was completed with the assistance of Paul Ekern, Emeritus/Water Resources Research Center; Hans-Jurgen Krock, Look Laboratory/Ocean Engineering; John Craven, Emeritus; and Chris Welch, Environmental Center.

Our reviewers found that the DEIS failed to address some of the most pressing issues concerning a second deep draft harbor on Oahu. Section 1.2 states that the current

1 expansion would help reduce overland transport costs for goods and materials destined for leeward Oahu. However, Barbers Point Harbor is too small to handle the larger container ships that are the backbone of international and interstate commerce, and the proposed expansion will not solve the problem. If a second city is to succeed on the Ewa plain, it will need access to a deep draft harbor that conveniently supplies the materials that a city requires. Otherwise, the Ewa region will continue to rely on Honolulu Harbor for most of its international shipping, thereby remaining functionally a suburb to Honolulu. The consequence of not creating a harbor that is large enough to serve the Ewa plain should be examined in the final document.

2.5 Blasting and Mechanical Excavation

2 Concern over the use of blasting in the excavation of the new harbor expansions is evident. The document notes that protective measures would be necessary to minimize damage from blast vibration. Since blasting during the initial harbor construction resulted in extended delays to the project and damage to nearby residences, it would be prudent to be very specific about blasting mitigation measures and techniques. To state that "the size of explosive charges must be smaller than previous used" does not speak to the issue. How much smaller? What is the radius of expected damage from the "smaller" charges? What numerical modeling or experimental evidence can be cited in support of a chosen charge size? Although section 5.1.2.3 contends that vibration levels from blasting would be "just perceptible" no documentation is cited to support this claim. The issue of using blast charges is potentially contentious, and should be addressed accordingly.

2.6 The Use of Public Funds and Public Lands

3 Our reviewers expressed concerns about the offhand treatment of the use of public monies to be troublesome. According to the document, a "need" exists for the harbor expansion. Further, in section 4.2.2.1 it states that the expansion is being promoted through a cooperative effort between the state and private sector. If this is truly a joint state/private venture, then why are all $155 million dollars coming from public funds? How is the private sector contributing to the harbor expansion? Who is the beneficiary of this expansion? To whom will the costs accrue? A statement that this benefits the people of Hawaii clouds the issue that specific interests will benefit from the expenditure (i.e. the shipping industry, large landholders in the harbor area, developers in the Ewa plain). The document needs to provide a cost-benefit analysis of the primary and secondary impacts of the harbor expansion which clearly identifies who reaps the benefits of the development, who bears the costs, and how the costs and benefits compare when amortized over a realistic interval.

5.2 Tsunamis

A particular concern was voiced over the inadequacy of the description and analysis
of potential impacts from tsunami wave conditions. A previous mathematical analysis
4 calculated that the resonance time for a standing wave in Barbers Point Harbor was on the
order of 13.5 minutes. Since tsunamis typically have wave periods between 10 and 20
minutes, the model suggests that Barbers Point Harbor is prone to severe tsunami damage.
The resonance time for the harbor could cause a substantial amplification of the tsunami
resulting in major destruction to the harbor area. Since this problem is potentially quite
severe, it should be re-evaluated to take into account the new harbor expansion.

5.5 Groundwater
5.5.1 Existing Conditions

The explanation of caprock/basal aquifer dynamics seemed unnecessarily confusing. The section starts off by saying that the caprock is 250 feet thick at Barbers Point Harbor. It then states that at the inland extension of the harbor the caprock is 200 feet thick. Does the caprock change by a width of 50 feet in the vicinity of the harbor. If so, where?

5

The section further states that the "Waianae basalt aquifer is a source of drinking water four miles to the east and upgradient." Does this statement refer to a well site? Or is this the limit of brackish water/fresh water interaction? The document traces the recharge source of the Waianae aquifer to the Waianae range, the Koolau aquifer, and possibly the Wahiawa high level aquifer. However, it does not adequately describe the gradient of the fresh and brackish water. We suggest the use of diagrams and maps to meaningfully portray the boundaries and interactions of groundwater in the Barbers Point Harbor region.

5.5.2 Probable Impact of the Proposed Action

This section gives a cursory description of the original construction impacts of
Barbers Point Harbor and the projected impacts of the currently proposed project to the
caprock aquifer. In addition to the superficial description, the document makes references
to the "head" and "head contour" of the limestone caprock aquifer. No definition or related
6 significance of these parameters is given. How are the "head" and "head contour" related
to the alteration of the caprock groundwater flow regime? Are these parameters important
indicators of groundwater flow conditions? Our reviewers suggest a much more thorough
discussion of past caprock groundwater changes, predicted future caprock groundwater
changes, and the pertinent measures and indicators related to these changes. A citation is
included concerning a study of the impacts to groundwater hydrology of the proposed
project, however very little of the pertinent information is included in the current document.
This SEIS should be a stand alone document that "may incorporate by reference unchanged

material from the [original EIS]; however, in addition, it shall fully document the proposed changes from the original EIS and completely and thoroughly discuss the EIS process followed for these changes" (11-200-28 HAR).

5.6.2.4 Probable Long-term Impact of Proposed Action

7 In the discussion of long-term impacts, the question of potential oil spills has been almost neglected. The evaluation of the increased potential for oil spills is non-existent. Under mitigation measures the document defers to the ability of the Clean Island Council to respond to any spill event. However, recent research at the Environmental Center has highlighted deficiencies in oil spill response capabilities. It is our understanding that tugs big enough to respond and move a fully laden tanker do not exist in the Hawaiian Islands. Further, the ability of response technology to adequately clean up a major oil spill is in question. If this is true, then the increased potential for oil spills at Barbers Point Harbor need to be evaluated in this light. If a spill occurs at the harbor under the "right" conditions, then such an event could be disaster for both Waikiki and island tourism. An impact analysis of this potential scenario needs to be undertaken. Further, our reviewers suggest that a plan to ensure spill prevention be outlined as one of the mitigation measure in the final document.

Thank you for the opportunity to comment.

Sincerely,

John T. Harrison
Environmental Coordinator

cc: OEQC
Harbors Division, DOT
Parsons Brinckerhoff Quade and Douglas, Inc.
Roger Fujioka
Paul Ekern
Hans-Jurgen Krock
John Craven
Chris Welch

Responses to the University of Hawaii, Environmental Center

Response to Comment 1

Barbers Point Harbor is not being expanded to serve only development in the Ewa plain. If it was, it would attempt to duplicate the cargo handling services offered at Honolulu Harbor, similar to the port facilities on the neighbor islands. The purpose of the proposed action is to help Barbers Point Harbor complement Honolulu Harbor and augment the State's port system. Honolulu Harbor is expected to continue to be the port of choice among container shippers. At present, Matson Navigation, Inc. and Sealand Inc., the State's two largest container shippers, have not expressed interest in using Barbers Point Harbor. Another container cargo terminal is also being planned at the former Kapalama Military Reservation. Therefore, in the foreseeable future, Ewa will continue to rely on container shipping at Honolulu Harbor. It is incorrect, however, to state that Barbers Point Harbor is too small to handle the larger container ships. The harbor was designed for a 720 foot container vessel and, because the expansion will better equip the harbor to handle container vessels, the possibility remains that in the future container shippers may use the harbor.

Barbers Point Harbor will probably handle petroleum products, dry- and neo-bulk cargo, coal, automobiles, and other cargo that would no longer be able to use Honolulu Harbor as the Honolulu Waterfront Master Plan and the Piers 19 to 35 Master Plan are implemented. Furthermore, future businesses, similar to AES-BP's co-generation plant in Ewa, may take advantage of Barbers Point Harbor.

Response to Comment 2

As noted in section 2.5.1.1, "Blasting and Mechanical Excavation," noise and vibration impacts are addressed in detail in sections 5.11, "Noise," and 5.12, "Vibration," and in Appendix A-1. Appropriate mitigation measures, listed in section 5.12.4 include:

- specified vibration limits that will be in the construction contract documents to minimize annoyance at potentially affected residential areas,
- specified quality control measures,

- a requirement that the contractor retain a qualified blasting consultant to plan the work, and
- monitoring of vibrations at sensitive locations throughout the construction period.

Section 5.12.1, "Vibration Measurements and Standards," and Section 4.5.7 and Table 16 of Appendix A-1 discuss vibration criteria and physiological effects. The relationship between vibration level, charge size and distance is given in section 4.5.2, "Blasting Vibration," of Appendix A-1. This information is presented in tabular form in Tables 14 and 15, "Charge Weight vs Peak Velocity as a Function of Distance," of Appendix A-1. Application of this technology by a qualified blasting consultant would be used to develop a blasting plan with appropriate charge sizes to limit vibrations to the specified levels.

Response to Comment 3

Contrary to the premise of the comment, the proposed action is not a "State/private venture." As stated in section 4.2.2.1, "Hawaii State Plan," the proposed action is a cooperative effort between the State and private sector.

The EJC, the land owner, is transferring two parcels (see Figure 2-4, "Barbers Point Harbor Land Ownership") to the State of Hawaii. The 84 acre parcel has been acquired by the State at no cost.. The 56.5 acre parcel will be acquired at a lower than market price with the condition that the State make the necessary improvements to the harbor by certain dates. Alternative harbor sites for the additional facilities were considered and eliminated for the reasons stated in section 3.2, "Alternative Harbor Sites." Because The EJC owns most of the land surrounding Barbers Point Harbor and is planning industrial developments in the area, they will certainly benefit from making their land available.

A benefit-cost analysis is not a requirement for this SEIS. Socio-economic impacts, such as employment and tax revenues, are discussed in section 6.4.2, "Probable Socio-Economic Impact."

Response to Comment 4

The Revised Environmental Impact Statement for Barbers Point Harbor on Oahu (1978) described the need for a comprehensive evaluation of tsunami effects. Numeric modeling was done for the original harbor by the U.S. Army Engineer Waterways Experiment Station (Tsunami Response of Barbers Point Harbor, Hawaii, 1982). The model used a variety of incident wave amplitudes, periods and land elevations to illustrate the effect of a tsunami at the harbor. The same potential concerns regarding the effects of a tsunami on the proposed harbor in light of the apparent long period resonant characteristics still exist. The period of resonance is dependent upon the harbor geometry, and for harbors suitable for ocean-going shipping the dimensions are such that the resonant period will fall within the period range of tsunamis. The report concluded that the harbor location is well chosen with respect to the tsunami hazard, as Barbers Point has relatively small open coast tsunami amplitudes. This report did not consider the expansion area in the model. However, the scenarios developed should remain representative of what would be seen at the expanded harbor. The results of this study will be applied to the design and operation of new harbor facilities.

Section 5.2, ""Tsunamis," in the Final SEIS has been modified for a more comprehensive discussion of tsunami hazards.

Response to Comment 5

The 50-foot change in thickness from the edge of the existing harbor into the expansion area was estimated based on a slope derived from borings which penetrate bedrock.

There are two wells which produce drinking water from the Waianae Basalt Aquifer about 3-5 miles north-east and upgradient of Barbers Point Harbor. The Waianae Basalt Aquifer is unaffected by the proposed action and is therefore not described in detail.

Final SEIS section 5.5., "Groundwater," has been revised for greater clarity.

Response to Comment 6

The report, Hydrological Impacts Proposed Expansion of the Barbers Point Harbor (1993), has been added as Appendix A-5 to the final SEIS and section 5.5, "Groundwater," has been revised for a more through discussion of probable impacts.

Response to Comment 7

Barbers Point receives all the crude oil that enters the State and an oil spill could indeed be a disaster for Waikiki and island tourism, as described in Oil Spills at Sea Potential Impacts on Hawaii (1993). However, the off-loading system of crude oil at Barbers Point Harbor involves two offshore moorings, located 2 and 2.5 miles from shore. The harbor expansion will not affect these moorings.

The Final SEIS addresses only the issues involved with the proposed action. The type of oil spills which may occur within the harbor would involve the transport of refined oil in small vessels to the outer islands and other areas in the Pacific (Barbers Point Harbor Modification Study, 1991). Under the provisions of the Oil Pollution Act of 1990, oil transfer facilities and the vessels that use them will be required to have oil spill contingency plans. Spills by vessels at Barbers Point Harbor are more easily contained given the narrow opening to the harbor and would not affect Waikiki. Harbor operation procedures will be enforced to prevent spills involving these facilities and vessels.

JOHN WAIHEE
GOVERNOR OF HAWAII

PETER A. SYBINSKY, Ph.D.
[redacted]
DIRECTOR OF HEALTH

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

In reply, please refer to:

November 25, 1994 92-316/epo

To: The Honorable John Waihee
Governor, State of Hawaii
c/o Director, Office of Environmental Quality Control
220 South King Street, 4th Floor
Honolulu, Hawaii 96813

From: Peter A. Sybinsky, ~~Ph.D.~~
Director of Health

Subject: Draft Supplemental Environmental Impact Statement (DSEIS)

Basin Expansion and Tug Pier (Job H.C. 1823)
Barbers Point Harbor
Ewa, Oahu

Thank you for allowing us to review and comment on the subject document. We have the following comments to offer in addition to those found in our letter dated October 22, 1992, addressed to Mr. Calvin M. Tsuda, Department of Transportation (attached):

Air Pollution

The Basin and Tug Pier Expansion portion of the project will remove and stockpile over two million cubic yards of dredged material. As mentioned in the DSEIS, Campbell Industrial Park (CIP) has five possible locations to stockpile the material which would be from twenty feet to forty feet high. Due to the nature of the project and the constraints that are attached to it, there is a significant potential for nuisance odors to become a
1 problem. As mentioned in the DSEIS, the residents of Honokai Hale and Nanakai Gardens have experienced nuisance odors from stockpile material due to the previous basin expansion project. By creating the large material stockpiles, it is a possibility that the material concentrated in the center will not be exposed to the sun and air to dry. The odors may be intensified and last for a longer period.

Construction activities must comply with provisions of Chapter 11-60.1, Hawaii Administrative Rules, Section 11-60.1-33, Fugitive Dust.

The contractor should provide adequate means to control dust from road areas and during the various phases of construction activities, including, but not limited to:

a. planning the different phases of construction, focusing on minimizing the amount of dust-generating materials and activities, centralizing material transfer points and onsite vehicular traffic routes, and locating potentially dusty equipment in areas of the least impact;

b. providing an adequate water source at site prior to startup of construction activities;

2 c. landscaping and rapid covering of bare areas, including slopes, starting from the initial grading phase;

d. control of dust from shoulders, project entrances, and access roads;

e. providing adequate dust control measures during weekends, after hours, and prior to daily startup of construction activities; and

f. control of dust from debris being hauled away from the project site.

If you have any questions on this matter, please call Mr. Wilfred Nagamine, Chief, Clean Air Branch at 586-4200.

Solid Waste

3 As this project is being proposed by the State Department of Transportation, the Department of Health recommends that the development include recycled content building materials whenever possible. Procurement guidelines for state agencies mandate preferences for products which were manufactured with post-consumer recycled material. Recycled plastic lumber is more weather resistant than traditional lumber and is locally available. Also, glasphalt is available as a base course for roadpaving purposes. Minimum standards for state agency projects were mandated by Act 201-94.

Should you have any questions on this matter, please contact Ms. Carrie McCabe of the Office of Solid Waste Management at 586-4240.

Water Pollution

A National Pollutant Discharge Elimination System (NPDES) permit is required for any discharge to waters of the State including the following:

1. Storm water discharges relating to construction activities for projects equal to or greater than five acres;

2. Storm water discharges from industrial activities;

4 3. Construction dewatering activities;

4. Cooling water discharges less than one million gallons;

5. Ground water remediation activities; and

6. Hydrotesting water.

Any person wishing to be covered by the NPDES general permit for any of the above activities should file a Notice of Intent with the Department's Clean Water Branch at least 90 days prior to commencement of any discharge to waters of the State.

Any questions regarding this matter should be directed to Mr. Denis Lau of the Clean Water Branch at 586-4309.

Noise and Radiation

Noise from harbor and warehouse activities associated with such development may impact the surrounding residences and hotel
5 guests in terms of annoyances.

Should there by any questions on this matter, please call Jerry Haruno, Environmental Health Program Manager, Noise and Radiation Branch at 586-4701.

Attachment

c: CAB
CWB
OSWM
NRB
Mr. David Atkin, Ph.D. (Parsons Brinckerhoff)
Mr. Marshall Ando
(Department of Transportation,Harbors Division)

Responses to the State Department of Health

Response to Comment 1

The proposed stockpiling sites are not located in Campbell Industrial Park. Refer to Figure 2-12, "Expansion Areas and Potential Stockpile Areas."

Odors associated with previously stockpiled material at the project site were probably related to the decay of organic matter removed from the sea floor when the entrance channel was excavated. Open ocean excavation is not part of the proposed project. There will only be a small amount of organic material excavated as part of this project associated with the existing harbor shoreline. Also as noted in section 5.13, "Air Quality," prevailing wind direction is offshore and odors will usually be carried away from residential areas.

There is *no evidence from past experience* that large stockpiles "intensified" the odors or caused them to "last for a longer period."

Response to Comment 2

General mitigation measures to control dust are described in section 5.13, "Air Quality." The contractor's dust control plan will include measures such as those described in the comment.

Response to Comment 3

The proposed project will comply with the standards for State agencies mandated by Act 201-94.

Response to Comment 4

Discussions with staff of the State DOH indicated that an NPDES permit for construction dewatering activities might be required to authorize the dewatering discharges from excavation and stockpiling activities to enter the State waters. Section 4.3, "Permits and Approvals Required," identifies the requirement for an NPDES permit for stormwater associated with construction activities. No other NPDES permit has been identified as applicable to the proposed action.

Response to Comment 5

Mitigation measures to reduce noise levels are described in section 5.11, "Noise."

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET, 5TH FLOOR
HONOLULU, HAWAII 96813
PHONE: (808) 523-4427 • FAX: (808) 527-5498

JEREMY HARRIS
MAYOR

GAIL M. KAITO
Acting Director

RONALD S. LIM
Acting Deputy Director

September 28, 1994

The Honorable John Waihee
Governor
State of Hawaii
c/o Office of Environmental Quality Control
220 S. King Street, Suite 400
Honolulu, Hawaii 96813

Dear Governor Waihee:

Subject: Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
Job H.C. 1823 and Future Pier and Storage Yard Improvements at
Barbers Point Harbor, Ewa, Oahu, Hawaii
Draft Supplemental Environmental Impact Statement (SEIS)

The Department of Housing and Community Development (DHCD) has no comments to offer on the Draft Supplemental Environmental Impact Statement (SEIS) for the above subject project.

Should you have any questions, please contact Charlotte Yoshioka of our Planning and Analysis Division at 527-5090.

Thank you for the opportunity to comment.

Sincerely,
Original signed by
Gail M. Kaito

GAIL M. KAITO
Acting Director

cc: Mr. Marshall Ando,
State Department of Transportation
Mr. David Atkin,
Parson Brinckerhoff Quade and Douglas, Inc.

DEPARTMENT OF PARKS AND RECREATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

JEREMY HARRIS
[redacted]
MAYOR

WALTER M. OZAWA
DIRECTOR

ALVIN K.C. AU
DEPUTY DIRECTOR

RECEIVED
OCT 4 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

September 30, 1994

Mr. David Atkin, Ph.D.
Parsons Brinckerhoff
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Atkin:

Subject: Draft Supplemental Environmental Impact Statement for Basin Expansion and Tug Pier at Barbers Point Harbor (Job H.C. 1823) and Future Pier and Storage Yard Improvements at Barbers Point Harbor Ewa, Oahu, Hawaii

We have reviewed the above-described report and have no comment to offer at the present time.

Thank you for the opportunity to review this project.

If there are any questions, please contact Lester Lai of our Advance Planning Branch at 523-4696.

Sincerely,

For WALTER M. OZAWA, Director

WMO:ei

We Add Quality to Life

RECEIVED
OCT - 6 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

PB 94-1084

October 3, 1994

Honorable John Waihee, Governor
State of Hawaii
c/o Office of Environmental
Quality Control
220 South King Street
Honolulu, Hawaii 96813

Dear Governor Waihee:

Subject: Draft Supplemental Environmental Impact Statement (SEIS) for Basin Expansion and Tug Pier at Barbers Point Harbor, Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu, Hawaii

We have reviewed the subject draft SEIS and have no comments to offer. Thank you for allowing us to be part of the review process.

Very truly yours,

W. F. REMULAR
Acting Director and
Building Superintendent

GN:jo
cc: G. Tamashiro
State Dept. of Transportation,
Harbors Div. (Marshall Ando)
✓Parsons Brinckerhoff Quade & Douglas, Inc.
(David Atkin)

DEPARTMENT OF PUBLIC WORKS

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET
HONOLULU, HAWAII 96813

RECEIVED
OCT 10 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

JEREMY HARRIS
MAYOR

KENNETH E. SPRAGUE
DIRECTOR AND CHIEF ENGINEER

ENV 94-239

October 6, 1994

Mr. David Atkin, Ph.D.
Environmental Task Leader
Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Dr. Atkin:

Subject: Draft Supplemental Environmental Impact Statement (DSEIS), Basin Expansion and Tug Pier at Barbers Point Harbor, TMK: 9-1-14: Por. 2 & 24

We have reviewed the subject DSEIS and have the following comments:

1. Traffic mitigation measures as stated on pages 5-40 through 5-42 should be completed prior to construction of the Basin Expansion and Tug Pier improvements.

2. Proposed future access road to the project site should be constructed in accordance with the City standards if the roadway is planned to be dedicated to the City.

3. Provide best management practices (BMPs) or engineering control to minimize the discharge of pollutant into the harbor.

4. A NPDES permit for industrial activity may be required by the State Department of Health for storm water discharges from any open storage areas.

Should you have any questions, please contact Mr. Alex Ho, Environmental Engineer, at 523-4150.

Very truly yours,

for Alex Ho

KENNETH E. SPRAGUE
Director and Chief Engineer

Responses to City and County of Honolulu, Department of Public Works

Response to Comment 1

The implementation of these traffic mitigation measures is not part of the proposed project. Section 5.10, "Traffic," has been clarified in response to the comment.

Response to Comment 2

The EJC, the developer of the Kapolei Business Park, may dedicate the new harbor access road to the City and County of Honolulu following its construction. It is the responsibility of The EJC to ensure that the road is designed to City and County of Honolulu standards.

Response to Comment 3

A Best Management Practice (BMP) plan will be prepared in support of the necessary DOH permit applications. Appropriate erosion/pollution control measures will also be included in the project plans and specifications.

Response to Comment 4

According to DOH staff, the proposed action does not require the NPDES general permit coverage for stormwater discharges from industrial activities because none of the proposed action items are included in the industrial activity categories that would trigger this General Permit type.

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
801 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96813 - AREA CODE (808) 529-3111

FRANK F. FASI
MAYOR

MICHAEL S. NAKAMURA
CHIEF

HAROLD M. KAWASAKI
DEPUTY CHIEF

OUR REFERENCE BS-LK

October 11, 1994

RECEIVED
OCT 14 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

The Honorable John Waihee
Governor of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Dear Governor Waihee:

This is in response to your request for comments on a Draft Supplemental EIS for Barbers Point Harbor.

This project is expected to have no significant impact on police services. We have no additional comments to make at this time.

Thank you for the opportunity to review this document.

Sincerely,

Michael S. Nakamura
Chief of Police

By [signature] for
EUGENE UEMURA
Assistant Chief of Police
Administrative Bureau

cc: Harbor Division
Department of Transportation
David Atkin, Ph.D.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96843

October 26, 1994

RECEIVED
OCT 26 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

Mr. David Atkin
Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Mr. Atkin:

Subject: Your Letter of September 21, 1994 Regarding the Draft Supplemental Environmental Impact Statement (SEIS) for Basin Expansion and Tug Pier at Barbers Point Harbor, Job H. C. 1823 and Future Pier and Storage Yard Improvements at Barbers Point Harbor, TMK: 9-1-14: Por. 02 and 24, Ewa, Oahu, Hawaii

Thank you for the opportunity to review and comment on the Draft SEIS for the proposed project. We have the following comments to offer:

1. There are five existing water meters currently serving the project site.
2. The developer will be required to obtain a water allocation from the Department of Land and Natural Resources (DLNR).
3. The storage requirements within Campbell Industrial Park should be coordinated with Campbell Estate. A revised water master plan of the expansion and increased water usage should be submitted for our review and approval. The availability of water will be determined when the building permit application is submitted for our review and approval.
4. The developer may be required to pay our water system facilities charge for transmission depending on the location of the DLNR source.
5. If a three-inch or larger meter is required, the construction drawings showing the installation of the meter should be submitted for our review and approval.

6. The proposed project is subject to our cross-connection control requirements prior to the issuance of the building permit application.

7. The on-site fire protection requirements should be coordinated with the Fire Prevention Bureau of the Honolulu Fire Department.

8. Regarding Section 7.1.2, the revised Ewa Water Master Plan should be prepared by the Ewa Plain Water Development Corporation and submitted for our review and approval.

If you have any questions, please contact Barry Usagawa at 527-5235.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

Responses to City and County of Honolulu, Board of Water Supply

Response to Comment 1

One of the five water meters is for domestic supply; the remaining four are for fire protection. This information has been added to section 7.1, "Water Supply."

Response to Comment 2

The SDOT will apply for the additional water allocation from the DLNR as warranted with future expansion improvements (refer to section 7.1, "Water Supply.")

Response to Comment 3

The water master plan for the harbor will be revised and updated to include future expansion improvements.

Response to Comment 4

This information has been noted.

Response to Comment 5

Construction drawings which include the installation of any three-inch or larger water meter will be submitted for BWS review and approval prior to construction.

Response to Comment 6

This information has been noted.

Response to Comment 7

This information has been incorporated into new section 7.4, "Fire Protection."

Response to Comment 8

The Ewa Plain Water Development Corporation (EPWDC) is not currently updating the Ewa Water Master Plan.

PLANNING DEPARTMENT
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

RECEIVED
OCT 28 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

JEREMY HARRIS
MAYOR

ROBIN FOSTER
CHIEF PLANNING OFFICER

ROLAND D. LIBBY, JR.
DEPUTY CHIEF PLANNING OFFICER

BS 9/94-4397

October 26, 1994

Parsons Brinckerhoff Quade & Douglas, Inc.
Pacific Tower, Suite 3000
1001 Bishop Street
Honolulu, Hawaii 96813

Attention: David Atkin, Ph.D.
Environmental Task Leader

Gentlemen:

Draft Supplemental Environmental Impact Statement
for Barbers Point Harbor, Ewa Oahu

We have reviewed the subject Draft Supplemental Environmental Impact Statement (DSEIS) and offer the following comments.

We have no objections at this time to the construction and operation of the proposed facility, based on the information that has been provided.

1 In reference to the closure of Barbers Point Naval Air Station (BPNAS) on pg. 4-7, it should be included that representatives from the City and County of Honolulu are also members on the BPNAS Reuse Committee. Further, there are a number of State and City proposals that have been forwarded to the BPNAS Reuse Committee, in addition to the federal agencies and proposals listed.

2 In reference to the Ewa Development Plan on pg. 4-22, it should be added that the Planning Department is currently involved in a comprehensive revision program to revise and update the Ewa Development Plan. Final recommendations for revision to the Ewa Development Plan are anticipated to be proposed for adoption in late March 1995.

Thank you for the opportunity to comment on the subject DSEIS report. Should you have any further questions on the matter, you may contact Brian Suzuki of our staff at 527-6073.

Sincerely,

ROBIN FOSTER
Chief Planning Officer

RF:ft

Responses to City and County of Honolulu, Planning Department

Response to Comment 1

Your comments regarding City and County of Honolulu representation in the BPNAS reuse committee and City and County of Honolulu proposals for BPNAS has been incorporated in section 4.1.3, "Proposed Land Use Developments."

Response to Comment 2

The additional information regarding the Ewa Development Plan was incorporated in section 4.2.3.2, "Ewa Development Plan."

FIRE DEPARTMENT

CITY AND COUNTY OF HONOLULU

3375 KOAPAKA STREET, SUITE H425
HONOLULU, HAWAII 96819-1869

RECEIVED
NOV 1 1994
PARSONS BRINCKERHOFF
HONOLULU, HI

JEREMY HARRIS
MAYOR

RICHARD R. SETO-MOOK
FIRE CHIEF

ERNEST Y. SUEMOTO
FIRE DEPUTY CHIEF

October 26, 1994

Office of Environmental Quality Control
220 South King Street, Fourth Floor
Honolulu, Hawaii 96813

Dear Sir:

SUBJECT: Basin Expansion and Tug Pier at Barbers Point Harbor, Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu, Hawaii

We have reviewed the subject material provided and foresee no adverse impact in Fire Department facilities or services. Fire protection services will be provided from Makakilo and Nanakuli engine companies with ladder service from Waipahu.

A new fire station is being constructed near the entrance of Campbell Industrial Park and is tentatively scheduled for completion in March of 1994. This new station will house an engine and a ladder company and provide fire protection in the expansion area.

Access for fire apparatus, water supply and building construction shall be in conformance to existing codes and standards.

Should you have any questions, please call Assistant Chief Attilio Leonardi of our Administrative Services Bureau at 831-7775.

Sincerely,

for RICHARD R. SETO-MOOK
Fire Chief

CW:ny
Copy to: Harbors Div., State Dept. of Transportation (Marshall Ando)
Parsons Brinkerhoff Quade & Douglas Inc. (David Atkin)

EIS report attached.

Response to City and County of Honolulu, Fire Department

A new section, "Fire Protection," was included in Chapter 7, incorporating the information you have provided.

DEPARTMENT OF TRANSPORTATION SERVICES
CITY AND COUNTY OF HONOLULU
PACIFIC PARK PLAZA
711 KAPIOLANI BOULEVARD, SUITE 1200
HONOLULU, HAWAII 96813

JEREMY HARRIS
~~FRANK F. FASI~~
MAYOR

JOSEPH M. MAGALDI, JR.
DIRECTOR

AMAR SAPPAL
DEPUTY DIRECTOR

November 4, 1994

The Honorable John D. Waihee
Governor
State of Hawaii
c/o Office of Environmental
  Quality Control
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Dear Governor Waihee:

Subject: Basin Expansion and Tug Pier, Barbers Point Harbor
Draft Supplemental Environmental Impact Statement
TMK: 9-1-14: Portion 2 and Portion 24

This is in response to the Draft Supplemental Environmental Impact Statement submitted to us for review on September 21, 1994 by Parsons Brinckerhoff Quade and Douglas, Inc.

Based on our review, we have the following comments:

1. The method of determining the number of vehicular trips generated by this project should be clarified.

2. The traffic impact analysis included the future harbor access road intersecting Kalaeloa Boulevard. However, it is our understanding that the proposed access road will not be constructed as part of this project. If this is the case, the traffic analysis should be revised to reflect the condition.

3. If the harbor access road is to be constructed with the project and the intent is to dedicate the road to the City, then it should be designed to City standards.

4. For your information, the intersection of Kalaeloa Boulevard at Malakole Street will be modified and signalized in the near future.

Should you have any questions, please contact Lance Watanabe of my staff at 523-4199.

Sincerely,

JOSEPH M. MAGALDI, JR.
Director

cc: Office of Environmental Quality Control
State Department of Transportation,
Harbors Division
Parsons Brinckerhoff Quade & Douglas, Inc.

Responses to City and County of Honolulu, Department of Transportation Services

Response to Comment 1

The number of trips generated by the proposed action was estimated by Pacific Planning & Engineering, Inc. in their Traffic Impact Assessment Report for Barbers Point Harbor, prepared in 1992. Their estimate was based on the existing Barbers Point Harbor operations, cargo forecasts and the number of existing and proposed ship berths. Trip generation was estimated from conversations with the staff of shipping and trucking companies.

Response to Comment 2

The future harbor access road will be constructed as part of the Kapolei Business Park development (Final EIS, Kapolei Business-Industrial Park, 1990). Since Kapolei Business Park has been approved by the necessary agencies and is currently under construction, the traffic analysis assumed that the future harbor access road will be in place by the year 2005, even though it is not part of the proposed action. Therefore, the traffic analysis was not revised to reflect the condition of no new road.

Response to Comment 3

The EJC, the developer of the Kapolei Business Park, may dedicate the new harbor access road to the City and County of Honolulu following its construction. It is the responsibility of The EJC to ensure that the road is designed to City and County of Honolulu standards.

Response to Comment 4

Section 5.10, "Traffic," was revised to reflect this information.

HAWAII STATE DEPARTMENT OF TRANSPORTATION

OFFICIAL COMMENTS

FOR

BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU

JOB H.C. 1823

STATEMENT OF EMOGENE MARTIN

Taken at a Public Hearing at the Estate of James Campbell Building, Laulima Room, 1001 Kamokila Boulevard, Kapolei, Hawaii on Thursday, October 13, 1994 commencing at 5:54 p.m.

BEFORE:

PRISCILLA GONZAGA, CSR #127
Notary Public, State of Hawaii

(Reporter's disclosure is available.)

EMOGENE MARTIN: My name is Emogene Martin and I live at 91-257 Hanapouli Circle, Apartment 18-F in Ewa Beach. And I'm the president of Friends for Ewa. And I am a member of the -- I'm a board member of the Ewa Neighborhood Board number 23. I was past president for three terms, '85 to '87. And I'm a director for the Ewa Beach Community Association. And I think that goes back from 1983. So that's what, over ten years.

And you want me to comment on what I feel about the expansion?

I attended the dedication of the basin, the deep draft harbor when they first opened. And at that time, I realized the surrounding communities, especially Honokai Hale, Nanakai Gardens that were really the people who were affected with the blasting. And they went through, you know, some trying times. But I feel that after that was all completed, things were settled, people were able to talk to, you know, the harbors people, whoever was involved in it. They gave a good basis on when you going to come back and do it again but on a smaller scale. And I think it's happening in a more amicable way as far as community is concerned. Because it gives them a good head start to know this is coming, prepare yourself, you know. It's not going to be as big as the first time.

So I feel that what I've viewed on the -- the monitor and the displays that, you know, highlights the different things that's all connected, people have thoughts about, you know, would there be fish poisoning, ciguatera. And then there was some doctor out there explaining it to me. I feel that this is really necessary that you really have the public really become involved with it and you keep the level of surprise, you know, at a minimum.

And we just want to be very successful, what you do, you know, in the area because the impact is, you know, generally with the foundation of the second city itself. I think it's really important.

So as far as you know my viewpoint, I think the steps taken are necessary and they're good. I don't see anything detrimental about it especially with a staff of, you know, experts you have out front. That's very, very important so people know what they're talking about. So that's about it.

(Concluded at 6:01 p.m.)

--ooOoo--

CERTIFICATE

STATE OF HAWAII)
) SS.
CITY AND COUNTY OF HONOLULU)

I, PRISCILLA GONZAGA, a Notary Public of Hawaii, do hereby certify:

That on October 13, 1994, the statement contained herein was taken down by me in machine shorthand and was thereafter reduced to typewriting under my supervision;

That the foregoing represents, to the best of my ability, a true and correct copy of the proceedings had in the foregoing matter.

I further certify that I am not of counsel for any of the parties hereto, nor in any way interested in the outcome of the cause named in the caption.

Dated this October 27, 1994, in Honolulu, Hawaii.

PRISCILLA GONZAGA, CSR #127
Notary Public, State of Hawaii
My commission expires: 8/19/98

Testimony by Friends of Ewa

No response required.

PUBLIC HEARING

RE:

BASIN EXPANSION AND TUG PIER AT

BARBERS POINT HARBOR - OAHU

JOB H.C. 1823

AND FUTURE PIER AND STORAGE YARD IMPROVEMENTS

AT BARBERS POINT HARBOR

STATEMENT OF JANE ROSS

Taken at the hearing held by the State Department of Transportation Harbors Division at the Estate of James Campbell Building, Laulima Room, 1001 Kamokila Boulevard, Kapolei, Hawaii, on Wednesday, October 19, 1994, commencing at 7:40 p.m.

REPORTED BY:
Cynthia L. Murphy, RPR, CSR 167
Notary Public, State of Hawaii

WEDNESDAY, OCTOBER 19, 1994 7:40 P.M.

--o0o--

MS. JANE ROSS: I'm Jane Ross. I'm the secretary of the Honakai Hale/Nanakai Gardens Community Association. I am speaking for the association in the absence of our president, who works late and was unable to be here. I don't think he finishes work until seven o'clock at night.

I just had a very lengthy discussion with the consultants and have looked at their various methods of construction, the method of blasting, the method of hydraulic dredging, and the Swiss cheese method. As far as our community is concerned, blasting is out. We went through three years of hell with blasting during the construction of the main basin of the Barbers Point Harbor. We do not want or intend to go through that again.

I understand from the consultants that they -- their charges would be less per hole. If my recollection is correct, they're talking 250 pounds of explosive in some 20 holes. They claim that the basin, the original basin, had much higher charges, 2,000 perhaps in the holes. I don't know what 250 times 20 would result in. I do know what the Kiewit Construction Companies construction method of blasting resulted in, and I have no confidence -- and when I say "I," I mean we -- do not have confidence in the figures that are being estimated by consultants.

The Swiss cheese method seems to be a very logical method. Rather than to weaken the coral by digging holes and blasting, my understanding is that they weaken the coral by digging many, many, many more holes to weaken it, and then they can come in with a piece of equipment, some kind of a clamshell auger or other equipment, to then dig out the weakened material. This is an innovative method, the consultants said, and the drawback is that it would cost more in terms of time and money.

It seems to me that the State has an obligation to do these projects so that those who have lived in the area for many, many years before they ever started their project are not adversely affected. And now I see that this does not seem to be their intent. They seem perfectly willing to have the residents have their homes shaken daily without any consideration that we are expected, who live nearby, to pay a higher price for the construction of that harbor than the other residents of the state. That is not fair. We are never -- we have never been and are not now against the project. We are merely against the method of construction which would save the State money but would cost us more in terms of our quality of life and damage to our homes, which brings up yet another point that needs to be mentioned, and that is, when the work is done by whatever means.

During the construction of the original basin, we experienced night work all night long. There were the backup bells on the equipment, which only need to be heard 150 feet away, and yet were heard as though it was in your living room where we live in Honokai Hale. Also, the trucks that were getting the coral and making the huge mounds where it was to be stacked, we could hear their engines, vroom, vroom, vroom, as they were charging up that steep hill, and then they honked at each other. Those coming down honked at the ones going up. You heard everything at night. Then when they unloaded, they dumped, it was clank, clank, bang, bang, all night long. So it was the beep, beep, vroom, vroom, and clank, clank. How can you take that down? This is not fair. It's not reasonable.

So besides the blasting, which actually shook our homes, it seemed like the -- there was never a sound. It seemed like the vibration came up the walls of the house and that the roof made a noise like -- the only thing I can say is like it clapped. So the vibration came up the sides of the walls, and the roof clapped. In our living room, our sturdy upholstered swivel rockers rocked. If the dogs were on the carpet and the thing occurred, they would jump up off the floor scared. They didn't know anything about blasting, so it couldn't have been their imagination, as we were accused of having it be our imagination that some of these things were happening. When I was in the yard, sitting on the grass, just enjoying the afternoon after work with my animals, I heard the house make that noise behind me, and I had -- I turned around, and the dogs, again, they turned around and jumped up. So these are the kinds of things that we cannot tolerate.

These stockpiles, we understand that, despite the fact that, during the construction of the original basin, the stockpiles caused us problems, that they're thinking of putting them there again, which is absolutely asinine for several reasons. First of all, because they cause problems, and they're just repeating it because it's cheap to do it that way. Secondly, because the State has other projects at, I think, at Honolulu Harbor. There's a project where they need this coral for whatever they're going to do. Also --

UNIDENTIFIED WOMAN: The airport.

MS. ROSS: Is it the harbor or the airport?

UNIDENTIFIED WOMAN: The airport.

MS. ROSS: I can't remember. But there's a State project, either the harbor or the airport. Then there's also the Department of Economics and Tourism that have a project, they would like -- they're interested in this coral fill. So it makes sense that that coral fill from a State project be given to these other State projects for their use. The problem seems to be the idiocy of the State in that they want to charge these people, State people, to transport the coral for them. Now that is ridiculous. The harbor developers want to charge these other State projects to transport the coral from the harbor to their project. They feel that, if they got the coral from anywhere else, the fill from anywhere else, they would have to pay, and so they should pay for at least the transporting because the coral is free. Now, we're talking here State project to State project.

It seems to me that, since this harbor expansion is a State project, that included in the cost of that expansion should be the disposal of that coral, whether it's to a State project, like the airport, or the harbor, or business and economic development, or a private sector. I can see how the private sector might be charged, but not a State agency being charged to transport the coral from another State agency's project.

I don't know if I've said this before, and if I have I'm sorry to repeat. If cost, time and money are more important than anything else to the start and completion of this project, then it is grossly unfair to those of us who live here. Because besides being expected to pay the taxes that everybody else paid to see this project happen, we are being asked to pay an even higher price in the destruction of our peace and quiet, our quality of life, and possibly our health. I say that because these things that I have been talking about cause stress, and stress is destructive to one's health. The coral piles, if they are allowed to be placed near us, produce coral dust, which is also damaging to the health. We already have emissions from Campbell Industrial Park, which is near, if not at, its limit. To add now this additional pollution of coral dust is unreasonable.

I think I have covered the three points. Our community wants no blasting, we want no night work, not working all night long. I don't think we would object to a ten-hour day that the consultant was mentioning, provided the ten-hour day is reasonable, I mean, it doesn't go into the night hours excessively. And the coral mounds.

And we would certainly ask that the people responsible for developing the contract that will go out to bid to eliminate these things and to make that contract flexible enough so that, if there is a problem experienced by the residents, that the contractor building the project would have to make some adjustments from the original specifications in the contract.

I may not have covered everything here, because I can't remember really what I said in my long conservation with the consultants versus what I said here. But I can be reached at 682-5577 and would be happy to provide any additional information or clarification on what may not be clear.

I might just add one other thing. It seems to me that blasting is, to the consultants, the number one choice of construction despite everything that has happened in the past, and again, it's time and money. So we say time and money are less important than the well-being of people, and all people should share this cost, not heavily those who live nearby. Thank you.

(A discussion was held off the record.)

MS. ROSS: Addendum. The -- one of my concerns is also about the possibility that the brackish water aquifer will leak out into the harbor, as I understand happened when they constructed the original basin. We cannot afford to lose even that brackish water, because it is used for the irrigation of golf courses and common areas. And if desalinization needs to take place, it will be easier to desalinate that water than to take sea water. So we really can't afford to lose it, and I think that this needs to be covered very carefully in the EIS.

I know that for the construction of the Ewa Marina, there were -- it was mentioned that they might also break the barrier of the brackish water aquifer, and there were several methods by which this could be corrected. I can't remember what they were right off the top of my head, but it can be done. It is more costly, but it's worth it if our valuable water resource is to be saved.

Other residents were also concerned about the fish kill, since there was a tremendously large fish kill in the construction of the original harbor. We are talking about daily counts of in excess of 12,000 fish by name. The fishermen along the Waianae Coast, many of them are subsistence fishermen, earning their living, as well as feeding their family, by fishing. They came to a number of meetings and expressed the fact that the fish are not there as they used to be, that the harbor did affect it. Well, it was a spawning ground, from what we understand, for young fish, and so naturally, if you destroy the coral, the spawning ground is destroyed, and you have fewer adults. There was concern that something similar may happen here. I'm not sure that that's the case, because it's inside the basin, and I don't know how many fish are there. But I pass that concern on. The Hawaiian Civic Club for our area brought up that concern at that last meeting on Sunday, so I pass it on for you folks.

(The hearing concluded at 8:02 p.m.)

--oOo--

C E R T I F I C A T I O N

I, CYNTHIA L. MURPHY, Certified Shorthand Reporter and Notary Public of the State of Hawaii, do hereby certify that the foregoing pages comprise a full, true and correct transcript of the proceedings held on Wednesday, October 19, 1994, relative to the aforementioned matter.

Dated this 2nd day of November, 1994.

Cynthia L. Murphy, RPR, CSR No. 167
Notary Public, State of Hawaii
My Commission Expires: 12/15/97

Responses to testimony by Honokai Hale/Nanakai Gardens Community Association

Comments on blasting

Probable Impacts and mitigation measures are discussed in sections 5.11, '"Noise," and 5.12, "Vibration." Vibration limits would be specified in construction contract documents.

Comments on construction noise and night work

Construction noise mitigation measures are discussed in section 5.11, "Noise." These measures are described in further detail in Appendix A-1, section 4.13.1, "Construction Noise." Hours of construction are governed by DOH Regulations as discussed in section 5.11.1, "Noise Standards and Criteria."

Comments on stockpiling

Because the materials to be removed in the construction of the expansion areas have commercial value, it is expected that the stockpiles will be temporary, although several years could pass before all of the material is reclaimed. Potential uses for the coral material are described in section 6.4.2.1, "Economic Impact of Construction." Although the material will be used on future projects, the specific projects and their timing are at present not known. As described in section 6.3, "Visual," stockpiles will be limited in height to reduce their visual impact until they are gone. Mitigation measures to control dust are found in the mitigation section of 5.13, "Air Quality."

Comments on groundwater

Groundwater from the upper-most limestone aquifer near the harbor is currently used for coral washing and industrial cooling. This groundwater is too saline for irrigation purposes. The proposed action will not affect the salinity of the groundwater. Groundwater flow into the harbor will also remain constant at approximately 0.7 mgd. After current irrigation practices cease, however, groundwater flow into the harbor will decrease by about half. However, this anticipated decrease is not associated with this project.

The text in section 5.5, "Groundwater," has been revised to address these concerns more clearly and the report, Hydrological Impacts Proposed Expansion of the Barbers Point Harbor (1993), has been added as Appendix A-5.

Comments regarding the Ewa Marina project should be referred to the developer of that project, Haseko.

Comments on fish kills

Section 5.6.3, "Marine Biology," has been revised to address these concerns.

Sunrise, Mt. McKinley Ansel Adams

SIERRA CLUB LEGAL
DEFENSE FUND, INC.

The Law Firm for the Environmental Movement

223 South King Street, 4th Fl., Honolulu, HI 96813 (808) 599-2436 FAX (808) 521-6841

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OCT 24 1994
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HONOLULU, HAWAII

October 21, 1994

David Atkin
Parsons Brinckerhoff Quade and Douglas, Inc.
Pacific Towers
1001 Bishop Street, Suite 3000
Honolulu, Hawai'i 96813

Dear Mr. Atkin:

The Sierra Club Legal Defense Fund requests to be a consulted party to the Draft Environmental Impact Statement (DEIS) on the Barber's Point Harbor Expansion and Tug Pier and Storage Yard Improvements. We would appreciate a copy of the DEIS on this project. Thank you very much.

Sincerely,

Marjorie Ziegler

Marjorie Ziegler
Resource Analyst

Response to the Sierra Club Legal Defense Fund

The Sierra Club Legal Defense Fund was sent a copy of the Draft SEIS and will receive a copy of the Final SEIS.

HAWAII STATE DEPARTMENT OF TRANSPORTATION
OFFICIAL COMMENTS
FOR
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823

PLEASE LEAVE YOUR COMMENTS AT THE HEARING
OR MAIL TO:

DEPARTMENT OF TRANSPORTATION HARBORS DIVISION
79 S. NIMITZ HIGHWAY
HONOLULU, HAWAII 96813

OFFICIAL COMMENTS MUST BE POSTMARKED BY NOVEMBER 7, 1994

THE FOLLOWING IS SUBMITTED BY:

NAME: West Beach Estates

ADDRESS: 91-100 Kamoana Place

CITY AND ZIP CODE: Kapolei, HI 96707

West Beach Estates (WBE) formally submits the following concerns and questions:

1. Hydraulic modeling and/or numerical analyses were accomplished to study the impact of the proposed actions within the deep-draft harbor. "These studies documented that the harbor experiences natural resonance modes which cause standing waves to occur under certain long period ocean wave conditions."

   What will be the impact, if any, on the West Beach Marina, West Marina entrance channel and shared ocean entrance channel?

2. What will be the long-term impact, if any, of the proposed actions on the water circulation and water quality of the West Beach Marina? What studies, if any, were accomplished in this regard?

3. What will be the quantitative increase in water born traffic? What will be the change in the type of water born traffic? What will be the impact of the water born traffic, both as to numbers and types, on the West Beach Marina entrance channel and the shared ocean channel?

4. The Ko Olina Fairways (TMK 9-1-56:14) are under construction and scheduled for occupancy starting in February 1995. Also, Lagoon #4 (TMKs 9-1-57: 16 & 17) has been open to the general public since June of 1994. Impacts from the proposed harbor expansion need to be assessed for these two areas.

Date: November 3, 1994

Signature: [signature]
Kenneth M. Williams
Senior Project Manager

USE ADDITIONAL SHEETS IF NECESSARY

Responses to West Beach Estates

Response to Comment 1

Modeling performed by the Army Corps of Engineers showed that the proposed basin expansion will improve surge conditions over those presently existing in the harbor. Impacts on West Beach Marina were not specifically addressed, although if surge conditions improve in the harbor, surge conditions in West Beach Marina would also be expected to improve. In addition to expanding the basin, other improvements suggested by the Army Corps of Engineers modeling include flaring a portion of the entrance channel, building a jetty, and deepening the harbor and channel. All of these measures would have positive impacts on hydraulic conditions in the channels, harbor and marina.

Response to Comment 2

Expansion of the harbor basin should have no significant impact on water circulation or water quality in West Beach Marina. The current and circulation patterns at the harbor entrance will not be significantly altered, and this is the primary influence that the deep-draft harbor has on the marina. The expanded harbor basin will have an increased tidal prism (volume of water exchanged by the tide), with no increase in entrance channel size. Thus, tidal currents may be somewhat stronger at the harbor entrance. This could have a beneficial impact on circulation within the marina. No specific investigations were conducted with regard to circulation or water quality within West Beach Marina.

Response to Comment 3

Future vessel call frequencies will be largely dependent on market conditions, and therefore the quantitative increase in maritime traffic is very difficult to estimate. The 2010 Master Plan for Barbers Point Harbor (1991) forecasted that in 1995 approximately 120 ships and 300 barges will use the harbor. Much of the future cargo destined for Barbers Point Harbor will be used at the AES-BP co-generation plant, for construction activities, and for present and future business that locate near the harbor.

It is also likely that cargo needing substantial storage space, such as automobiles, will be handled at the harbor.

The 2010 Master Plan addressed the potential conflict between recreational boating and commercial shipping. To mitigate these potential problems a control tower is proposed to monitor shipping in the channel. However, the construction of the control tower is not proposed as part of this project. It would be constructed later when vessel traffic conditions warrant.

Response to Comment 4

This information has been incorporated in the Final SEIS. Sections 4.1.2, "Surrounding Land Uses," 5.11, "Noise," and 5.12, "Vibrations," and Figures 4-1, "Existing Land Uses," and 5-12, "Estimated Construction Equipment Noise at Sensitive Receptors," have been modified to reflect the proximity of Ko Olina Fairways and Lagoon No. 4.

Lāhui Hawai'i
National Land Committee
P.O. Box 1256 • Pahoa, HI 96778

November 4, 1994

Honorable John Waihee
Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, HI 96818

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

Atten tion: Marshall Ando

Gentlemen:

Re: Barbers Point Harbor Basin Expansion and Tug Pier, and Future Pier and Storage Yard Improvements

Ka Lahui Hawaii is the only Sovereign Nation of 23,000 plus citizens in the State of Hawaii.

We unanimously OPPOSE your plan of action in expanding and improving the existing Barbers Point Harbor, located in Ewa.

1 Our opposition is the dredging of 2.5 million cubic yards of coral limestone rock. The minerals and other natural and cultural resources of the lands and submerged lands of the archipelago, as well as the plant and animal forms, aquatic an d terrestrial, which dwell therein, belong to us the Hawaiian people. SUBMERGED LANDS ARE CEDED LANDS AND THEREFORE YOU DO NOT HAVE THE RIGHT TO DREDGE 2.5 million cubic yards. See also, Re Land Title Robisnon, 49 Haw. 429, 440, 421 P.2d. 570, 577 (1966).

2 Also, the water rights. You are not too clear in the sudy of water, primarily ground water.

Ka Lahui Hawaii requests that you submit a full report on the above matters as soon as possible.

Sincerely Yours,

Clara L. Kakalia

(Mrs.) CLARA L. K AKALIA
Chair, N ational land Committee

cc: Kia'aina Mililani Trask

Responses to Ka Lahui Hawaii

Response to Comment 1

We believe the areas to be excavated are presently fastlands not submerged lands, and therefore are not Ceded Lands by virtue of being submerged. Information on the present and future ownership of the fastlands that will be affected by the proposed action is provided in section 2.2.2, "Land Ownership." According to current land ownership information, title to these lands lies with the State of Hawaii.

Response to Comment 2

The SDOT, Harbors Division is planning to apply for a Water Use Permit from the Commission on Water Resource Management.

The text in section 5.5, "Groundwater," has been revised for greater clarity and the report, Hydrological Impacts Proposed Expansion of the Barbers Point Harbor (1993) has been added as Appendix A-5.

The Estate of James Campbell

RECEIVED
NOV 1 0 1994
PARSONS BRINCKERHOFF
HONOLULU, HAWAII

November 7, 1994

BY TELECOPY AND MAIL

Honorable John Waihee
Governor
State of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, HI 96813

Supplemental Environmental Impact Statement for
Basin Expansion and Tug Pier at Barbers Point Harbor
Job HC1823 and Future Pier and Storage Yard
Improvements at Barbers Point Harbor Ewa, Oahu, Hawaii
(the "Supplemental EIS")

Dear Sir:

Thank you very much for the opportunity to provide comments on your Supplemental EIS. The Estate of James Campbell supports efforts aimed at the expansion and further development of the Barbers Point Harbor. This support extends to the planned basin expansion, and pier and storage yard improvements.

We do have the following comments on the Supplemental EIS. To ease your review we use the page numbers and paragraph references as set forth in the Supplemental EIS. (eg. Chapter 1, Page 1, Paragraph 1). We feel that these comments will need further clarification in the final EIS.

1 • Executive Summary, Page 3, Paragraph 2: The closest residential area is the Ko Olina Fairways project, which is now under construction. It is located about halfway between Honokai Hale and the Project Area.

• Chapter 1, Page 2-7, Paragraph 1: The transfer of the 84-acre parcel should occur shortly. As a result, this transfer may take place before the 56.5-acre transfer.

2 • Figure 2-4: The State DOT Harbors Division has indicated that the State is no longer interested in stockpiling coral in the location shown as Stockpile Area No. 5. As a result, it should be deleted in total from the Supplemental EIS.

3 • Page 2-19, Section 2.5.1.2 Hydraulic Dredging: The State Harbors Division has indicated that hydraulic dredging is no longer contemplated. Therefore, this method should be deleted.

1001 Kamokila Boulevard, Kapolei, Hawaii 96707 Phone (808) 674-6674 Facsimile (808) 674-3111

4 • <u>Page 2-23, Section 2.5.2, Stockpiling of Removed Material</u>: Text indicates that there will be about 2.3 million cubic yards of coral limestone, coral sands, gravel, and clay for stockpiling. It would be appropriate to give some indication as to the quantity of each of these elements that will be removed for stockpiling.

5 • <u>Page 4-4, Section 4.1.2, Paragraph 6</u>: The residential development referred to as the City of Kapolei is actually the Villages of Kapolei.

6 • <u>Page 4-5, Section 4.1.3, Paragraph 2</u>: The text refers to the Kapolei Business - Industrial Park. This should be the Kapolei Business Park.

7 • <u>Page 4-7, Section 4.1.3</u>: No elementary, intermediate, or high schools are planned for the City of Kapolei. Additional schools may be planned for the Kapolei area.

8 • <u>Page 4-8, Section 4.1.4, Probable Land Use Impact</u>: An existing coral processing plant operated by Grace Pacific could be impacted by the Harbor expansion project. Also, future development opportunities could be impeded if stockpile area 4 is used.

9 • <u>Page 4-20, Section 4.2.2.6, Coastal Zone Management Program</u>: What will be the geographic scope of the drainage master plan that will be developed to control the discharge of storm water runoff for the Harbor area ? Further, what is the timing of the development of such a master plan ?

10 • <u>Chapter 5, Physical Environment, Page 5-21, Section 5.6.3.1, Existing Conditions</u>: It would help the lay reader if common fish names were used.

11 • <u>Chapter 7, Public Services, Page 7-1, Section 7.1.2, Probable Impact of Proposed Action</u>: A factor of 880 gallons per day per acre was used to estimate water use. Could you please give the basis for the use of this factor ?

• <u>Chapter 11, Proposed Mitigation Measures, Page 11-1</u>: We appreciate the extent to which possible mitigation factors and measures have been researched. We support all measures that would mitigate any noise vibration, water quality, air quality, hazardous waste, archaeological, visual, or endangered species or other impacts on the environment.

Once again, thank you for the opportunity to comment on the Supplemental EIS. We look forward to the incorporation of our comments.

If you have any questions, require further information or if we can be of any further service to you on this or any related matter, please feel free to call me directly at 674-3176.

Sincerely,

David H. Franzel
Manager, Residential/Resort Properties

fgr:01002900\K10604

cc: Mr. David McCoy, Campbell Estate
Mr. Russell Alger, Campbell Estate
Mr. Marshal Ando, Harbors Division
Dr. David Atkin, Parsons, Brinckerhoff

Responses to The Estate of James Campbell

Response to Comment 1

The paragraph has been changed to state that Honokai Hale/Nanakai Gardens are the closest existing residential areas, however, Ko Olina Fairways will be the closest residential area by the time construction begins.

Response to Comment 2

Stockpile Area 5 and related discussion has been deleted from the Final SEIS.

Response to Comment 3

Although hydraulic dredging is presently viewed as a less favorable construction method due to the need for significantly greater stockpiling and settlement pond areas, it is a feasible method and therefore has been retained in the Final SEIS.

Response to Comment 4

Quantities of each type of material expected to be encountered are not known with sufficient accuracy to make such a comment in the Final SEIS.

Response to Comment 5

Comment noted, and references to the residential development have been corrected throughout the Final SEIS.

Response to Comment 6

Comment noted, and the business park is now referred to as Kapolei Business Park throughout the Final SEIS.

Response to Comment 7

Section 4.1.3, "Proposed Land Use Developments," has been modified in response to your comment.

Response to Comment 8

Although the processing plant will not be affected by the proposed excavation, it will have to be relocated once construction of the storage yards begins. Grace Pacific is aware of this project and will modify their operations to allow the future development. Development opportunities may be impeded by material placed in Stockpile 4 since this parcel is designated in the Ewa Development Plan for industrial use. Discussions between the State of Hawaii and The EJC on the use of the parcel will continue so that the higher priority development areas are not used for stockpiling.

Section 4.1, "Land Use," has been modified to reflect your concerns.

Response to Comment 9

The geographic scope of the drainage master plan will include all newly acquired State land (section 2.2, "Project Location and Land Ownership"). Runoff from upland areas which naturally drain into the new State parcels will also be evaluated. The drainage master plan is being prepared concurrently with the construction plans for the harbor excavation.

Response to Comment 10

Section 5.6.3, "Marine Biology," now provides common fish names in addition to their scientific names.

Response to Comment 11

The basis of using 880 gpd per acre was the actual water consumption for a comparable area within Honolulu Harbor, as described in section 7.1, "Water Supply."

FAX

AMERICAN LUNG ASSOCIATION. of Hawaii

FAX NUMBER: 528-2368

TO: David Atkin

FROM: Shirley Robinson

DATE: 11/7/94

TOTAL PAGES INCLUDING COVER SHEET: 1

SUBJECT: DSEIS for Basin Expansion and Tug Pier at Barbers Point.

MESSAGE:

- Attached are our comments.

IF YOU DO NOT RECEIVE ALL THE FAX SHEETS, PLEASE CALL __________ AS SOON AS POSSIBLE.

OPERATOR:

AMERICAN LUNG ASSOCIATION FAX NO. 808-537-5971

When You Can't Breathe, Nothing Else Matters®

American Lung Association of Hawaii
245 N. Kukui Street
Honolulu, HI 96817-3921
Fax: (808) 537-5971
Phone: (808) 537-5966

page S-61

① ¶ S.13.4 "Figure S-10 displays..." there is no figure S-10.

② ¶ S.13.4 DSEIS needs to address the "quantitative air quality impact analysis." from harbor expansion

Responses to the American Lung Association

Response to Comment 1

Figure 5-16, "Approximate Barbers Point Harbor Air Pollution Emissions for Year 2010 and Significant Air Pollution Emission Rates," was incorrectly referenced as Figure 5-10 in the first paragraph of section 5.13.4, "Probable Long-Term Impact of Proposed Action." The citation is correct in the Final SEIS.

Response to Comment 2

A quantitative air quality analysis has been performed (Air Quality Study for the Proposed Barbers Point Harbor Expansion Project, 1992) and was described in section 5.13, "Air Quality," of the Draft SEIS.

SENT BY:HARBORS DIV-ENRG BRCH ;11- 2-94 ;10:16AM ; 8085871864→808 5282368 ;# 2

Meredith Monteville
92-993 Makakilo Dr #44
Ewa Beach, HI. 96707-1376

HONOLULU HI 968
PM
28 OCT
1994

DOT
Harbor's Division
79 So. Nimitz Hwy.
Hono. Hi 96813

OCT 31 10 00 AM '94
HARBORS DIVISION

10-28-94

1. Ch, HAR
2. HAR-
E

Dear Sir:

Since I was unable to attend your Public Hearing, I wanted to communicate that I am a concerned citizen and resident of Makakilo. It's exciting to see the plans you have for the Harbor Expansion. I'm very much in favor and supportive of your plans

Meredith Monteville

CHAPTER 16

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APPENDICES

APPENDIX A-1

NOISE AND VIBRATION IMPACT ASSESSMENT

Noise and Vibration Impact Assessment

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
Job H.C. 1823
and
Future Pier and Storage Yard Improvements at Barbers Point Harbor
Ewa, Oahu, Hawaii

Prepared for
State of Hawaii
Department of Transportation
Harbors Division

by

Parsons Brinckerhoff Quade and Douglas, Inc.

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1. INTRODUCTION

The Hawaii Department of Transportation, Harbors Division plans to expand the existing Harbor basin by excavating an approximate 1,100' by 1,100' area adjacent to the harbor to a depth of approximately 40' below the existing level. This report identifies potential noise and vibration impacts during project construction and operation, and where necessary, it recommends suitable mitigation to satisfy project criteria and to avoid undesirable effects.

The report supplements a noise study which was performed in 1992, for the Barber's Point Harbor Expansion Project, by Darby and Associates, Acoustical Consultants. This study provided a discussion of the present and future noise producing activities within the harbor, estimated future noise levels with the project and listed applicable noise standards and guidelines to assess the potential impacts of the harbor extension project. An extension of the earlier study was required to specifically address issues that were not covered in detail in the earlier report including the

a) determination of road traffic noise impacts following the widely accepted federal guidelines; and
b) analysis of construction noise and vibrations based on specific scenarios of probable construction methods and equipment.

2. CONCLUSIONS

A noise and vibration analysis was conducted to determine the potential impacts of the Barbers Point Harbor Expansion Project. The two major results of the analysis are:

- Road traffic noise levels during operation of the expanded harbor would not be noticeably higher than the existing levels and the future levels without the Project (year 2005).
- Construction noise and vibration impact analysis shows that with suitable precautions, there would be no adverse impacts during harbor expansion. Recommendations are made for mitigating potential blasting noise and vibration Impacts, since blasting would be used in one of the three proposed construction methods.

3. ROAD TRAFFIC NOISE IMPACT ASSESSMENT

3.1 Introduction

This section describes the methodologies and procedures that were used to assess the traffic noise impacts and recommends appropriate mitigation during operation of the expanded Barbers Point Harbor. The analysis offers an assessment of the potential traffic noise impacts on sensitive land uses in the area.

3.2 Basic Concepts

Noise levels are measured in units called decibels. Since the human ear does not respond equally to all frequencies (or pitches), measured sound levels (in decibel units at standard frequency bands) are adjusted or weighted to correspond to the frequency response of human hearing and the human perception of loudness. The weighted sound level is expressed as one overall noise level in units called A-weighted decibels (dBA) and is measured with a calibrated noise meter.

Since an instantaneous noise measurement (measured in dBAs) describes a noise level at just one moment of time, and since traffic noise, construction noise, and other environmental noises fluctuate from moment to moment, other descriptors representing noise levels over extended periods of time are commonly used in environmental noise studies. To quantify such noise levels and to relate them to annoyance and other subjective attributes of noise, it is common practice to average the noise energy over a specified period of time into a single number called the equivalent continuous noise level (Leq). The Leq is the level of a constant sound which in a given situation and time period, has the same sound energy as does the time-varying sound over the same period.

A time period of one hour for measuring the Leq is considered adequate in measuring the magnitude and extent of traffic noise in urban environments. However, extensive traffic noise measurements in urban areas have shown that noise levels monitored over periods less than one hour are found to truly reflect the Leq measurements taken over one hour. The use of one hour equivalent sound level, commonly expressed as Leq (1 hour), is appropriate because it is sensitive to the frequency of occurrence, and duration of noise events associated with urban road traffic which is characterized by high levels of infrequent noise. For measurements, predictions and impact assessment, this report uses Leq (1 hour) for road traffic noise.

3.3 Human Perception to Changes in Noise Levels

The average ability of an individual to perceive changes in noise levels is well documented. Generally, changes in noise levels less than 3 dBA will be barely perceived by most listeners, whereas a 10 dBA change normally is perceived as a doubling (or halving) of noise levels. The general principle on which most noise acceptability criteria are based is that a change in noise level is likely to cause annoyance wherever it intrudes upon the existing noise from all other sources (i.e., annoyance depends upon the noise that exists before the start of a new noise-generating project or an expansion of an existing project).

3.4 Community Noise Levels

Community noise levels in most urban areas usually lie in the range of 45 to 85 dBA, 45 being the daytime level in a typical quiet living room, and 85 dBA being the approximate level on a sidewalk adjacent to heavy traffic. For reference and orientation to the decibel scale, representative environmental noises and their respective dBA levels are shown in Table 1.

3.5 Noise Standards and Criteria

The basic goals of noise standards, as they apply to the Barbers Point Harbor expansion project, are to minimize the potential impacts of the operation of the project on the community and to provide noise control consistent with economic constraints and appropriate technology.

The criteria for determining noise impacts depend upon existing ambient noise and existing or proposed land use in areas around the project. As the Barbers Point Harbor expansion project would add more traffic to existing roadways, the U.S. Federal Highway Administration (FHWA) land use or activity categories are used for assessing noise impacts. FHWA criteria are the accepted national standards for estimating traffic noise impacts and for assessing engineering and economic feasibility of mitigation.

Table 1

COMMON INDOOR AND OUTDOOR NOISE LEVELS

OUTDOOR	NOISE LEVELS (dBA)	INDOOR
Jet Flyover at 100 ft.	110	Rock Band
Gas Lawn Mower at 3 Ft.	100	Inside Subway Train (NY)
Diesel Truck at 50 Ft.	90	Food Blender at 3 Ft.
Noisy Urban Daytime	80	Garbage Disposal at 3 Ft. Shouting at 3 Ft.
Gas Lawn Mower at. 100 Ft.	70	Vacuum Cleaner at 10 Ft.
Commercial Area Heavy Traffic at 300 Ft.	60	Normal Speech at 3 Ft. Large Business Office
Quiet Urban Daytime	50	Dishwasher Next Room.
Quiet Urban Nighttime Quiet Suburban Nighttime	40	Small Theatre, Large Conference Room (Background)
Quiet Rural Nighttime	30	Library Bedroom at Night Concert Hall (Background)
	20	Broadcast and Recording Studio
	10	
	0	Threshold of Hearing

Source: Highway Noise Notes; Bole, Beranek, and Newman; 1972

The traffic noise analysis procedure outlined in the US Federal Highway Administration (FHWA) regulations (23 Code of Federal Regulations, Part 722) consists of:

a) identifying sensitive land uses which may be affected by the project traffic noise,
b) determining traffic noise impacts at the sensitive receptors, and
c) assessing the engineering and economic feasibility of mitigation to protect the affected receptors.

Noise sensitive receptors in the vicinity of the project fall in FHWA land use category 'B', or 'C' (Table 2). Land uses in category 'B' include residences, churches, libraries, schools, hotels and hospitals. Category 'B' activities should be considered for noise abatement when the outdoor noise levels at category 'B' sites approaches or exceeds 67 dBA. Category 'C' land uses, such as commercial or industrial development, have a higher noise abatement criterion of approaching or exceeding 72 dBA.

According to the FHWA regulations, noise impacts occur under either of the two conditions; when the predicted traffic noise levels approach or exceed the noise abatement criteria (NAC) (absolute criterion), or when the predicted traffic noise levels substantially exceed the existing noise levels (relative criterion).

Though the FHWA provides no specific criteria for determining when the predicted noise levels "substantially" exceed existing noise levels, some quantitative guidelines are necessary to assess the effects of increases in noise levels over existing levels. The relative criterion commonly used for subjectively assessing the effects of noise level increases above existing noise levels is the following: for traffic noise, an increase over existing of 0 - 5 dBA is considered "no impact" whereas an increase of greater than 15 dBA is considered a "substantial impact".

Appropriate mitigation measures should be considered where impacts are identified by applying one of the two criteria, but not both. The decision to use one of the two criteria depends on whether the future predicted noise levels approach or exceed the FHWA NAC. If the future noise levels approach or exceed the FHWA NAC the absolute criteria should be used; otherwise the relative criteria should be used.

Table 2

NOISE ABATEMENT CRITERIA (NAC) FOR HIGHWAY PROJECTS

Activity Category	A- Weighted sound level* (dBA)		Description of Activity
	Leq	L(10)	
A	57	60	Lands on which serenity and quiet of extraordinary significance serve an important public purpose and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	70	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospital.
C	72	75	Developed lands, properties, or activities, not included in Categories A or B.
D	-	-	Undeveloped lands.
E	52	55	Interior spaces of category B, where applicable.

Source: Federal Highway Administration 23CFR 772

* A project may be evaluated on the basis of either L(10) or Leq, but not both.

CRITERIA FOR INCREASE IN FUTURE NOISE LEVEL OVER EXISTING NOISE LEVEL

Increase (dBA)	Impact Classification
0 - 5	No impact
6 - 10	Minor impact
11- 15	Moderate impact
Greater than 15	Serious impact (substantial)

The increase is an average of several state impact classifications reported in "Highway Traffic Noise in the United States - Problem and Response", FHWA, April 1986, revised November, 1987.
The above classifications appear to be the most accepted definitions by the state and FHWA.

3.6 Existing Noise Levels - Measurement Program

Existing ambient noise levels were sampled over a period of 5 to 10 minutes at seven locations during November 1993 (Figure 1). The selected locations were in the general vicinity of roads leading to the harbor and other major highways in the area. Furthermore, the monitoring locations included residential locations and a wildlife habitat within the study area. The measurement sites were selected on the basis of several factors, the most important of which was the site's potential sensitivity to changes in noise levels. The measurements were generally completed to provide data during the daytime and nighttime periods. Each measurement location and its land use category is provided in Table 3.

3.7 Equipment used in Noise Measurements

A Bruel and Kjaer (B&K) Type 2231 Sound Level Meter fitted with a calibrated B&K Type 5155 microphone was used in noise measurements. The microphone fitted with its windshield was placed at a height of approximately 5.5 feet above the ground level. All measurements were performed under acceptable climatic and street surface conditions (wind velocity less than 12 miles per hour and street surface dry).

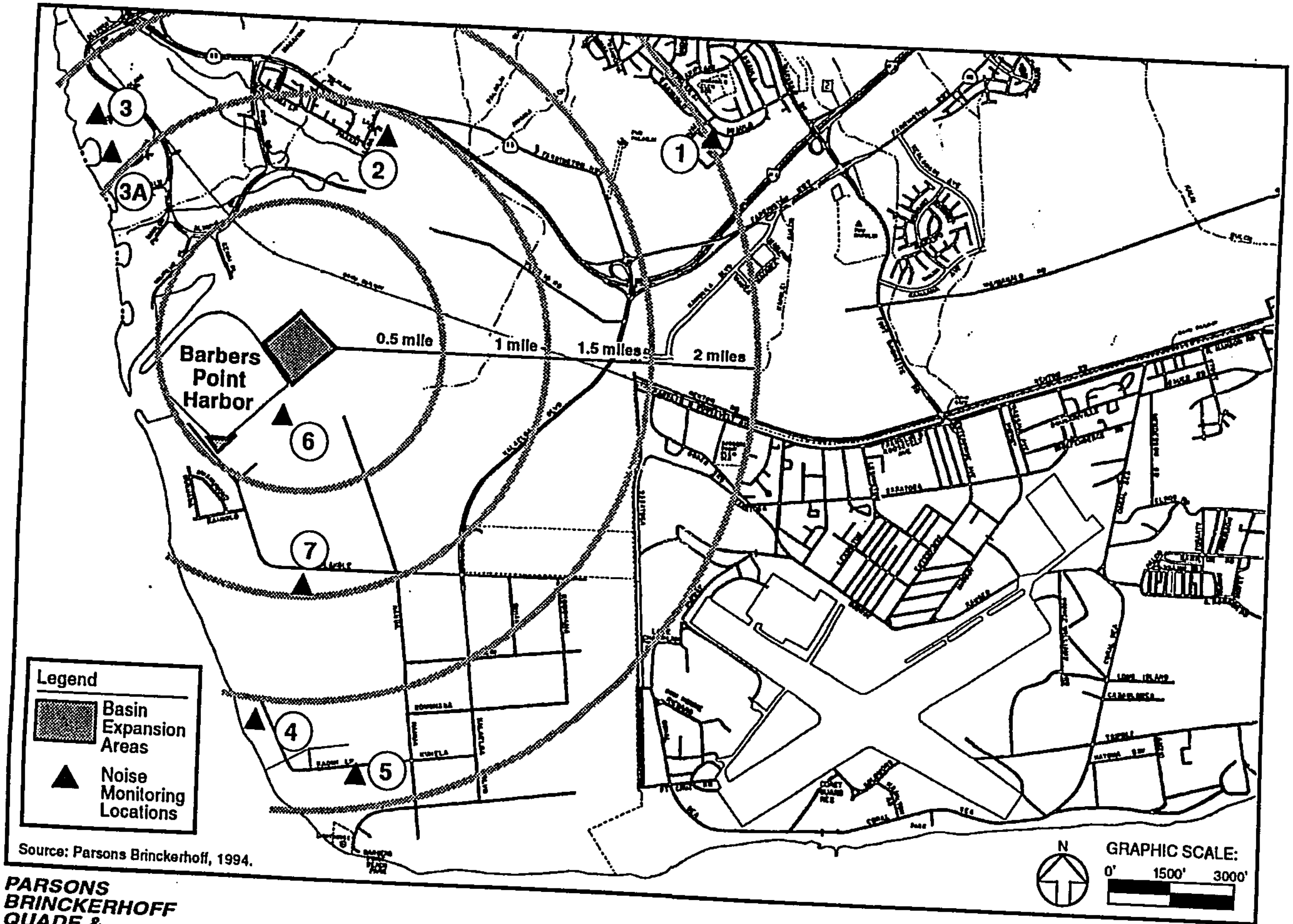
3.8 Existing Ambient Noise Levels

The principal sources of existing noise in the project area are motor vehicles on adjacent streets and general activities in abutting residential and industrial areas.

The results of the ambient noise survey are presented in Table 3. As shown by the data, the FHWA noise abatement criterion of approaching or exceeding an Leq of 72 dBA for category "C" commercial sites is exceeded at 2 monitored sites (sites 5 and 7). These sites are located close to roadways carrying heavy trucks. Existing noise levels are below the FHWA NAC at the monitored residential sites (sites 1, 2 and 3). The residential sites receive noise primarily from local light traffic and from more distant traffic on main arteries.

3.9 Future Noise Levels - Model Results

Existing and future noise levels with and without the project were calculated using a PC version of the FHWA traffic noise prediction model, Stamina 2.0. Input to the computer model



Source: Parsons Brinckerhoff, 1994.

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Noise Monitoring Locations
BASIN EXPANSION AND TUG PIER AT BARBERS POINT HARBOR, OAHU
JOB H.C. 1823
Noise and Vibration Impact Assessment
FIGURE 1

Table 3

BARBERS POINT HARBOR EXPANSION
MEASURED EXISTING NOISE LEVELS (Nov, 1993)

(IN Leq(dBA) MEASURED OVER THE NOTED TIME PERIODS)

Site No.	Site Description	Land use	Approximate Distance from nearest Road Median (Feet)	Noise Levels (dBA)	Time Period	Comments
1	Akaawa Street, Makakilo.	Residential	1824 ft. from WB H-1 Freeway, 2210 ft. from WB Farrington HWY.	54	10:40 - 10:50 AM	One low flying aircraft
				45	10:08 - 10:13 PM	Three helicopters
2	Lealoa St., Honokai Hale	Residential	1018 ft. from WB Farrington HWY.	54	11:34 - 11:44 AM	Traffic on H-1, light local traffic.
				43	11:00 - 11:05 PM	Traffic on H-1, light local traffic. One helicopter.
3	Ko 'Olina Resort @ Olani Place	Hotel		47	10:43 - 10:48 PM	Near Hotel
3A	Ko 'Olina Visitor Center	Commercial		70	12:18 - 12:23 PM	With two aircraft during measurement period
				53	12:25 - 12:30 PM	Without Aircraft
4	Pond @ fence about 250 ft from flare	Pond		66	1:05 - 1:10 PM	Flare Noise (intermittent)
5	Generation Plant, Kaomi Loop	Commercial		71	11:15 - 11:20 AM	3 Heavy trucks passed within 20' of microphone
6	At Harbor approximately 150 ft from unloading ship	Commercial		66	1:30 - 1:35 PM	General Activities: truck movements, 3 cranes unloading onto 3 trucks.
7	Refinery (about 150 ft from tanks) on Malakole Road	Commercial	25 ft. from WB Malakole Street. 4018 ft. NB Kalaeloa Blvd.	74	1:40 - 1:45 PM	Trucks 80-90 dBA, approximately 25 ft from noise monitor, 10 to12 trucks passed by.

consisted of the angle subtended by the roadways at each receptor, the perpendicular distance from the roadway to the receptor and shielding and ground absorption corrections appropriate to each receptor site. Traffic information in the form of vehicles per hour (cars, medium trucks, and heavy trucks) and speeds (Tables 4, 5 and 6) was also coded for each roadway. The computer program calculated the noise levels at each receptor location.

Existing and future noise levels with and without the project were calculated at 7 receptor locations using the model. The traffic noise model was validated by comparing the model predicted level with the measured level with the relevant traffic parameters as input to the traffic noise model. The model-predicted noise levels at the 2 monitored sites directly affected by road traffic noise (sites 1 and 2) were in reasonable agreement with the measured noise levels, thus validating the traffic noise model and confirming that the measured noise levels are mainly due to traffic on roadways near the receptor sites.

3.10 Factors Influencing Changes in Traffic Noise Levels

Changes in motor vehicle patterns must be quite substantial to produce a noticeable change in a community's traffic noise environment. Examples of the change required either in traffic volumes, traffic speeds, or distance from moving traffic to a receptor to generate a 3-dBA increase in noise level are as follows:

- a 100 percent increase in hourly auto traffic volumes;
- a 100 percent increase in hourly truck volumes;
- a 100 percent increase in the combination of hourly auto volumes and truck volumes;
- an increase in vehicular speed of 15 miles per hour; or
- a reduction of one-third the distance between the noise source and the receptor.

3.11 Impact Assessment Criteria

For this project, an increase in future predicted traffic noise level of 5 dBA or more over existing traffic noise level is considered an impact (see Table 2). This follows the generally accepted procedure for assessing road traffic noise impacts. This relative criterion is applied in all cases where the existing and future noise levels are less than the FHWA NAC applicable to the particular land use category (Table 2). FHWA Noise Abatement Criterion (NAC), which

Table 4

1 HOUR AM & PM EXISTING VEHICLE VOLUMES AND SPEED NEAR SENSITIVE RECEPTORS

Site No.	Description	Existing 1993							
		AM				PM			
		Volume			Speed	Volume			Speed
		Cars	MT	HT	(mph)	Cars	MT	HT	(mph)
1	W.B H-1 Freeway	1921	138	29	55	1419	102	22	55
	E.B H-1 Freeway	882	63	13	55	1558	112	24	55
	W.B Farrington HWY (HWY-93)	138	10	2	35	316	23	5	35
	E.B Farrington HWY(HWY-93)	493	32	7	35	467	34	7	35
2	W.B Farrington HWY (HWY-93)	680	49	10	45	1599	115	24	45
	E.B Farrington HWY(HWY-93)	1558	112	24	45	875	63	13	45
7	W.B. Malakole Street	339	24	5	25	74	5	1	25
	E.B. Malakole Street	49	3	1	25	208	15	3	25
	N.B Kalaeloa Blvd	243	17	4	35	1494	107	23	35
	S.B Kalaeloa Blvd	1771	127	27	35	362	26	6	35
8	N.B Kalaeloa Blvd	243	17	4	35	1494	107	23	35
	S.B Kalaeloa Blvd	1771	127	27	35	362	26	6	35
9	W.B H-1 Freeway	1921	138	29	55	1419	102	22	55
	E.B H-1 Freeway	882	63	13	55	1558	112	24	55
	W.B Farrington HWY (HWY-93)	138	10	2	35	316	23	5	35
	E.B Farrington HWY(HWY-93)	493	32	7	35	467	34	7	35
10	W.B Farrington HWY (HWY-93)	680	49	10	45	1599	115	24	45
	E.B Farrington HWY(HWY-93)	1558	112	24	45	875	63	13	45
11	W.B Farrington HWY (HWY-93)	680	49	10	45	1599	115	24	45
	E.B Farrington HWY(HWY-93)	1558	112	24	45	875	63	13	45

MT - Medium trucks (2 Axles, 6 Tires)
HT - Heavy Trucks (More than 2 Axles and More than 6 Tires)

Source: Pacific Planning & Engineering, Inc. July 2, 1992

Table 5

1 HOUR AM & PM FUTURE VEHICLE VOLUMES AND SPEED NEAR SENSITIVE RECEPTORS - WITHOUT PROJECT

Without Project (2005)										
Site No.	Description	AM				PM				
		Volume			Speed	Volume			Speed	
		Cars	MT	HT	(mph)	Cars	MT	HT	(mph)	
1	W.B H-1 Freeway	1903	136	29	55	3013	216	46	55	
	E.B H-1 Freeway	2052	180	38	55	4922	353	75	55	
	W.B Farrington HWY (HWY-93)	175	13	3	35	478	34	7	35	
	E.B Farrington HWY(HWY-93)	644	46	10	35	543	39	8	35	
2	W.B Farrington HWY (HWY-93)	1615	116	25	45	3947	283	60	45	
	E.B Farrington HWY(HWY-93)	3372	242	51	45	2788	200	42	45	
7	W.B. Malakole Street	368	28	6	25	193	14	3	25	
	E.B. Malakole Street	110	8	2	25	294	21	4	25	
	N.B Kalaeloa Blvd	442	32	7	35	2052	147	31	35	
	S.B Kalaeloa Blvd	2263	162	34	35	672	48	10	35	
8	N.B Kalaeloa Blvd	497	36	8	35	228	164	35	35	
	S.B Kalaeloa Blvd	2484	178	38	35	773	55	12	35	
9	W.B H-1 Freeway	1903	136	29	55	3013	216	46	55	
	E.B H-1 Freeway	2052	180	38	55	4922	353	75	55	
	W.B Farrington HWY (HWY-93)	175	13	3	35	478	34	7	35	
	E.B Farrington HWY(HWY-93)	644	46	10	35	543	39	8	35	
10	W.B Farrington HWY (HWY-93)	1615	116	25	45	3947	283	60	45	
	E.B Farrington HWY(HWY-93)	3372	242	51	45	2788	200	42	45	
11	W.B Farrington HWY (HWY-93)	1615	116	25	45	3947	283	60	45	
	E.B Farrington HWY(HWY-93)	3372	242	51	45	2788	200	42	45	

MT - Medium trucks (2 Axles, 6 Tires)
HT - Heavy Trucks (More than 2 Axles and More than 6 Tires)

Source: Pacific Planning & Engineering, Inc. July 2, 1992

Table 6

1 HOUR AM & PM FUTURE VEHICLE VOLUMES AND SPEED NEAR SENSITIVE RECEPTORS - WITH PROJECT

With Project (2005)										
Site No.	Description	AM				PM				
		Volume			Speed	Volume			Speed	
		Cars	MT	HT	(mph)	Cars	MT	HT	(mph)	
1	W.B H-1 Freeway	4195	301	64	55	3496	251	53	55	
	E.B H-1 Freeway	2576	185	39	55	5032	361	77	55	
	W.B Farrington HWY (HWY-93)	175	13	3	35	478	34	7	35	
	E.B Farrington HWY(HWY-93)	644	46	10	35	543	39	8	35	
2	W.B Farrington HWY (HWY-93)	1670	120	25	45	4066	292	62	45	
	E.B Farrington HWY(HWY-93)	3501	251	53	45	2843	204	43	45	
7	W.B. Malakole Street	414	30	6	25	202	15	3	25	
	E.B. Malakole Street	129	9	2	25	331	24	5	25	
	N.B Kalaeloa Blvd	451	32	7	35	2079	149	32	35	
	S.B Kalaeloa Blvd	2282	164	35	35	681	49	10	35	
8	N.B Kalaeloa Blvd	626	45	10	35	2364	170	36	35	
	S.B Kalaeloa Blvd	2843	204	43	35	902	65	14	35	
9	W.B H-1 Freeway	4195	301	64	55	3496	251	53	55	
	E.B H-1 Freeway	2576	185	39	55	5032	361	77	55	
	W.B Farrington HWY (HWY-93)	175	13	3	35	478	34	7	35	
	E.B Farrington HWY(HWY-93)	644	46	10	35	543	39	8	35	
10	W.B Farrington HWY (HWY-93)	1670	120	25	45	4066	292	62	45	
	E.B Farrington HWY(HWY-93)	3501	251	53	45	3359	204	43	45	
11	W.B Farrington HWY (HWY-93)	1670	120	25	45	4066	292	62	45	
	E.B Farrington HWY(HWY-93)	3501	251	53	45	3359	204	43	45	

MT - Medium trucks (2 Axles, 6 Tires)
HT - Heavy Trucks (More than 2 Axles and More than 6 Tires)

Source: Pacific Planning & Engineering, Inc. July 2, 1992

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is an absolute criterion, is used only in cases where the existing and the future noise levels approach or exceed the FHWA criteria.

3.12 Assessment of Existing and Future Traffic Noise Levels

Existing noise levels in the study area show that they are largely due to motor vehicle traffic. This factor will continue to govern ambient noise levels in the future.

Future noise levels do not exceed the FHWA noise abatement criteria at all of the residential sites except at sites 10 and 11 near Farrington Highway. Therefore, the relative impact criterion which is based on estimating the increase in future traffic noise level with the measured and predicted existing noise levels are used in the impact analysis.

3.13 Results of Noise Impact Assessment

Results of traffic noise impact assessment along the project corridor are shown in Tables 7 and 8. *The predicted future noise levels show an increase over existing noise levels by* 5 dBA or less at all of the sensitive sites. However, at sites 10 and 11 the future predicted traffic noise levels would be higher than the FHWA NAC which is 67 Leq (1 hour) for residential sites.

3.14 Mitigation of Noise Impacts

When the road traffic noise impacts were judged against the relative impact criterion only minor imperceptible impacts were identified at the residential sites. Therefore, road traffic noise abatement measures are not warranted at these sites. At the residential sites 10 and 11 the future noise levels with the Harbor Expansion Project is the same as the future noise levels without the Project in the year 2005. With or without the project, future noise levels exceed the FHWA NAC of 67 dBA Leq (1 hour). Noise abatement should be considered for these sites. Guidelines are provided in FHWA 23 CFR 772 to select appropriate mitigation measures.

Table 7

BARBERS POINT HARBOR EXPANSION
COMPARISON OF FUTURE (2005) NOISE LEVELS WITH EXISTING (1993) NOISE LEVELS

(in Leq(1HOUR) dBA)

Site No.	Site Description	Land use	Approximate Distance from nearest Road Median (Feet)	Predicted * Existing (1993) Noise Levels		Predicted Without Project (2005) Noise Levels		Predicted With Project (2005) Noise Levels		Predicted With Project Minus Existing Noise Levels		Predicted With Project Minus Without Project Noise Levels		Impact (Relative Criterion)
				AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	
1	Akaewa Street, Makakilo	Residential	1824 ft. from WB. H-1 Freeway. 2210 ft. from WB Farrington HWY.	55	55	57	59	59	60	4	5	2	1	No Impact
2	Laaloa Street Honokai Hale	Residential	1018 ft. from WB Farrington HWY.	54	55	58	59	58	59	4	4	0	0	No Impact
7	Refinery(about 150 ft from tanks) on Malakole Road	Commercial	25ft. from WB Malakole St. 4018 ft. NB Kalaeloa Blvd.	57	55	58	58	58	58	1	3	0	0	No Impact
8	Corner of Franklin D. Roosevelt Ave. & Saratoga St.	Residential	900 ft. from Kalaeloa Blvd.	52	51	53	54	54	54	2	3	1	0	No Impact
9	Akaula Pl. near HWY-93 WB.	Residential	1000 ft. from WB H-1 Freeway, 1700 ft. from WB Farrington HWY.	57	58	59	62	61	62	4	4	2	0	No Impact
10	Kaaoao Pl. near EB. HWY-93 , close Honokai Hale	Residential	100 ft. from WB Farrington HWY.	64	65	68	69	68	69	4	4	0	0	N/A
11	EB. HWY-93, near Nanakai Gardens	Residential	100 ft. from WB Farrington HWY.	64	65	68	69	68	69	4	4	0	0	N/A

* Predicted existing noise levels are based on existing traffic volumes, classification and speed. Stamina 2.0 traffic noise model was used in the predictions.

1. The impact assessment is based on the magnitude of change over existing levels. (see Table 2, bottom half)

2.N/A - Future noise levels at sites 10 and 11 approach or exceed FHWY NAC. Hence, relative impact criterion is not applicable to sites 10 and 11.

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Table 8

BARBERS POINT HARBOR EXPANSION
EXISTING(1993), AND FUTURE (2005) NOISE LEVELS COMPARISON WITH FHWA NAC

[In Leq(1HOUR) dBA]

Site No.	Site Description	Land use	Approximate Distance from nearest Road Median (Feet)	Predicted Existing (1993) Noise Levels[1]		Predicted Without Project (2005) Noise Levels		Predicted With Project (2005) Noise Levels		FHWA NAC[2]	Noise Abatement To Be Considered
				AM	Night	AM	PM	AM	PM		
1	Akaawa Street, Makakilo	Residential	1824 ft. from WB.H-1 Freeway. 2210 ft. from WB.Farrington HWY.	55	55	57	59	59	60	67	No
2	Laaloa Street, Honokai Hale	Residential	1018 ft. from WB.Farrington HWY.	54	55	58	59	58	59	67	No
7	Refinery(about 150 ft from tanks) on Malakole Road	Commercial	25 ft. from WB.Malakole St. 4618 ft. NB.Kalaeloa Blvd.	57	55	58	58	58	58	72	No
8	Corner of Franklin D. Roosevelt Ave. & Saratoga St.	Residential	900 ft. from Kalaeloa Blvd.	52	51	53	54	54	54	67	No
9	Akaula Pl. near HWY-93 WB.	Residential	1000 ft. from WB.H-1 Freeway, 1700 ft. from WB.Farrington HWY.	57	58	59	62	61	62	67	No
10	Kaaoao Pl. near EB. HWY-93 , close Honokai Hale	Residential	100 ft. from WB.Farrington HWY.	64	65	68	69	68	69	67	Yes
11	EB. HWY-93, near Nanakai Gardens	Residential	100 ft. from WB.Farrington HWY.	64	65	68	69	68	69	67	Yes

1. Predicted existing noise levels are based on existing traffic volumes, classification and speed. Stamina 2.0 traffic noise model was used in the predictions.
2. NAC: FHWA Noise Abatement Criteria (67 dBA for category "B" Residential sites,72 dBA for category "C" Commercial sites).

4. CONSTRUCTION NOISE AND VIBRATION IMPACT ASSESSMENT

4.1 Introduction

This section describes potential construction noise and vibration impacts, under three different construction scenarios, during the proposed expansion of the Barbers Point Harbor. Impacts have been assessed on nearby structures, on more distant residential receptors, and on wildlife in the area. Also, the section describes standards and criteria recommended to limit potential adverse impacts under each construction scenario and recommends appropriate mitigation measures.

4.2 Impacts

In general, unmitigated construction impacts have the potential to generate community noise and vibration complaints if:

a) the construction activities take place over a long time frame ;
b) the community is within approximately 1,500 feet of the construction site and is exposed to noise from typical construction activities; and
c) blasting is used for excavation which has the potential to create annoyance at the nearby residences or cause minor structural damage to adjacent structures.

4.3 Barbers Point Harbor Construction

The three proposed construction methods including the excavation and disposal alternatives are described in Barbers Point Harbor Expansion Description of Excavation and Disposal Alternatives, Ogden Beeman & Associates, April 1994. The report provides a detailed description of the three proposed methods and identifies possible equipment spreads under each construction scenario. Project construction activities would be carried out in several phases, each of which would have its own mix of equipment and its own noise and vibration characteristics. The total noise and vibration from the construction site would depend on the construction method that is used for the project and the construction phasing. The construction methods would be determined by the contractor submitting the lowest bid. The construction method used would have to comply with the applicable terms of the plans and specifications.

The nearby residential communities include Ko Olina Resort, Honokai Hale, and Nanakai Gardens. These areas are approximately 4,000 to 5,000 feet from the construction site. The nearest engineered structures, whose structural integrity would need to be considered, include a coal conveyor, a cement silo and a number of pier structures. All of these structures are within 500 feet of the construction site. Depending on the selected method of construction, the nature and extent of the noise and vibration impacts would vary. The noise and vibration impacts and their assessment and mitigation are described in the following paragraphs.

4.4 Noise and Vibration Associated with Harbor Construction Activities Other Than Blasting

This is a general discussion of construction noise and vibration impacts applicable to major construction projects. Construction noise and vibration are generated primarily by the engines which provide the motive and /or operating power for construction equipment. Other sources of noise in construction equipment include mechanical and hydraulic systems, cooling fans, and engine exhaust. Noise levels from construction equipment can range from less than 70 dBA at 50 feet for stationary pumps to peaks of over 100 dBA at 50 feet for pile drivers. A list of construction equipment and their noise levels at a distance of 50 feet is presented in Table 9. Typical ground vibration levels generated by construction equipment operating at a distance of 100 feet from the equipment are presented in Table 10.

4.5 Blasting Noise and Vibration - General Information

4.5.1 Blasting Noise

Rock blasting with explosives produces an air blast which is a pressure wave transmitted from the blast outward into the surrounding area. This pressure wave consists of audible sound that can be heard, and concussion or subaudible sound which cannot be heard. If the pressure of this wave -- termed overpressure -- is sufficient, it can cause structural damage. However, air blast is usually an annoyance problem and does not cause structural damage.

Table 9

TYPICAL NOISE LEVELS OF PRINCIPAL CONSTRUCTION EQUIPMENT

CONSTRUCTION EQUIPMENT	NOISE LEVEL (in dBA at 50 feet)
Bulldozer	80
Front End Loader	72-84
Dump Truck	83-94
Jackhammer	81-98
Crane with Headache Ball	75-87
Backhoe	72-93
Scraper	80-93
Crane	71-82
Welding Generator	71-82
Concrete Mixer	74-88
Concrete Pump	81-84
Concrete Vibrator	76
Air Compressor	74-87
Pile Driver	91-105
Paver	86-88
Grader	80-93
Roller	73-75
Tamper	74-77

Source: US Environmental Protection Agency 1971

Table 10

TYPICAL CONSTRUCTION EQUIPMENT VIBRATION LEVELS AT 100 FEET

SOURCE	MAXIMUM PARTICLE VELOCITY (in/sec)	PEAK VELOCITY (in/sec)
Diesel Pile Driver (36,000 ft-ib or 49,000 joules)	0.2	0.28
Vibratory Pile Driver	0.15	0.21
Vibratory Compactor	0.03	0.04
Pavement Breaker	0.05	0.07
Large Bulldozer	0.011	0.016
Heavy Trucks	0.01	0.014
Jackhammers	0.003	0.0042

For other distances d, the expected vibration velocity may be determined by the formula:

$V_d = V_{100} / (d/100)$

Where V_d, and V_{100} are vibration velocities at d feet and 100 feet, respectively.

Source: Adapted from C.G.Balachandran and R.G. Patching, Report on the Predesign Studies of Noise and Vibration for N.W. L.R.T. Calgary, Canada 1986

Air blast overpressure is most commonly measured in decibels (dB). It can also be measured in pounds per square inch, p.s.i. The relationship between overpressure expressed in decibels (dB) and in pounds per square inch (p.s.i) is as follows:

dB = 20 log P/P(ref)

where: dB = sound level in decibels

P = overpressure in p.s.i.

P(ref) = 3×10^{-9} p.s.i.

To better understand the decibel levels on linear scale (dB Lin) and their corresponding pressures in square inch (p.s.i.), some typical sound levels with values in both dB and p.s.i. are shown in Table 11.

Sound produced by a blast is primarily low frequency energy, and sound measuring devices should have a low frequency response capability to accurately represent the overall sound levels. Therefore, it is preferable to use a linear-peak network, having quick response time and equal sensitivity from very low to very high frequencies, in the sound measuring equipment. For purposes of comparison, sound levels measured with standard weighting networks are given in the Table 12.

Overpressures (sound levels) that are likely to cause glass breakage occur at much lower levels than those that cause structural damage, such as cracking plaster. U.S. Bureau of Mines Bulletin 656 has proposed an overpressure of 0.5 p.s.i. (164 dB) as a safe level for prevention of glass breakage. They have indicated that blasting which generated ground vibration below 2.0 inches/second (major structural damage criterion) automatically limited air overpressures to safe levels, that is, less than 0.5 p.s.i (164 dB).

Siskind and Summers, have proposed a safe level of 0.007 p.s.i. for preventing glass breakage. These levels are lower than the levels proposed by the Bureau of Mines Bulletin 656 and thus have the added benefit of reducing annoyance. These levels are shown in Table 12.

Table 11

TYPICAL SOUND PRESSURE LEVELS IN dB AND EQUIVALENT AIR BLAST OVERPRESSURES IN POUNDS PER SQUARE INCH (psi)

dB	psi	
180	3.0	structural damage
176	2.0	plaster cracks
164	0.5	windows break
160	0.3	
140	0.03	OSHA maximum 100 impacts/day
128	0.007	U.S. Bureau of Mines maximum
120	0.003	OSHA maximum 10,000 impacts/day (jack hammer)
100	0.0003	pneumatic hammer
80	0.00003	
60	0.000003	conversational speech
40	0.0000003	
20	0.00000003	
0	0.000000003	threshold of hearing

Source: Rock Blasting, G.J. Konya and E.J. Walter, U.S. D.O.T., DTFH 61 - 83 - C - 00110

HW-BH11.XLS

Table 12

SAFE BLASTING SOUND PRESSURE LEVELS IN dB AND AIRBLAST OVERPRESSURES IN POUNDS PER SQUARE INCH

Sound Level Limits				
	Linear peak		C-peak or C-fast	A - peak or A - fast
	dB	psi	dB	dB
Safe	128	0.007	120	95
Caution	128 to 136	0.007 to 0.018	120 to 130	95 to 115
Limit	136	0.018	130	115
	Recommended		Not Recommended	

Source: Siskind and Summers, U.S. Bureau of Mines TPR 78,1974

The following relation between scaled distance and maximum charge weight of explosive per delay period has been suggested by Siskind and Summers and it is based on a conservative safe limit value of 0.007 p.s.i.

$$180 = D/W^{0.33}$$

where D is the distance in feet from blasting site to the receptor and W is the maximum charge per delay in pounds.

4.5.2 Blasting Vibration

Some common vibration sources and their vibration levels are presented in Table 13. Construction activities like rock blasting and pile driving produce seismic waves which people inside nearby structures can feel, if the vibrations are strong. Seismic waves consist of body waves and surface waves. Surface waves produce larger ground motions and carry large amounts of energy.

The purpose of blasting is to fracture rock. This requires an amount of energy sufficient to exceed the strength of the rock, i.e., exceed the elastic limit. When this occurs, the rock fractures. As fracturing continues, the energy is used up and eventually falls to a level less than the strength of the rock, and at that point, fracturing stops. The remaining energy would pass through the rock, deforming but not fracturing it, because the deformation is within the elastic limit. This deformation would result in the propagation of seismic waves. As a seismic wave passes through the rock, the rock particles vibrate about their equilibrium position. The velocity with which the particles vibrate is a direct measure of the energy carried by the seismic waves. Instruments commonly used for measuring vibration velocities are known as seismographs. They normally measure particle velocity since the standards for assessing damage and annoyance effects are based on particle velocity.

There are two principal factors that affect the vibration level which results from the detonation of an explosive charge: distance from the blast to the receptor, and charge size. The approximate relationship between vibration level (particle velocity), charge size and distance is as follows:

Table 13

COMMON VIBRATION SOURCES AND THEIR LEVELS

Vibration Source	Peak Velocity (in/sec)
Foot Stamping	0.0099
Truck Passing Building	0.0014 - 0.0057
General Traffic Passing Building	0.00028 - 0.0028
Plumbing Running	0.00021 - 0.0084
Floor in Building Mechanical Room	0.0007 - 0.0028
Background Inside Houses	
- Main Floor	0.00028 - 0.0007
- Basement	0.00011 - 0.0007
Near Base of Trees, Strong Winds	0.0014 - 0.005
Freight Train (60 feet)	0.014
Bus Passing (50)	0.0056
Automobile (100 feet)	0.000896
Light Rail Transit (50 feet), Concrete Ties	0.0056

Source: C.G. Balachandran and R.G.Patching, A Report on the Predsign Studies for Noise and Vibration for N.W.L.R.T. Calgary, Canada, 1986

$v = 100\,(d/W^{0.5})^{-1.6}$

where :

v = particle velocity in inches/second,

d = distance in feet, shot to receptor or sensor, and

W = maximum explosive charge per delay in pounds.

The velocity obtained from this formula is the most probable value. Using this formula particle velocities have been calculated for different charge weights and distances and the results are presented in Tables 14 and 15. If the distance is doubled, the particle velocity is reduced to one third of its original value. If the distance is cut in half, the particle velocity would be tripled.

4.5.3 Construction Site Noise and Vibration Standards

On Oahu construction site noise is regulated by Department of Health, State of Hawaii (HDOH) requirements contained in Title 11, Chapter 43, Community Noise Control for Oahu. Hours of construction activity are limited to daytime hours between 7:00 a.m. and 6:00 p.m. Construction noise in excess of ninety-five dBA at or beyond the property line of the construction site is not allowed except between 9:00 a.m. and 5:30 p.m. on weekdays. Construction activity generating less than ninety-five dBA is allowed on Saturdays between 9.30 a.m. and 5.30 p.m. Construction activity is not allowed on Sundays and specified public holidays. The project would not be permitted to exceed the noise levels stipulated by these requirements unless a variance is granted by HDOH. The State may grant such a variance, upon application, if the granting of the variance is in the public interest and would not substantially endanger human health or safety and if compliance with the rules, regulations, or standards from which the variance is sought would produce serious hardship without equal or greater benefits to the public.

There are no similar local standards or guidelines to control construction vibration. Potential vibration effects caused by construction of the project could include damage to sensitive structures, annoyance to people living or working in the project area, and interference with the operation of sensitive research or manufacturing equipment and processes. In the absence of local standards to control construction vibration, the project criteria selected to evaluate these effects have been compiled from international standards and are presented in Tables 16 through 18.

Table 14

CHARGE WEIGHT vs PEAK VELOCITY AS A FUNCTION OF DISTANCE

DISTANCE (ft)	CHARGE WEIGHT (lb)				PEAK VELOCITY (in/sec)			
D	W1	W2	W3	W4	V1	V2	V3	V4
25	100	200	300	400	23.083	40.190	55.590	69.975
50	100	200	300	400	7.615	13.258	18.338	23.083
75	100	200	300	400	3.980	6.930	9.585	12.066
100	100	200	300	400	2.512	4.373	6.049	7.615
200	100	200	300	400	0.829	1.443	1.995	2.512
300	100	200	300	400	0.433	0.754	1.043	1.313
400	100	200	300	400	0.273	0.476	0.658	0.829
500	100	200	300	400	0.191	0.333	0.461	0.580
600	100	200	300	400	0.143	0.249	0.344	0.433
700	100	200	300	400	0.112	0.194	0.269	0.338
800	100	200	300	400	0.090	0.157	0.217	0.273
900	100	200	300	400	0.075	0.130	0.180	0.226
1000	100	200	300	400	0.063	0.110	0.152	0.191
1100	100	200	300	400	0.054	0.094	0.130	0.164
1200	100	200	300	400	0.047	0.082	0.114	0.143
1300	100	200	300	400	0.041	0.072	0.100	0.126
1400	100	200	300	400	0.037	0.064	0.089	0.112
1500	100	200	300	400	0.033	0.057	0.079	0.100
1600	100	200	300	400	0.030	0.052	0.072	0.090
1700	100	200	300	400	0.027	0.047	0.065	0.082
1800	100	200	300	400	0.025	0.043	0.059	0.075
1900	100	200	300	400	0.023	0.039	0.054	0.068
2000	100	200	300	400	0.021	0.036	0.050	0.063
2200	100	200	300	400	0.018	0.031	0.043	0.054
2300	100	200	300	400	0.017	0.029	0.040	0.050
2400	100	200	300	400	0.016	0.027	0.037	0.047
2500	100	200	300	400	0.015	0.025	0.035	0.044
2600	100	200	300	400	0.014	0.024	0.033	0.041
2640	100	200	300	400	0.013	0.023	0.032	0.040

Formula: V (peak particle velocity in in/sec) = $100(D/W^{0.5})^{-1.6}$
D = distance form blasting site to receptor in feet.
W = charge weight in pounds.

Table 15

CHARGE WEIGHT vs PEAK VELOCITY AS A FUNCTION OF DISTANCE

DISTANCE (ft)	CHARGE WEIGHT (lb)				PEAK VELOCITY (in/sec)			
D	W1	W2	W3	W4	V1	V2	V3	V4
2500	100	200	300	400	0.015	0.025	0.035	0.044
2600	100	200	300	400	0.014	0.024	0.033	0.041
2700	100	200	300	400	0.013	0.022	0.031	0.039
2800	100	200	300	400	0.012	0.021	0.029	0.037
2900	100	200	300	400	0.011	0.020	0.028	0.035
3000	100	200	300	400	0.011	0.019	0.026	0.033
3100	100	200	300	400	0.010	0.018	0.025	0.031
3200	100	200	300	400	0.010	0.017	0.024	0.030
3300	100	200	300	400	0.009	0.016	0.022	0.028
3400	100	200	300	400	0.009	0.016	0.021	0.027
3500	100	200	300	400	0.009	0.015	0.020	0.026
3600	100	200	300	400	0.008	0.014	0.020	0.025
3700	100	200	300	400	0.008	0.014	0.019	0.024
3800	100	200	300	400	0.007	0.013	0.018	0.023
3900	100	200	300	400	0.007	0.012	0.017	0.022
4000	100	200	300	400	0.007	0.012	0.017	0.021
4100	100	200	300	400	0.007	0.011	0.016	0.020
4200	100	200	300	400	0.006	0.011	0.015	0.019
4300	100	200	300	400	0.006	0.011	0.015	0.019
4400	100	200	300	400	0.006	0.010	0.014	0.018
4500	100	200	300	400	0.006	0.010	0.014	0.017
4600	100	200	300	400	0.005	0.010	0.013	0.017
4700	100	200	300	400	0.005	0.009	0.013	0.016
4800	100	200	300	400	0.005	0.009	0.012	0.016
4900	100	200	300	400	0.005	0.009	0.012	0.015
5000	100	200	300	400	0.005	0.008	0.012	0.015
5100	100	200	300	400	0.005	0.008	0.011	0.014
5200	100	200	300	400	0.005	0.008	0.011	0.014
5300	100	200	300	400	0.004	0.008	0.011	0.013

Formula: V (peak particle velocity in in/sec) = $100(D/W^{0.5})^{-1.6}$
D = distance form blasting site to receptor in feet.
W = charge weight in pounds.

Table 16

ACCEPTANCE CRITERIA FOR PHYSIOLOGICAL VIBRATION EFFECTS

Vibration Effects on People	Frequencias 10 - 100 Hz Vmax [in/sec]
Imperceptible	0.0063
Just perceptible	0.0252
Clearly perceptible	0.0787
Annoying	0.2520
Unpleasant, Painful if lasting	0.6299

Source: Adapted from *Vibrations in Structures*, H.Bachmann and W. Ammann. International Association for Bridge and Structural Engineering, 1987. Korenev B.G., Rabinovic I. M.: Structural dynamics handbook in German, VEB Verlag furs Bauwesen, East Berlin GDR, 1980.

Table 17

STRUCTURAL CATEGORIES ACCORDING TO SN 640312 (SWISS STANDARD)

Structural Category	Definition
I	reinforced-concrete and steel structures(without plaster) such as industrial building with concrete basement floors and walls, above-grade masonry underground structures such as caverns, tunnels, galleries, lined and unlined
II	buildings with concrete floors and basement walls, above-grade walls of building with concrete basement floors and walls, above-grade masonry underground structures such as caverns, tunnels, galleries, with masonrylines:
III	building with concrete basement floors and walls, above-grade masonry walls, timber joist floors
IV	buildings which are particularly vulnerable and worth protecting

Source: Vibrations in structures, H.Bachmann and W. Ammann.
International Association for Bridge and Structural Engineering, 1987

Table 18

ACCEPTANCE CRITERIA OF SN 640312 (SWISS STANDARD) FOR THE STRUCTURAL CATEGORIES OF TABLE 18

Structural Category	Source M		Source S	
	f [Hz]	Vmax [in/sec]	f [Hz]	Vmax [in/sec]
I	10 to 30	0.47	10 to 60	1.18
	30 to 60	0.47 to 0.71*	60 to 90	1.18 to 1.57**
II	10 to 30	0.31	10 to 60	0.71
	30 to 60	0.31 to 0.47*	60 to 90	0.71 to 0.98**
III	10 to 30	0.2	10 to 60	0.47
	30 to 60	0.2 to 0.31*	60 to 90	0.47 to 0.71**
IV	10 to 30	0.12	10 to 60	0.31
	30 to 60	0.12 to 0.2*	60 to 90	0.31 to 0.47**

Source M: machinery, traffic, construction works - (*) the lower value applies to 30 Hz, the upper to 60 Hz, with interpolation in between.

Source S: blasting operations - (**) the lower value applies to 60 Hz, the upper to 90 Hz, with interpolation in between.

Source: Vibrations in structures, H.Bachmann and W. Ammann.
International Association for Bridge and Structural Engineering, 1987

4.5.4 Existing Noise and Ground Vibration Levels

Existing noise levels were measured at seven locations in the vicinity of the harbor (Figure 1). These locations represent sensitive areas which could be potentially affected by construction activities during the harbor expansion. The measured existing noise levels at the seven locations are presented in Table 3. These noise levels provide ambient noise conditions against which construction noise impacts can be assessed.

Existing peak ground vibration levels were also measured outside typical structures in each of the following residential areas: Makakilo, Honokai Hale, and Ko Olina Resort. The measurements indicate that peak daytime ground vibration velocity levels ranged between 0.003 and 0.004 in/sec which is below the threshold of perception. These levels are generally due to road traffic in these areas.

4.5.5 Equipment Used in Baseline Noise and Vibration Measurements

Equipment used in noise measurements have already been listed under the section describing traffic noise impacts. For vibration measurements, a calibrated Bruel and Kjaer (B&K) Type 4379 accelerometer was used along with a calibrated B&K Type 2231 Sound Level Meter. The peak vibration velocity levels were read directly from a B&K protractor which converts decibels read on the meter to peak vibration velocities.

4.5.6 Construction Noise and Vibration Levels

Typical construction equipment noise levels are presented in Table 9. Major construction equipment vibration levels are presented in Table 10. The maximum Leq (1 hour), unmitigated noise levels at the construction site at a distance of 50 feet from the combined operation of all construction equipment, except blasting, generally lie in the range of 90 dBA to 95 dBA. Vibration levels depend on the source of vibration (blasting, pile driving), distance to receptor and type of intervening medium (soil and rock).

4.5.7 Assessment of Blasting Vibration and Vibration Criteria

Buildings and occupants in the vicinity of a construction site would respond to ground vibrations, and the effects of vibration would fall into one of the following categories:

1) no perceptible effects at the lowest levels of vibration;
2) low rumbling sounds and perceptible vibration at moderate levels; and
3) architectural and / or structural damage at the highest levels.

The selection criteria for acceptable vibration falls into two categories: one for structural integrity and the other for human sensitivity. Though both topics have been studied and assessment methods have been developed, vibration criteria for structural integrity (major building damage) have been firmly established and are widely accepted. The criteria for human sensitivity and annoyance depend on many subjective factors and are not readily available. Studies indicate that the range of vibration levels which are perceptible to the occupants of buildings, but remains acceptable to them, is rather small. Another factor is the vibration exposure duration. The standards generally allow for increased exposure levels for shorter exposure times, i.e., the shorter the duration the higher the level of acceptable vibration.

The current trend is to use vibration velocity for assessing the acceptability for both human sensitivity and building damage. For human annoyance, acceptable vibration velocities range from low levels for sustained vibration of more than 1 hour per day to higher levels for transient vibration lasting less than 10 minutes per day over the frequency range 1 to 100 Hz.

For this study a Swiss standard (SN 640312) is used for assessing structural damage and another European standard for assessing physiological effects. The use of European standards is appropriate for the following reasons: (a) available U.S. standards are more applicable for evaluating physiological effects of sustained (continuous) vibrations than for evaluating the same for short-term (transient) vibrations which are generated by blasting; and, (b) the European standards are more comprehensive than the U.S. standards in terms of defining categories of structures and the sources and frequencies of vibrations that are likely to affect structural integrity. Therefore, the U.S. standards are not used in this project to evaluate physiological and structural effects due to the blasting.

Both of the European standards specify acceptability criteria in terms of vibration velocity level. The Swiss Standard for structural damage criteria clearly defines the structural category, the type of vibration source, and the frequency range of interest in blasting operations. All of this information is presented in a convenient usable form (Tables 17 and 18).

The vibration criteria for this project, in terms of peak particle velocity, for the three categories are the following:

1) imperceptible—less than 0.005 inch/second;
2) barely perceptible vibration—less than 0.025 inch/second; and
3) no architectural or structural damage—less than 0.3 inch/second.

4.6 Construction Scenario No. 1 - Excavate by Blasting

Rock blasting and subsequent removal of the material by backhoe, clamshell, and/or dragline would be used in this scenario. The nearest engineered structures are the coal conveyor and the piers. The contractor will determine the charge weights and time delays which will result in a peak vibration velocity less than 0.3 in/sec at the identified engineered structures. The formula $v=100(d/W^{0.5})^{-1.6}$ can be used in determining the peak particle velocity at the nearest structure. Since the above structures are not sensitive to annoyance, the annoyance criterion does not apply to blasting vibration levels at these structures. There is no likelihood of architectural or structural damage to these structures because the peak vibration velocity is limited to a maximum of 0.3 inch/second, the project criterion level for no architectural or structural damage.

The nearest residences are approximately 4000 feet away from the blast site and they are potentially sensitive to annoyance. At these structures, using the same formula and the same maximum charge per delay, the peak vibration velocity levels, are expected to be on the order of 0.015 in/sec. At such low vibration velocity levels ground vibration would be in the barely perceptible range. Such low vibration velocities would not cause even minor damage to structures. The above criteria - peak particle velocities of 0.3 in/sec for minor structural damage and 0.025 in/sec for "just perceptible" vibration - are consistent with the observations that complaints resulting from ground vibration generally occur at levels one order of magnitude below the levels that may cause minor structural (cosmetic) damage. It should be noted that the monitored blasting vibration velocity levels at residential structures in Honokai Hale during previous project were in the range 0.01 to 0.18 in/sec. At such ground vibration velocities, annoyance was expressed by residents of Honokai Hale. Some of the measured ground vibration velocities for the previous project were much higher than the peak velocity of 0.025 in/sec, which would be specified as the residential criterion for the proposed harbor expansion during blasting. Therefore, it is anticipated that ground vibration and any resulting ground motion during blasting would be barely perceptible and would not create annoyance at the nearby residences at Honokai Hale and Nanakai Gardens residential areas.

All other construction equipment including bulldozers, loaded trucks, jackhammers, augers for drilled shafts, and earth movers would generate less than project criteria vibration levels beyond 50 feet and would satisfy the damage risk criteria for nearby structures.

Under this scenario, the estimated construction site noise levels at a distance of 50 feet from construction equipment are presented in Table 19. Also, listed in this Table are types and numbers of construction equipment in a typical spread of equipment that could be used on the site and their Leq (1 hour) noise levels. Total noise levels from all of the equipment at a distance of 50 feet would be 90 dBA. Also, the estimated total noise level at 50 feet has been projected to sensitive receptors located at other distances from the construction site. The projected construction Leq (1 hour) noise levels at these receptors lie the range 45 to 60 dBA (Table 20).

Construction noise would blend in with the existing ambient noise at the sensitive receptor sites. When the construction noise levels are added to the ambient noise levels, the total noise level would be only 1 to 2 dBA higher than the existing level. This increase would be imperceptible. Construction noise would not exceed the HDOH maximum of 95 dBA at the property line.

The effects of wind direction on the propagation of noise are not considered here; previous observations have shown that blasting and other noises from the construction site are more perceived during occasional Kona winds than during the more prevalent trade winds. It is expected that during most of the year the trade winds will prevail and, as a result, the noise that propagates to the residential areas would be less than the conservative estimate made in Table 20. During the original Barber's Point construction there were some complaints about noise, during Kona weather conditions, but they were not related to blasting.

Table 19

ESTIMATED CONSTRUCTION EQUIPMENT NOISE

Construction Scenario 1, Excavate by Blasting

Noise Source	Noise Level at 50 Ft. (dBA)	Usage Factor[1]	No. of Equipment	Leq(1Hour) at 50 Ft.(dBA)
D8 Dozer	88	0.3	2	86
D7 Dozer	86	0.3	1	81
375 Backhoe	80	0.3	1	75
15c.y. Backhoe	80	0.3	1	75
8 c.y. Dragline	85	0.2	1	78
988 Loader	83	0.2	1	76
773 End dumps	90	0.1	4 (45trips/hr)	80
769 End dumps	90	0.1	3 (45trips/hr)	80
Total			14	90

1. Usage factor is defined as the percent of time, divided by 100, that the equipment is operated at full power while on site. Guidelines for the selection of usage factors are provided in the USEPA Report NT ID700.1, "Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances," December 31, 1971.

Table 20

ESTIMATED CONSTRUCTION EQUIPMENT NOISE AT SENSITIVE RECEPTORS

Construction Scenario 1: Excavate by Blasting

Sites No.	Site Description	Land Use	Distance from Construction Sites (feet)	Estimated Noise Level Leq(1hr)(dBA)
1	Akaawa Street, Makakilo.	Residential	9,300	45
2	Laaloa Street, Honokai Hale	Residential	4,000	52
3	Ko Olina Hotel, Olani Place	Hotel	6,000	48
3A	Ko Olina Visitor Center	Commercial	5,200	50
4	Pond @ fence about 250 ft from flare	Pond	7,000	47
5	Generation Plant, Kaomi Loop	Commercial	8,500	45
7	Refinery on Malakole Road	Commercial	4,300	51
8	Corner of Franklin D. Roosevelt Ave. & Saratoga St.	Residential	7,000	47
10	Kaaoao Pl. near EB HWY-93, near Honokai Hale	Residential	5,100	50
11	EB HWY-93, near Nankai Gardens	Residential	5,500	49
12	Kohupono Place in Makakilo	Residential	8,900	45
13	Ko Olina Golf Course Clubhouse	Golf Course	4,200	52
13A	Ko Olina Golf Course (Nearest Portion)	Golf Course	1,000	60
14	Ko Olina Resort Beach	Beach	4,100	52
15	Campbell Industrial Park	Industrial	6,000	48

HW-BH20.XLS

Blasting noise levels and air blast overpressures are known to vary over a wide range depending on how well the charge is confined within the blast hole. Without mitigation, explosion of unconfined charges of 250 pounds per delay, could theoretically generate linear peak noise levels of 150 decibels (dB lin) within 0.5 miles of the blast site. However, to avoid these undesirable effects, construction specifications would require the use of noiseless shock tube leads, detonation of charges from the bottom of the hole, and quality control measures for stemming the charge at the top of the hole. With these precautions, it is expected that linear peak noise levels due to blasting would not exceed the recommended safe level of 128 dB (lin) at a distance of 0.5 miles from the blast site. Industrial activities at the harbor will have their own high levels of noise at distances within 0.5 miles from the harbor. Since the receptors within 0.5 miles are not sensitive to noise they will not experience adverse noise impacts during blasting. Note that this analysis is based on the decibel linear scale, not the decibel 'A' scale used in HDOH regulations. Refer to paragraph 4.5.1 for an explanation of linear scale and to Table 12 for a comparison with the dBA scale.

At the more distant residential areas blasting noise levels would be considerably below this level and therefore, would not create annoyance. No mitigation of blasting noise levels would be required provided precautions are taken with respect to limiting the charge weight, the use of noiseless leads, detonation from the bottom of the hole, and stemming at the top of the hole.

4.7 Construction Scenario No. 2 - Excavate by Cutterhead Dredge

This construction method would involve ripping of surface material with conventional land-based equipment down to water level. Then a hydraulic dredge equipped with a suitable cutterhead would be floated into the existing harbor and dig its way into the expansion area. The dredging equipment would consist of a cutter head dredge with a minimum of 5,000 HP and a maximum of 12,000 HP which would include generator sets. The shore equipment would consist of two D-7 or D-8 dozers. Based on the maximum size dredge, the total mechanical power this method would be more than 12,000 HP which is roughly twice the mechanical power required under scenario 1. When translated into noise levels, construction equipment under this option would generate a total noise about 3 dBA higher than noise produced under scenario 1, which is 90 dBA at 50 feet (Table 19). If the minimum size dredge (5,000 HP) were used, noise levels under this scenario would be approximately the same as in scenario 1. These noise levels are well below the State Department of Health permissible daytime maximums. A HDOH Noise Variance may be required if dredging activity continues 24 hours a day.

Using this construction method, ground vibration levels would satisfy both the acceptability criteria for annoyance and the damage criteria for nearby structures. Therefore, no mitigation would be required for construction equipment vibration.

4.8 Construction Scenario No. 3 - Excavate without Blasting

The method assumes that auger drilling would be used to weaken the material before excavation and removal. Additional equipment would be similar to those under construction scenario 1. The total mechanical horse power of on-site equipment is roughly the same as in scenario 1. Therefore, total noise level from the construction site and its impact would also be very similar to that under scenario 1. Potential adverse noise and vibration impacts under scenario 1, which are primarily due to blasting, would not exist under this method. No mitigation would be required for both noise and vibration impacts.

4.9 Construction of Tugboat Pier

Construction of a pile-supported tugboat pier would involve the use of pile driving equipment at the project site. Impact pile drivers are known to produce noise levels on the order of 100 to 105 decibels on the 'A' scale and vibration velocity level of 0.5 in/sec at a distance of approximately 50 feet from the pile driving equipment. There are no buildings within 500 feet of the proposed tugboat pier. At a distance of 500 feet, the noise level would be reduced to 85 dBA and the vibration level would be 0.05 in/sec. These levels are below the criteria levels for annoyance and structural damage and therefore, there would be no adverse impact due to pile driving. Also, geotechnical studies for the project indicate that pre-drilling would be required through hard coral material, and therefore actual pile driving would be limited during construction of the tugboat pier. Potential impacts of both pile driving and pre-drilling during tugboat pier construction are of no consequence.

Receptors within 500 feet of the proposed tugboat pier are subject to high noise levels due to activities such as handling of scrap metal and other cargo. Construction noise would not create adverse effects because it would be comparable to existing noise levels in the area.

4.10 Effects on Endangered Wildlife Species

Endangered wildlife in the project vicinity include the Hawaiian stilt, the Humpback whale, and the Green turtle.

Potential sources of adverse noise and vibration impacts due to the proposed construction methods include noise from general construction equipment, noise from dredging operations, and noise and vibration from blasting on the land and in the water.

4.11 Effects on Hawaiian Stilts

Hawaiian stilts are known to inhabit nest sites in the vicinity of the project area, and are acclimated to high levels of human and industrial activity. Baseline noise measurements were taken to show noise levels at which Hawaiian stilts are not disturbed and noise levels to which they can be acclimatized. During baseline noise measurements Hawaiian stilts were spotted in the pond area (site 7, Table 3), about 250 feet from an active flare producing noise levels of approximately 66 dBA with occasional peaks reaching 70 dBA.

Estimated harbor expansion construction noise levels at the pond site are on the order of 45 dBA which is far below the existing noise levels at the same site (see Table 20).

Blasting could take place at a distance of approximately 4,000 feet from the pond. If used, blasting is expected to occur only once per day, limited to a few minutes duration. Such intermittent short duration activity at such low levels of noise 90 to 100 dB on the 'C' scale and vibrations on the order of 0.02 to 0.03 in/sec is not expected to disrupt the nesting habits of the Hawaiian stilt. When appropriate corrections are applied to the 'C' scale readings, to obtain 'A' scale noise levels, the 'A; scale noise levels would not be much different from the existing noise levels at this site.

4.12 Effects on Marine Life

Available research studies on the effects of noise and vibration on marine life were reviewed. Most of these studies address underwater explosion effects on marine life. Therefore, the results of these studies are not directly applicable to the harbor expansion project since any blasting associated with this project would take place on land and not in the water. Also, with detonation of explosive charges taking place on land, the land/water interface would act as a reflector for noise and vibration. The vibration energy would not be transmitted into the water as efficiently as it would through a homogeneous medium such as land/land or water/water. When this attenuation factor is taken into account, the transmitted noise and vibration levels would be nearly the same as ambient levels.

While discussing noise effects on marine life, it is necessary to understand the masking effects of other noise sources normally prevalent in the ocean. Prevailing oceanic ambient noise levels are due to many sources in the ocean. These sources include turbulent pressure fluctuations, oceanic traffic, surface agitation, seismic background, and molecular agitation. Intermittent high noise level acoustic sources in the ocean's noise environment include earthquakes and explosions, ships and industrial activity, and shallow-water wind dependent noise. Noise levels from the above sources range from 60 to 120 dB and they occur over a wide frequency range ---from subaudible frequencies to 100,000 Hz. Ambient noise levels are important in determining the range to which a specific industrial or blasting sound can be heard, and the range to which an animal can hear a sound of interest in the presence of background noise. Prevailing ambient noise can mask other noises depending on the spectral levels and intensity of the intruding noise from construction activities including blasting. In the vicinity of the harbor, underwater noise levels from blasting and dredging activities would be masked by the prevailing ambient noise.

4.13 Mitigation Measures

4.13.1 Construction Noise

Construction site noise levels and work hours are subject to State Department of Health (HDOH) regulations. While most of the proposed construction operations would comply with the regulations without mitigation, certain operations require mitigation measures, as follows:

- If hydraulic dredging is used as the excavation method, a variance from the HDOH regulations would be required to permit 24 hour/day operations.
- Construction specifications for the blasting method of excavation would require the use of noiseless shock tube leads, detonation of charges from the bottom of hole, and

quality control measures for stemming the charge at the top of the hole to eliminate or minimize surface noise.

If required, additional measures to mitigate construction noise impacts are available and they include the following:

Construction strategy modification - adoption of alternative construction processes, operational techniques, or scheduling procedures in order to minimize noise impacts.

- Utilization of sound path modification methods (e.g. temporary noise barriers);
- preferred positioning of equipment to reduce site noise emissions;
- provision of effective silencers or mufflers for all diesel-powered equipment; and
- provision of sound-attenuating housings or enclosures around noise producing equipment;
- limiting the use of back-up alarms and public address systems;
- sound-deadening material to line or cover hoppers, conveyor transfer points, storage bins and chutes;
- maintenance of all equipment such that parts of vehicles and loads are secure against rattling and banging; and
- limiting the equipment idling on site.

Community relations - minimize the disruption caused by unavoidable noise by alerting the public to the scheduling of noisy construction activities and by preparing and implementing a noise monitoring program to enforce attainment of construction noise level criteria.

4.13.2 Construction Vibrations

No mitigation measures are required for construction vibrations associated with hydraulic dredging or for excavation without blasting. If blasting is used in the excavation method, the following mitigation measures would be appropriate:

- Specify vibration limits in contract documents of 0.30 in/sec to protect structures and 0.025 in/sec to minimize annoyance at potentially affected residential areas.
- Specify appropriate blasting quality control measures to ensure adequate control of the process.

- Specify that the contractor retain a qualified blasting consultant to provide a plan and initiate blasting work, including the supervision of initial test blasting to establish effects and baseline conditions.
- Monitor vibrations at sensitive locations throughout the construction period.
- Conduct pre-construction structural integrity inspections of sensitive structures in the vicinity.
- Inform people living and working in the vicinity about the construction method, probable effects, quality control measures and precautions to be used, and the channels of communication available to them.

APPENDIX A-2

BARBERS POINT DEEP-DRAFT HARBOR PROPOSED HARBOR EXPANSION MARINE ENVIRONMENTAL ASSESSMENT

BARBERS POINT DEEP DRAFT HARBOR
PROPOSED HARBOR EXPANSION
MARINE ENVIRONMENTAL ASSESSMENT

Prepared for:

Parsons Brinckerhoff Quade & Douglas, Inc.
Two Waterfront Plaza, Suite 220
500 Ala Moana Boulevard
Honolulu, Hawaii 96813

Prepared by:

Dr. David A. Ziemann
OI Consultants, Inc.
Makapuu Point
Waimanalo, Hawaii 96795

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EXECUTIVE SUMMARY

The Harbors Division, Department of Transportation, State of Hawaii, proposes to expand the existing Barbers Point Harbor, located on the west coast of the island of Oahu. The expansion will consist of a roughly trapezoidal area (880' x 1100' x 1100') along the northeast edge of the existing basin, and a smaller area at the southwestern corner, both dredged to a depth of -38 feet. Associated construction will consist of shoreside piers and wharfs.

The expanded harbor and new shoreside facilities are being constructed to handle an increase in large shipping to the area, with increased potential for unauthorized discharges of wastes and/or oil. Additional dredging in the area may result in further redistribution of groundwater, with additional freshwater flowing out of the harbor channel. Increased boat traffic will result in further resuspension and transport of fine sediment from the harbor bottom. The potential for impacts from these activities on the nearshore water quality and marine biological communities is great, and requires careful analysis of the potential impacts to mitigate serious negative impacts.

In order to assess the potential for significant negative environmental impacts due to the proposed harbor expansion, a three part study was undertaken: surveys of the water quality and marine biological communities in the waters immediately offshore and to either side of the harbor entrance channel; a comparison of these data to historical data; and analysis of the potential impacts of the proposed harbor expansion on the existing marine environment.

The water quality data were collected on a single survey on January 19, 1994, during typical trade wind conditions. The physical structure of the water within the harbor and in the adjacent nearshore area was determined from vertical profiles of temperature, salinity, and turbidity taken at 14 stations within the harbor and entrance channel, and at 12 nearshore water quality stations. The water quality of the nearshore waters was characterized from samples taken at 12 stations located along three offshore station lines off the harbor, and three additional stations within the harbor proper. Eleven physico-chemical parameters and one biological parameter were measured during this survey. These parameters were chosen to conform with the State of Hawaii water quality criteria and to reflect groundwater and freshwater dynamics in the area and sediment input.

Turbidity levels were highly variable within the harbor. Vertical profiles showed increased turbidity near the bottom at stations along the rear of the harbor and a decrease in turbidity at the bottom at the harbor mouth. Turbidity levels decreased dramatically along the axis of the harbor and entrance channel. The outer channel stations showed transmission levels greater than 95% below 2 m, but still showed some influence of the

outflowing lower salinity, higher turbidity water above 2 m. Turbidity levels at the nearshore stations were similar to those in the channel and decreased toward the 10 m and 20 m stations. Turbidity levels appeared to be higher in samples taken from south of the harbor than from north of the harbor.

The distribution of dissolved nutrients and particulate organic material in the harbor reflected the effects of groundwater influx and the low flushing rates typical of semi-enclosed water bodies. Concentrations of dissolved nitrogen (ammonium and nitrate + nitrite) were 2 - 100 times higher than in the nearshore samples. Total nitrogen, which contains dissolved and particulate material, was 2 - 4 times higher in the harbor. Dissolved phosphate and total phosphorus concentrations were similar in the harbor and nearshore waters. Nutrient levels in the nearshore waters were generally highest in the shoreline samples, and decreased to nearly non-detectable levels at the 20 m stations. There were no apparent north-south differences.

Concentrations of chlorophyll were higher by a factor of 2 - 7 in the harbor than in the nearshore waters. The high levels in the harbor reflect the growth of phytoplankton supplied with nutrients from groundwater, abundant sunlight, and low flushing rates. The high suspended particulate load in the harbor and resultant high turbidity probably serves to limit the growth rate of the phytoplankton by decreasing light penetration.

The geometric means of the nearshore and harbor samples were calculated for all water quality parameters and compared to the appropriate state of Hawaii water quality numerical criteria for open coastal waters and embayments, respectively. For the nearshore waters, the dissolved nitrogenous nutrients (ammonium and nitrate + nitrite), turbidity and chlorophyll exceeded the water quality criteria. Ammonium and nitrate + nitrite exceeded their respective criteria by about 4 X, while turbidity was 50% and chlorophyll was 33% higher than their criteria. Total nitrogen and total phosphorus did not exceed the water quality criteria. Within the harbor, ammonium and nitrate + nitrite exceeded the water quality criteria by factors of 4 X and 8 X, respectively. Turbidity exceeded the water quality criterion by a factor of 4 X. Total nitrogen, total phosphorus and chlorophyll levels were well below the respective criteria.

The relationships between dissolved silicate and salinity and dissolved nitrate and salinity were similar and generally followed the conservative mixing curve. The high silicate and nitrate levels imply that groundwater is the primary source of nutrients entering the harbor. The similarity between the silicate - salinity and nitrate - salinity plots and the linear relation between silicate and nitrate imply that groundwater is the primary source of nitrate, and that there are no additional sources of nitrate input that might be attributed to terrestrial activities such as agriculture or landscaping. The lack of any relation between ammonium and salinity suggests that little ammonium is carried into the harbor or the nearshore marine environment by groundwater; the observed levels of ammonium are likely the result of biological activity by marine organisms.

Surveys for estimations of substrate coverage, benthic community composition and fish abundances were located at three depths along four parallel lines extending from the shoreline to the southwest. The sites of qualitative transects and quantitative survey lines were, as nearly as possible, the same as those occupied during the previous harbor impacts study (AECOS, 1985). Biological surveys were conducted using SCUBA on January 8, February 20, and March 2, 1994, during periods of light winds and calm seas.

In the nearshore waters extending up to 1,500 m on either side of the harbor entrance channel and offshore to depths of 20 m, there were areas with three distinct sets of physical and biological characteristics (commonly termed "biotopes"). These biotopes were mainly the consequence of the bottom substrate composition and the depth of the water column (corresponding to the amount of wave energy): the shallow inshore limestone bench; the limestone plate with extensive beds of living and dead coral at depths of 6 - 10 m; and the deep (15+ m) limestone plate covered with a thin algal-sand mat.

In addition to the depth-related differences in fish populations and benthic community distributions, there were significant differences at the same depths on the north and south sides of the entrance channel. Generally speaking, both corals and fish were more abundant and speciose to the north of the channel. There was also a striking difference in the distribution of sand between stations to the north, where little sand was present, and south of the harbor entrance channel, where the bottom was covered with sand deposits or mixed sand - macroalgal mats.

Our assessment of the potential impacts of the proposed harbor expansion has been prepared based on historical data and that generated by this study. These data were used, in conjunction with the results of previous oceanographic studies and mathematical modeling of the turbidity plume dynamics (Sea Engineering, Inc., 1994), to establish the zones of potential impact and levels of discharge water quality in the receiving waters.

We project that there will be no significant direct impacts to the marine environment due to the proposed excavation and subsequent construction of shoreside facilities. The majority of the material to be removed is currently behind the existing edges of the harbor. The removal of material along the rear wall of the harbor to open the newly-created harbor extension will kill any organisms which may have settled there. Due to the highly turbid nature of the harbor waters and the strong groundwater influx, however, it is not likely that any significant number of corals have become established in this area. In mitigation, approximately 3X new wall surface will be exposed after construction for potential colonization.

The impacts of the proposed harbor expansion on the water quality of the harbor and adjacent nearshore marine waters are expected to be small and temporary. A study of the impacts of the proposed expansion on the groundwater resources of the area (Mink 1994) concluded that little change in groundwater quality or quantity would result from the proposed dredging and construction activities. Therefore, the harbor would continue to serve as a focus for groundwater flow, channeling previously diffuse shoreline discharge to a discharge from the harbor mouth. No significant changes in the dissolved nutrient load into the harbor or the resultant organic particulate distribution would be expected. Much greater change in groundwater flow and quality is to be expected due to decreased groundwater discharge by agriculture as the land use upslope from the harbor changes from agriculture to resort and residential use.

There will be increased inorganic particulate material suspended in the harbor waters and discharged to the adjacent nearshore marine waters during and for some time after the removal of the berm between the newly-excavated extension and the harbor. The magnitude and duration of this condition will depend to a great extent on the construction methods used. Under some construction methods, no change in suspended particulate load would be expected, and no change in water quality or marine biological communities would result. Under other construction methods, some additional material would be generated by the dredging activities and suspended in the harbor waters. This material would pass out of the harbor to the adjacent nearshore ocean waters, with the larger, faster sinking particles leaving the water column rapidly and the smaller, slower sinking particles remaining in the water and being transported along or offshore with the currents.

Data collected under a range of wave and current conditions over a four-year period show that the projected increased turbidity levels fall within the range of variability experienced by the site under natural conditions. Thus, while the waters within a small area centered around the mouth of the harbor may experience turbidity levels which exceed the state water quality standard, these levels will be within the range of values shown to occur in the area under natural conditions.

Other potential adverse impacts include increased boat usage of the harbor and the incidental and accidental introduction of contaminants into harbor and nearshore waters. Marine vessels use leaded and unleaded gasolines and diesel fuels that can be a source of contamination to harbor waters. Generally, most fuel and oil spills are incidental to fueling activities and are accidental and small. However, floating petroleum products and oil have not been conclusively shown to damage corals, and reef communities can exist in areas subject to long-term oil pollution. Similarly, hydrocarbon contaminants do not appear to adversely affect algal, invertebrate or fish populations within marinas or harbors unless there is a massive spill. The elimination of wastes from vessel holding tanks into harbor waters is prohibited by both state and federal regulations. Vessels are required to empty their wastes at local pump-out stations. Illegal discharges can occur and might constitute a potential health hazard. However, bacteria contained in sewage wastes are rapidly killed off by the combination of salinity and sunlight. The time required to kill off 90% of coliform bacteria in seawater is approximately 20 minutes; thus, few bacteria would remain several hours after a spill. The existing flushing action of the harbor by tidal flows and groundwater influx will not be changed by the harbor expansion. These processes would serve to move the limited amount of pollutants that might be introduced into the harbor into open ocean waters where they will undergo natural weathering and degradation.

Since no change in the quality or flow of groundwater is expected as the result of the proposed expansion activities, the primary potential impact to marine biological communities will be related to the elevated levels of turbidity and increased rates of sedimentation of suspended particulate material. Elevated levels of turbidity will have no lasting effect on the resident fish or green sea turtle populations. Turbidity levels are not expected to rise to levels which might somehow cause actual physical distress to resident fishes, or to decrease visibility to a point that feeding or avoidance of predators is inhibited. Short-term and highly localized areas of high turbidity can simply be avoided by highly motile fish. Turbidity levels are also not likely to affect resident green sea turtles. Brock observed off West Beach that turtles were actually found in greater abundance in waters that were more highly turbid than those that were clearer. He did not observe the same phenomenon off Hawaii Kai, but did observe turtles there in both clear and turbid waters.

Benthic populations of stony corals, macroalgae and macroinvertebrates cannot move from an area which may experience elevated turbidity or sedimentation rates. However, these communities have evolved in areas which experience naturally high levels of turbidity and sedimentation at some frequency, and have developed mechanisms to cope with these events. The increase in sedimentation rates which are projected under worst case conditions will not result in any significant degradation to the resident coral communities.

One of the construction options entails drilling and blasting to loosen the material before removal. Such blasting has the potential to impact marine life within some distance from the blast site. No significant immediate mortalities to fish populations are expected, since the blasting will occur some distance from the ground-water interface, the charges will be small, and the resultant shock waves are expected to be minimal.

The shock waves may be felt by sensitive marine mammals if they are within a short distance of the construction site. Generally, however, whales and other smaller marine mammals do not venture close to shore. Surveys of the locations and trajectories of migrating humpback whales have shown that humpback whales and most other smaller whales seldom come into waters within the 100 fathom contour off Oahu. The 100 fathom contour is found at a distance of just under one mile offshore of the harbor. The shock waves from small charges set off at some depth underground and several thousand feet inland is not expected to have any significant negative impact on humpback whales or other marine mammals which may be passing through the area.

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BARBERS POINT DEEP DRAFT HARBOR EXPANSION
MARINE ENVIRONMENTAL ASSESSMENT

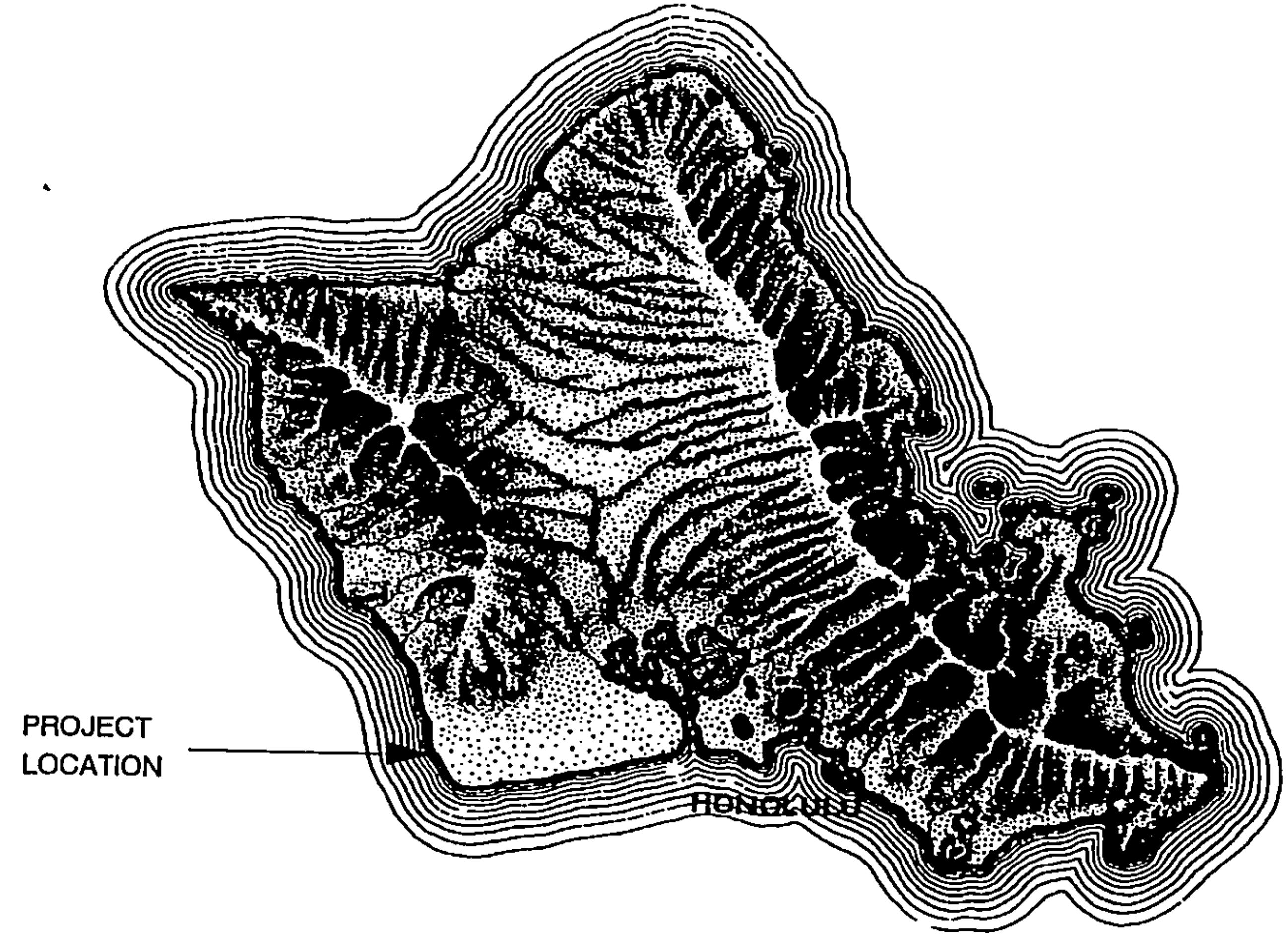
BACKGROUND

The Harbors Division, Department of Transportation, State of Hawaii, proposes to expand the existing Barbers Point Deep Draft Harbor, located on the west coast of the island of Oahu (Figure 1). The expansion (Figure 2) will consist of a roughly trapezoidal area (880' x 1100' x 1100') along the northeast edge of the existing basin, and a smaller area at the southwestern corner, both dredged to a depth of -38 feet. Associated construction will consist of shoreside piers and wharfs.

Marine biological surveys of the area between Barbers Point and Kahe Point (Kimmerer and Durbin, 1975) identified areas of complex benthic communities and high coral cover, which were at one time considered for nomination as a Marine Life Conservation District. The impacts of the first harbor expansion in 1984 were documented in a series of technical reports describing the pre-construction, construction, and post-construction water quality and marine biological conditions (AECOS, 1982; AECOS, 1985; AECOS, 1986). Baseline conditions and impacts associated with the development of the Ko Olina recreational swimming lagoons and marina have also been described (Bienfang and Brock, 1980; OI Consultants, 1984; OI Consultants, 1987; OI Consultants, 1988; OI Consultants, 1990; AECOS, 1991). In general, the water quality impacts due to both the harbor and the resort construction activities have been short-lived and relatively benign. Some changes in intertidal macroalgal communities have been documented due to changes in groundwater discharge patterns. The construction-related impacts to the benthic communities have ranged from insignificant to severe, with the most damage associated with the dredging of the harbor entrance channel. Natural events such as Hurricane Iwa and severe winter storms have had greater impact.

Marine waters between Kahe Point and Barbers Point are classified "A" by the State Department of Health. Harbors and marinas are allowable uses within class "A" waters. The coastline on either side of the harbor entrance is also popular for shoreline fishing.

The expanded harbor and new shoreside facilities are being constructed to handle an increase in large shipping to the area, with increased potential for unauthorized discharges of wastes and/or oil. Additional dredging in the area may result in further redistribution of groundwater, with additional freshwater flowing out of the harbor channel. Increased boat traffic will result in further resuspension and transport of fine sediment from the harbor bottom. The potential for impacts from these activities on the nearshore water quality and marine biological communities is great, and requires careful analysis of the potential impacts to mitigate serious negative impacts.

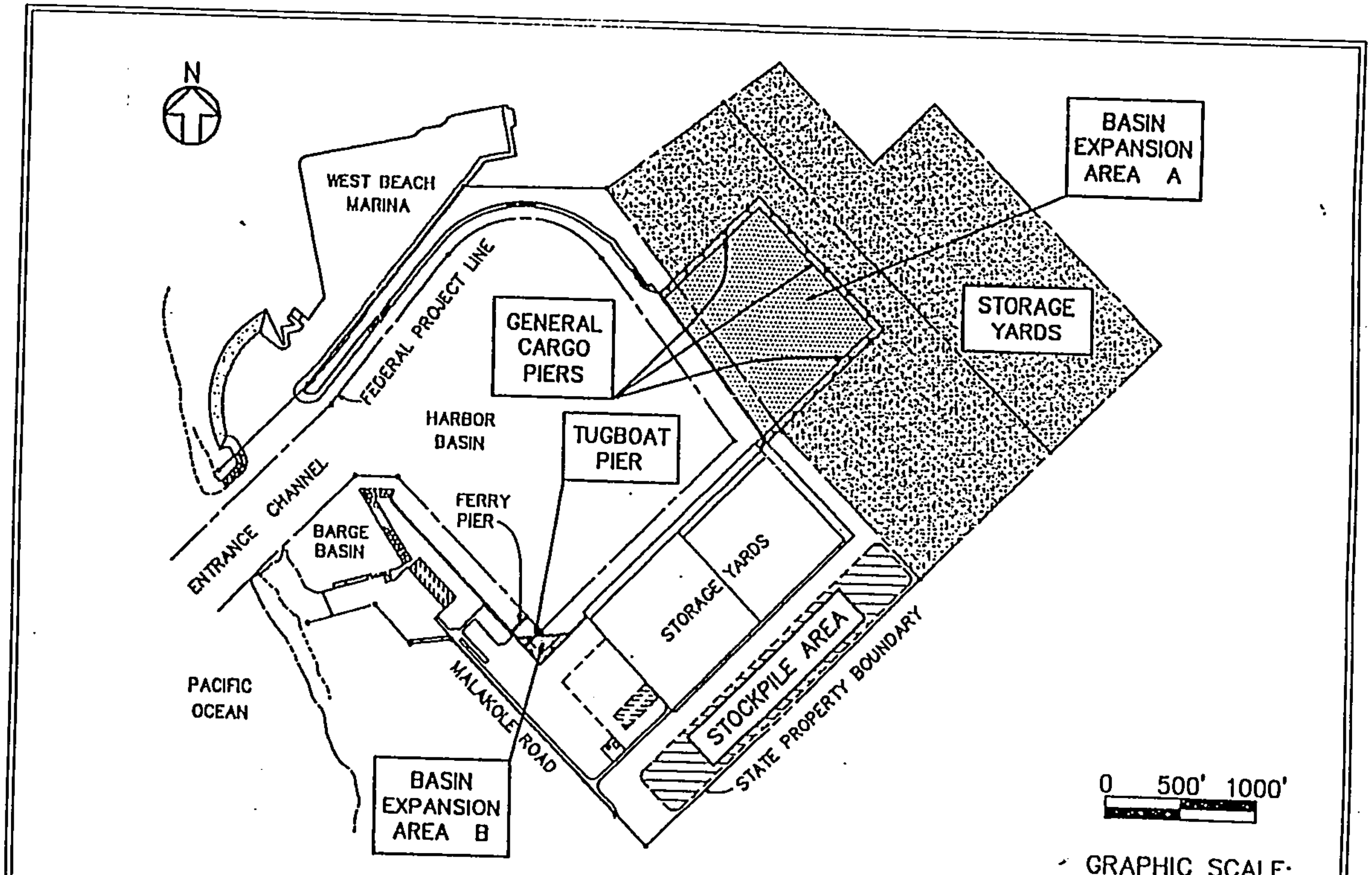


OI Consultants, Inc.
Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

PROJECT LOCATION

Figure 1



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Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

PROJECT SITE PLAN

Figure 2

In order to assess the potential for significant negative environmental impacts due to the proposed harbor expansion, a four part study was undertaken: surveys of the water quality and marine biological communities in the waters immediately offshore and to either side of the harbor entrance channel; a comparison of these baseline data to historical data; analysis of the potential impacts of the proposed harbor expansion on the existing marine environment; and preparation of a monitoring plan for the construction project.

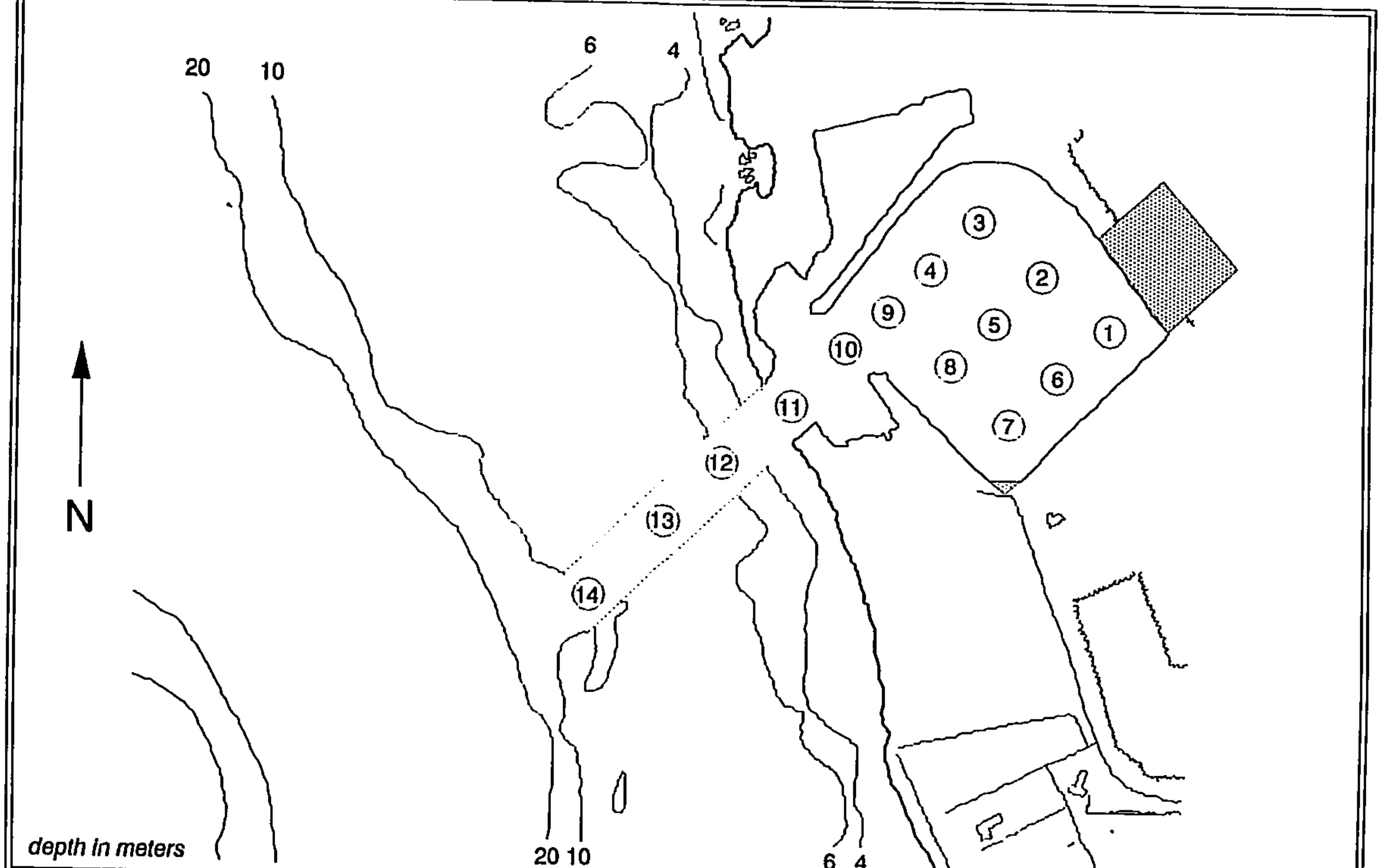
WATER QUALITY SURVEY

Methods

The water quality data were collected on a single survey on January 19, 1994, during typical trade wind conditions. The physical structure of the water within the harbor and in the adjacent nearshore area was determined from vertical profiles of temperature, salinity, and turbidity (as percent transmission) taken at 14 stations within the harbor and entrance channel (Figure 3), and at all nearshore water quality stations (Figure 7). Profiles were taken with a conductivity - temperature - depth (CTD) profiling system fitted with a 25 cm path length transmissometer. Sampling frequency was set such that data were collected at approximately 20 cm depth intervals. Profiles extended from 0.5 m below the surface to just above the bottom at each station.

The water quality of the nearshore waters was characterized from samples taken at 12 stations located along three offshore station lines off the harbor (Station Lines A - C; Figure 4), and three additional stations within the harbor proper (Stations H1 - H3). Nearshore stations were located at the shoreline and at equally spaced intervals offshore, in water depths of approximately 15, 30 and 60 feet (5, 10 and 20 m). These sample stations correspond to those occupied during the first expansion impact study (AECOS, 1985). A single sample was collected at the shoreline station. Two samples were collected at all other nearshore stations: 0.5 m below the surface, and 0.5 m above the bottom. Samples within the harbor were collected at 0.5 m below the surface, at mid-depth, and 0.5 m above the bottom.

Eleven physico-chemical parameters and one biological parameter were measured during this survey. These parameters were chosen to conform with the State of Hawaii water quality criteria and to reflect groundwater and freshwater dynamics in the area and sediment input. The parameters can be divided into four main categories: 1) physical water quality parameters: temperature (TEMP), salinity (SAL), and dissolved oxygen (DO); 2) measures of suspended material: turbidity (TURB) and total suspended solids (TSS); 3) algal nutrients and other biological indicators: nitrate+nitrite (NO_3), ammonium (NH_4), phosphate (PO_4), silicate (Si), total nitrogen (TN) and total phosphorus (TP). One biological parameter, chlorophyll *a* (CHL) was used to measure



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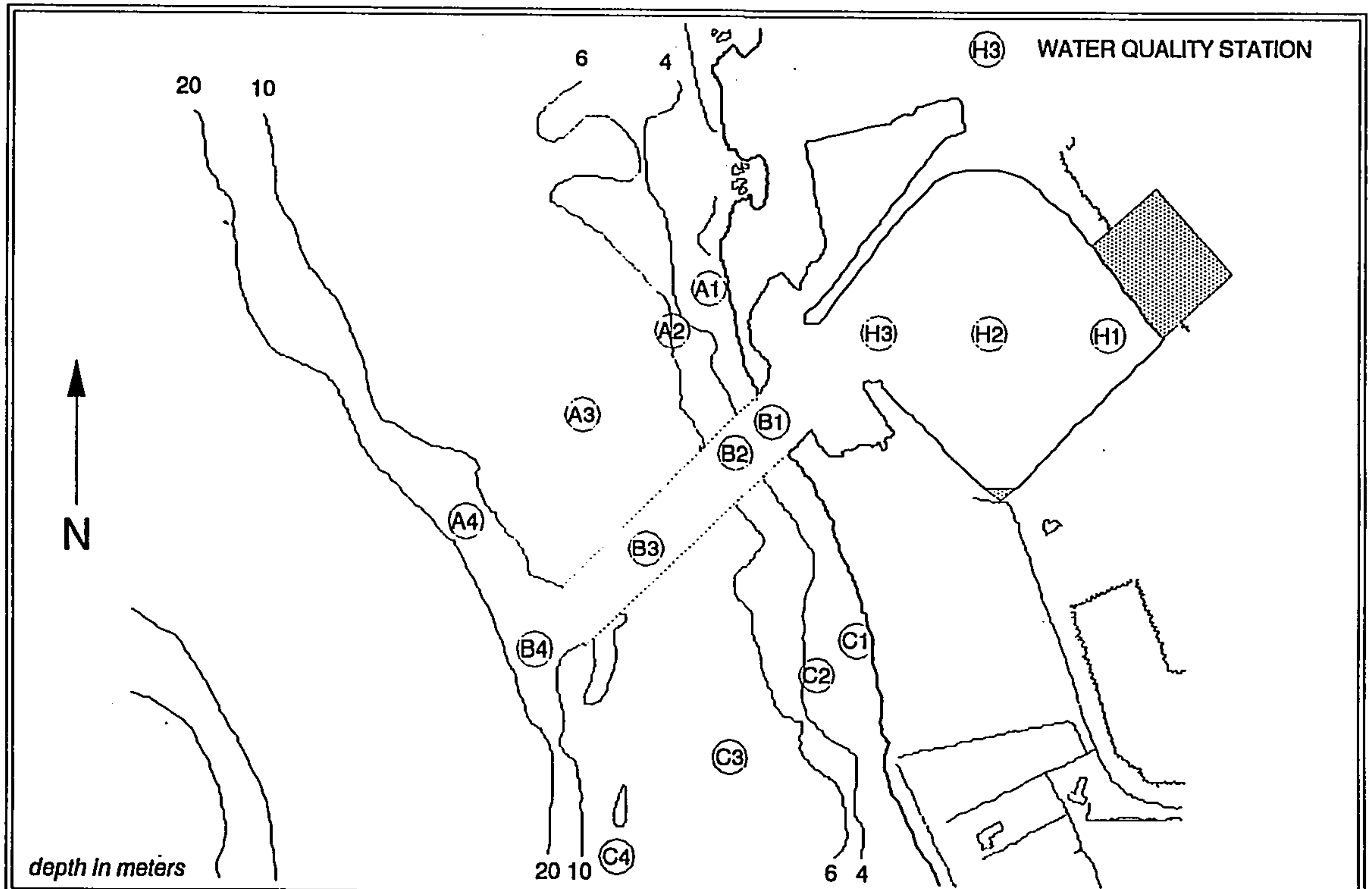
Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

STATION LOCATIONS FOR VERTICAL PROFILES

Figure 3



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Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

STATION LOCATIONS FOR WATER QUALITY SURVEYS

Figure 4

plant biomass. The general methods used to measure these parameters are listed in Table 1.

Large volume (4 l) samples collected at one station within the harbor (H2) and one in the nearshore (B1), were filtered onto glass fiber filters and analyzed for particulate constituents (carbonate, terrigenous, and organic fractions), as were samples of bottom sediment collected by divers at all biological survey stations. The filters and sediment samples were dried and weighed for total weight; treated with dilute acid to dissolve the carbonate fraction, dried and weighed again for terrigenous + organic weight; and finally combusted at 500oC and weighed again for inorganic weight.

Results

The results of the vertical profile survey for temperature, salinity, and turbidity are presented in Figures 5, 6 and 7, respectively. In each figure, the upper plot (A) presents vertical profiles for stations 1 - 9, located within the harbor proper; the middle plot (B) presents the profiles from stations 3, 4, 9, 10, 11, 12, 13, and 14, a linear progression from the back of the harbor to the seaward end of the entrance channel; and the lower plot (C) presents the vertical profiles from the nearshore water quality stations.

Temperature was generally vertically uniform and varied little within the harbor (Figure 5A). Lowest temperatures were seen at Station 4, midway along the northwestern side of the harbor, while warmest temperatures were observed at Station 2, midway along the northeastern side. Temperatures decreased at most stations within the bottom 2 m. The difference between minimum and maximum temperatures was less than 0.2°C.

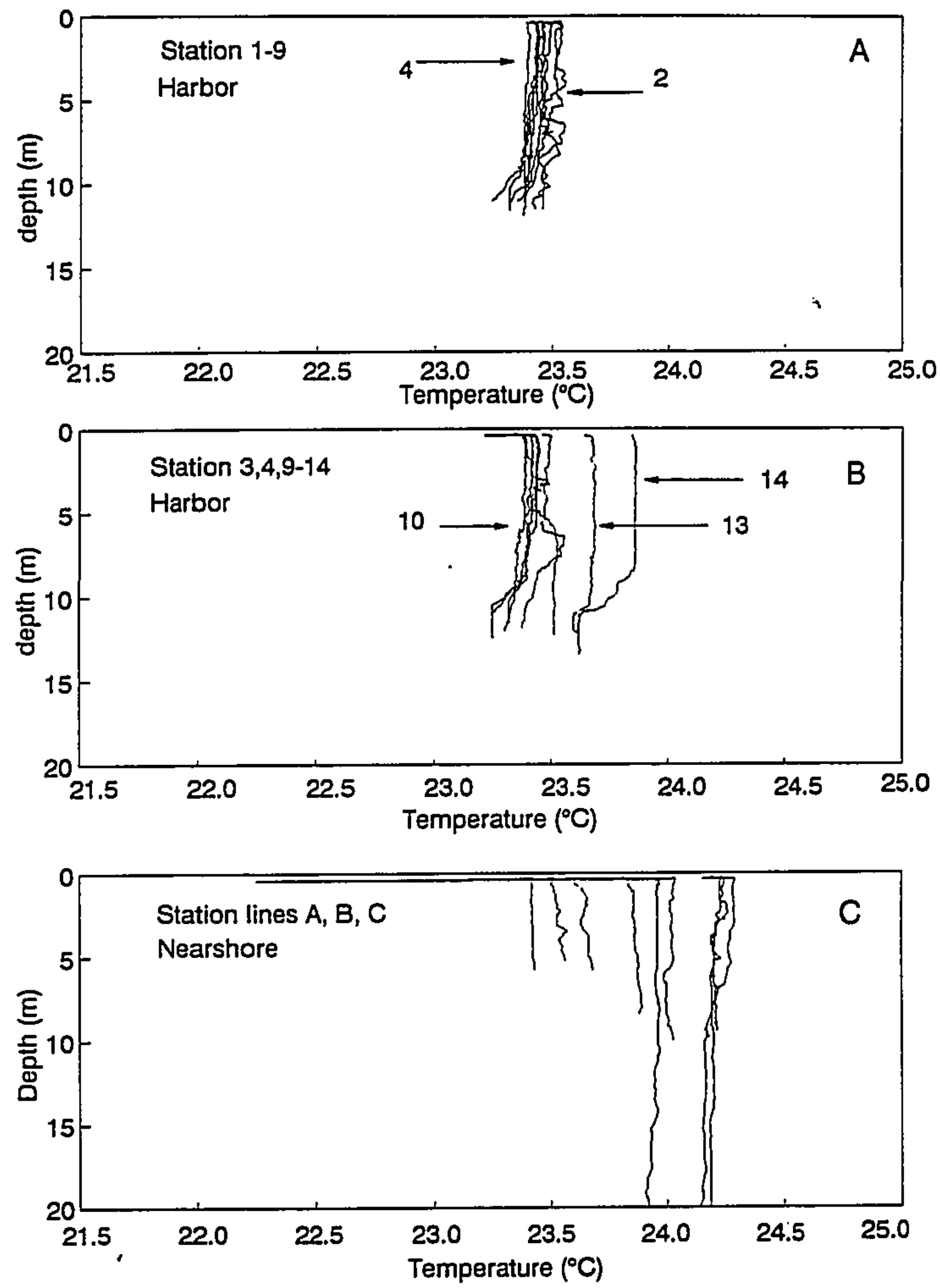
Water temperature increased along the axis of the harbor (Figure 5B), from lowest values at stations 3 and 4 (23.3°C) to highest values at Station 14 (23.8°C). The greatest increases in temperature occurred between stations 12 - 13 and 13 - 14. Temperature was generally vertically uniform until the bottom 2 - 3 m.

Water temperature at the 5 m nearshore stations was similar to that at the comparable channel stations (Figure 5C). Temperature at the 10 and 20 m stations were warmer than the inshore or harbor stations, ranging from 23.8 to 24.3°C. Temperature at all nearshore stations was vertically uniform.

Salinity within the harbor (Figure 6A) was generally uniform (approximately 34.8 ppt) with the exception of Station 1, at the rear corner of the harbor, which showed a significant decrease in salinity, especially at the surface. This pattern reflects a strong influx of brackish water at or near this station.

Table 1. Methods for water quality sampling and analysis.

Parameter	Collection and Analysis Method
Temperature	YSI field oxygen meter
Dissolved Oxygen	YSI field oxygen meter
Water Samples:	2 liter Niskin bottle
Nutrients	Technicon AutoAnalyzer II;
NH_4	Solorzano, 1969
NO_3/NO_2	Technicon Inc., 1977
PO_4	Murphy and Riley, 1962
$Si(OH)_4$	Strickland and Parsons, 1972
Total Nitrogen	D'Elia et al., 1977
Total Phosphorus	Grasshoff et al., 1983
Salinity	AGE Instruments Model 2100 salinometer
Turbidity	Turner Designs nephelometer; APHA, 1992
Suspended Solids	Filtration, Cahn electrobalance; APHA, 1992
Chlorophyll *a*	Turner Designs fluorometer; Strickland and Parsons, 1972
Sediment	Acidification; combustion Gross, 1971



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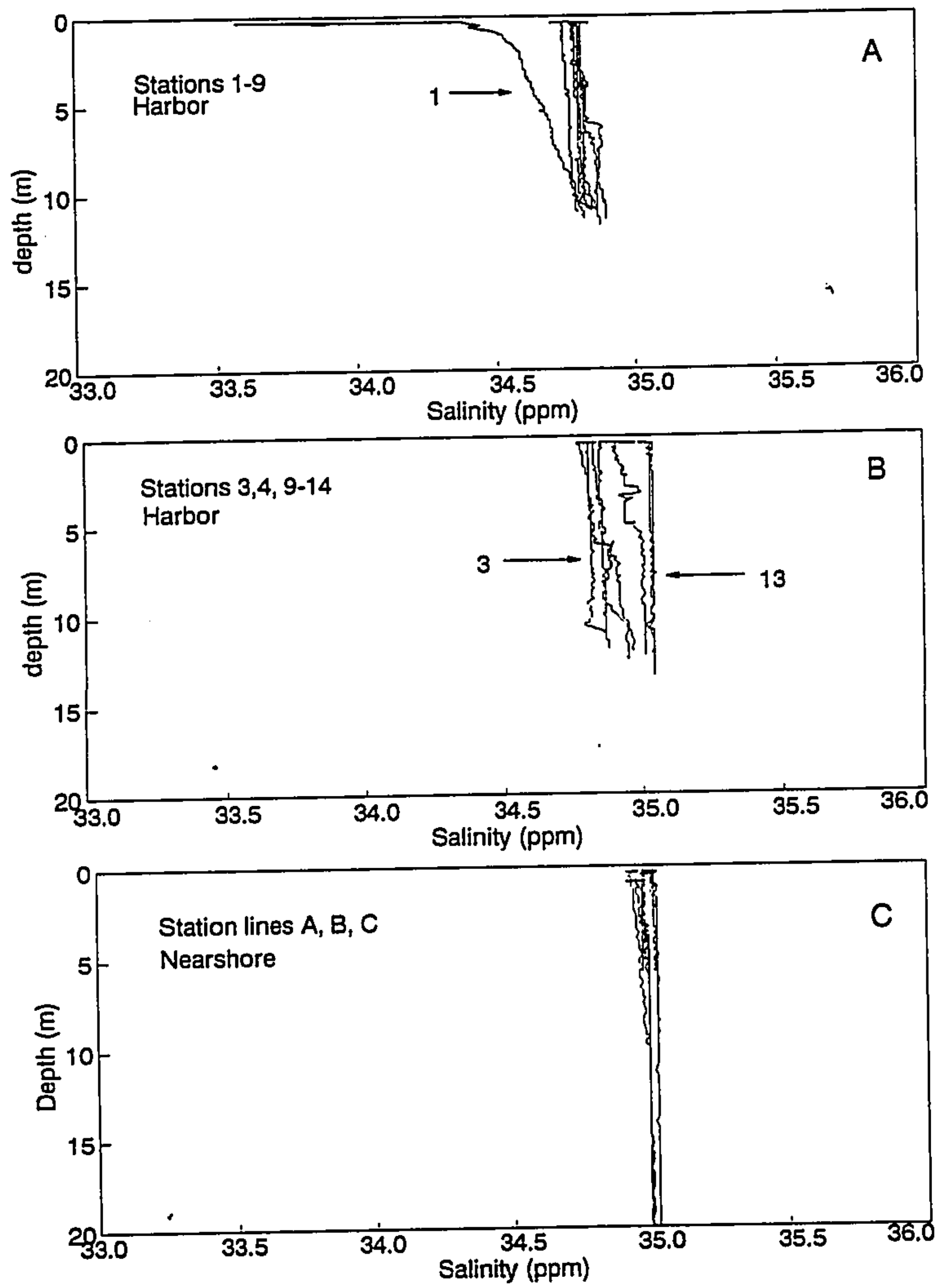
BARBERS POINT HARBOR EXPANSION STUDY

VERTICAL PROFILES: TEMPERATURE

Figure 5



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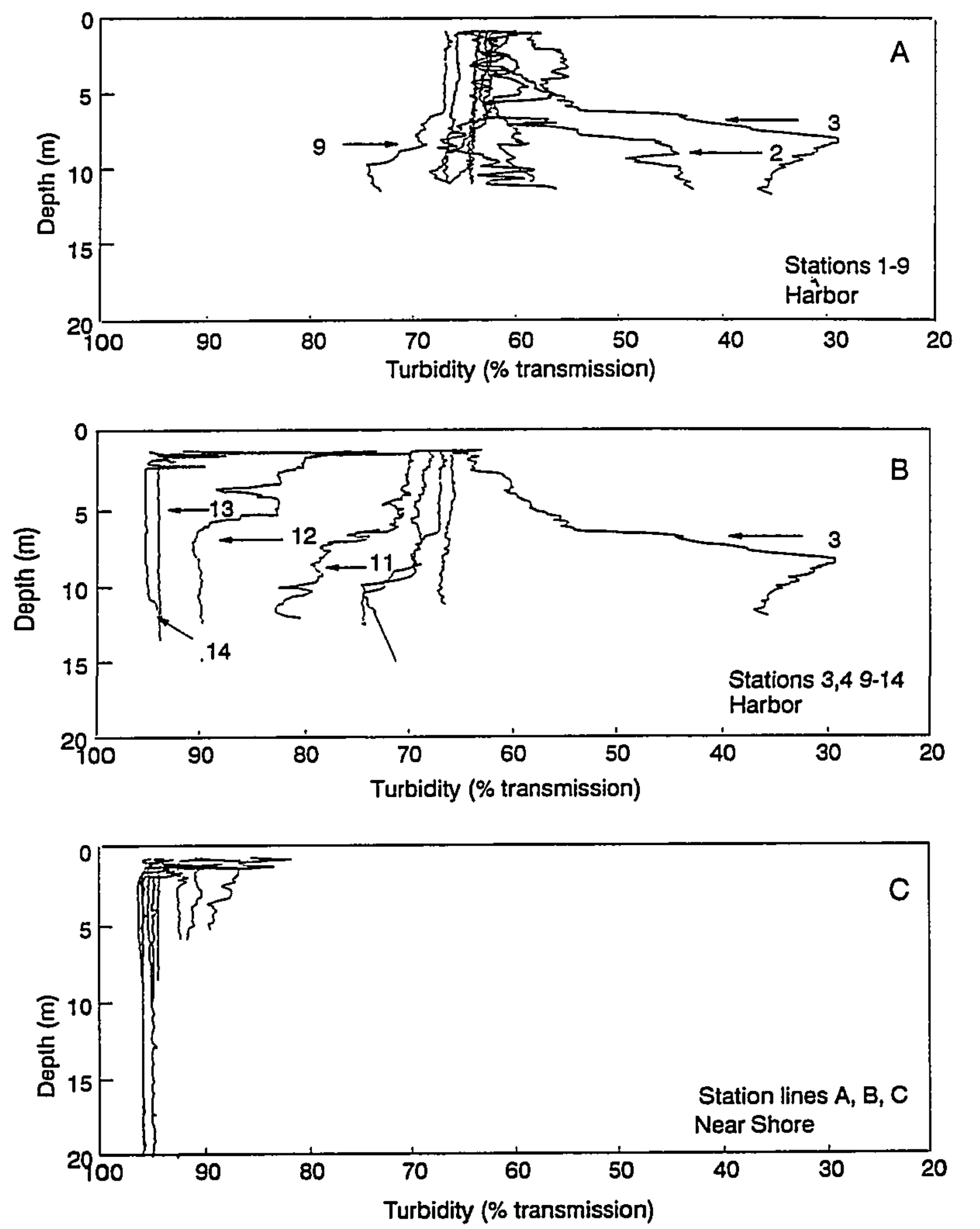
BARBERS POINT HARBOR EXPANSION STUDY

VERTICAL PROFILES: SALINITY

Figure 6



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Salinity gradually increased along the axis of the harbor and channel (Figure 6B) from a low (34.7 ppt) at Station 3 to maximum values (35.1 ppt) at stations 13 and 14. Some vertical gradients in salinity observed at stations 9 - 12 reflect the outflow of lower salinity, less dense water within the upper 5 m of the channel. This outflow is not apparent at Station 13.

Salinity at the nearshore stations (Figure 6C) was uniform both vertically and between stations, and the same as that observed at the outer channel stations (35.1 ppt).

Turbidity levels, expressed as the percent transmission of light through a 25 cm path length, were highly variable within the harbor (Figure 7A). Vertical profiles showed increased turbidity near the bottom at stations along the rear of the harbor (stations 2 and 3), and a decrease in turbidity at the bottom at Station 9, the harbor mouth.

Turbidity levels decreased dramatically along the axis of the harbor and entrance channel (Figure 7B). Elevated near-bottom turbidity at Station 3 (30% transmission) decreased rapidly to Station 4 (65% transmission), where turbidity levels were vertically uniform. Turbidity levels in the upper 7 m decreased slightly to 70% transmission between Station 4 and Station 11, while turbidity below 7 m decreased to greater than 80% transmission at Station 11. Station 12 showed further decreased turbidity, with 90% transmission below 5 m. The outer channel stations showed transmission levels greater than 95% below 2 m, but still showed some influence of the outflowing lower salinity, higher turbidity water above 2 m.

Turbidity levels at the 5 m nearshore stations (Figure 7C) were similar to those in the channel (87% - 93% transmission), while at the 10 m and 20 m stations, transmission levels were greater than 95% below 2 m, and somewhat elevated above 2 m.

The results of the water quality survey performed on January 26, 1994, are presented in Table 2. Station locations are shown in Figure 4. Temperature and salinity values from discrete samples within the harbor and the nearshore area reflect the vertical and horizontal patterns described above. Levels of dissolved oxygen and pH were generally uniform and typical of well-mixed nearshore waters. As would be expected from the transmissometry profile data, levels of turbidity and total suspended solids were highest at Station H1, intermediate at Station H2, and lowest at Station H3 within the harbor, and decreased from the shallow to the deeper stations in the nearshore samples. Turbidity levels appeared to be higher in samples taken from south of the harbor (Stations B1-B4 and C1-C4) than from north of the harbor (Station A1-A4).

The distribution of dissolved nutrients and particulate organic material in the harbor reflected the effects of groundwater influx and the low flushing rates typical of semi-enclosed water

Table 2. Water quality results for samples taken at Barbers Point, Oahu on January 19, 1994. Station locations are shown in Figure 4. "GeoMean Nearshore" is the geometric mean of all nearshore samples; "GeoMean Harbor" is the geometric mean of all harbor samples; "Open Coastal WQS" is the state of Hawaii water quality standards numerical criterion for "dry" marine open coastal waters; "Embayment WQS" is the state of Hawaii water quality standards numerical criterion for "dry" marine embayments.

SAMPLE I.D.	DEPTH (m)	TEMP (deg C)	SAL (ppt)	DO (mg/l)	pH (units)	TURB (NTU)	TSS (mg/l)	NH4 (uM)	NO2+NO3 (uM)	TN (uM)	PO4 (uM)	TP (uM)	SI (uM)	CHL (ug/l)
A-1S	0.5	.NST	35.01	NST	8.12	0.19	2.63	1.05	0.59	6.21	0.10	0.55	4.23	0.06
A-2S	0.5	23.30	35.18	6.71	8.21	0.22	1.83	1.32	1.48	6.73	0.10	0.47	5.00	0.08
A-2B	4.5	23.30	35.04	6.77	8.20	0.18	2.66	1.05	1.26	7.12	0.10	0.47	5.00	0.08
A-3S	0.5	23.80	35.34	6.54	8.19	0.10	2.66	ND	0.44	5.31	0.05	0.39	2.31	0.10
A-3B	8.5	23.70	35.10	6.54	8.20	0.12	2.05	1.05	0.44	6.34	0.05	0.43	2.44	0.10
A-4S	0.5	23.90	35.12	6.69	8.22	0.11	1.95	0.26	0.07	5.57	0.02	0.43	2.05	0.14
A-4B	18.5	23.80	35.11	6.53	8.20	0.16	1.50	0.26	0.04	5.69	0.02	0.47	2.05	0.18
B-1S	0.5	NST	35.03	NST	8.19	0.66	2.93	0.26	1.63	7.38	0.05	0.47	7.82	0.46
B-2S	0.5	23.40	35.14	6.67	8.20	0.49	2.19	0.26	1.48	7.25	0.10	0.47	6.28	0.26
B-2B	5.0	23.40	35.13	6.76	8.19	0.42	1.84	0.13	1.19	6.99	0.10	0.47	5.13	0.25
B-3S	0.5	24.00	35.16	6.52	8.23	0.07	1.48	0.26	0.04	5.57	0.02	0.47	2.05	0.11
B-3B	8.5	23.90	35.10	6.51	8.25	0.10	1.70	0.39	0.04	5.57	ND	0.43	2.05	0.16
B-4S	0.5	24.20	35.09	6.43	8.25	0.10	1.66	0.53	ND	6.99	ND	0.43	1.79	0.07
B-4B	20.0	24.00	35.07	6.47	8.24	0.11	3.93	0.79	ND	5.82	ND	0.47	1.79	0.12
C-1S	0.5	NST	35.11	NST	8.28	0.32	2.23	0.53	0.37	6.21	0.02	0.43	4.36	0.18
C-2S	0.5	23.50	35.12	6.70	8.26	0.34	2.97	0.66	0.96	7.12	0.05	0.47	4.74	0.25
C-2B	5.0	23.50	35.14	6.73	8.25	0.25	1.69	0.79	0.89	6.73	0.05	0.47	4.23	0.25
C-3S	0.5	24.20	35.17	6.48	8.26	0.07	1.25	ND	0.04	5.05	ND	0.39	1.79	0.27
C-3B	8.5	24.10	35.11	6.49	8.26	0.10	1.26	0.66	ND	5.69	ND	0.39	1.79	0.10
C-4S	0.5	24.10	35.31	6.49	8.25	0.07	1.74	0.13	ND	5.05	ND	0.39	1.79	0.10
C-4B	19.0	24.10	35.12	6.46	8.23	0.06	2.39	0.26	ND	5.31	ND	0.43	1.79	0.10
H-1S	0.5	23.40	34.98	6.46	8.21	0.95	2.81	1.58	2.82	11.52	0.02	0.51	11.79	0.07
H-1M	6.0	23.30	34.91	6.43	8.22	1.21	2.68	0.26	2.74	9.32	0.05	0.47	11.67	0.74
H-1B	11.0	23.20	35.04	6.45	8.22	0.80	1.98	0.79	2.07	8.28	0.05	0.55	8.85	0.49
H-2S	0.5	23.40	34.89	6.48	8.22	1.45	3.79	1.58	3.26	13.59	0.02	0.55	13.08	0.69
H-2M	6.0	23.30	34.86	6.42	8.22	1.28	4.75	1.05	3.11	10.48	0.02	0.55	12.82	0.77
H-2B	11.0	23.10	34.91	6.25	8.20	1.21	5.23	1.32	2.67	9.45	0.05	0.55	11.54	0.46
H-3S	0.5	23.50	34.83	6.42	8.17	1.97	4.59	1.45	3.56	15.79	0.10	0.55	13.46	0.56
H-3M	6.0	23.40	34.89	6.41	8.20	1.67	5.23	0.79	2.45	9.58	0.10	0.59	11.03	0.56
H-3B	11.0	23.30	34.91	6.30	8.20	1.45	4.56	1.05	2.59	8.93	0.10	0.55	10.51	0.38
Geo Mean Nearshore		23.63	35.06	6.52	8.22	0.30	2.44	0.58	0.73	7.21	0.05	0.47	4.45	0.20
Open Coastal WQS						0.20		0.14	0.25	7.86		0.52		0.15
Geo Mean Harbor		23.32	34.91	6.40	8.21	1.29	3.77	0.98	2.78	10.55	0.05	0.54	11.56	0.45
Embayment WQS						0.40		0.25	0.36	10.71		0.65		0.50

bodies. Concentrations of dissolved nitrogen (ammonium and nitrate + nitrite) were 2 - 100 times higher than in the nearshore samples. Total nitrogen, which contains dissolved and particulate material, was 2 - 4 times higher in the harbor. Dissolved phosphate and total phosphorus concentrations were similar in the harbor and nearshore waters.

Nutrient levels in the nearshore waters were generally highest in the shoreline samples, and decreased to nearly non-detectable levels at the 20 m stations. There were no apparent north-south differences.

Concentrations of chlorophyll were higher by a factor of 2 - 7 in the harbor than in the nearshore waters. The high levels in the harbor reflect the growth of phytoplankton supplied with nutrients from groundwater, abundant sunlight, and low flushing rates. The high suspended particulate load in the harbor and resultant high turbidity probably serves to limit the growth rate of the phytoplankton by decreasing light penetration.

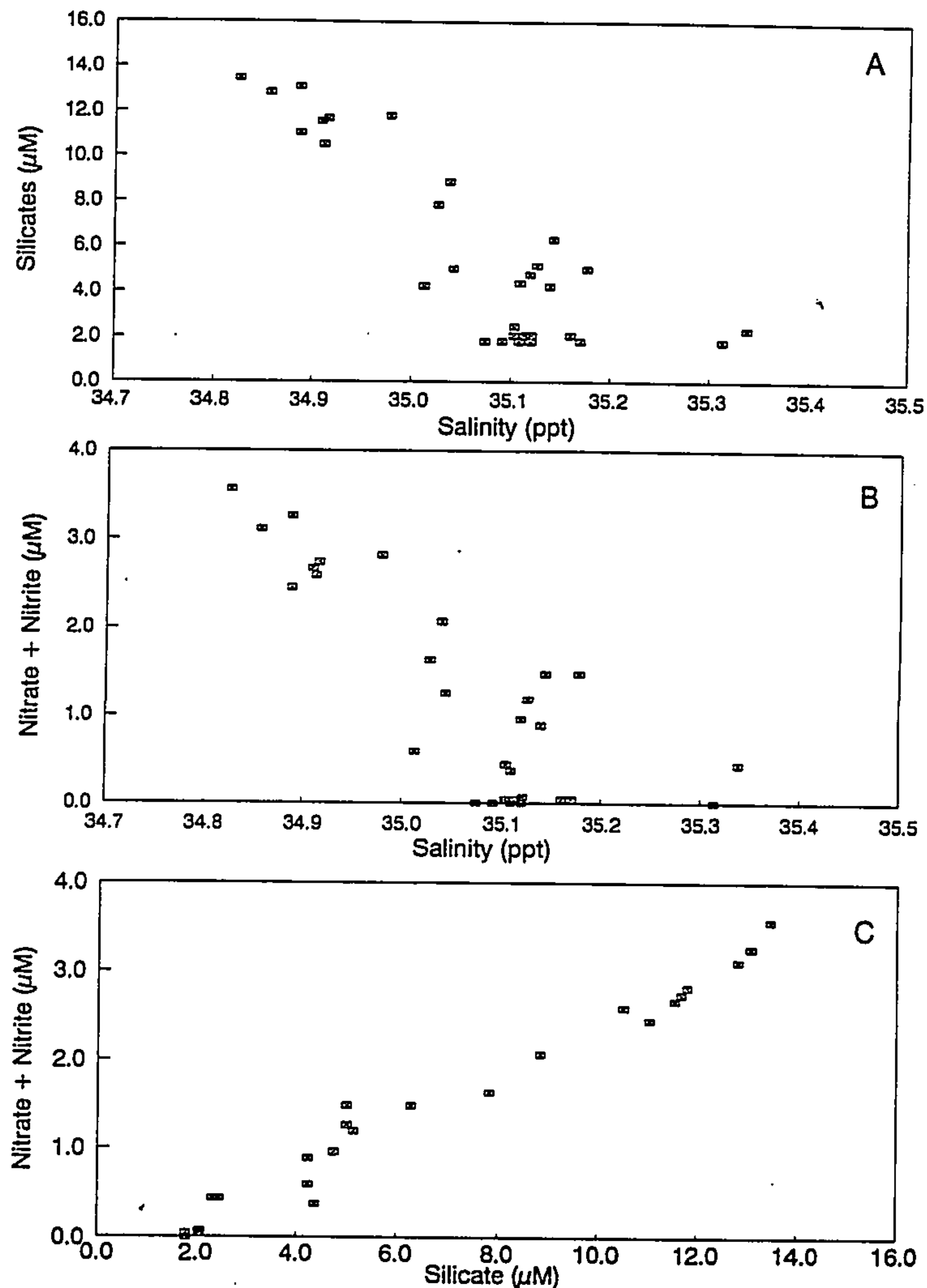
The geometric means of the nearshore and harbor samples were calculated for all water quality parameters and compared to the appropriate state of Hawaii water quality numerical criteria for open coastal waters and embayments, respectively (Table 2). The volume of groundwater discharged along the coastline (estimated by Mink and Yuen, 1993, at 1 - 2 million gallons per mile per day) is low enough that the Barbers Point area can be considered as being "dry" open coastal waters in the standards classification, while the harbor itself receives less than 1% of its volume per day, and is thus considered to be a "dry" embayment.

For the nearshore waters, the dissolved nitrogenous nutrients (ammonium and nitrate + nitrite), turbidity and chlorophyll exceeded the water quality criteria. Ammonium and nitrate + nitrite exceeded their respective criteria by about 4 X, while turbidity was 50% and chlorophyll was 33% higher than their criteria. Total nitrogen and total phosphorus did not exceed the water quality criteria.

Within the harbor, ammonium and nitrate + nitrite exceeded the water quality criteria by factors of 4 X and 8 X, respectively. Turbidity exceeded the water quality criterion by a factor of 4 X. Total nitrogen, total phosphorus and chlorophyll levels were well below the respective criteria.

The relationships between selected water quality parameters are presented in Figures 8 - 10. These relationships provide evidence as to the sources of the high nutrient and turbidity levels observed in the harbor and nearshore waters.

A conservative element is one whose concentration is not changed by biological process such as excretion, denitrification, uptake, etc. If salinity is taken as a conservative element present at



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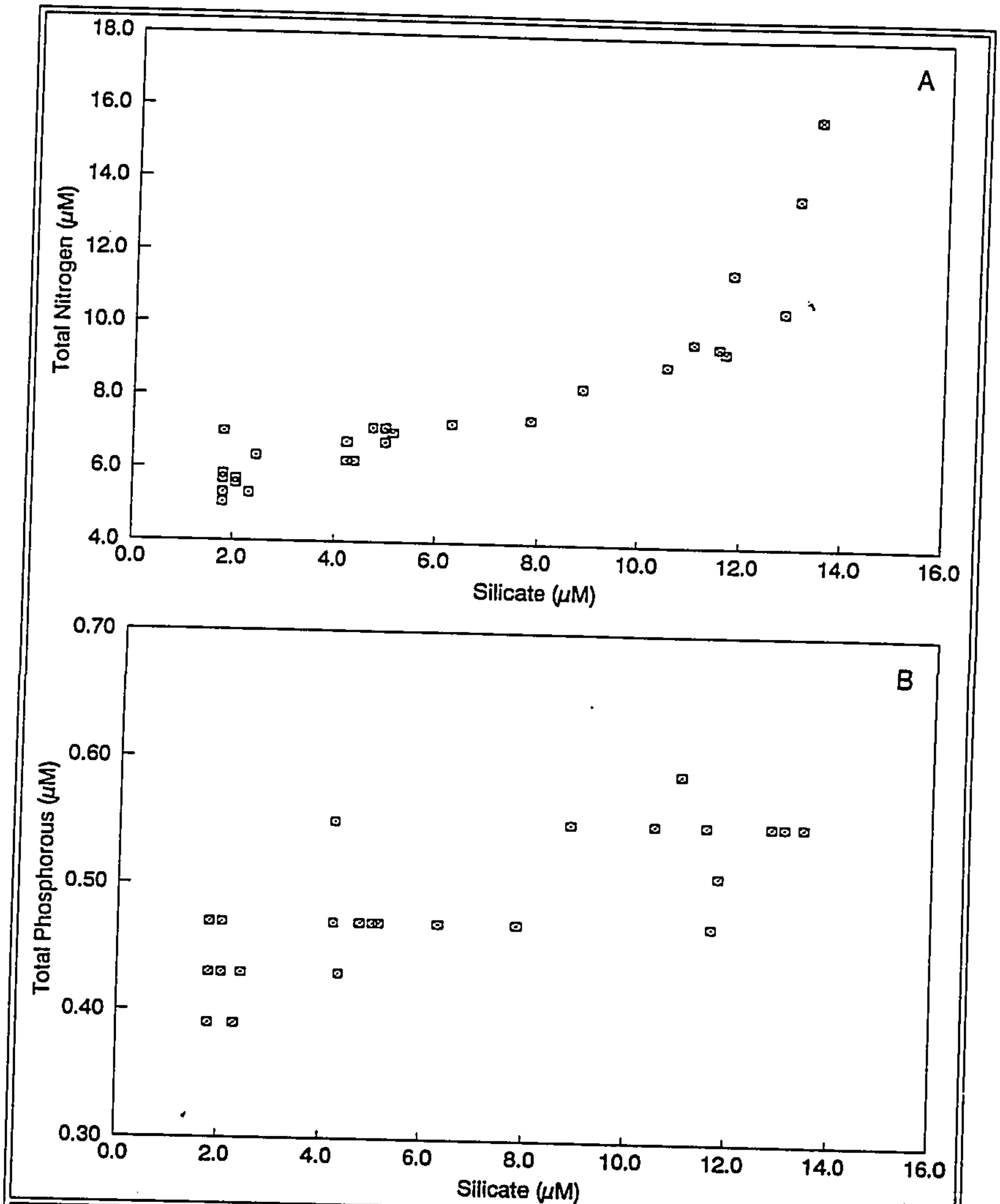
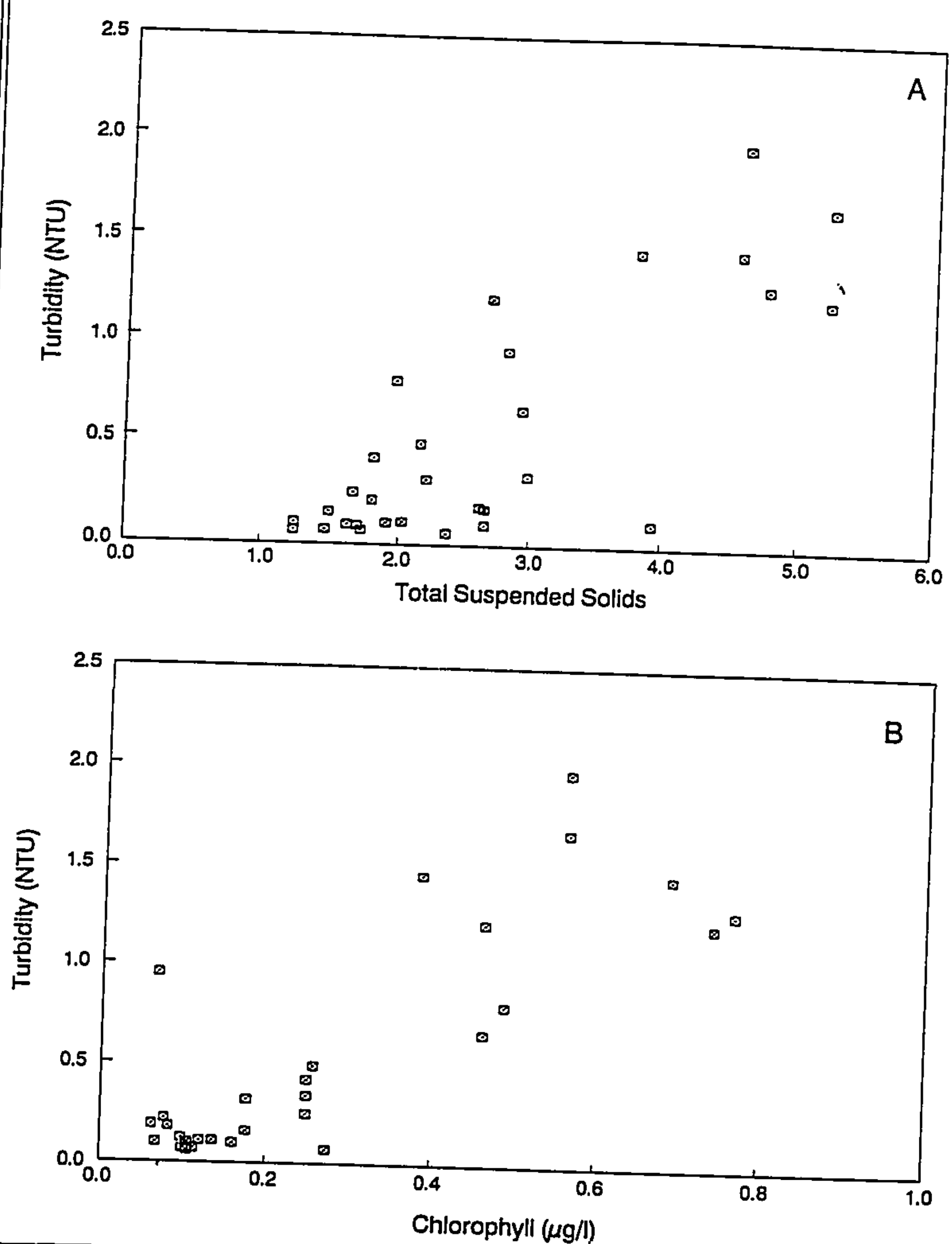
BARBERS POINT HARBOR EXPANSION STUDY

RELATIONSHIP BETWEEN SELECTED WATER QUALITY PARAMETERS

Figure 8



OI Consultants, Inc. Makapuu Point Waimanalo, Hawaii 96795	BARBERS POINT HARBOR EXPANSION STUDY RELATIONSHIP BETWEEN SELECTED WATER QUALITY PARAMETERS	Figure 9



OI Consultants, Inc. Makapuu Point Waimanalo, Hawaii 96795	BARBERS POINT HARBOR EXPANSION STUDY RELATIONSHIP BETWEEN SELECTED WATER QUALITY PARAMETERS	Figure 10

approximately 35 ppt in open ocean water and at near 0 ppt in fresh water, then a plot of any other conservative element against salinity will result in a straight line, where such a straight line relationship exists between a conservative element present in different concentrations in two water bodies mixed at varying ratios. A nonconservative element plotted against salinity will show data points above the conservative mixing line if other sources of the element are present, and will show points below the line if active uptake or removal of the element is occurring. Deviations from the mixing line may also occur if there are more than two sources of the element being mixed together. If plots of potentially nonconservative elements (such as nitrate or phosphate) against a conservative element are linear, this implies that no addition or removal by processes other than mixing have occurred.

The relative abundances of selected water quality parameters also provide information as to the source of these parameters. For example, silicate is found in extremely high concentrations in fresh or slightly brackish groundwater in all the Hawaiian Islands due to the dissolution of silicate from the basaltic rocks which make up the islands. Nitrate is also found in high concentrations, primarily due to the breakdown of organic material and bacterial action on organics. Ammonium is generally found only in waters fed by wastewater treatment discharges or agricultural fertilization. Phosphate, on the other hand, is generally very low in groundwater because the phosphate molecule is bound up by the typical Hawaiian soils.

There is generally some level of "noise" in any relationship between water quality parameters. This noise can obscure relationships between parameters which otherwise might be present. Over short time scales, and in areas where diatom populations are low and silicate uptake is also low, clearer relationships between conservative and nonconservative elements can be seen using silicate rather than salinity as the conservative property.

The relationships between dissolved silicate and salinity (Figure 8A) and dissolved nitrate and salinity (Figure 8B) were similar and generally followed the conservative mixing curve. Plots of phosphate against salinity were similar to that of nitrate. The high silicate and nitrate levels imply that groundwater is the primary source of nutrients entering the harbor. The similarity between the silicate - salinity and nitrate - salinity plots and the linear relation between silicate and nitrate (Figure 8C) imply that groundwater is the primary source of nitrate, and that there are no additional sources of nitrate input that might be attributed to terrestrial activities such as agriculture or landscaping. The lack of any relation between ammonium and salinity suggests that little ammonium is carried into the harbor or the nearshore marine environment by groundwater; the observed levels of ammonium are likely the result of biological activity by marine organisms.

The plot of total nitrogen against silicate (Figure 9A) suggests there may be some loss of nitrogenous material from the water column. If there were no loss, the relationship between total nitrogen and silicate would be expected to be a straight line; the downward deviation of the line indicates a change (an uptake or loss) due to a process other than physical mixing. This loss is likely due to settling of particulate material containing nitrogenous compounds, since the relationship between nitrate and silicate showed no evidence of dissolved nitrogen uptake. The plot of total phosphorus versus silicate is too noisy to provide support for this hypothesis.

The plots of turbidity versus total suspended solids (Figure 10A) and chlorophyll (Figure 10B) show that the observed turbidity levels are the result of both suspended non-living particulate material (resuspended from the bottom of the harbor by boat traffic or from the ocean bottom by wave action) and living phytoplankton. The predominant effect is from non-living particulates. This conclusion is also supported by the compositional data from large volume samples collected at mid-depth at Station H2 (within the harbor) and B3 (the entrance channel). Mean dry weights for duplicate samples from both stations (4.72 mg/l and 1.22 mg/l, respectively) were similar to those observed in the small volume samples (see Table 2). At Station H2, the carbonate fraction composed 79.2% of the sample, while in the entrance channel, carbonate composed 71.4%. The balance at both stations was a mix of inorganic terrigenous sediment and fine organic particulate material, including phytoplankton.

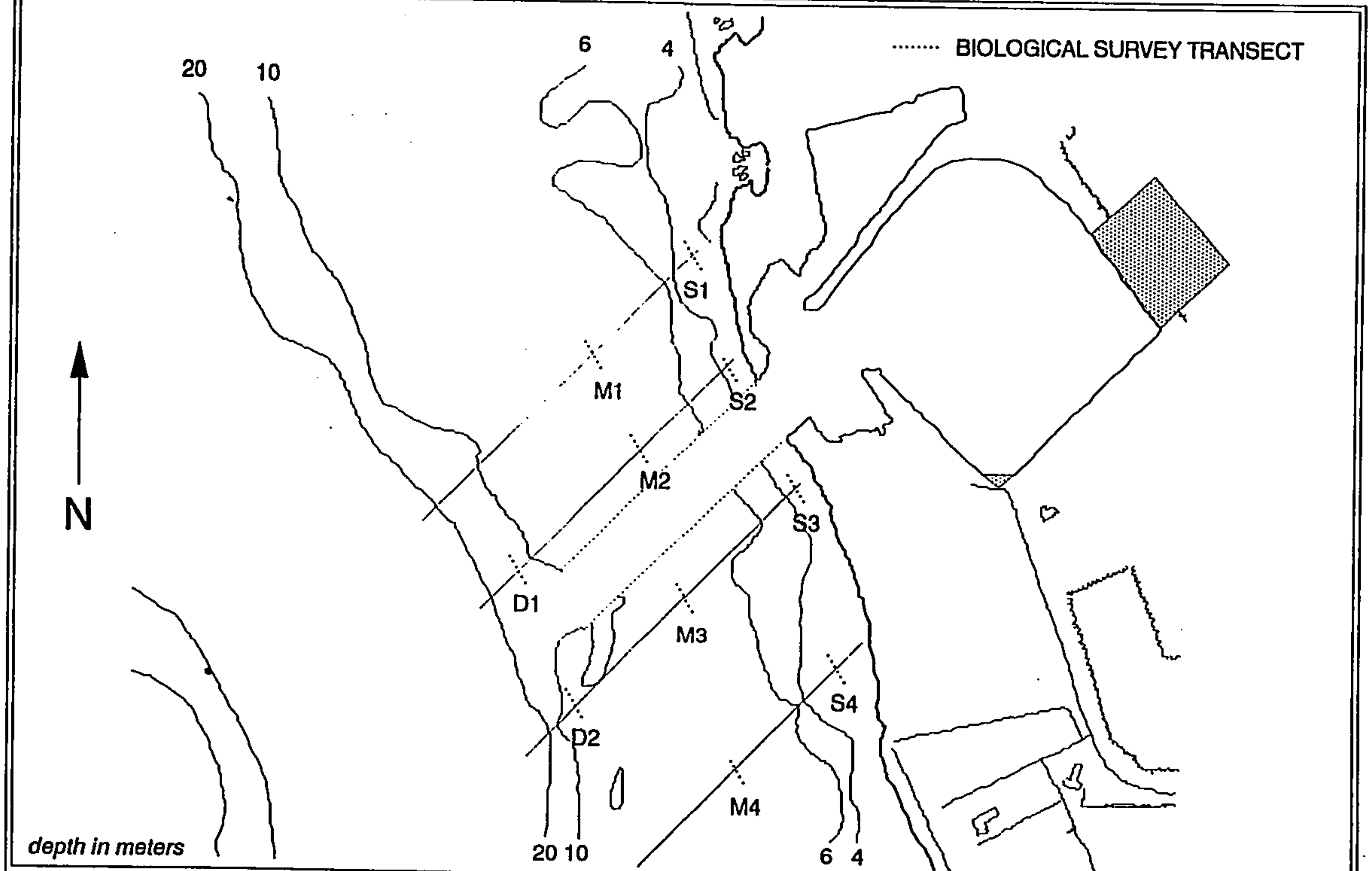
MARINE BIOLOGICAL SURVEY

Methods

Surveys for estimations of substrate coverage, benthic community composition and fish abundances were located at depths of 3, 8 and 15 m along four parallel lines extending from the shoreline to the southwest (Figure 11). The sites of qualitative transects and quantitative survey lines were, as nearly as possible, the same as those occupied during the previous harbor impacts study (AECOS, 1985). Biological surveys were conducted using SCUBA on January 8, February 20, and March 2, 1994, during periods of light winds and calm (1 ft) seas.

At each transect station, a fish survey was performed first. As a diver paid out a 50 m transect line in a direction parallel to the depth contour, all fish within a 3 m corridor along the line were identified and counted. After reaching the end of the transect line, the diver returned along the line looking for individuals hidden in the coral or algae, if present.

Substrate coverage was estimated by the point-intersect method. A 1.1 m x 1.1 m quadrat frame containing a grid of lines spaced 10 cm apart was placed at 10 selected points along the survey



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Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

STATION LOCATIONS FOR MARINE BIOLOGICAL SURVEYS

Figure 11

line. The substrate type under each grid intersection was identified and noted. Non-living substrate was classified as limestone, limestone rubble, basalt, large basalt boulders, small basalt rocks, sand, and a thin sand layer (<1 cm) overlying hard substrate. Living stony corals were identified to species.

Individual organisms >2 mm in size occurring within the quadrats were identified and counted. Over sand bottoms, the number of invertebrate burrows was recorded. For the colonial zoanthids and octocorals, numerical abundance was recorded by the percent areal coverage of the colony rather than the number of individuals.

Species diversity was calculated for coral and algal communities using the Shannon-Weaver Index formula (Ludwig and Reynolds, 1988):

$$H' = -\sum_{i=1}^{n} (p_i \, ln \, p_i)$$

where p_i = the percent coverage by the i^{th} species in the quadrat. For fish populations the species diversity was calculated using Shannon's Index (Ludwig and Reynolds, 1988):

$$\hat{H}' = -\sum_{i=1}^{n} (n_i/n \, ln \, n_i/n)$$

where n_i = the number of individual in the i^{th} species and n = the total number of individuals on the transect.

Results

Results of the benthic surveys for bottom substrate, coral species, fish and invertebrates are presented in Tables 3 - 6. The distributions of corals and the most abundant fish species by station are presented in Figures 12 and 13.

In the nearshore waters extending up to 1,500 m on either side of the harbor entrance channel and offshore to depths of 20 m, there were areas with three distinct sets of physical and biological characteristics (commonly termed "biotopes"). These biotopes were mainly the consequence of the bottom substrate composition and the depth of the water column (corresponding to the amount of wave energy): the shallow inshore limestone bench; the limestone plate with extensive beds of living and dead coral at depths of 6 - 10 m; and the deep (15+ m) limestone plate covered with a thin algal-sand mat.

In addition to the depth-related differences in fish populations and benthic community distributions, there were significant differences at the same depths on the north and south sides of the entrance channel (Figures 12 and 13). Generally speaking, both corals and fish were more abundant and speciose to the north

Table 3. Percent coverage of substrate determined from 1 m² quadrats at Barbers Point Deep Draft Harbor. Species composition of coral cover is given in Table 4.

Transect	Substrate	Quadrat # 1	2	3	4	5	6	7	8	9	10	Mean
S1	Limestone	74	78	84	44	78	76	94	97	86	95	80.6
	Live Coral	26	22	16	56	22	24	6	3	14	5	19.4
total		100	100	100	100	100	100	100	100	100	100	
S2	Limestone	100	96	100	100	98	100	100	100	100	100	99.4
	Live Coral	0	4	0	0	2	0	0	0	0	0	0.6
total		100	100	100	100	100	100	100	100	100	100	
S3	Thin Sand	97	96	97	97	95	90	92	96	93	92	94.5
	Live Coral	3	4	3	3	5	10	8	4	7	8	5.5
total		100	100	100	100	100	100	100	100	100	100	
S4	Sand	0	0	0	0	55	0	0	0	0	0	5.5
	Thin Sand	98	97	99	97	0	0	0	0	0	0	39.1
	Limestone	0	0	0	0	45	88	95	95	91	98	51.2
	Live Coral	2	1	1	3	0	12	5	5	9	2	4.0
total		100	98	100	100	100	100	100	100	100	100	
M1	Thin Sand	0	5	0	0	0	0	0	0	0	0	0.5
	Rubble/Sand	8	0	20	0	0	0	0	0	0	0	2.8
	Limestone	0	0	0	72	43	32	20	52	63	60	34.2
	Live Coral	26	95	34	28	52	19	31	20	32	33	37.0
	Dead Coral	66	0	46	0	5	49	43	28	5	7	24.9
total		100	100	100	100	100	100	94	100	100	100	
M2	Sand	0	0	0	0	0	0	5	3	0	8	1.6
	Thin Sand	5	2	0	0	15	5	0	0	20	0	4.7
	Rubble	0	0	24	0	83	91	5	13	23	65	30.4
	Live Coral	24	37	1	9	2	4	37	34	22	27	19.7
	Dead Coral	71	61	75	81	0	0	53	50	35	0	42.6
total		100	100	100	90	100	100	100	100	100	100	
M3	Thin Sand/Algae	99	95	99	95	99	99	98	95	100	90	96.9
	Live Coral	1	5	1	3	1	1	2	5	0	10	2.9
	Dead Coral	0	0	0	2	0	0	0	0	0	0	0.2
total		100	100	100	100	100	100	100	100	100	100	
M4	Thin Sand	99	12	16	84	42	82	18	22	0	12	38.7
	Rubble	0	0	0	6	0	0	0	0	0	0	0.6
	Limestone	0	0	0	0	48	0	47	0	64	51	21.0
	Live Coral	1	41	7	10	10	18	15	10	36	27	17.5
	Dead Coral	0	47	77	0	0	0	20	68	0	10	22.2
total		100	100	100	100	100	100	100	100	100	100	
D1	Sand	0	3	0	0	0	0	0	0	0	0	0.3
	Thin Sand/Algae	99	83	87	88	98	98	86	98	98	95	93.0
	Live Coral	1	14	13	12	2	2	6	2	2	5	5.9
	Dead Coral	0	0	0	0	0	0	8	0	0	0	0.8
total		100	100	100	100	100	100	100	100	100	100	
D2	Thin Sand/Algae	88	86	92	82	99	98	87	98	85	95	91.0
	Live Coral	13	9	3	8	1	2	10	2	10	3	6.1
	Dead Coral	9	5	5	10	0	0	3	0	5	2	3.9
total		110	100	100	100	100	100	100	100	100	100	

Table 4. Coral species and percent coverage determined from 1 m² quadrats at Barbers Point Deep Draft Harbor.

Transec	Species	Quadrat # 1	2	3	4	5	6	7	8	9	10	Mean
S1	*Montipora verrucosa*		5	4	6	4	2	7	15	4	9	5.6
	Pavona varians			1			1					0.2
	Pocillopora damicornis							1				0.1
	Pocillopora meandrina	6			1	7	2	1		2		1.9
	Porites compressa				1	1	22					2.4
	Porites lobata	13	18	16	51	19		1	3	5	8	13.4
	Total Coral Coverage	19	23	21	59	31	27	10	18	11	17	23.6
	Species Diversity	0.43	0.46	0.47	0.60	0.68	0.54	0.32	0.39	0.36	0.42	0.61
S2	*Pocillopora meandrina*		1			1					1	0.3
	Porites lobata		1			1						0.2
	Total Coral Coverage		2			2					1	0.5
	Species Diversity		0.09			0.09					0.05	0.03
S3	*Montipora verrucosa*						1	1	1	1		0.4
	Porites lobata	4	4	4	2	6	9	10	4	7	7	5.7
	Total Coral Coverage	4	4	4	2	6	10	11	5	8	7	6.1
	Species Diversity	0.13	0.13	0.13	0.08	0.17	0.26	0.28	0.17	0.23	0.19	0.19
S4	*Montipora verrucosa*						1			1	1	0.3
	Pocillopora meandrina								1			0.1
	Porites lobata	1	1	1	2	1	6	4	4	7	2	2.9
	Total Coral Coverage	1	1	1	2	1	7	4	5	8	3	3.3
	Species Diversity	0.05	0.05	0.05	0.08	0.05	0.21	0.13	0.17	0.23	0.12	0.13

Table 4 (cont). Coral species and percent coverage determined from 1 m^2 quadrats at Barbers Point Deep Draft Harbor.

Transec	Species	1	2	3	4	5	6	7	8	9	10	Mean
M1	*Montipora verrucosa*			3	4	4	3	6	4		21	4.5
	Montipora patula			4	37	47	2	13	5	19	6	13.3
	Porites compressa	4							1			0.5
	Porites lobata	21	98	15		2	6	4	10	11	1	16.8
	Total Coral Coverage	25	98	22	41	53	11	23	20	30	28	35.1
	Species Diversity	0.46	0.02	0.52	0.50	0.56	0.35	0.56	0.55	0.56	0.54	0.73
M2	*Montipora verrucosa*	2		0.5	0.5	1		0.5	3	7	3	1.8
	Pocillopora damicornis	1										0.1
	Pocillopora meandrina	1	4	1	3	1	2	1	0.5	4	0.5	1.8
	Porites compressa	1										0.1
	Porites lobata	17	19		1		1	39	27	4	22	13.0
	Total Coral Coverage	22	23	1.5	4.5	2	3	40.5	30.5	15	25.5	16.8
	Species Diversity	0.52	0.44	0.07	0.18	0.09	0.12	0.44	0.49	0.44	0.46	0.42
M3	*Pocillopora meandrina*		0.5	1	3	0.3		1	1		8	1.5
	Montipora patula	4							2			0.6
	Porites lobata	0.5					0.3		2	1		0.4
	Total Coral Coverage	4.5	0.5	1	3	0.3	0.3	1	5	1	8	2.5
	Species Diversity	0.16	0.03	0.05	0.11	0.02	0.02	0.05	0.20	0.05	0.20	0.11
M4	*Montipora patula*		9			1	3			12	6	3.1
	Montipora verrucosa	0.3					2			1		0.3
	Pocillopora meandrina		3	1	6	0.2	1	2		4	4	2.1
	Porites lobata		30	9	3	6	10	6	7	10	11	9.2
	Total Coral Coverage	0.3	42	10	9	7.2	16	8	7	27	21	14.8
	Species Diversity	0.02	0.68	0.26	0.27	0.23	0.46	0.25	0.19	0.66	0.54	0.43

Table 4 (cont). Coral species and percent coverage determined from 1 m² quadrats at Barbers Point Deep Draft Harbor.

Transec	Species	Quadrat # 1	2	3	4	5	6	7	8	9	10	Mean
D1	*Montipora patula*									2		0.2
	Pocillopora edouxi			1								0.1
	Pocillopora meandrina		15	2	5			1	1		5	2.9
	Porites lobata		1	9	3	1	0.3	4				1.8
	Total Coral Coverage		16	12	8	1	0.3	5	1	2	5	5.0
	Species Diversity		0.33	0.34	0.25	0.05	0.02	0.17	0.05	0.08	0.15	0.20
D2	*Montipora patula*						1		0.5			0.2
	Pocillopora damicornis				1			0.3				0.1
	Pocillopora meandrina	6	7		3		0.5	6	0.5	9		3.2
	Porites lobata	3		2	6	1	0.5	0.5	0.5	3	2	1.9
	Total Coral Coverage	9	7	2	10	1	2	6.8	1.5	12	2	5.3
	Species Diversity	0.27	0.19	0.08	0.32	0.05	0.10	0.21	0.08	0.32	0.08	0.20

Table 5. Abundance of fish observed in 50 m transects at Barbers Point Deep Draft Harbor, 1994.

Transect	S1	S2	S3	S4	M1	M2	M3	M4	D1	D2
Depth (m)	2.1	2.1	2.4	2.1	7.6	7.6	7.6	7.6	13.7	13.7
Visibility (m)	6.1	9.1	1.5	3.7	9.1	9.1	7.6	6.1	7.6	10.7
Species										
Synodontidae										
Synodus dermatogenys									1	
Muraenidae										
Gymnothorax flavimarg	1									
Gymnothorax meleagris							1			
Gymnothorax undulatus										1
Aulostomidae										
Aulostomus chinensis										
Fistulariidae										
Fistularia commersoni	1				1					
Serranidae										
Cephalopholis argus					1					
Holocentridae										
Myripristis berndti									2	
Sargocentron punctatissimum		39								
Sargocentron xantherythrum										5
Scorpaenidae										
Sebastapistes ballieui										
Apogonidae										
Apogon kallopterus										1
Apogon taeniopterus										
Cirrhitidae										
Cirrhitops fasciatus					1	2		1	2	1
Cirrhitus pinnulatus										
Paracirrhites arcatus	3				1	3	6	3	21	44
Paracirrhites fosteri										
Carangidae										
Decapterus macarellus										45
Lutjanidae										
Lutjanus kasmira									80	
Lethrinidae										
Monotaxis grandoculis								1		
Mullidae										
Mulloides flavolineatus				1			1			
Mulloides vanicolensis		11								
Parupeneus bifasciatus										
Parupeneus clyclostomus					1					
Parupeneus multifasci	4	5		4	14	14	2	12	8	59
Parapeneus porphyreus										

Table 5 (cont). Abundance of fish observed in 50 m transects at Barbers Point Deep Draft Harbor, 1994.

Species \ Transect	S1	S2	S3	S4	M1	M2	M3	M4	D1	D2
Chaetodontidae										
Chaetodon auriga							1	1		
Chaetodon fremblii		1						2		
Chaetodon kleinii									1	3
Chaetodon lunula		4						2		
Chaetodon miliaris					3			9	33	
Chaetodon multicinctus								2		2
Chaetodon ornatissimus										
Chaetodon quadrimacul	1	2			1	1		5	2	2
Forcipiger flavissimus								2		
Pomacanthidae										
Centropyge fisheri										1
Centropyge potteri									3	
Pomacentridae										
Abedefduf imparipennis		7		1	4					
Chromis hanui					2					13
Chromis ovalis								4		
Chromis vanderbuilti		24		2		25	36	4	3	20
Chromis verater									5	
Dascyllus albisella			4						14	35
Plectroglyphidodon johnston		1	1		8			4		3
Stegastes fasciolatus	2				14	4		6		
Labridae										
Anampses chrysocephalus										
Chelinus bimaculatus							1			1
Bodianus bilunulatus					1			1		
Coris gaimard						2	1		3	
Coris venusta						2		4		
Gomphosus varius										
Halichores ornatissimus					1	3				1
Macropharyngodon geoffroy							2			
Novaculichthys taeniourus										
Pseudochelinus evanidus										2
Pseudochelinus octotaenia			2				4			
Stethojulis balteata					1	2	2			
Labroides phthifophagus					3				1	1
Thalassoma ballieui										
Thalassoma duperrey	18	36	1	25	7	14	2	18	4	16
Thalassoma purpureum										
Scaridae										
Scarus sordidus (female)									1	
Scarus sp. (juvenile)						1		1		
Zanclidae										
Zanclus cornutus		2		1						

Table 5 (cont). Abundance of fish observed in 50 m transects at Barbers Point Deep Draft Harbor, 1994.

Transect / Species	S1	S2	S3	S4	M1	M2	M3	M4	D1	D2
Acanthuridae										
Acanthurus achilles										
Acanthurus dussumieri										
Acanthurus leucoparius					4	4		2		1
Acanthurus nigrofuscu	33	6		2	21	16		26	2	
Acanthurus olivaceous		5			1	21		3	28	
Acanthurus triostegus	2	25		1				1	2	
Ctenochaetus strigosus					39			28		
Naso lituratus							1			
Zebrasoma flavescens					3					
Gobidae										
unidentified species										
Blennidae										
Exallias brevis										
Plagiotremus goslinei							1			
Monacanthidae										
Pervagor spilosoma					5	1				
Balistidae										
Melichthys niger								1		
Melichthys vidua					1	1	2	1	2	
Rhinecanthus retangul	1	2				1	4			
Sufflamen bursa					4	4		4	4	15
Ostraciidae										
Lactoria fornasini									1	
Ostracion meleagris										
Tetradontidae		2								
Canthigaster amboinen	1									
Canthigaster coronata										2
Canthigaster jactator					9	5	2	5	2	2

	S1	S2	S3	S4	M1	M2	M3	M4	D1	D2
total # individuals	67	172	8	37	151	126	69	153	225	276
# species	13	18	6	10	28	22	19	30	26	26
Shannon's Index	1.53	2.20	1.21	1.21	2.59	2.46	1.93	2.76	2.21	2.35

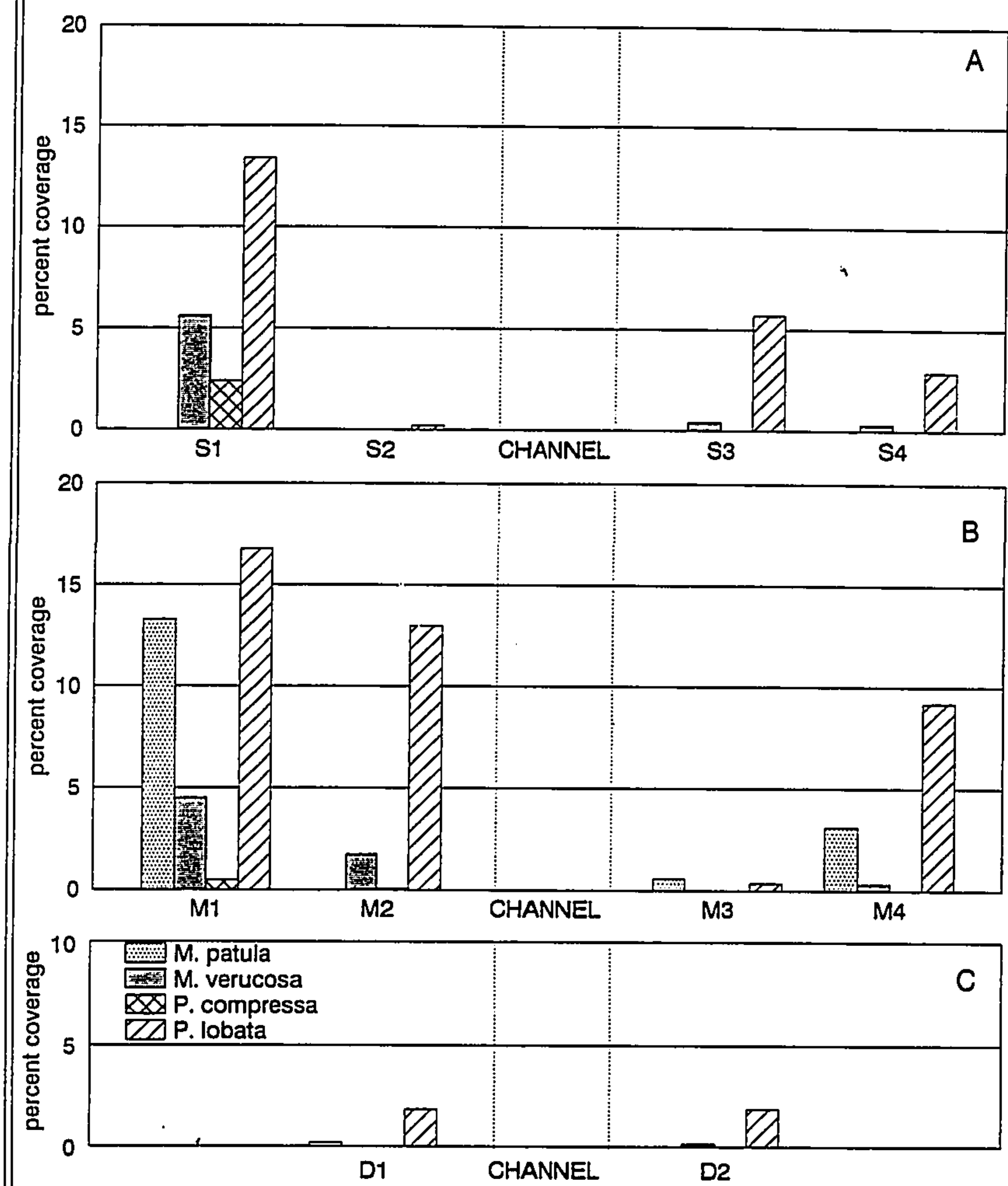
no diversity calculation for inverts

Table 6. Invertebrate species and abundance determined from 1 m² quadrats at Barbers Point Deep Draft Harbor.
The octocorals (Anthelia) are colonial animals; numerical abundance is presented as the area covered by the colony, rather than by the number of individuals.

Transect	Species	Quadrat # 1	2	3	4	5	6	7	8	9	10	Mean
S1	*Echinometra oblonga*			1				1				0.2
	Diadema paucispinum								1	1		0.2
	Anthelia edmondsoni	2				1			1			0.4
S2	*Echinometra mathaei*	30	76	75	60	50	61	30	8	75	100	56.5
	Echinometra oblonga	3	3	5		6	2				2	2.1
	Conus ebraeus	2	2	4					1	1		1.0
	Diadema paucispinum					1						0.1
	Conus abbreviatus						1					0.1
	Conus lividus						1	1				0.2
	Pinctada radiata										1	0.1
	Spirobranchus giganteus						1					0.1
	Serpulorbis variabilis										3	0.3
S3	*Echinometra mathaei*	21	4	2	1	3	2	9	2	5	3	5.2
	Conus ebraeus		1				2				1	0.4
	Anthelia edmondsoni		1	1				2				0.4
S4	*Echinometra mathaei*	2		15	11		2	1	30	5	3	6.9
	Echinometra oblonga				1			1				
	Conus ebraeus			1								0.1
	Diadema paucispinum						1					0.1
	Conus flavidus			1								
M1	*Echinometra mathaei*				1			1				0.2
	tunicate										1	0.1
M2	*Echinometra mathaei*	14	4	32	12	13		2	14	12	5	10.8
	Diadema paucispinum								1			0.1
	Conus sp.									1		0.1
	Serpulorbis variabilis		2			1						0.3
	Palythoa turburculosa	1		4			1					0.6
M3	*Echinometra mathaei*	2							2			0.4
	Echinostrephus aciculatus								1			0.1
	Tripneustes gratilla								1			0.1
	Serpulorbis variabilis	4			5	2	2					1.3
	Conus sp.		1									0.1
	tunicate				2		1					0.3
	Trizopagurus strigatus			1								0.1
	small red sponge	1.2										0.1
	gr sponge			11		12		2	4	12	6	4.7
	Morula uva	1		2								0.3
M4	*Echinometra mathaei*	1	2	2		2	6	1	2	3	1	2.0
	Echinostrephus aciculatus	4				3	1		3		2	1.3
	Spirobranchus giganteus		2									0.2
	tunicate (black)		2		2					1	1	0.6
	Trizopagurus strigatus			1								0.1
	Conus sp.						1					0.1

Table 6 (cont). Invertebrate species and abundance determined from 1 m^2 quadrats at Barbers Point Deep Draft Harbor.
The octocorals (Anthelia) are colonial animals; numerical abundance is presented as the area covered by the colony, rather than by the number of individuals.

		Quadrat #										
Transect	Species	1	2	3	4	5	6	7	8	9	10	**Mean**
D1	*Diadema paucispinum*			1	2							0.3
	Spirobranchus giganteus			2								0.2
	tunicate (black)				1		3			5		0.9
	Conus sp.			1								0.1
	Palythoa turburculosa			2			2					0.4
	Serpulorbis variabilis	2		2	18	5	8	8	10	10	6	6.9
	med gr sponge			6					2			0.8
D2	*Echinometra mathaei*								2		3	0.5
	Echinostrephus aciculatus				2	1	1	3	4	1	8	2.0
	Diadema paucispinum									2		0.2
	Serpulorbis variabilis	5	8	5	4	2	7	12				4.3
	tunicate (black)	3	4	4	1	1	1	3	1		4	2.2
	Morula uva			1								0.1



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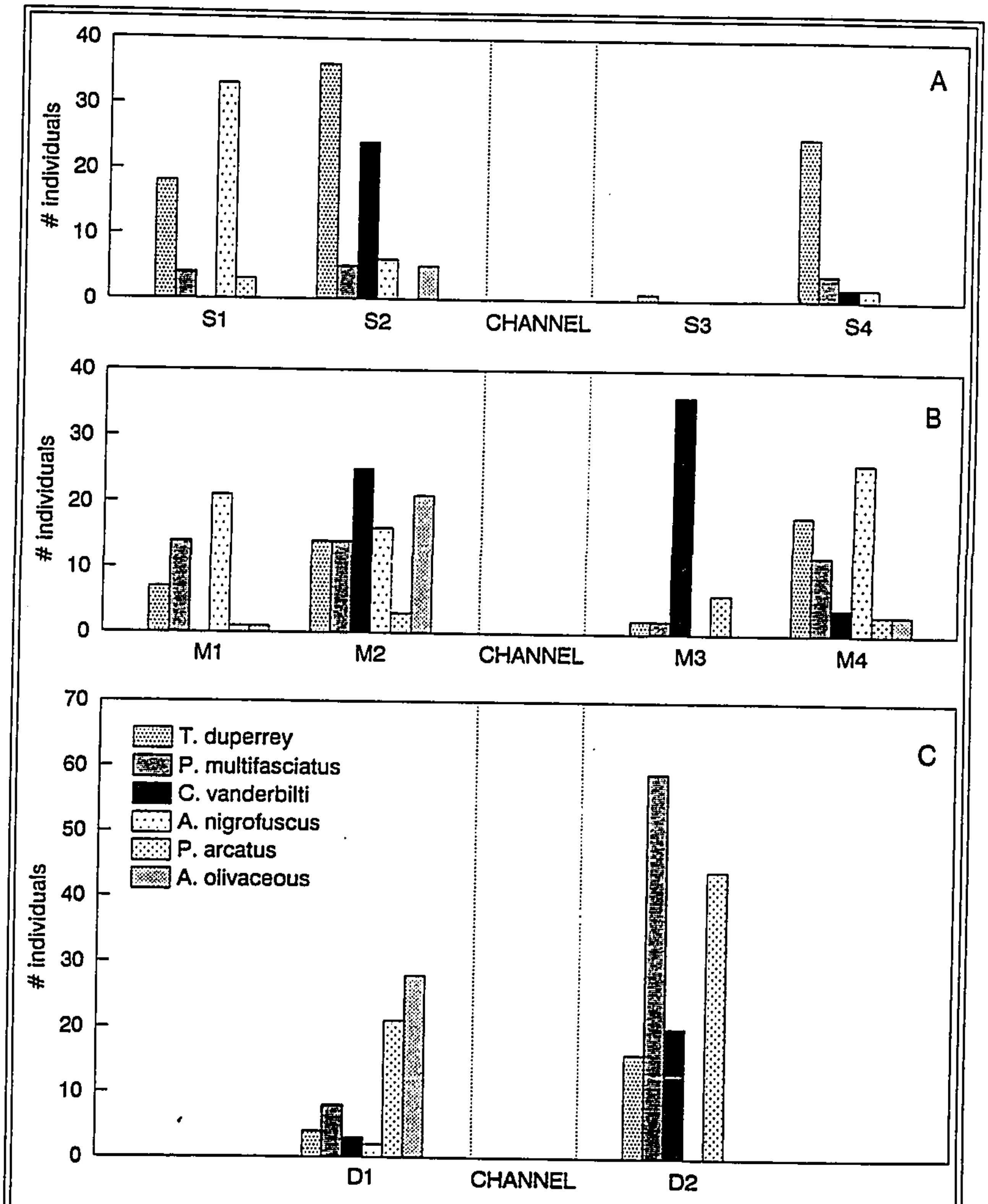
BARBERS POINT HARBOR EXPANSION STUDY

CORAL SPECIES DISTRIBUTION

Figure 12



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Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

FISH DISTRIBUTION

Figure 13

of the channel. There was also a striking difference in the distribution of sand between stations to the north, where little sand was present, and south of the harbor entrance channel, where the bottom was covered with sand deposits or mixed sand - macroalgal mats.

Inshore:

The inshore survey area covered bottom depths of approximately 2 m. In all areas, the bottom (Table 3) was predominantly a limestone bench with a small amount of live coral (average cover less than 6%; see below). Extensive sand patches and a thin sand layer covering the limestone were found only south of the harbor channel; little sand was observed north of the channel.

At all inshore stations, *Porites lobata* was the dominant species (Table 4). Coral coverage was highly variable, generally less than 6%, with the exception of the northernmost inshore station (S1) which had an average coral coverage of 24%. Most of the coral was of a low, prostrate form (*P. lobata* and *Montipora verrucosa*). At Station S1, there was one isolated instance of a bed of *P. compressa* covering 22% of a quadrat (1 m^2). *Pocillopora meandrina*, whose sturdy branches able to withstand the high surf energy in the area, was occasionally present.

Macroalgae were predominantly very short (<1 cm), unidentified, filamentous red algae. Scattered individual strands of *Amansia glomerata, Asparagopsis taxiformis, Gelidiella acerosa* and *Galuxura fastigiata* were observed within the quadrats.

The number of fish (Table 5) was highly variable between the inshore stations, with many more fish observed at stations to the north of the harbor entrance channel: 172 individuals of 18 species were seen at Station S2, just north of the channel, while only eight individuals of six species were observed at Station S3, an equal distance to the south of the channel. The inshore stations had the lowest number of species and species diversity index when compared to the mid and deep stations.

Major families of fish at the inshore stations included labrids (21 - 68% of fish population), almost exclusively the saddleback wrasse, *Thalassoma duperrey;* acanthurids (8 - 54% of the fish populations), mainly *Acanthurus nigrofuscus* and *A. triostegus*, two very common inshore species; and pomacentrids (8-19% of the inshore fish populations), mainly *Chromis vanderbilti* and *Abudefduf imparipennis*. At Station S2, two large schools accounted for over one-third of the fish present: squirrelfish, *Sargocentron punctatissimum*, with 39 individuals and manini, *Acanthurus triostegus*, with 25 individuals.

Invertebrates (Table 6) were limited mainly to sea urchins (Echinoderms), especially *Echinometra mathaei*, a rock boring urchin which cuts pockets in the limestone bench. This species made up over 90% of the invertebrates present inshore. Station

S2 had the highest number of invertebrates (and urchins) with an average of 60 individuals per m^2. Other urchins (*Echinometra oblonga* and *Diadema paucispinum*) were observed only occasionally. Various species of cone shells were present but rarely averaged more than one per 10 m^2.

Mid-depth

The substrate at the mid-depth (7 - 8 m) stations (Table 3) was limestone plate with interspersed beds of live and dead coral. South of the harbor channel, a thin layer of sand covered the limestone. Again, sand layers or deposits were seen only south of the channel. Live coral coverage generally averaged 25%, with the exception of Station M3, immediately south of the channel, where coral coverage averaged only 3%. Unlike the inshore and deep stations, beds of dead *Porites lobata* and *P. compressa* were observed in the mid-depth areas, averaging 24% coverage of the bottom. The dead corals appeared to be physically intact, suggesting a sediment or chemical related mortality rather than physical destruction. Live corals were recolonizing the areas of dead coral substrate.

Coral species (Table 4) were similar to those found inshore. *Porites lobata* dominated the coral present, with some *Montipora patula* and *M. verrucosa* at Station M1. Beds of live finger coral, *P. compressa*, were essentially absent.

Macroalgae were more abundant and more speciose at the mid-depth stations than at the shallow or deeper stations. At stations M1, M2 and M4, a variety of closely-cropped mats covered 10 - 20% of the bottom substrate. These mats were made up of *Dictyota, Gelidiella* and *Spyridia*, as well as an unidentified filamentous red alga. Station M3, had essentially 100% algal coverage, primarily by the unidentified red algal mat. *Trichoglea requenii*, which was frequently observed in earlier surveys (AECOS, 1985), was not present during this survey.

Although there were no large schools of fish present (Table 5), the mid-depth stations M1 and M4 had over 150 individuals per station, much higher than the inshore station average. Only slightly fewer individuals (126) were seen at Station M2, but only 69 individuals were seen over the flat, low coral bottom at Station M3. An average of 23 species were represented, with the greatest numbers from the acanthurid, pomacentrid, and labrid families. *Acanthurus nigrofuscus* and *A. olivaceous*, as well as *Ctenochaetus strigosus*, which did not appear inshore, were the most common acanthurid species. The pomacentrid, *Chromis vanderbilti*, was observed in equal numbers at stations M2 and M3 on either side of the channel over very different bottom types. *Thalassoma duperrey* was common, although not in as high numbers as in the shallow stations. The goatfish, *Parupeneus multifasciatus*, was observed more frequently than in the inshore areas.

Invertebrates were generally scarce, with urchins, worms and mollusks encountered only occasionally. The boring urchin, *Echinometra mathaei*, was common at Station M2 (11 m^{-2}) while an unidentified green sponge was common at Station M3 (5 m^{-2}).

Offshore

Offshore at the 14 m stations, the bottom substrate (Table 3) was limestone covered with a thin sand - algal mat. Just offshore from these stations, the bench sloped sharply down from 14 m to a sand and rubble bottom at 30 m.

Coral coverage (Table 4) was limited to a few heads of *Pocillopora meandrina* with some *Porites lobata* occasionally present. *Montipora patula, Pocillopora edouxi and P. damicornis* were seen only rarely. The average coral coverage was 6% of the bottom substrate.

The majority of the bottom at the deep stations was covered by a mat of red filamentous algae similar to that at the mid-depth stations. This mat covered from 60 - 100% of the bottom along the transect lines. Scattered fronds of *Lyngbya majuscula* were seen within the mat.

Fish abundance at the deep stations was the highest of all the stations, with 225 individuals at Station D1 and 276 individuals at Station D2. Large schools of *Lutjanus kasmira* (80 individuals), *Parupeneus multifasciatus* (59 individuals), *Chaetodon miliaris* (33 individuals) and *Acanthurus olivaceous* (28 individuals) were observed. A school of opelu (*Decapterus macarellus*) swam through the transect area high in the water column (45 individuals). Fewer acanthurids were observed at the deeper stations. Arc-eyed hawkfish (*Paracirrhites arcatus*) were numerous in the scattered heads of *Pocillopora meandrina*.

Tube worms (*Serpulorbis variabilis*) were found throughout the deep stations. The sea urchin *Echinostrephus aciculatus* was found in small numbers along transect D2.

REVIEW OF HISTORICAL ENVIRONMENTAL CONDITIONS

Two major construction projects have had potential impacts on the water quality of the Barbers Point Harbor and adjacent waters: the original expansion of the Barber Point Harbor, and construction of the shoreline lagoons and marina at the Ko Olina Resort, immediately to the north of the harbor. The time frames for these two construction projects, and the environmental studies associated with each, are summarized in Table 7. The table also presents the timing of two major storm events which had significant impacts on the nearshore marine environment.

Table 7. Timeline of water quality and marine biological surveys, construction activities and storm events for periods of development of the Barbers Point Harbor and the Ko Olina Resort, West Beach, Oahu.

Water Quality Surveys - Barbers Point Harbor

October - November 1975	Water quality survey of original harbor	ECI, 1975
August - October, 1982	Preconstruction water quality surveys	AECOS, 1982
February - April, 1983	Channel augering Water quality surveys	AECOS, 1986
May - August, 1983	Channel dredging Water quality surveys	AECOS, 1986
September 1983 - June 1984	Channel dredging, harbor excavation Water quality surveys	AECOS, 1986
July 1984 - April 1985	Harbor excavation	
April - July 1995	Berm removal, final harbor dredging Water quality surveys	AECOS, 1986
August - November 1985	Post-construction Water quality surveys	AECOS, 1986

Marine Biological Surveys - Barbers Point Harbor

October - November 1975	Marine biological survey	ECI, 1975
January 1980	Severe winter storm	
November 1982	Hurricane Iwa	
February - April, 1983	Channel augering	
May - August, 1983	Channel dredging	
September 1983 - June 1984	Channel dredging, harbor excavation	
July 1984 - April 1985	Harbor excavation	
April 1985	Post-construction marine biological survey	AECOS 1985
April - July 1995	Berm removal, final harbor dredging	

Table 7 (cont). Timeline of water quality and marine biological surveys, construction activities and storm events for periods of development of the Barbers Point Harbor and the Ko Olina Resort, West Beach, Oahu.

Water Quality Surveys - Ko Olina Resort		
November 1979	Water quality survey	Bienfang & Brock, 1980
August - September 1986	Baseline water quality surveys	OIC, 1987
August 1987 - December 1989	Construction of lagoons and marina Monthly water quality monitoring	S.E.A., 1987 - 1989
February - December 1990	Post-construction Monthly water quality surveys	S.E.A., 1990
April 1990	Post-construction water quality surveys	OIC, 1990
Marine Biological Surveys - Ko Olina Resort		
November 1979	Benthic and fish community survey	Bienfang & Brock, 1980
January 1980	Severe winter storm	
November 1982	Hurricane Iwa	
June 1984	Benthic and fish community survey	Brock, 1984
August - September 1986	Baseline marine biological survey	OIC, 1987
April 1988	Lagoon 1 preconstruction intertidal survey	AECOS 1991
August 1987 - December 1989	Construction of lagoons and marina	
November 1988	Lagoon 1 post-construction biological survey	Brock 1988
March - May 1988	Intertidal bench macroalgal survey	Smith 1988
September 1988 - March 1990	Lagoon 1 post-construction intertidal survey	AECOS 1991
March 1990	Post-construction intertidal bench survey	AECOS 1990
August - October 1990	Post-construction marine biological survey	Brock 1990

The water quality studies associated with the original expansion of the Barbers Point Harbor consisted of a survey of the original barge harbor (ECI, 1975), a series of preconstruction surveys (AECOS, 1982), surveys which examined the effects of channel augering, channel dredging, excavation of the new harbor basin behind a berm, removal of the berm, and post-construction conditions (AECOS, 1986). Water quality surveys have also been performed as part of the present study (OIC, 1994). The results of these surveys are presented in Table 8. In general, the water quality conditions within and in the nearshore waters adjacent the Barbers Point Harbor have returned to levels similar to those observed in 1975, before the deep draft harbor expansion. The higher levels of ammonium and nitrogen in the 1994 surveys are more likely the result of the shoreline and shallow water sampling than any real change in conditions; these shallow samples reflect the influence of high nutrient groundwater more than samples taken further offshore.

The construction phase monitoring (AECOS, 1986) for the harbor construction focused on turbidity and suspended solids generated primarily by the augering and dredging of the entrance channel. During dredging (the activity which generated the greatest turbidity), water samples collected upstream (depending on the direction of the currents) were not significantly different from ambient, preconstruction conditions. Downstream stations showed significantly elevated turbidity and suspended solids levels. Water quality samples taken after construction of the channel had been completed showed a rapid return to preconstruction levels.

While systematic decreases in parameters such as turbidity and chlorophyll have been observed from 1982 to 1994, the levels of dissolved nitrogenous materials (ammonium and nitrate), chlorophyll and turbidity observed in 1994 exceed the applicable water quality standards. However, the levels of most of these parameters exceeded the state water quality standards in 1975, before the extensive harbor expansion. These high levels of dissolved nutrients, chlorophyll and turbidity represent natural, ambient conditions. There is no evidence that the expansion of the harbor has had any significant effect on harbor or coastal water quality.

Water quality studies at the Ko Olina (West Beach) resort consisted of a water quality survey in support of the original project EIS (Bienfang and Brock, 1980); preconstruction baseline surveys (OIC, 1987); monthly construction phase monitoring (S.E.A., 1987 - 1989); and monthly post-construction surveys (S.E.A., 1990) and an extensive water quality and marine biological postconstruction survey (OIC, 1990).

Table 8. Comparison of geometric mean values for water quality parameters for surveys performed at the Barbers Point Harbor.

	TN (ug/l)	NH4 (ug/l)	NO3 (ug/l)	TP (ug/l)	PO4 (ug/l)	Chl a (ug/l)	TSS (mg/l)	Turb (NTU)
EMBAYMENTS								
1975	--	4.1	22.6	--	8	0.32	--	4
1982	--	--	--	--	--	--	23	15.8
1985	--	--	5.1	--	6	1.94	5.5	3.3
1994	147	13.7	38.9	16.74	1.55	0.45	3.77	1.29
W. Q. STANDARDS	150	3.5	5	20		0.5		0.4
COASTAL WATERS								
1975	--	2.2	3	--	4.5	0.06	--	0.33
1982	204	2	3.9	60.1	5.2	0.44	2.4	0.85
1985	--	--	2.7	--	7	0.73	3.2	1.2
1994	101	8.12	10.22	14.57	1.55	0.2	2.44	0.3
W. Q. STANDARDS	110	2	3.5	16		0.15		0.2

Comparisons of water quality conditions off the Ko Olina resort between 1979 and 1990 were summarized in OIC (1990). Their summary data is presented here as Table 9. The authors concluded that, while there were some changes in parameter levels between surveys in 1979, 1986 and 1990, most of the variation in water quality appears to be due to discrete events, some of which could be related to construction, maintenance and landscaping activities at the resort, and others which could be traced to periods of intense local rainfall or wave activity. In virtually all cases, the changes in water quality that occur during these events are transitory (lasting weeks to months) but are of much greater magnitude than long-term changes.

Marine biological surveys at the Barbers Point Harbor were performed in 1975 and 1985. In the intervening years, the area was subject to several major winter storms, Hurricane Iwa, and the construction of the harbor channel and expansion. The postconstruction survey (AECOS, 1985) concluded that only a relatively small area on either side of the entrance channel had been significantly impacted by construction activities. A highly disturbed zone with little or no living coral was observed within approximately 100 m on either side of the channel; an intermediate zone with some evidence of disturbance and with some living corals present was observed from 100 to 250-300 m from the channel; and undisturbed areas extended beyond the intermediate zone. The causes of the coral destruction were attributed to a combination of direct construction activities (dredging and dragging of barge cables across the bottom) and sedimentation. Extensive damage to corals outside the areas of immediate impact were attributed to storm events.

Much wider and more extensive damage to the coral communities in the area were attributed to the effects of severe storms which had occurred in the period between the 1976 and 1985 surveys. Waves generated by the 1980 event attained heights of over 20 feet and did extensive damage to coral communities at depths as great as 60 feet along the west coast of Oahu (Dollar, 1982). Coral communities along the leeward coast of Oahu sustained considerable damage from Hurricane Iwa (Dr. S. Coles, pers. comm, reported in AECOS, 1985). Qualitative observations by Dr. J. Maragos (pers. comm. reported in AECOS, 1985) four to ten weeks after Iwa indicated considerable damage to reef corals, including dislodged *Porites* heads and scars on the reef where corals had presumably been attached.

The macrothalloid alga *Trichoglea requienii* was dominant in the highly disturbed zones on either side of the channel after channel construction, but lost its dominance within 200 m of the channel. The presence of *Trichoglea* was taken as an indicator of recent disturbance because of its ability to colonize disturbed substrate to the exclusion of other life forms.

Table 9. Summary of water quality conditions at West Beach, Oahu, as determined from surveys taken in 1979 (Bienfang and Brock, 1980), 1986 (OIC, 1987) and 1990 (OIC, 1990). Data are geometric means for all transects, stations, depths and sampling days. Hawaii state water quality criteria ("W. Q. S.") for "dry" open coastal waters are presented for comparison.

STUDY	TN (ug/l)	NH4 (ug/l)	NO3 (ug/l)	TP (ug/l)	PO4 (ug/l)	Chl a (ug/l)	TSS (mg/l)	Turb (NTU)
1979	--	13.4	1.4	--	1.9	0.36	--	0.2
1986	130	14.8	2.8	19.6	3.2	0.40	2.8	0.3
1990	153	9.1	2.1	13.4	5.1	0.19	4.7	0.5
W. Q. S.	110	2.0	3.5	16.0	--	0.15	--	0.2

In the present study, several indications of recovery from the highly disturbed nature of the area on either side of the channel were observed. First, *Trichoglea* was no longer a dominant component of the benthic community. In fact, no evidence of *Trichoglea* was seen in any of the present surveys. Second, numerous heads of Pocillopora meandrina were seen scattered over the previously barren zone on either side of the channel, extending down along the vertical channel walls as well. The size of the largest heads observed (10 - 15 cm in diameter) suggest that recolonization of the channel began immediately after construction stopped, and that these corals have been growing at or near their maximum rate of 1 - 2 cm per year.

Because of declining population sizes, the green sea turtle (*Chelonia midas*) was granted protection under the federally mandated Endangered Species Act in 1977-78. As adults, green sea turtles are known to forage and rest in the shallow waters around the main Hawaiian Islands. Reproduction in the Hawaiian population occurs primarily during the summer months in the Northwest Hawaiian Islands, with adults migrating during the summer months to these isolated atolls and returning to the main islands in late summer or early fall. In the main islands, green sea turtles will rest along ledges or in caves in coastal waters usually from 40 - 80 ft in depth during the day, and travel into shallow waters at night to forage on macroalgae. The normal range of these daily migrations is about one kilometer.

Brock (1990) performed a series of green sea turtle surveys in the waters off the Ko Olina resort before, during and after construction of the shoreline lagoons. Before the start of construction, he observed extensive use of the ledge at 60 ft depth and over 1 km offshore as a turtle resting place during the day. While Brock did not perform any surveys at night, early morning shoreline surveys found turtles foraging for macroalgae off the shoreline bench (OIC, 1990). Early in the construction phase, Brock observed that the turtles had moved from the deeper offshore ledge to a resting place in shallower water only 250 m offshore from the construction activities. Later during construction, the turtles dispersed along the coast off West Beach within about 400 m of the shore, and maintained this distribution for the remaining 13-month lagoon construction period. Brock observed a decrease in size (shift from adult to juveniles) during the study period, but attributed this to reproductive migration patterns. He concluded that no significant impacts to the turtle population had resulted from the West Beach lagoon construction.

Brock (1989) performed a similar study off Hawaii Kai in support of the EIS for the proposed intraisland ferry system. He determined the distribution and abundance of green sea turtles and macroalgal communities in the waters adjacent the Hawaii Kai entrance channel. He concluded that the population of green sea turtles at Hawaii Kai was composed primarily of juveniles and sub-adults. The turtles were observed resting during the day along a band of hard substrate offshore and away from the channel. At night the turtles came into shallower water to feed. Brock (1989) concluded, given the observed abundances and distribution of turtles and the level of boat traffic through the area, that the turtles were relatively unaffected by the presence or level of boating or diving activity, and that the proposed ferry would not pose a significant threat to the turtle population.

IMPACT ASSESSMENT

Our assessment of the potential impacts of the proposed harbor expansion has been prepared based on historical data and that generated by this study. These data were used, in conjunction with the results of previous oceanographic studies and mathematical modeling of the turbidity plume dynamics (Sea Engineering, Inc., 1994), to establish the zones of potential impact and levels of discharge water quality in the receiving waters.

Direct Impacts

There will be no significant impacts to the marine environment due to the proposed excavation and subsequent construction of shoreside facilities. The majority of the material to be removed is currently behind the existing edges of the harbor. The removal of material along the rear wall of the harbor to open the newly-created harbor extension will kill any organisms which may have settled there. Due to the highly turbid nature of the harbor waters and the strong groundwater influx, however, it is not likely that any significant number of corals have become established in this area. In mitigation, approximately 3X new wall surface will be exposed after construction for potential colonization.

Indirect Impacts

Indirect impacts of the proposed harbor expansion may be characterized as short-term or permanent changes in the water quality of the harbor and/or adjacent nearshore marine environment, or changes to the adjacent marine biological communities due to changes in water quality or suspended particulate material transport and sedimentation.

Water Quality Impacts

The impacts of the proposed harbor expansion on the water quality of the harbor and adjacent nearshore marine waters are expected to be small and temporary. A study of the impacts of the proposed expansion on the groundwater resources of the area (Mink 1994) concluded that little change in groundwater quality or quantity would result from the proposed dredging and construction activities. Therefore, the harbor would continue to serve as a focus for groundwater flow, channeling previously diffuse shoreline discharge to a discharge from the harbor mouth. No significant changes in the dissolved nutrient load into the harbor or the resultant organic particulate distribution would be expected. Much greater change in groundwater flow and quality is to be expected due to decreased groundwater discharge by agriculture as the land use upslope from the harbor changes from agriculture to resort and residential use.

There will be increased inorganic particulate material suspended in the harbor waters and discharged to the adjacent nearshore marine waters during and for some time after the removal of the berm between the newly-excavated extension and the harbor. The magnitude and duration of this condition will depend to a great extent on the construction methods used. The levels of suspended sediment created, the rates of transport through the harbor and out to the ocean, and the distribution of this material in the nearshore marine environment have been mathematically modeled (Sea Engineering, Inc., 1994) under different assumptions of construction method and current speed through the harbor.

Under some construction methods (suction dredge with cutter head, which discharges the dredged material on shore to a settling basin), no change in suspended particulate load would be expected, and no change in water quality or marine biological communities would result. Under other construction methods, some additional material would be generated by the dredging activities and suspended in the harbor waters. This material would pass out of the harbor to the adjacent nearshore ocean waters, with the larger, faster sinking particles leaving the water column rapidly and the smaller, slower sinking particles remaining in the water and being transported along or offshore with the currents.

The distribution of turbidity and particulate material sedimentation rates (above ambient levels) were modeled for a variety of cases (Sea Engineering, Inc., 1994). The results of these models are given as probability distributions of turbidity and sedimentation rate (Figures 14 and 15). In each figure, the lines radiating from the mouth of the harbor present the probability that the flow from the harbor will be in that direction at any particular time. This can also be taken as the fraction of time (integrated over intervals of days to years) that a particle released from the harbor mouth would travel along that line. The arcs radiating outward from the harbor mouth represent the lines of equal turbidity or sedimentation rate as determined by the model. Lines nearest to the harbor represent the highest turbidity and sedimentation rate, while those furthest from the harbor represent the lowest.

The model results presented in Figures 14 and 15 are "worst case" results for two dredge operation scenarios and the greatest (0.1 ft per sec) through-harbor current. In Case 2, turbidity levels are projected to be 0.28 NTU above ambient at the mouth of the harbor, and to decrease to 0.06 NTU above ambient within 1,000 feet of the harbor mouth. Under the Case 5 assumptions, turbidity at the harbor mouth would be 0.82 NTU above ambient, and would decrease to 0.20 NTU within 1,000 feet. Data collected during the present study and presented above show that the ambient turbidity levels within the nearshore open coastal waters off the harbor exceed the state water quality standards numerical criterion for turbidity under the most benign of conditions.

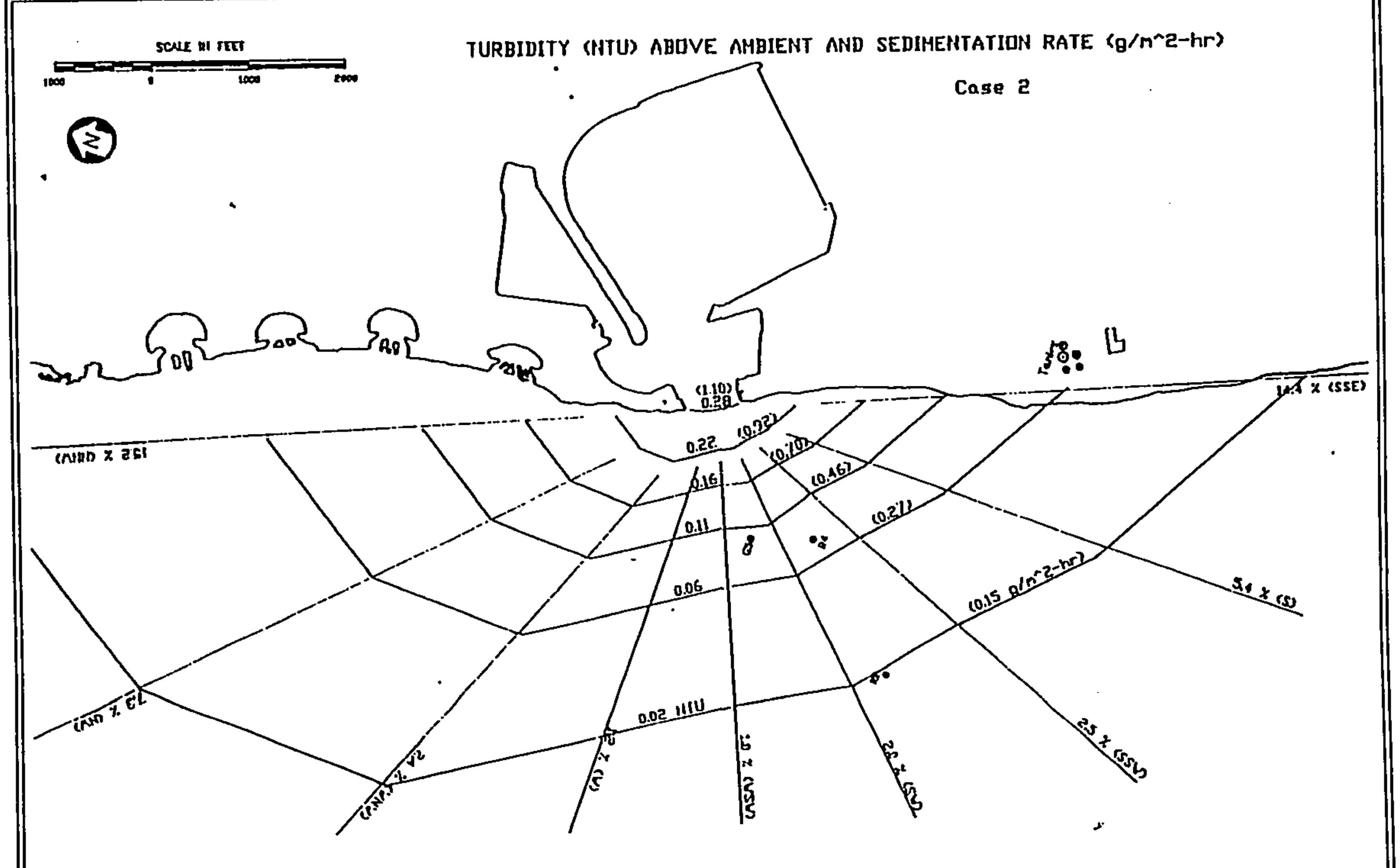
Data collected under a range of wave and current conditions over a four-year period (Figure 16: from OI Consultants, Inc., 1990) show that the increased turbidity levels projected by the model fall within the range of variability experienced by the site under natural conditions. (Note that in Figure 16, some peaks in turbidity are related to the opening of the recreational lagoons constructed as part of the Ko Olina resort. Other, equally high peaks in turbidity can be attributed to a period of heavy surf and rainfall. Note also the rapid return to "ambient" conditions after each of these events.) Thus, while the waters within a small area centered around the mouth of the harbor may experience turbidity levels which exceed the state water quality standard, these levels will be within the range of values shown to occur in the area under natural conditions.

Other potential adverse impacts include increased boat usage of the harbor and the incidental and accidental introduction of contaminants into harbor and nearshore waters. Normal operations within harbors result in the incidental and accidental spilling of a limited amount of fuels and oils. The discharge of boat sewage is closely regulated by state and federal regulations and raw sewage cannot be directly discharged into harbor waters.

Marine vessels use leaded and unleaded gasolines and diesel fuels that can be a source of contamination to harbor waters. Generally, most fuel and oil spills are incidental to fueling activities and are accidental and small. However, floating petroleum products and oil have not been conclusively shown to damage corals (Johannes, 1975), and reef communities can exist in areas subject to long-term oil pollution (Shin, 1972). Similarly, hydrocarbon contaminants do not appear to adversely affect algal, invertebrate or fish populations within marinas or harbors unless there is a massive spill.

The elimination of wastes from vessel holding tanks into harbor waters is prohibited by both state and federal regulations. Vessels are required to empty their wastes at local pump-out stations. Illegal discharges can occur and might constitute a potential health hazard. However, bacteria contained in sewage wastes are rapidly killed off by the combination of salinity and sunlight. The time required to kill off 90% of coliform bacteria in seawater is approximately 20 minutes; thus, few bacteria would remain several hours after a spill.

The existing flushing action of the harbor by tidal flows and groundwater influx will not be changed by the harbor expansion. These processes would serve to move the limited amount of

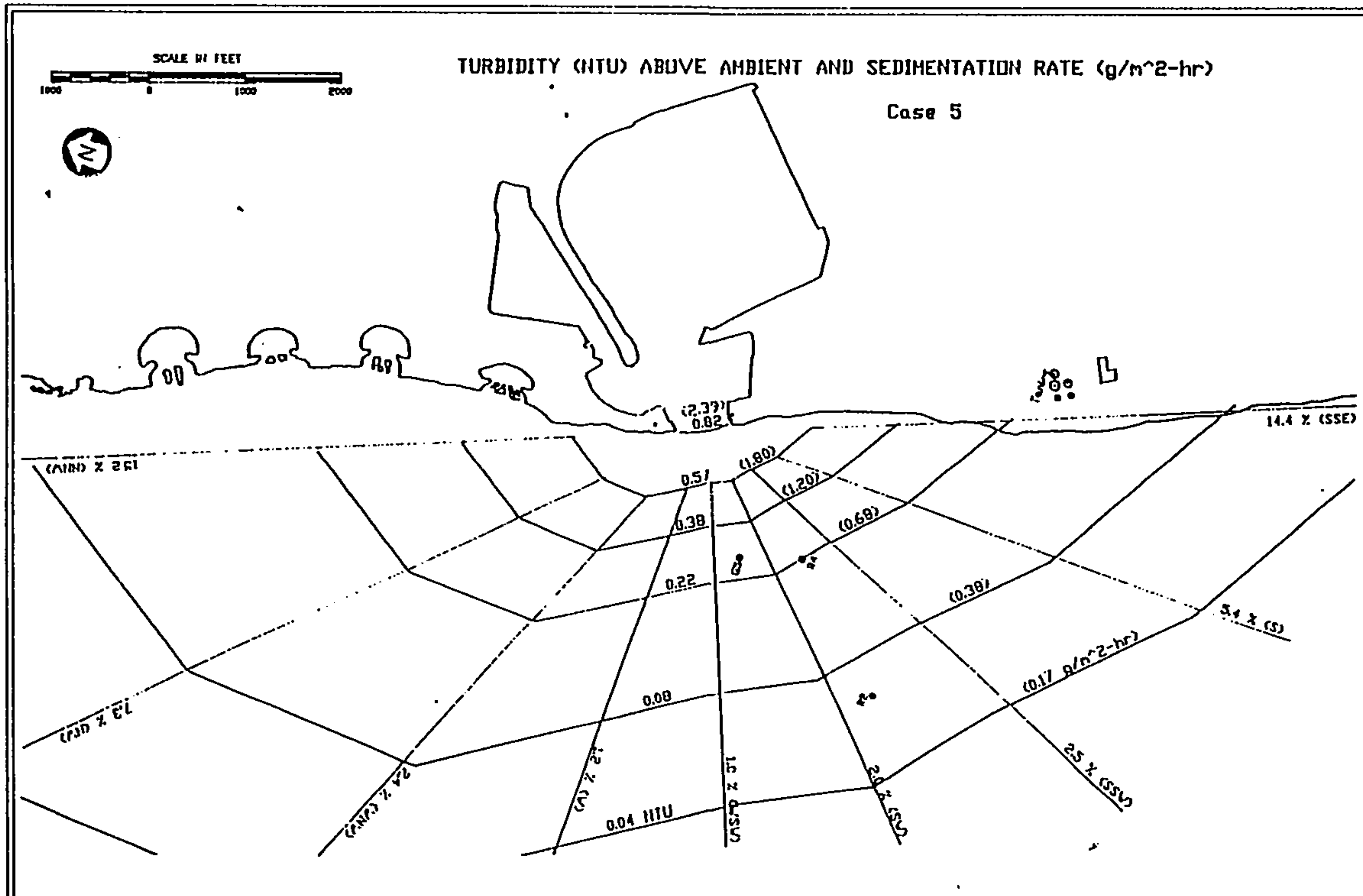


OI Consultants, Inc.
Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

PROBABILITY DISTRIBUTION OF TURBIDITY AND SEDIMENTATION RATE: CASE 2

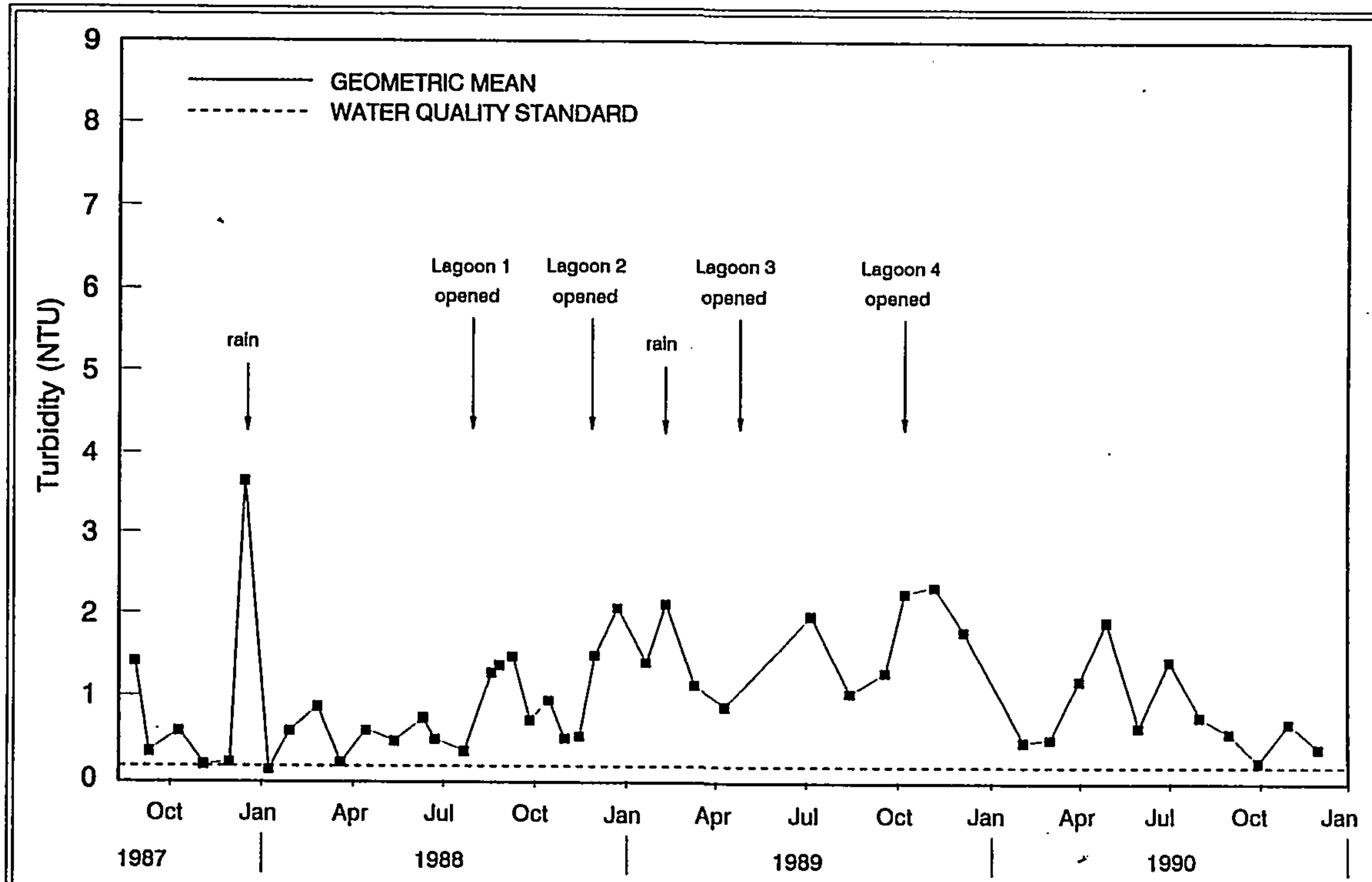
Figure 14



OI Consultants, Inc.
Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY
PROBABILITY DISTRIBUTION OF TURBIDITY AND SEDIMENTATION RATE: CASE 5

Figure 15



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Makapuu Point
Waimanalo, Hawaii 96795

BARBERS POINT HARBOR EXPANSION STUDY

TIME SERIES OF TURBIDITY AT WEST BEACH, OAHU
(from OI CONSULTANTS, INC., 1990)

Figure 16

pollutants that might be introduced into the harbor into open ocean waters where they will undergo natural weathering and degradation.

Marine Biological Impacts

Since no change in the quality or flow of groundwater is expected as the result of the proposed expansion activities, the primary potential impact to marine biological communities will be related to the elevated levels of turbidity and increased rates of sedimentation of suspended particulate material. Elevated levels of turbidity will have no lasting effect on the resident fish or green sea turtle populations. Turbidity levels are not expected to rise to levels which might somehow cause actual physical distress to resident fishes, or to decrease visibility to a point that feeding or avoidance of predators is inhibited. Short-term and highly localized areas of high turbidity can simply be avoided by highly motile fish. This would appear to be the case already at the harbor, where fish populations in the naturally higher turbidity waters to the south of the harbor channel are much less abundant than to the north (Figure 13).

Turbidity levels are also not likely to affect resident green sea turtles. Brock (1988a) observed off West Beach that turtles were actually found in greater abundance in waters that were more highly turbid than those that were clearer. He did not observe the same phenomenon off Hawaii Kai (Brock, 1988a), but did observe turtles there in both clear and turbid waters.

Benthic populations of stony corals, macroalgae and macroinvertebrates cannot move from an area which may experience elevated turbidity or sedimentation rates. However, these communities have evolved in areas which experience naturally high levels of turbidity and sedimentation at some frequency, and have developed mechanisms to cope with these events.

Stony corals secrete a mucous which entraps sediment particles and is continuously sloughed off, thus keeping the coral clean. The cleaning rate for corals is quite high. Natural sedimentation rates and their effects on five species of corals were studied at San Cristobol Reef, Puerto Rico, over an 18-month period (Rogers, 1983). Natural sedimentation rates ranged from 10 - 40 g m^{-2} d^{-1}. While some species were more tolerant of the sediment loading than others, no coral mortality was observed. The sediment rejection abilities of colonies of *Montastrea cavernosa* were monitored in a series of field and laboratory experiments. Under conditions of natural sediment deposition, colonies were capable of removing virtually all sediment from their surfaces (up to 138 g m^{-2} d^{-1}; Lasker, 1980). The effects of heavy sedimentation on corals was examined in the laboratory using *Astrangia danae*. Colonies receiving applications of clean fine sand at a rate of 85 g m^{-2} d^{-1} for four weeks were not different from controls in terms of colony weights, growth rates or net oxygen exchange rates (Peters and Pilson, 1985).

Sedimentation rates under worst case projections for the proposed excavation range from 26 - 57 g m^{-2} d^{-1} (given as 1.1 - 2.4 g m^{-2} h^{-1} in Figures 14 and 15) at the mouth of the harbor, and decrease to 7-10 g m^{-2} d^{-1} within 1,000 feet of the harbor. These sedimentation rates are lower than the natural sedimentation rates observed on reefs off Puerto Rico (Rogers, 1983), and less than one-tenth the rates which corals have been shown to tolerate without significant impact (Lasker, 1980; Peters and Pilson, 1985). Thus, the increase in sedimentation rates which are projected under worst case conditions will not result in any significant degradation to the resident coral communities.

One of the construction options entails drilling and blasting to loosen the material before removal. Such blasting has the potential to impact marine life within some distance from the blast site. No significant immediate mortalities to fish populations are expected, since the blasting will occur some distance from the ground-water interface, the charges will be small, and the resultant shock waves are expected to be minimal.

The shock waves may be felt by sensitive marine mammals if they are within a short distance of the construction site. Generally, however, whales and other smaller marine mammals do not venture close to shore (Forestell et al., 1993). During the months of November to May, humpback whales (*Megaptera novaeangliea*) migrate from Alaskan waters to the major mating, calving and calf rearing grounds off Maui, and back. Survey data suggest that the whales migrate to Maui waters directly, although some animals make their way along the coast of the island of Oahu. Surveys of the locations and trajectories of migrating humpback whales have shown that humpback whales and most other smaller whales seldom come into waters within the 100 fathom contour off Oahu, but are frequently seen inside that depth off Maui and Hawaii. The spinner dolphin (*Stenella longirostris*), which occurs in Hawaiian waters throughout the year, is the only cetacean which occurs commonly in waters shallower than 100 fathoms off Oahu.

The 100 fathom contour is found at a distance of just under one mile offshore of the harbor. The shock waves from small charges set off at some depth underground and several thousand feet inland is not expected to have any significant negative impact on humpback whales or other marine mammals which may be passing through the area.

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APPENDIX A-3

BARBERS POINT HARBOR TURBIDITY INVESTIGATIONS

BARBERS POINT HARBOR
TURBIDITY INVESTIGATIONS

Prepared For:

Parsons, Brinkerhoff, Quade & Douglas, Inc.
Two Waterfront Plaza, Suite 220
500 Ala Moana Boulevard
Honolulu, HI 96813

Prepared By:

Sea Engineering, Inc.
Makai Research Pier
41-202 Kalanianaole Hwy., Ste. 8
Waimanalo, HI 96795

July 1994

#93-43

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EXECUTIVE SUMMARY

INTRODUCTION

This study of ambient turbidity and suspended solids concentration in the Barbers Point Harbor basin and coastal waters adjacent to the harbor has been accomplished to document historical and existing ambient conditions, and to assess possible turbidity impacts during construction of a proposed harbor basin expansion. Turbidity is a measurement of light scattering within a water sample, and is thus a measurement of suspended particulate material in the water, and indirectly a measure of light transmittance. The turbidity is expressed as nephelometric turbidity units, or NTUs. The State Water Quality Standards prescribe mean turbidity criteria applicable to the project area. This study consisted of a review of existing available information for the project area, field investigation of ambient turbidity and currents in the harbor basin and coastal waters, and development of a numerical model for prediction of possible dredging impacts with regard to coastal water turbidity.

Barbers Point Harbor, located on the southwest corner of Oahu, was constructed between 1982 and 1985, and provides commercial port facilities for deep draft cargo vessels. The State Harbors Division proposes to increase the approximate 100 acre basin by about 25 acres to create additional dock space, a project which will involve excavating approximately 2.3 million cubic yards of primarily coralline (limestone) material.

AMBIENT TURBIDITY AND CURRENT CONDITIONS

Present State Water Quality Standards applicable to the harbor basin and open coastal waters are 0.4 and 0.2 NTU, respectively. Water quality monitoring in the project area was conducted by AECOS, Inc. before, during and after construction of the harbor. Pre-construction measurements showed considerable variability in the nearshore water turbidity, with apparent dependance on factors such as sea conditions (turbidity increased with wave action), distance from shore, and proximity to the entrance of an existing small barge harbor at the site. The mean value of turbidity measured at the harbor mouth, and nearshore waters within about 1,500 feet north and south of the barge harbor, was 3.3 NTU and 1.3 NTU, respectively. The mean ambient turbidity exceeded the State water quality criteria by a considerable amount and virtually all the time prior to initiation of construction for the new Barbers Point Harbor. The reasons why ambient coastal water turbidity in the project vicinity exceeds State water quality criteria are unknown. However, based on the historical data and the field investigations conducted for this study, it is evident that naturally occurring ambient conditions result in the criteria not being achievable at this location.

The inland harbor basin was excavated behind a plug left in the entrance channel in order to eliminate turbidity impacts to coastal waters during this portion of harbor construction. The majority of construction monitoring was concerned with dredging of the offshore entrance channel, and this data is not directly pertinent to the issue of dredging within the confines of the harbor basin. During removal of the plug at the harbor mouth, however, several data sets combine measurements of turbidity and suspended solids within the harbor basin, at the entrance and alongshore and offshore. These data sets are useful for calibrating a predictive model. The final monitoring measurements were made for a period after dredging was completed to document nearshore water quality following completion of construction activities. The post-construction measurements showed ambient turbidity in the coastal water adjacent to the harbor to be about the same as pre-construction conditions, and AECOS (1986) stated in their final report that "A return to pre-construction water quality with respect to these parameters is suggested by these results."

Other water quality and turbidity measurements have been made in the general project vicinity, most notably a series of measurements made from about 1980 to 1990 for the West Beach/Ko'Olina Resort development. This data also shows that nearshore coastal water turbidity equals or exceeds the State criteria essentially all the time. In December 1993, measurement of ambient turbidity accomplished as part of this study also showed that nearshore waters exceed the State criteria, with a geometric mean value of 0.6 NTU versus the standard of 0.2 NTU. There is, however, a great deal of natural variability in turbidity both within the harbor basin and outside in nearshore waters. Inside the harbor, ship movement results in localized and temporary increases in turbidity by stirring up bottom sediment. Outside the harbor, wave action often results in elevated turbidity in shallow water nearshore. On two different field investigation days, the turbidity in the harbor basin was noted to increase by as much as 0.8 NTU over the course of the day, for reasons which are unknown.

Detailed current studies conducted over a ten year period in the harbor vicinity show that reversing tidal currents dominate the current structure in the nearshore coastal waters with the primary directions of flow parallel to the shore and bottom contours. The average nearshore (less than 30-foot depth) current speed is typically less than 1 ft/sec (0.5 knots), with little vertical variation in current speed in the top 35 feet of the water column.

SUSPENDED SOLIDS AND TURBIDITY PLUME MODEL

A numerical model of suspended solids transport, dilution and fallout (settling) can be used to assess the potential impact to harbor basin and coastal water turbidity as a result of the proposed dredging to expand the harbor basin. The model employed is based on methodology initially developed by Brooks (1959) for estimating plume dilution. The considerable extent of available data pertinent to the project site, including monitoring during dredging activities similar to the proposed activity, greatly facilitates the development and calibration of a numerical model. Construction of the existing harbor was accomplished by large backhoe work from land, and clamshell dredging offshore and to remove the entrance channel plug as the last construction step. It is not known at this time what construction method will be utilized for the basin expansion, presumably either mechanical means (backhoe, dragline or clamshell) or hydraulic cutterhead dredging, however clamshell dredging typically introduces the greatest suspended solids concentration into the water. Data for model calibration is also available from the prior dredge monitoring to aid in determining model input parameters and calibration. It is assumed that if exposed clamshell dredging can be shown to result in acceptable or no significant turbidity impacts, then any other reasonable dredging operation, such as excavation behind a plug or silt screen or by hydraulic dredge, would also be acceptable.

The model basically estimates suspended solids plume spread and centerline concentration decrease by transport and mixing in a uniform current flow, coupled with a concentration decrease by settling due to particle fallout. The modeling is done in two steps: Step 1 calculates change in turbidity within the harbor basin and estimates a concentration at the harbor mouth; and Step 2 calculates plume dilution and transport by coastal currents to estimate impacts to nearshore water quality. Four case studies are considered with the following variables:

Case Number	Initial Concentration (mg/l)	Initial Plume Width (feet)	Current Speed (ft/s)
1	70	60	0.05
2	70	60	0.1
3	40	300	0.05
4	40	300	0.1

The initial concentrations and plume widths are based on review of data collected during Barbers Point Harbor construction monitoring and general dredging information texts. These concentrations are considered to be very conservative, worst case conditions for the proposed basin enlargement project. The rationale for using such conservative values is that if this doesn't result in a significant problem, then there is very little chance of a turbidity problem resulting from the proposed project. The current speeds in the harbor basin are derived from the field measurements. The 0.05 ft/s speed is considered reasonably representative of average, long duration flow across the harbor, and the 0.1 ft/s current speed is representative of the highest, or worst case, flow across the harbor basin. The speeds are very conservative in that they are considered to persist uniformly, even during flood tide when the flow across the basin would be considerably reduced.

Existing ambient conditions and the results of the dredging impact modeling are summarized on the table at the end of this Executive Summary. The results illustrate that with a current speed of 0.05 ft/s the turbid plume would not reach the harbor mouth with turbidity greater than about 0.13 NTU above ambient. Even with a worst case 0.1 ft/s current the turbid plume would have an estimated turbidity at the harbor mouth of about 0.8 NTU, or an approximate doubling of the ambient condition. However, this must taken in context with regard to the natural variability in turbidity in harbor and coastal waters. For example, the average 1982 pre-construction turbidity at the harbor mouth was 3.3 NTU, about 5 times greater than was measured in 1993 during this study. Ship movements in the harbor can also result in more than a doubling of turbidity within the harbor basin, as was measured during this study. In addition, for reasons not known, during the field investigations for this study the turbidity in the harbor basin was observed to increase by an average of 0.8 NTU simply during the course of the day. Thus, the estimated dredging impact on turbidity is within the typical limits of natural variability for this site. The dredging activity would also not result in turbidity greater than the existing natural variability in the nearshore coastal waters outside of the harbor. Based on the model predictions, and the historical as well as recent measurements and data for the project vicinity, the proposed dredging inside Barbers Point Harbor should not result in significant turbidity impacts outside of the harbor.

		Harbor Mouth	Nearshore Coastal Water (within 1,000 feet of harbor)
State WQ Standard		0.4 (in basin)	0.2
Pre BPH Construction (1982)		3.3	1.3
Post BPH Construction (1986 - 90)		1.2	0.2 - 1.0
December 1993 -	Range Mean	0.6 - 0.9 0.7	0.2 - 0.8 0.6
Model Results - Turbidity Increase Above Ambient Conditions	Case 1 Case 2 Case 3 Case 4	<0.04 <0.3 <0.1 <0.8	<0.03 <0.2 <0.1 <0.6

I. INTRODUCTION

PROJECT LOCATION AND GENERAL DESCRIPTION

Barbers Point Harbor is located on the southwest corner of Oahu, the leeward coast, and provides commercial port facilities for deep-draft vessels. The harbor was constructed as a joint federal (Army Corps of Engineers) and State (SDOT-HD) project, with construction initiated in 1982 and dredging of the harbor basin and entrance channel completed in 1985. The harbor basin was constructed entirely inland of the shoreline by excavation of the primarily coralline reef rock coastal plain, connected to deeper water by a dredged entrance channel. The harbor basin excavation was accomplished with a "plug" left in place between the basin and the entrance channel in order to reduce turbidity and suspended solids impacts on adjacent coastal waters. The plug was removed as the last step in construction after basin excavation was complete. The areal extent of the basin is about 100 acres, with a design depth of -38 feet mean lower low water (MLLW), and construction involved excavation of more than 7 million cubic yards of material. The existing harbor and proposed improvements are shown on Figure I-1.

The West Beach Marina was constructed in the early 1990s adjacent to Barbers Point Harbor to serve West Beach Estates and the Ko 'Olina resort. This privately constructed marina utilizes the Barbers Point Harbor entrance channel.

The proposed harbor improvement project involves basin expansion to create additional water area (approximately 25 acres) and dock space along the northeast side of the basin, as shown on Figure I-1, and will require the excavation of approximately 2.3 million cubic yards of material. In addition, a small amount of excavation (approximately 56,000 cubic yards) will be done in the south corner of the existing basin to square up the corner.

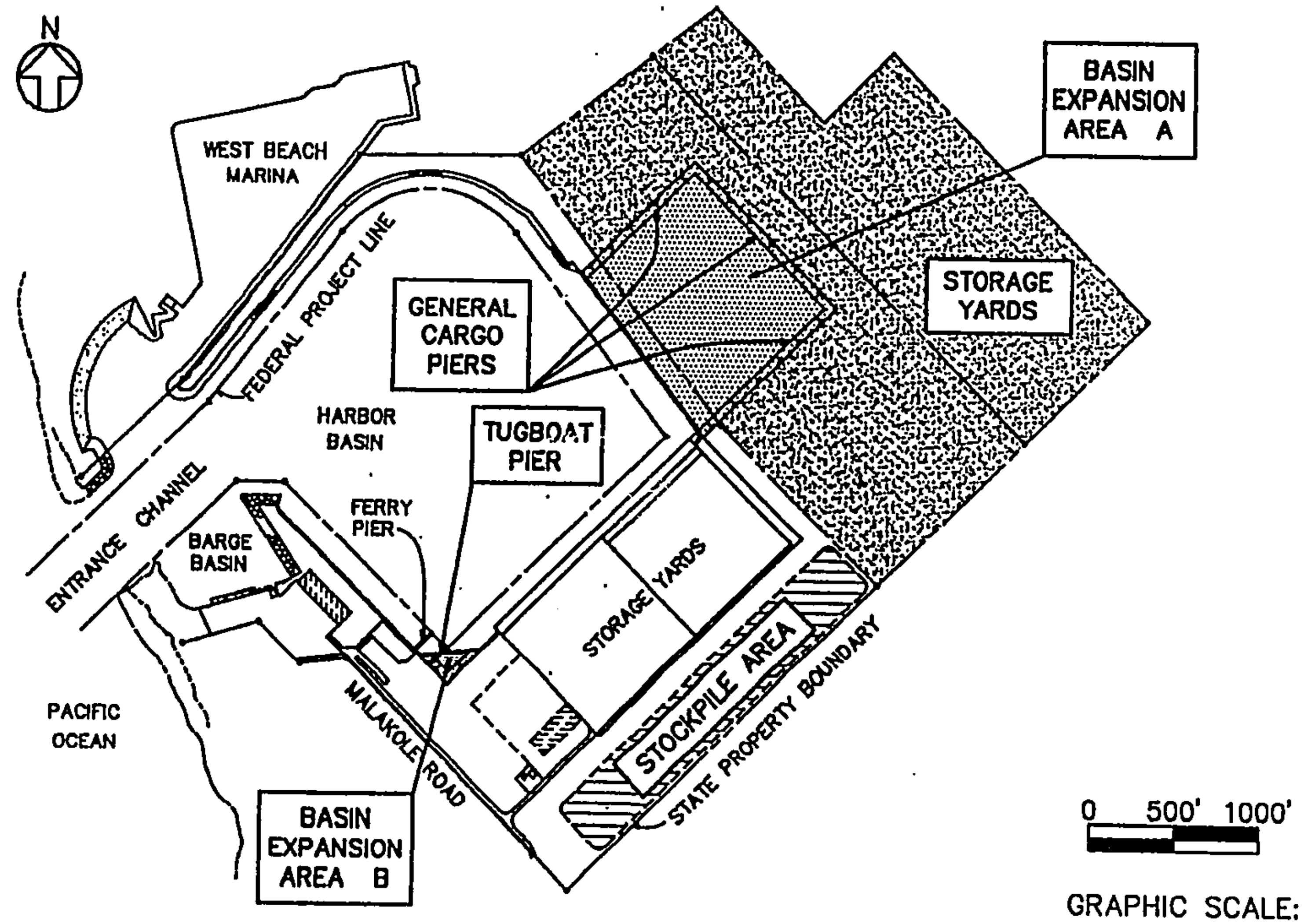

FIGURE I-1
BARBERS POINT HARBOR
AND PROPOSED IMPROVEMENTS

STUDY PURPOSE AND SCOPE OF WORK

The purpose of this study is to assess possible turbidity and suspended solids impacts on coastal water quality as a result of construction of the harbor improvements. The scope of work includes the following general tasks:

- o review of existing available information pertinent to the project, including previous oceanographic and monitoring studies before, during and after construction of Barbers Point Harbor and Ko 'Olina resort;
- o field investigation of existing turbidity and current/circulation conditions in the harbor and adjacent coastal water; and,
- o numerical modeling of turbidity plume transport and dispersion to assess possible water quality impacts.

Impact analysis of the project on general water quality and marine biota has been conducted by the Oceanic Institute concurrently with this study.

II. TURBIDITY AND SUSPENDED SOLIDS

GENERAL

A considerable amount of very pertinent data and analysis regarding turbidity and suspended solids concentrations is available for the project area; including monitoring by AECOS, Inc. during various phases of the Barbers Point Harbor construction (1982-1985) and measurements by several investigators during the West Beach Estates/Ko 'Olina resort infrastructure construction. The existing data provides both spatial and temporal data which are site specific and construction activity specific to the proposed harbor expansion project.

Turbidity is presented in terms of nephelometric turbidity units (NTU), which is a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the intensity of scattered light, the higher the turbidity. Suspended solids concentrations represent nonfilterable particulate material in the water, which could be of biological origin (i.e. plankton or algae), or in the vicinity of a dredging operation would represent fine dredged material temporarily suspended in the water column. Suspended solids are presented in milligrams per liter (mg/l). The State Water Quality Criteria for turbidity applicable to harbor basin waters and the adjacent coastal waters is as follows:

	NTU (geometric mean not to exceed the given value)
Barbers Point Harbor (Class A Embayment, "dry" criteria)	0.4
Open Coastal Waters (Class A, "dry" criteria)	0.2

Source: Hawaii Administrative Rules, Title 11, Department of Health, Chapter 54, Water Quality Standards, 1992.

The water quality standards are presented in terms of the geometric mean (as opposed to the arithmetic mean), as this considered to best represent the observed concentrations of water quality parameters such as turbidity and suspended solids. In this report data summaries and averages are presented as geometric means in order to be comparable with State Water Quality Standards.

Barbers Point Harbor is excavated in a groundwater limestone aquifer of brackish water (Aquifer 1), which has an estimated flux toward the coast of between 200 and 500 gallons per day per unit width of one foot (Mink & Yuen, 1993). This is less than one percent of the harbor volume per day, thus "dry" water quality criteria applies.

WATER QUALITY MONITORING DURING CONSTRUCTION OF BARBERS POINT HARBOR

AECOS, Inc. (1986) conducted water quality monitoring investigations in the vicinity of Barbers Point Harbor prior to, during and after construction of the harbor. Measurements primarily focused on turbidity and suspended solids, and were conducted to (1) document baseline conditions prior to construction activities, (2) monitor water quality changes during construction, and to (3) determine post-construction water quality at the harbor site.

Pre-Construction Monitoring

For the pre-construction monitoring water samples were collected at nine stations on five occasions, with samples taken one meter below the surface and one meter above the bottom. AECOS summed up pre-harbor construction ambient conditions as follows. "Ambient turbidity and suspended solids conditions in the immediate vicinity of Barbers Point Barge Harbor are determined by at least three factors: (1) prevailing weather and sea conditions; (2) distance from shore and/or depth; and (3) proximity to the harbor entrance. Thus, ambient conditions cannot accurately be defined by a single set of values, but rather must be characterized by a range of values." (Note - there existed a small barge harbor constructed in the 1960s at the site.)

The highest turbidity values occurred in the near surface samples just offshore of the harbor entrance, and this data, together with visual observations, indicated that the barge harbor waters had an influence on the immediate nearshore coastal waters. During south swell conditions high turbidity values were measured in nearshore waters all along the coast, presumably as a result of bottom sediments being stirred up and suspended by the wave motion. AECOS reported that the measured turbidity did not always agree with the visual observations, i.e. sometimes what appeared to be a more turbid area would measure less than an apparent turbid zone, and it was hypothesized that the turbid plume might have been only in a less saline thin surface layer (less than the 1 meter sampling depth) resulting from a fresh water outflow from the harbor.

AECOS summarized the pre-construction ambient turbidity and suspended solids conditions in the coastal waters as shown on Table II-1.

TABLE II-1. ESTIMATED AMBIENT TURBIDITY AND SUSPENDED SOLIDS CONCENTRATIONS FOR THE BARBERS POINT AREA (AECOS, 1986)

	Turbidity (NTU)		Suspended Solids (mg/l)	
Location	Geometric Mean	Standard Deviation	Geometric Mean	Standard Deviation
Harbor Entrance	3.3	2.1	4.2	2.7
Nearshore Waters (1,500' N & S of harbor)	1.3	2.3	4.2	2.7
Mid-Reef Waters (20' to 30' depth)	0.7	0.5	2.1	1.3
Offshore Waters (30'+ depth)	0.4	0.2	1.4	0.4

It is interesting to note that the AECOS measurements indicates that mean ambient turbidity exceeded the State water quality criteria by a considerable amount and virtually all the time prior to initiation of construction for the new Barbers Point Harbor. The reasons why ambient coastal water turbidity in the project vicinity exceeds State water quality criteria are unknown. However, based on the historical data and the field investigations conducted for this study, it is evident that naturally occurring ambient conditions result in the criteria not being achievable at this location.

Monitoring During Construction

The construction monitoring extended over a three year period, with a great deal of turbidity and suspended solids data obtained during different phases of the construction. The harbor basin was excavated virtually entirely while land-locked behind a plug left in the entrance channel, with the plug removed as the last step in construction. The majority of the data was obtained during dredging of the offshore portion of the entrance channel, and thus pertains to an extreme construction activity which is not included in the project addressed by this study. This data is thus not directly pertinent to the issue of dredging within the confines of the harbor basin. However, several data sets combine measurements of turbidity and suspended solids within the harbor basin, at the entrance (nearshore), alongshore and offshore. These are useful for verifying and calibrating predictive models. In addition, the large number of paired (same sample) turbidity and suspended solids measurements permits good correlation analysis for the two parameters during dredging activities quite similar to what will occur with harbor improvements (i.e. similar material to be dredged and likely similar dredge techniques).

Post-Construction Monitoring

The final monitoring measurements were made in conjunction with the opening of the plug between the new harbor and the old barge harbor basins, and for a period thereafter to document nearshore water quality following completion of construction activities. Opening of the plug was done gradually over about a six week period, thus water in the new basin came to equilibrium with coastal waters prior to final and complete opening of the plug. Measurements were only made at the harbor entrance (same location as for pre-construction sampling) and in the harbor basin; nearshore up and down coast, mid-reef and offshore waters were not sampled during the final monitoring phase. The mean turbidity and suspended solids values at the harbor entrance were as follows:

	Turbidity, NTU	Suspended Solids, mg/l
Surface	1.2	2.7
Bottom	1.3	3.8

These values are lower than the pre-construction ambient conditions at the harbor mouth, and correspond to the pre-construction nearshore water conditions, and thus AECOS (1986) stated in their report "A return to pre-construction water quality with respect to these parameters is suggested by these results."

Turbidity and Suspended Solids Correlation Analysis

The data base collected by AECOS was large with respect to turbidity and suspended solids measurements, with a total of 448 pairs (i.e. both turbidity and suspended solids measured in the same sample). A linear regression analysis of this data yielded the following relationship:

Suspended Solids = (1.59 x Turbidity) + 1.88,

with a correlation coefficient of 0.86.

WATER QUALITY INVESTIGATIONS FOR THE KO 'OLINA RESORT PROJECT

Surveys of water quality in the coastal waters off Ko 'Olina Resort were made by Bienfang and Brock (1980) and OI Consultants (1987 and 1990), as well as by S.E.A., Ltd. over a period from 1987 to 1990. It is interesting to note that Bienfang and Brock (1980) found some degradation of water quality, including and increase in turbidity, moving south from the Ko 'Olina area toward the harbor. They also reported that definable areas of more turbid water nearshore were observed moving from the south to the north under ebb tide conditions. These measurements and observations support the idea of considerable variability of turbidity conditions in the Barbers Point area, as well as the variability in "sources" of turbidity. AECOS (1991) summarizes the Bienfang and Brock and OI Consultants survey data for nearshore waters off Ko 'Olina as follows (geometric means of spatial data, not temporal or time series):

Date	Turbidity, NTU
1980	0.2
8/86	0.4
9/86	0.2
4/90	0.3
4/90	1.0

Time series measurements during the construction of the Ko 'Olina lagoons was obtained by S.E.A., Ltd. (1987-1990), and OI Consultants (1990) plotted the turbidity values over time. The plot shows that the nearshore water exceeds the 0.2 NTU geometric mean criteria essentially all the time, with or without "events" related to natural circumstances (rainfall) or construction activities.

DECEMBER 1993 FIELD INVESTIGATIONS

Methodology and Results

Field investigation of ambient turbidity conditions in the project area were accomplished on

December 17 and 22, 1993. Measurements were made both in the existing deep draft harbor basin and the adjacent coastal waters out to the approximate 60-foot depth contour, during both ebb and flood tide. Water samples were obtained at 1 foot, 10 foot and 20 foot depths using a Niskin sampling bottle, and turbidity was determined with a Turner Model 40 Nephelometer.

The field data collected is shown on Figures II-1 to II-4. Turbidity in the harbor basin typically ranged from 1 to 3 NTU, and was fairly uniform with depth, with occasional sampling showing somewhat higher turbidity in the near surface water. The field days were selected to coincide with ship movement into or out of the harbor, as these are events which have been noted in the past to result in an increase in turbidity. The ship movement, and particularly the tugs handling the vessels, did result in an obvious turbid patch, however it was of limited extent and no evidence was seen of the turbidity exiting the harbor or even reaching the harbor mouth. All of the measured turbidity values in the harbor basin exceeded the State Water Quality Criteria of 0.4 NTU by a factor of two or more, and the 1.32 NTU geometric mean of all the samples exceeds the criteria by a factor of three.

Measured turbidity in the nearshore coastal waters, within the approximate 20-foot contour, typically ranged between 0.2 to 0.8 NTU. Nearshore breaker heights were 2 to 3 feet on both days, and it is hypothesized that the wave action contributed to the relatively turbid conditions by stirring up fine material from the bottom. Seaward of the 20-foot contour the turbidity was lower, typically between 0.2 to 0.3 NTU, however occasional measurements were as high as 0.6 or 0.7 NTU.

A summary of the geometric mean turbidity values for all field measurements is shown on Table II-2.

TABLE II-2. SUMMARY OF BARBERS POINT HARBOR VICINITY TURBIDITY MEASUREMENTS, DECEMBER 17 AND 22, 1993
(Geometric Mean)

Harbor Basin	Harbor Entrance	Nearshore Waters (<18')	Mid-Reef Waters (18'-30')	Offshore Waters (<30')
1.32	0.72	0.59	0.30	0.23

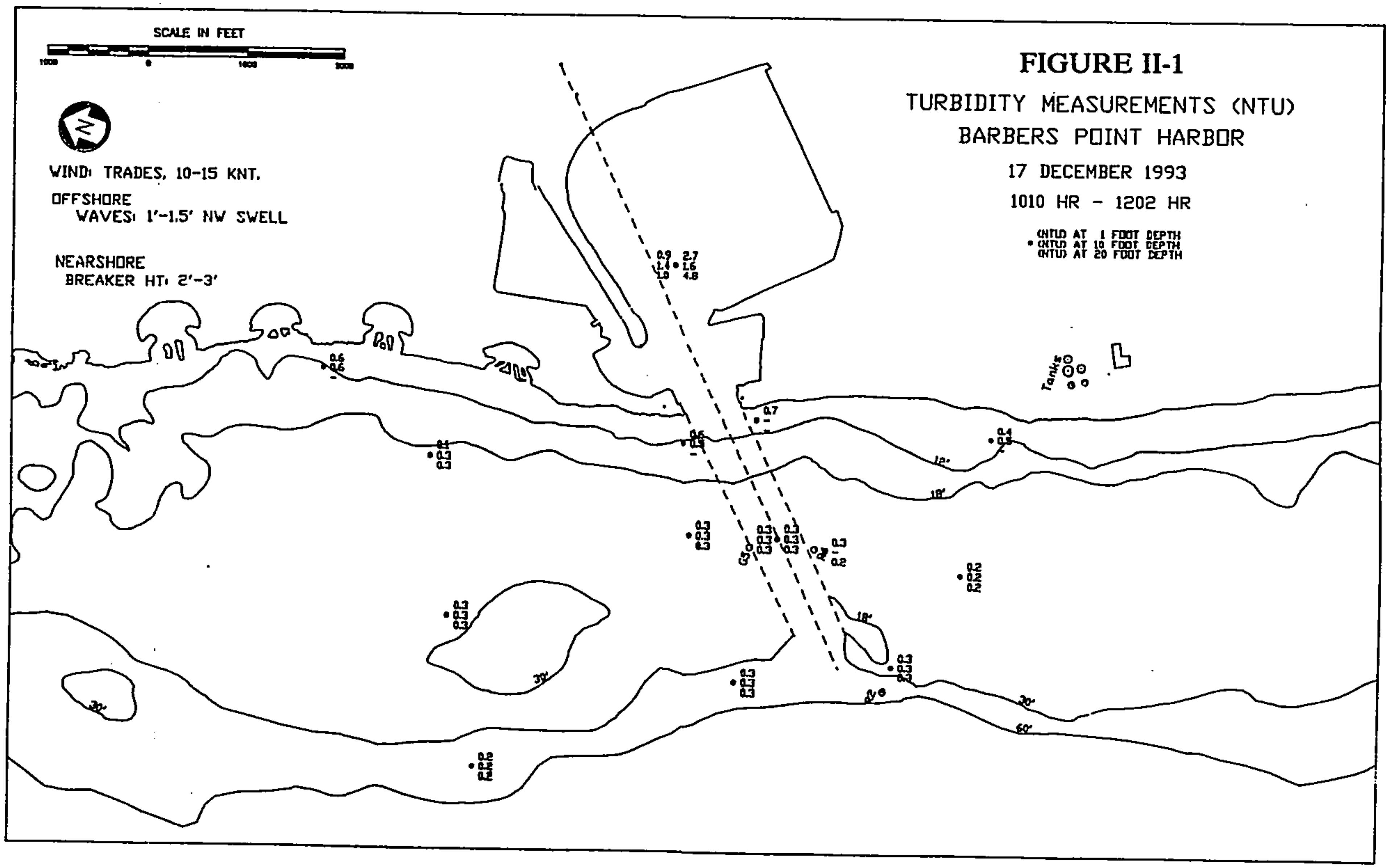
FIGURE II-1
TURBIDITY MEASUREMENTS (NTU)
BARBERS POINT HARBOR
17 DECEMBER 1993
1010 HR - 1202 HR
(NTU) AT 1 FOOT DEPTH
(NTU) AT 10 FOOT DEPTH
(NTU) AT 20 FOOT DEPTH
SCALE IN FEET
WIND: TRADES, 10-15 KNT.
OFFSHORE
WAVES: 1'-1.5' NW SWELL
NEARSHORE
BREAKER HT: 2'-3'
Tanks
12'
18'
30'
60'

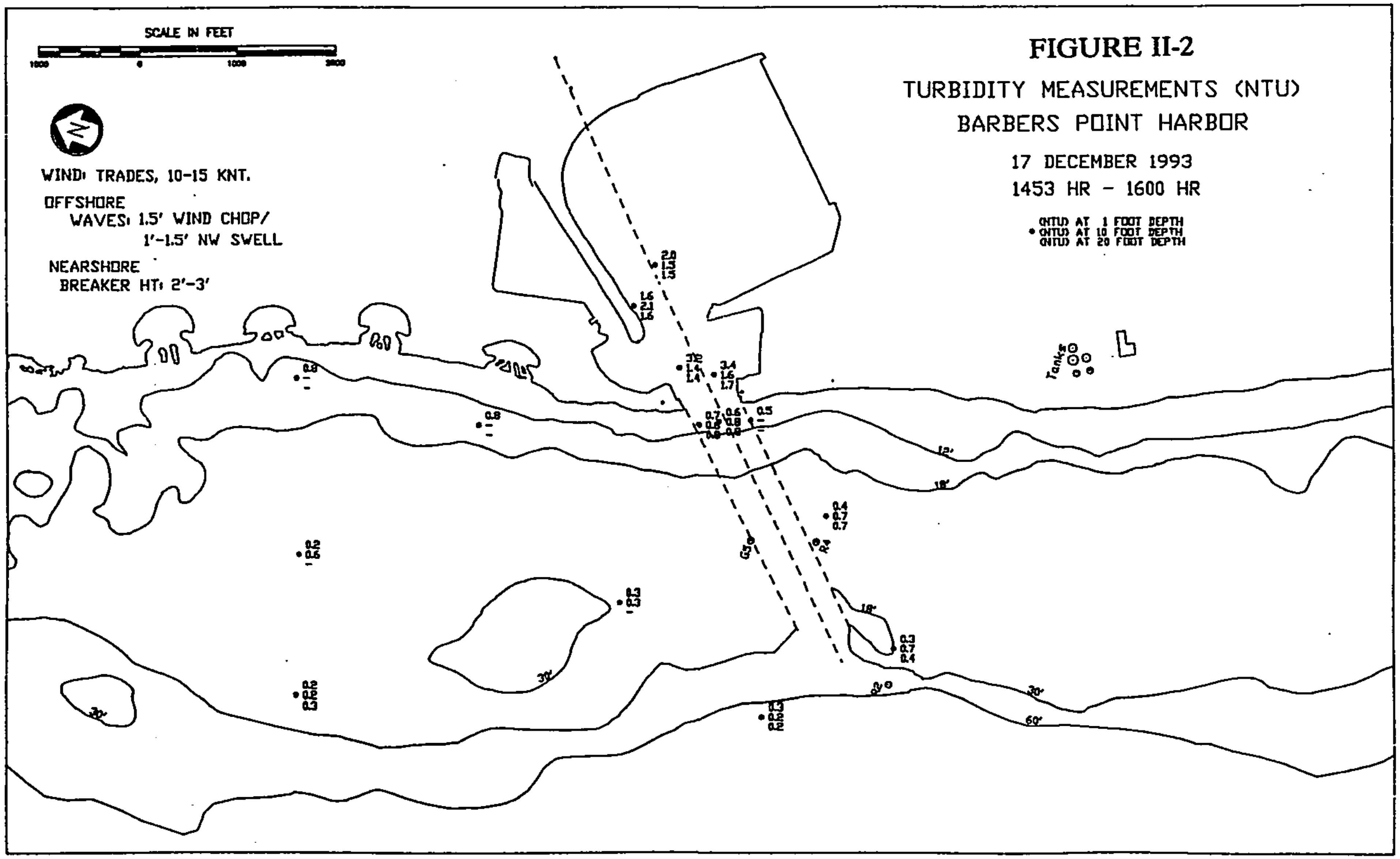

FIGURE II-2

TURBIDITY MEASUREMENTS (NTU)
BARBERS POINT HARBOR

17 DECEMBER 1993
1453 HR - 1600 HR

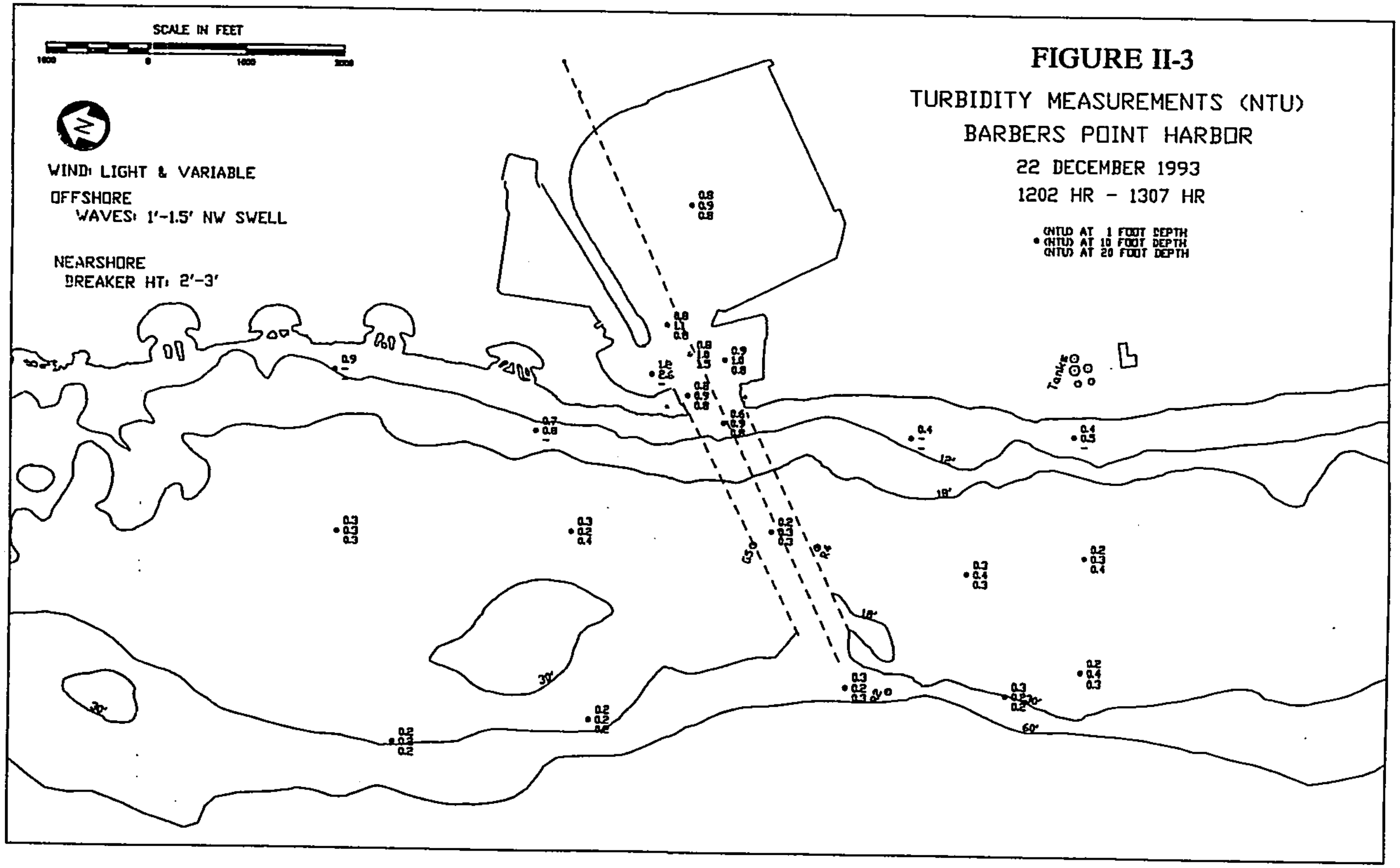

FIGURE II-3

TURBIDITY MEASUREMENTS (NTU)
BARBERS POINT HARBOR
22 DECEMBER 1993
1202 HR - 1307 HR

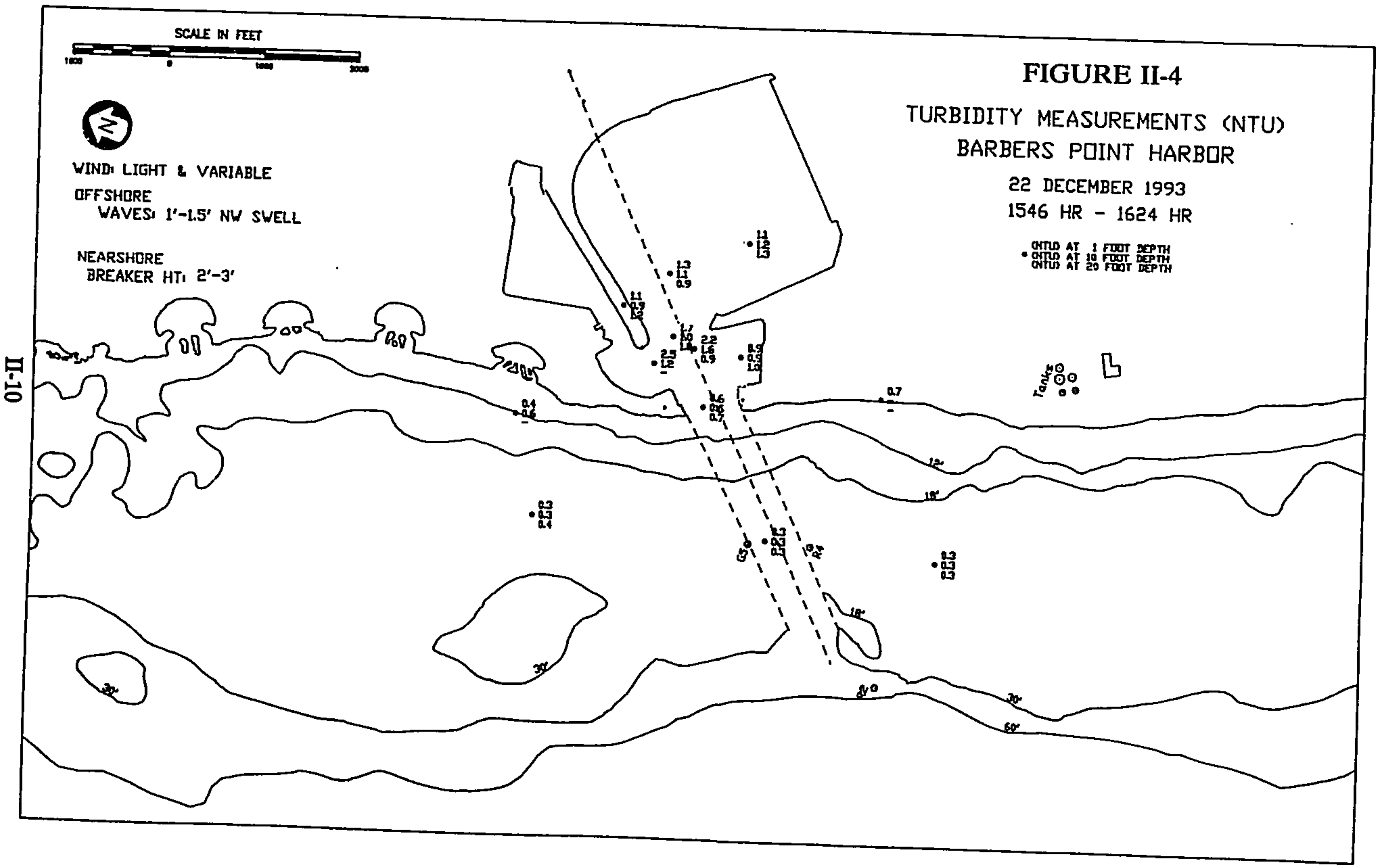

FIGURE II-4

TURBIDITY MEASUREMENTS (NTU)
BARBERS POINT HARBOR
22 DECEMBER 1993
1546 HR - 1624 HR

Existing Turbidity Variations Within The Harbor Basin

During the field investigations the turbidity within the harbor basin was noted to vary quite significantly. The first variation was a result of ship and tug movement, and is illustrated on Figure II-1. In the harbor basin, two data sets are shown at one measurement station, corresponding to before and after a tug turned a deep draft vessel in preparation for leaving the harbor. The increase in turbidity as a result of prop wash was as follows:

	Turbidity (NTU)		
Depth (feet)	Before	After	Increase
1	0.9	2.7	1.8
10	1.4	1.6	0.2
20	1.0	4.8	3.8

The turbidity increase was most significant at the deepest sampling depth, as would be expected because it was bottom sediment being temporarily suspended by the prop wash. The turbidity plume was quite localized, dissipated within about an hour, and did not move out of the harbor basin. A similar double set of measurements made at the same time outside the harbor in the entrance channel showed no change in turbidity as the vessel exited the harbor.

During both field days the surface turbidity within the harbor basin was observed to increase significantly as the day progressed. The reason for this is unknown, however it was distinct and repeated both days. The change (increase) in turbidity between successive measurements on the two days is shown on Figures II-5 and II-6. The average (geometric mean) increase in turbidity from early to late in the day was 0.8 NTU. This illustrates the existing natural variability of ambient water turbidity in the harbor, and the variability alone greatly exceeds the Water Quality Standard applicable to the harbor basin. This natural turbidity variation was not typical outside of the harbor, and where it was noted was likely a function of wave action varying nearshore.

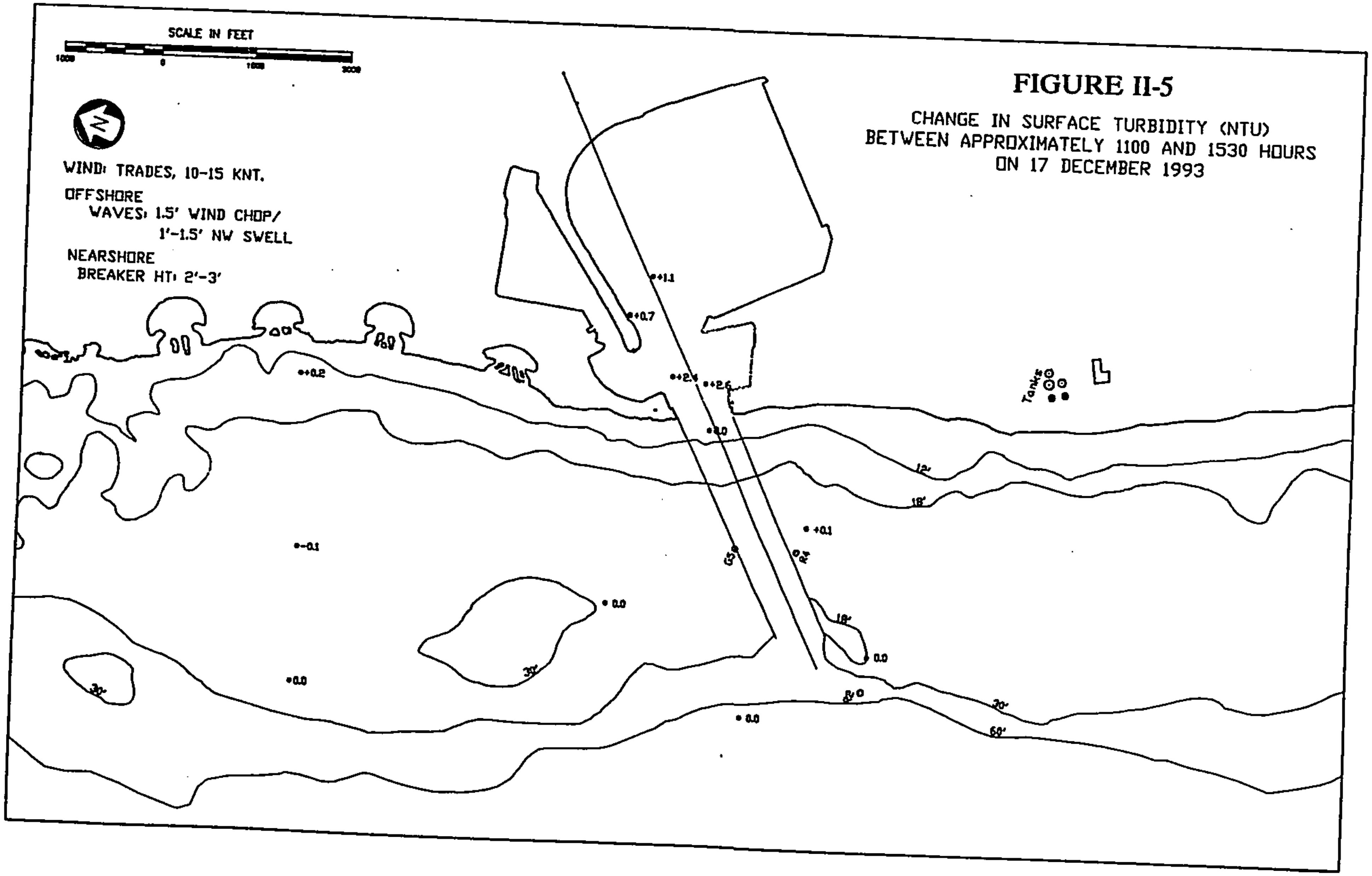

FIGURE II-5

CHANGE IN SURFACE TURBIDITY (NTU)
BETWEEN APPROXIMATELY 1100 AND 1530 HOURS
ON 17 DECEMBER 1993

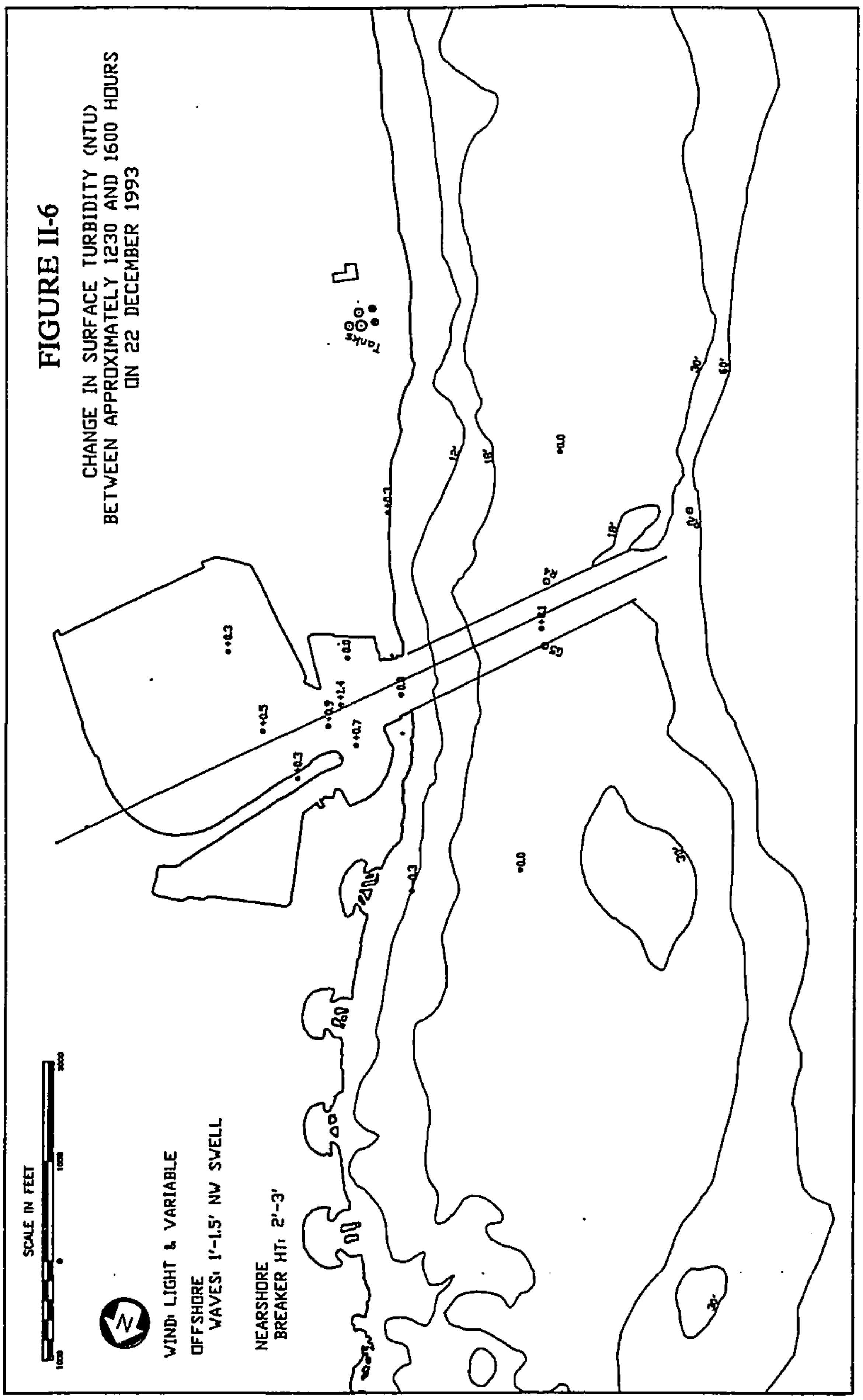

FIGURE II-6

CHANGE IN SURFACE TURBIDITY (NTU)
BETWEEN APPROXIMATELY 1230 AND 1600 HOURS
ON 22 DECEMBER 1993

III. COASTAL AND HARBOR CURRENTS

INTRODUCTION

Several long-term and/or detailed investigations of coastal currents in the vicinity of Barbers Point Harbor have previously been conducted, beginning in 1981. These include a 10-month data collection program conducted by Sea Engineering, Inc. to support design of the Ko 'Olina Resort shoreline features, and a two-month measurement program conducted by Sea Engineering to describe currents in the Barbers Point Harbor entrance channel. A detailed summary of existing current data for the west Coast of Oahu was prepared by Sea Engineering, Inc. (1991) for the U.S. Army Corps of Engineers, Honolulu Engineer District. In addition, current drogue measurements were made in December 1993 as part of this study to further define currents and circulation in the harbor basin and nearshore in the vicinity of the entrance.

The studies show that reversing tidal currents dominate the current structure. Flood tide currents flow predominantly to the southeast and ebb tide currents typically flow to the northwest. However, this is not always the case, and switches in the ebb and flood tide current directions occur relatively often and unpredictably. The average inshore (less than 30-foot depth) current speed is 12 to 15 cm/sec (0.25 knots).

The prevailing northeast tradewinds result in offshore winds at Barbers Point Harbor, with the direction varying from directly in-line with the entrance channel to an angle of approximately 30-degrees with the channel centerline. The harbor is located in a transition area for winds approaching directly over low elevation coastal land and the lee formed by the Waianae Mountains, and the effect of the tradewinds is moderate. Wind data from Barbers Point Naval Air Station shows mean wind speeds to be less than 10 knots, and the harbor area is typically less than this.

KO 'OLINA RESORT CURRENT STUDIES

During the period from May 1981 to February 1982, Sea Engineering, Inc. collected wave and current data that was used in support of design for the Ko 'Olina Resort (West Beach). The Ko 'Olina site is adjacent to the north side of Barbers Point Harbor, and all current data was collected within two miles of the harbor entrance channel.

Current meter data was collected at five locations off the project site, with one meter being rotated between the locations. Water depth varied from 29 to 42 feet, and the meter was typically in the bottom third of the water column. The current speed was typically 10 to 40 cm/sec (0.2 to 0.7 knots), flowing parallel to the bottom contours and reversing with the tide. Flood tide flow was typically to the southeast and ebb tide flow was to the northwest.

CURRENT INVESTIGATIONS IN THE BARBERS POINT HARBOR ENTRANCE CHANNEL

Sea Engineering, Inc. conducted investigations of the current structure in the harbor entrance channel under contract to Campbell Estate. Currents were measured in the channel for a two-month period in 1988, using insitu recording current meters supplemented by drogue measurements. One measurement station was located 1,800 feet offshore, in 24 feet of water on the north side of the channel, and after one month the meter was shifted seaward to a location 900 feet further offshore in 30 feet of water. Current speed and direction were recorded at 15-minute intervals. The current meter data is summarized in the speed/direction histograms on Table III-1.

Inspection of the current meter data indicates the following general current characteristics.

1. The prevailing currents are reversing tidal currents, with the primary directions of flow parallel to the shore and bottom contours.

2. Current speeds are less than 25 cm/sec (0.5 knots) 90 percent of the time. The drogue studies indicated that there is little vertical variation in current speed in the top 35 feet of the water column.

DECEMBER 1993 FIELD INVESTIGATIONS

Current and circulation investigations in the harbor basin and coastal waters adjacent to the entrance were conducted in December 1993, concurrent with the turbidity investigations. Current speed and path was measured by tracking the movement of drift drogues which extended from the surface to the 10-foot depth. The drogues were deployed and tracked during ebbing tide, when flow out of the harbor would be expected to be strongest. On December 17, the winds were 10-15 knot tradewinds blowinf offshore, and on December 22 the winds were light and variable. On both days there was a 1-1.5 foot north swell offshore, and nearshore breaker heights were 2-3 feet.

The drogue paths are shown on Figures II-1 and III-2, for December 17 and 22, respectively. Current speeds in the harbor basin and at the mouth varied between 0.8 and 0.25 ft/s on both days, but were more directionally consistent toward the mouth with the tradewinds. The average speed in the harbor basin was 0.15 ft/s.

Offshore, the current was strong and very directionally consistent on December 17, setting north parallel to the coast at an average speed of about 0.8 ft/s. On December 22, the current in the vicinity of the harbor entrance channel was less consistent both in speed and direction, setting in a southerly direction with a definite onshore component, with an average speed of about 0.3 ft/s. The speed and direction variability measured by the drogues is consistent with other long term measurements, as shown on Table III-1.

TABLE III-1
BARBERS POINT HARBOR ENTRANCE CHANNEL CURRENT SPEED AND DIRECTION JULY 29 TO OCTOBER 3, 1988

PERCENT FREQUENCY (%)

SITE: ENTRANCE CHANNEL OF BARBERS POINT HARBOR METER/WATER DEPTH: 12/24 DATE: 7/29/88 - 9/1/88

SPEED (CM/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0- 5.0	0.9	0.7	1.2	1.0	0.7	0.7	1.2	0.7	1.0	0.7	0.6	0.4	0.4	0.2	0.7	0.4	11.4
5.0- 10.0	1.8	1.5	1.2	1.8	2.1	2.0	3.1	3.8	2.0	1.3	0.9	0.4	0.6	0.8	1.2	1.8	26.3
10.0- 15.0	2.9	2.0	0.8	0.6	1.2	2.2	4.5	3.9	1.8	0.4	0.4	0.2	0.2	0.8	1.7	3.0	26.8
15.0- 20.0	1.0	0.7	0.2	0.2	0.4	2.3	4.1	3.3	0.6	0.1	0.0	0.0	0.1	0.3	1.5	4.0	18.9
20.0- 25.0	0.7	0.1	0.1	0.0	0.1	0.8	2.1	1.7	0.1	0.1	0.1	0.0	0.1	0.2	1.2	3.3	10.4
25.0- 30.0	0.4	0.1	0.0	0.0	0.1	0.1	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.5	4.2
30.0- 35.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.0	1.7
35.0- 40.0	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	0.1	0.1	0.1	0.3
TOTAL	7.7	5.0	3.5	3.7	4.6	8.3	15.9	14.4	5.4	2.5	2.0	1.0	1.2	2.4	7.3	15.2	100.0
AV. SPD	12.5	10.6	8.1	7.6	9.6	13.1	14.0	13.9	9.5	7.6	7.4	6.9	8.1	12.0	15.3	18.0	

THE TOTAL NUMBER OF DATA : 1636
THE RANGE OF CURRENT SPEED (CM/S): 0.3 - 39.9

PERCENT FREQUENCY (%)

SITE: ENTRANCE CHANNEL OF BARBERS POINT HARBOR METER/WATER DEPTH: 12/24 DATE: 9/2/88 - 9/13/88

SPEED (CM/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0- 5.0	1.0	0.4	0.0	0.0	0.0	0.2	1.0	0.8	0.2	0.6	0.6	0.4	0.4	0.2	0.4	0.4	6.4
5.0- 10.0	2.7	1.2	0.8	1.4	1.4	2.3	1.9	1.0	1.0	0.4	0.8	0.0	1.0	1.6	2.1	2.7	22.1
10.0- 15.0	2.5	1.0	0.4	0.6	0.6	1.9	4.5	2.1	0.6	1.0	0.2	0.4	0.6	1.6	4.1	5.4	27.1
15.0- 20.0	1.7	0.4	0.4	0.8	0.6	3.3	5.8	2.1	1.4	0.4	0.2	0.0	0.2	1.7	3.9	3.9	26.7
20.0- 25.0	0.4	0.0	0.0	0.0	0.0	0.8	2.9	1.7	0.0	0.0	0.0	0.0	0.0	0.6	2.3	2.7	11.4
25.0- 30.0	0.2	0.0	0.0	0.0	0.2	0.6	0.2	0.4	0.0	0.2	0.0	0.0	0.0	0.2	0.8	1.4	4.1
30.0- 35.0	0.2	0.0	0.0	0.0	0.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	1.9
35.0- 40.0	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	0.2
TOTAL	8.7	2.9	1.6	2.7	2.7	9.7	16.5	8.3	3.1	2.5	1.7	0.8	2.1	5.6	14.1	16.9	100.0
AV. SPD	12.5	9.5	11.1	11.6	12.7	15.7	15.1	15.3	12.2	11.1	7.1	8.0	9.1	13.9	16.1	16.1	

THE TOTAL NUMBER OF DATA : 516
THE RANGE OF CURRENT SPEED (CM/S): 1.0 - 36.3

PERCENT FREQUENCY (%)

SITE: ENTRANCE CHANNEL OF BARBERS POINT HARBOR METER/WATER DEPTH: 18/30 DATE: 9/13/88 - 10/3/88

SPEED (CM/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
0.0- 5.0	0.2	0.1	0.2	0.2	0.5	0.2	0.5	0.1	0.4	0.1	0.2	0.3	0.1	0.0	0.3	0.3	3.9
5.0- 10.0	1.0	0.9	1.0	1.3	2.5	2.0	2.7	1.4	0.5	0.2	0.2	0.5	0.3	0.1	1.5	1.5	17.7
10.0- 15.0	1.5	1.2	1.7	2.6	2.5	6.0	4.8	2.9	0.6	0.3	0.2	0.0	0.3	0.9	2.0	4.0	31.5
15.0- 20.0	1.5	0.6	1.3	1.3	2.5	4.4	5.1	1.0	0.4	0.0	0.1	0.3	0.2	0.6	2.8	3.7	25.8
20.0- 25.0	1.2	0.3	0.4	0.3	0.8	1.8	3.0	0.3	0.1	0.0	0.0	0.0	0.1	0.5	2.1	1.9	12.9
25.0- 30.0	0.4	0.0	0.3	0.1	0.2	0.8	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.7	5.9
30.0- 35.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	1.4
35.0- 40.0	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	0.1	0.4	0.3	0.9
40.0- 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	0.1	0.1
TOTAL	5.8	3.1	5.1	5.8	9.1	15.2	17.7	6.1	2.1	0.6	0.7	1.2	1.0	2.3	11.2	13.1	100.0
AV. SPD	15.3	12.5	14.9	12.9	13.1	15.0	15.8	13.4	10.2	8.6	9.2	8.9	11.3	16.9	18.8	17.2	

THE TOTAL NUMBER OF DATA : 956
THE RANGE OF CURRENT SPEED (CM/S): 1.2 - 41.8

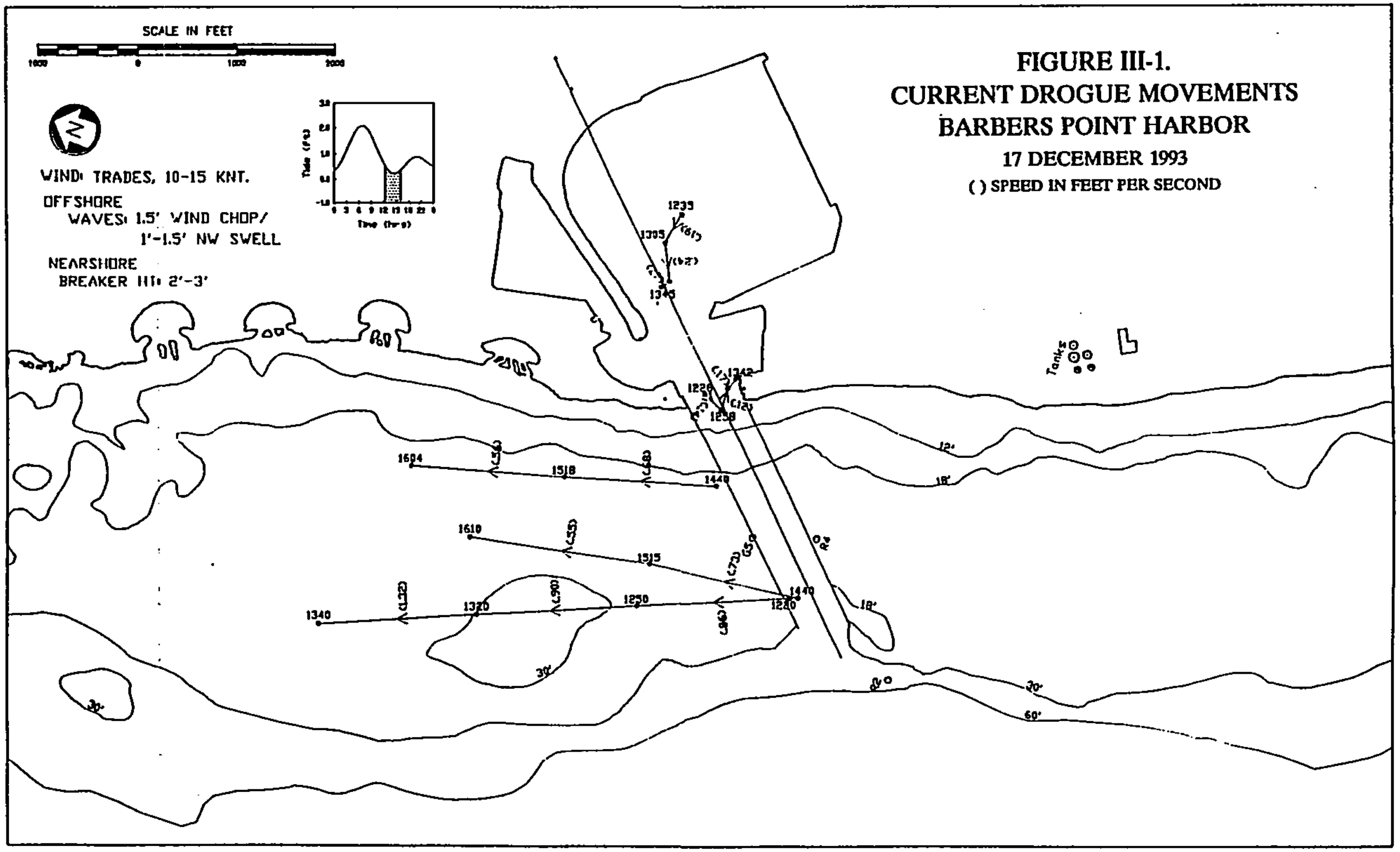

FIGURE III-1.
CURRENT DROGUE MOVEMENTS
BARBERS POINT HARBOR
17 DECEMBER 1993
( ) SPEED IN FEET PER SECOND

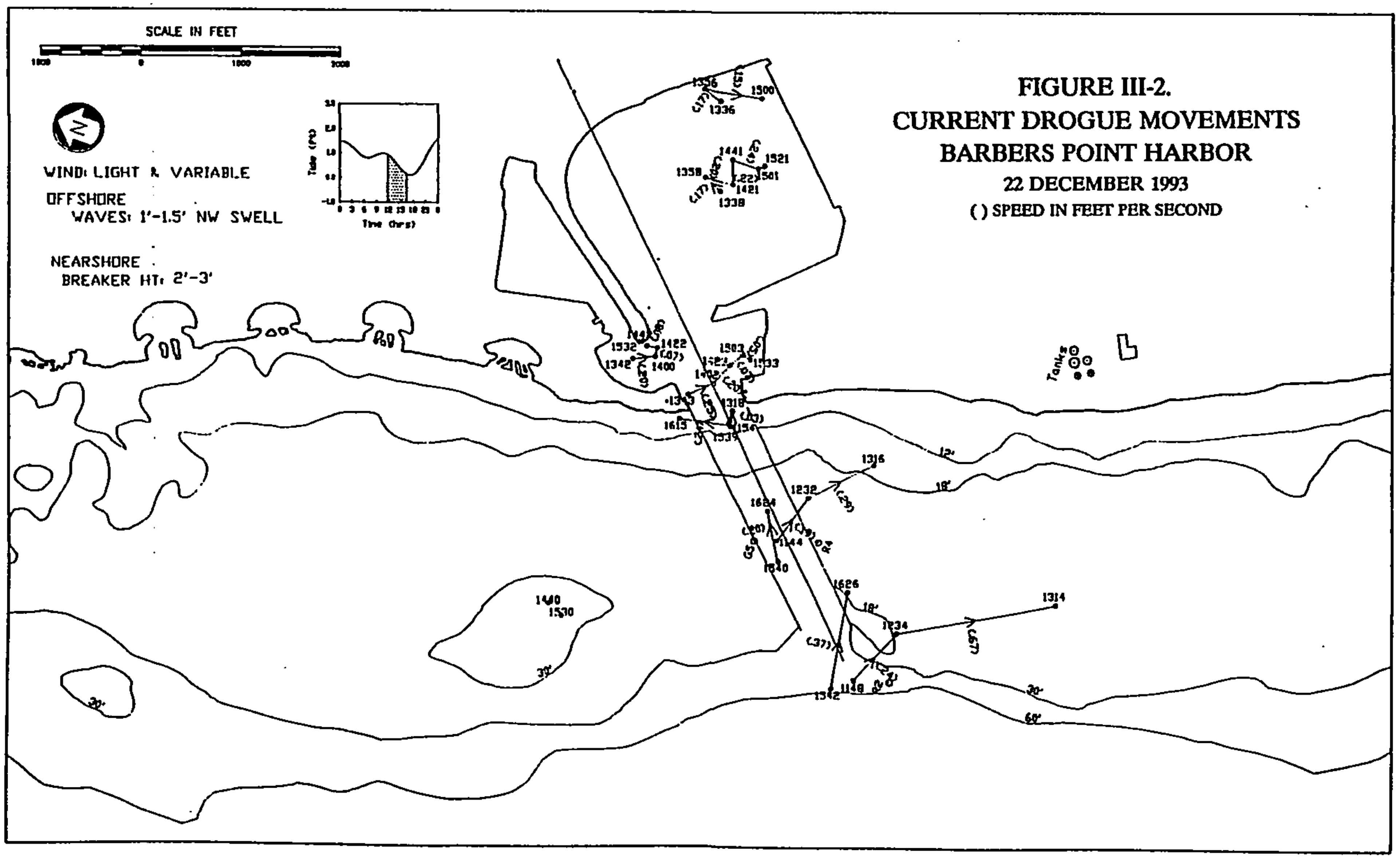

FIGURE III-2.
CURRENT DROGUE MOVEMENTS
BARBERS POINT HARBOR
22 DECEMBER 1993
( ) SPEED IN FEET PER SECOND

IV. NUMERICAL MODEL METHODOLOGY AND RESULTS

INTRODUCTION

The potential impact in the harbor basin and nearshore coastal waters of suspended solids loading in the water column as a result of dredging for the proposed harbor improvements can be assessed using numerical modeling techniques. The extent of detailed information obtained during monitoring of previous harbor dredging, coupled with the detailed current studies in the harbor vicinity, provides project specific data for model calibration. Pertinent information is also available from prior investigation during other harbor dredging projects in Hawaii. The modeling results of suspended solids plume dilution and transport can then be used to predict turbidity impacts on coastal waters during the proposed project.

Several dredging methodologies may be employed for construction of the harbor basin expansion. The construction plans and specifications for the existing harbor did not specify a dredging methodology to be used, they did, however, specify criteria to be met, including water quality impacts during dredging. It was anticipated that either mechanical (backhoe or clamshell) or hydraulic dredging would be used, however the methodology to be employed was left up to the discretion of the individual bidders. The successful bidder utilized large backhoes to excavate the harbor basin, with virtually the entire basin completed before a plug left in the entrance channel was removed and the basin connected to the sea. The offshore entrance channel dredging, plug removal, and some clean up work in the basin was accomplished with a barge mounted clamshell dredge.

It is anticipated that the proposed basin expansion construction methodology will again be left up to each bidder, with only performance criteria specified. Mechanical dredging similar to that employed previously is a likely methodology, and on-land area will be available for settling ponds should a contractor wish to employ hydraulic dredging equipment. Monitoring during construction of the existing harbor showed the greatest suspended solids loading in the water column to have occurred during operations such as clamshell dredging to remove the entrance channel plug and connect the inland excavated basin to the sea. For prediction of potential worst case construction impacts it is thus considered reasonable to evaluate suspended solids and turbidity transport and dilution resulting from exposed clamshell dredging in the vicinity of the basin expansion area. If this can be shown to not result in significant adverse impact, then other dredging activities, such as hydraulic dredging or dredging behind a plug or silt screen dike, which would be expected to have less potential impact, should also be acceptable.

The model employed is based on methodology initially developed by Brooks (1959) for estimating plume dilution, and discussed in detail in Grace (1978) and Fischer et al. (1979). The model basically estimates suspended solids plume spread and centerline concentration decrease by mixing and transport in a uniform current flow, coupled with a concentration decrease by settling due to particle fallout. The modeling is done in two steps. Step 1 is used to assess change in turbidity within the harbor basin and estimate an initial concentration at the harbor mouth. It describes suspended solids spread within the existing harbor basin, and incorporates settling of coarser sediments as they are transported by current within the basin. Step 2 of the model calculates plume dilution and transport by coastal currents and fallout of the finer material to estimate impacts to nearshore water quality. Details of the modeling methodology, assumptions used, and the results are presented in the following paragraphs.

MODEL METHODOLOGY

The Brooks Model estimates plume spread and centerline concentration by mixing in a uniform current flow (Grace, 1978; Fischer et al., 1979). The analysis assumes that vertical mixing and mixing in the direction of the current are negligible, that the effluent plume has the same density as the ambient water body and moves with the current system, and that mixing in the lateral direction can be described by the diffusion process and a diffusion coefficient. The assumption of uniform current flow is important because it restricts application of the model to the water layers characterized by uniform flow, or to time periods between tidal current reversals (about six hours for Hawaii's semi-diurnal tide).

Basic Equations

The Brooks Model assumes that the initial and subsequent diffusion coefficients are given by the following equations:

$$D_o = \alpha B^n$$

and

$$D = \alpha L_x^n$$

where,
D_o = initial diffusion coefficient
D = diffusion coefficient
α, n = empirical constants
B = initial plume width
L_x = nominal plume width ($=(2\sqrt{3})\sigma$).

The value of the exponent n is either 0 (constant diffusion coefficient, typical of small confined coastal areas or estuaries), 1 (typical of coastal situations) or 4/3 (which conforms to Richardson's Law and is typical of open ocean situations). The Brooks Model calculates the rate of decrease of the centerline concentration and the spread of the turbid plume using the following equations:

$$C_x/C_i = \mathrm{erf}\{[1.5/((L_x/B)^2-1)]^{1/2}\}$$

$$L_x/B = [1+2\beta(x/B)]^{1/2} \qquad \text{for } n=0$$

$$L_x/B = [1+\beta(x/B)] \qquad \text{for } n=1$$

$$L_x/B = [1+2\beta(x/B)/3]^{3/2} \qquad \text{for } n=4/3$$

where,

C_x = centerline concentration at a distance x
C_i = initial concentration at x=0
erf{ } = error function
$\beta = 12D_o/(uB)$
u = current speed.

In this study we generalized the above plume spread equations as shown below and used the equation:

$$L_x/B = [1+(2-n)\beta(x/B)]^{1/(2-n)}.$$

Decrease in Concentration Due to Sediment Fallout

The above equations are for conservative substances. For non-conservative substances, Brooks gives the following equation for the decrease of concentration due only to settling (in Grace, 1978):

$$C_x/C_i = \exp(-k_0 t)$$

Where, k_0 = sink rate
t = time.

The reduction in plume concentration due to particle settling can be estimated by the following equation and by expressing the settling rate as $k_0=w/d$:

$$C_x/C_i = \exp(-wt/d)$$

where, w = fall velocity
d = depth of water.

Fall velocity depends primarily on particle size, and can be approximated by using the following equation (Shore Protection Manual, U.S. Department of the Army, 1984):

$$w = (\gamma_s/\gamma - 1)gd_{50}^2/(18\nu)$$

where, γ_s = specific gravity of suspended sediment (use 2.72 for calcite)
γ = specific gravity of sea water (use 1.022)
g = acceleration of gravity
d_{50} = median grain size
ν = kinematic viscosity of sea water (use 8.5×10^{-3} cm^2/s)

The theoretical sedimentation rate is determined by taking the derivative of the above equation for the concentration deduction due to the sediment fallout with respect to time, t, and multiplying the result by the depth of the plume, d. The sedimentation rate is simply a product of the fall velocity and the concentration reduction due to the sediment fallout, and it is given by:

$$\text{Sedimentation Rate} = w\, C_i \exp(-wt/d).$$

The equation gives the theoretical sedimentation rate of sediment suspended in a quiet water column. It does not include the process of stirring and re-suspension of bottom sediment by waves and currents, which occurs virtually all the time in the nearshore coastal waters in the project vicinity. Thus, the sedimentation rate estimated here represents a very conservative, worst case situation, which would in actuality not be expected to be evident on the nearshore ocean bottom due to additional transport and concentration reduction due to waves and currents.

The total concentration decrease for a non-conservative substance such as temporarily suspended solids from dredging activity is then estimated by multiplying the concentration change due to diffusion by the concentration change due to sediment fallout.

Key Variables

The key variables for the modeling analysis are the diffusion coefficient, initial plume concentration, suspended sediment size, and current speed; as discussed below.

Empirical Constant α: The constant α is an empirically derived constant. Okubo (1974, In Fischer et al., 1979) give an estimate for α for engineering purposes in the following range:

$$0.002 \leq \alpha \leq 0.01 \ \ cm^{2/3}/s$$

or

$$0.74 \leq \alpha \leq 3.7 \ \ ft^{2/3}/hr.$$

According to Koh and Brooks (1975, In Grace, 1978), the approximate range for α is:

$$1.5 \times 10^{-4} \leq \alpha \leq 5 \times 10^{-3} \ \ ft^{2/3}/s$$

or

$$0.54 \leq \alpha \leq 18 \ \ ft^{2/3}/hr.$$

Pearson (1961, In Grace, 1978) suggested $\alpha = 0.001$ $ft^{2/3}/s$ or 3.6 $ft^{2/3}/hr$.

In this study we used Pearson's suggested value of 3.6 $ft^{2/3}/hr$ for α.

Empirical Value n: The value n is an exponent of the length scale of the turbid field which determines the rate of diffusion. Values of n are typically 0 for small confined coastal areas or estuaries, 1 for coastal situations, and 4/3 for open ocean situations.

Sullivan and Gerritsen (1972) determined dispersion coefficients using sedimentation data obtained in their dredging operation monitoring study at Kawaihae Harbor, Hawaii. Their results show that the approximate diffusion coefficient was 0.4 m^2/s or 15000 ft^2/hr. Using the effective width of the harbor (about 1000 ft) for the size of the eddies, a value of n is estimated to be 1.2 with a constant α of 3.6.

Approximate dimensions of Kawaihae harbor are 1500 feet wide, 2000 feet long and 35 feet deep with an entrance channel width of about 400 feet. Barbers Point harbor is about 2200 feet wide, 2100 feet long and 38 feet deep with an entrance channel width of 500 feet. Because the size of Barbers Point Harbor is comparable to the size of Kawaihae Harbor, the value for n of 1.2 from the Kawaihae Harbor diffusion coefficient calculation is considered applicable to Barbers Point Harbor.

Initial Concentration of Turbid Plume: Reported values of turbid plume concentrations caused by dredging operations vary widely, and depend on dredge type, location in the water column, distance from the dredge and ambient conditions. Herbich (1992) indicates that suspended solids concentrations may range from 30 to 80 mg/l at a distance of 200 feet from an enclosed clamshell dredge. Sustar et al. (1976) report suspended solids of 70 mg/l along the centerline of a clamshell dredge plume.

AECOS, Inc. (1986) reports their dredge operation monitoring study at Barbers Point harbor between 1982 and 1984. From a total of 246 surface and near bottom measurements reported by AECOS, seven cases of suspended solids concentrations over 40 mg/l were measured at a distance of about 500 feet from the source during the construction of Barbers Point Harbor. The maximum measured suspended solids concentration was 64 mg/l near the harbor bottom.

On February 1, 1983, clamshell dredging was performed in the barge harbor from 10 am to noon. During excavation of the entrance channel offshore, excavated material was brought into the barge harbor by scow, bottom dumped, and the excavated for removal to stockpiles on land. This sequence of dumping and rehandling in the water is an extreme case of agitating the material that will not occur during the proposed basin enlargement project. Right after the dredging operation, turbidity measurements were taken at the sampling stations in the harbor. An aerial photo taken on this day is also available, which shows an obvious turbidity plume in the dredge vicinity. The maximum turbidity measured on the day is 27 NTU. This turbidity data can be converted to a suspended solids load of 45 mg/l using the following relationship derived by AECOS (1986) (see Section II of this report):

$$\text{Suspended Solids (mg/l)} = 1.59\ (\text{NTU}) + 1.88$$

Based on the above information, two initial concentrations are considered in the model analysis: an initial suspended sediment concentration of 70 mg/l for an initial cloud size of 60 feet in width, and 40 mg/l for a initial plume size of 300 feet. These concentrations are considered to be very conservative, worst case conditions for the proposed basin enlargement project. The rationale for using such conservtive values is that if this doesn't result in a significant problem, then there is very little chance of a turbidity problem resulting from the proposed project.

Suspended Sediment Grain Size and Fall Velocity: Grain size characteristics for suspended solids at Barbers Point Harbor is not available, however similar coralline (limestone) material was dredged at Kawaihae Harbor for which a grain size distribution is available. Sullivan and Gerritsen (1972) report suspended solids grain size distribution near the discharge from a hydraulic dredge, and this distribution is considered to reasonably correspond to suspended grain size characteristics near a dredge source. A typical suspended grain size distribution during the dredging at Kawaihae Harbor is shown on Table IV-1.

The table shows that sediments greater than 0.0625 mm are not present, and thus immediately fall out. Over 50 percent of the solids are between 0.0221 mm and 0.0313 mm, and the median grain size is 0.0254 mm.

TABLE IV-1. TYPICAL SUSPENDED SEDIMENT DISTRIBUTION DURING KAWAIHAE HARBOR DREDGING OPERATION (1972)

Phi Value (ϕ)	Size (mm)	Weight Frequency (%)	Cumulative Frequency (%)
4.0-4.5	0.0625-0.0442	3	3
4.5-5.0	0.0442-0.0313	5	8
5.0-5.5	0.0313-0.0221	62	70
5.5-6.0	0.0221-0.0156	20	90
6.0-6.5	0.0156-0.0110	4	94
6.5-7.0	0.0110-0.0078	4	98
7.0-7.5	0.0078-0.0055	1	99
7.5-8.0	0.0055-0.0039	1	100
>8.0	<0.0039	0	-

TABLE IV-2. FALL VELOCITY FOR SUSPENDED SOLIDS

Phi Value (ϕ)	Grain Size (mm)	Fall Velocity	
		(ft/s)	(m/hr)
4.5	0.0442	6.8×10^{-3}	7.5
5.0	0.0313	3.4×10^{-3}	3.7
5.5	0.0221	1.7×10^{-3}	1.9
6.0	0.0156	8.5×10^{-4}	0.93
6.5	0.0110	4.2×10^{-4}	0.46
7.0	0.0078	2.1×10^{-4}	0.23
7.5	0.0055	1.1×10^{-4}	0.12
8.0	0.0039	5.3×10^{-5}	0.058

Fall velocities for the respective grain sizes are calculated and shown on Table IV-2. The fall velocities are used in the computation of suspended solid concentration reduction due to sediment fallout.

Current Speed in the Harbor: Drogue measurements of current speed and direction in the harbor basin and near the entrance during field investigations were not consistently related to tide changes. Theoretical currents at the harbor mouth can be calculated using methodology for calculating the average cross-sectional velocities in an inlet channel as presented in the Shore Protection Manual (U.S. Department of the Army, 1984). Important parameters for these calculations include the following:

Inner harbor surface area	=	59,000,000 ft^2
Channel width	=	600 ft
Channel length	=	1000 ft
Channel depth	=	40 ft
Tidal period	=	12.4 hrs
Mean tidal range	=	1.2 ft
mean diurnal range	=	1.9 ft

The equations for calculating the average and maximum tidal current speeds in the channel are the following:

$$V_m' = A_c T V_m / (2\pi \alpha_s A_b)$$

$$K_1 = \alpha_s A_b F / (2 L A_c)$$

$$K_2 = (2\pi/T)\{L A_b/(g A_c)\}^{1/2}$$

where,
V_m = maximum flow speed in the channel
A_c = cross-sectional area of the harbor entrance (=Bd)
A_b = harbor surface area
α_s = tidal amplitude in open ocean
α_b = tidal amplitude in the harbor
L = channel length
T = tidal period
F = $k_{en} + k_{ex} + fl/(4R)$
k_{en} = entrance-loss coefficient (use 0.2)
k_{ex} = exit-loss coefficient (use 1.0)
f = resistance coefficient (use 0.03)
R = hydraulic radius
B = channel width
d = water depth in the channel
g = gravitational acceleration.

The Shore Protection Manual presents a graphical relationship for the parameter V_m' versus K_1 and K_2. The average current speed is approximated equal to $(2/3)V_m$.

For a mean diurnal range of 1.9 feet, the calculated average current speed in the entrance channel at the harbor mouth is 0.22 ft/s and the peak speed is 0.33 ft/s. For a mean tidal range of 1.2 feet, the calculated average current speed is 0.14 ft/s and the peak speed is 0.21 ft/s. Theoretically, during ebb tide the flow would be out of the harbor, and during flood tide the flow would be into the harbor. In reality, the groundwater flow intercepted by the basin and the prevailing offshore winds result in at least a surface flow out of the harbor most of the time.

Inside the harbor the overall average current speed would be expected to be less than 0.2 ft/s. Based on drogue speeds observed in the harbor, current speeds across the harbor basin of 0.05 ft/s and 0.1 ft/s are considered representative of typical and worst case, respectively, average speeds during typical prevailing trade wind conditions.

Current Speed Outside the Harbor: Sea Engineering, Inc. (1991) measured currents in the Barbers Point Harbor entrance channel from July 1988 to October 3, 1988. Table IV-3 shows average current speed versus direction measured about 1800 feet offshore from the mouth of the harbor. The current data can be used in the model to calculate changes in suspended sediment concentration by direction in a turbid plume exiting the harbor mouth.

MODEL RESULTS

For comparison with State Water Quality Standards, the final model calculation results are given in turbidity units (NTU) using the following relationships:

For suspended solids concentration > 6 mg/l:

$$\text{Turbidity (NTU)} = 0.629[\text{Concentration (mg/l)}] - 1.18$$

and

For suspended solids concentration ≤ 6 mg/l:

$$\text{Turbidity (NTU)} = 0.220[\text{Concentration (mg/l)}]^{1.376}$$

The first equation is a rearrangement of the relationship derived by AECOS, Inc., and the second equation was determined from the data presented by AECOS, Inc. to accommodate small values of turbidity and concentration.

CORRECTION

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

discharge from a hydraulic dredge, and this distribution is considered to reasonably correspond to suspended grain size characteristics near a dredge source. A typical suspended grain size distribution during the dredging at Kawaihae Harbor is shown on Table IV-1.

The table shows that sediments greater than 0.0625 mm are not present, and thus immediately fall out. Over 50 percent of the solids are between 0.0221 mm and 0.0313 mm, and the median grain size is 0.0254 mm.

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5.5-6.0	0.0221-0.0156	20	90
6.0-6.5	0.0156-0.0110	4	94
6.5-7.0	0.0110-0.0078	4	98
7.0-7.5	0.0078-0.0055	1	99
7.5-8.0	0.0055-0.0039	1	100
>8.0	<0.0039	0	-

TABLE IV-2. FALL VELOCITY FOR SUSPENDED SOLIDS

Phi Value (ϕ)	Grain Size (mm)	Fall Velocity	
		(ft/s)	(m/hr)
4.5	0.0442	6.8×10^{-3}	7.5
5.0	0.0313	3.4×10^{-3}	3.7
5.5	0.0221	1.7×10^{-3}	1.9
6.0	0.0156	8.5×10^{-4}	0.93
6.5	0.0110	4.2×10^{-4}	0.46
7.0	0.0078	2.1×10^{-4}	0.23
7.5	0.0055	1.1×10^{-4}	0.12
8.0	0.0039	5.3×10^{-5}	0.058

Fall velocities for the respective grain sizes are calculated and shown on Table IV-2. The fall velocities are used in the computation of suspended solid concentration reduction due to sediment fallout.

Current Speed in the Harbor: Drogue measurements of current speed and direction in the harbor basin and near the entrance during field investigations were not consistently related to tide changes. Theoretical currents at the harbor mouth can be calculated using methodology for calculating the average cross-sectional velocities in an inlet channel as presented in the Shore Protection Manual (U.S. Department of the Army, 1984). Important parameters for these calculations include the following:

Inner harbor surface area	=	59,000,000 ft^2
Channel width	=	600 ft
Channel length	=	1000 ft
Channel depth	=	40 ft
Tidal period	=	12.4 hrs
Mean tidal range	=	1.2 ft
mean diurnal range	=	1.9 ft

The equations for calculating the average and maximum tidal current speeds in the channel are the following:

$$V_m' = A_c T V_m / (2\pi \alpha_s A_b)$$

$$K_1 = \alpha_s A_b F / (2 L A_c)$$

$$K_2 = (2\pi/T)\{L A_b / (g A_c)\}^{1/2}$$

where,
V_m = maximum flow speed in the channel
A_c = cross-sectional area of the harbor entrance (=Bd)
A_b = harbor surface area
α_s = tidal amplitude in open ocean
α_b = tidal amplitude in the harbor
L = channel length
T = tidal period
$F = k_{en} + k_{ex} + fl/(4R)$
k_{en} = entrance-loss coefficient (use 0.2)
k_{ex} = exit-loss coefficient (use 1.0)
f = resistance coefficient (use 0.03)
R = hydraulic radius
B = channel width
d = water depth in the channel
g = gravitational acceleration.

The Shore Protection Manual presents a graphical relationship for the parameter V_m' versus K_1 and K_2. The average current speed is approximated equal to $(2/3)V_m$.

For a mean diurnal range of 1.9 feet, the calculated average current speed in the entrance channel at the harbor mouth is 0.22 ft/s and the peak speed is 0.33 ft/s. For a mean tidal range of 1.2 feet, the calculated average current speed is 0.14 ft/s and the peak speed is 0.21 ft/s. Theoretically, during ebb tide the flow would be out of the harbor, and during flood tide the flow would be into the harbor. In reality, the groundwater flow intercepted by the basin and the prevailing offshore winds result in at least a surface flow out of the harbor most of the time.

Inside the harbor the overall average current speed would be expected to be less than 0.2 ft/s. Based on drogue speeds observed in the harbor, current speeds across the harbor basin of 0.05 ft/s and 0.1 ft/s are considered representative of typical and worst case, respectively, average speeds during typical prevailing trade wind conditions.

Current Speed Outside the Harbor: Sea Engineering, Inc. (1991) measured currents in the Barbers Point Harbor entrance channel from July 1988 to October 3, 1988. Table IV-3 shows average current speed versus direction measured about 1800 feet offshore from the mouth of the harbor. The current data can be used in the model to calculate changes in suspended sediment concentration by direction in a turbid plume exiting the harbor mouth.

MODEL RESULTS

For comparison with State Water Quality Standards, the final model calculation results are given in turbidity units (NTU) using the following relationships:

For suspended solids concentration > 6 mg/l:

$$\text{Turbidity (NTU)} = 0.629[\text{Concentration (mg/l)}] - 1.18$$

and

For suspended solids concentration ≤ 6 mg/l:

$$\text{Turbidity (NTU)} = 0.220[\text{Concentration (mg/l)}]^{1.376}$$

The first equation is a rearrangement of the relationship derived by AECOS, Inc., and the second equation was determined from the data presented by AECOS, Inc. to accommodate small values of turbidity and concentration.

TABLE IV-3. AVERAGE CURRENT SPEED, DIRECTION, AND FREQUENCY IN THE ENTRANCE CHANNEL OF BARBERS POINT HARBOR
(Record Period: 7/29/88 - 9/1/88; Meter/Water Depth: 12/24 ft)
(From Sea Engineering, Inc. (1991))

Direction	Average Speed		Frequency (%)
	(cm/s)	(ft/s)	
N	12.5	0.41	7.7
NNE	10.6	0.35	5.0
NE	8.1	0.27	3.5
ENE	7.6	0.25	3.7
E	9.6	0.31	4.6
ESE	13.1	0.43	8.3
SE	14.0	0.46	15.9
SSE	13.9	0.46	14.4
S	9.5	0.31	5.4
SSW	7.6	0.25	2.5
SW	7.4	0.24	2.0
WSW	6.9	0.23	1.0
W	8.1	0.27	1.2
WNW	12.0	0.39	2.4
NW	15.3	0.50	7.3
NNW	18.0	0.59	15.2

Harbor Basin (Model Step 1)

Two processes act on the turbid plume as it is transported by current across the harbor basin: dispersion and suspended sediment fallout. These processes are assumed to be independent. The final concentrations at the harbor mouth are therefore computed by multiplying the concentration reductions from sediment settling and dispersion times the initial plume concentration. Concentration reductions due to sediment settling are shown in Tables IV-4 and IV-5, for a water depth of 38 feet in the harbor and a nominal 20 foot depth outside the harbor. The tables show changes in suspended solids concentration with time for each grain size. The last column gives overall relative concentrations for the grain size distribution as given in Table IV-1.

The results show that in the harbor 85% of the suspended material with grain size of 4.5ϕ (0.0442 mm) or greater will settle to the bottom within 3 hours, and 85% with grain size of 5.5ϕ (0.0221 mm) or greater will fallout within 12 hours. Overall suspended solids will decrease 55 percent from the initial concentration after 6 hours and 90 percent after 24 hours. After 48 hours only about 4 percent of the initial concentration of suspended sediment will still be in suspension. The overall suspended sediment concentration reduction due to settling is applied to the overall calculation of turbidity plume concentration reduction with time and transport distance from the source (or dredge site).

Four case studies of dredge plume concentration reductions due to transport, dilution and fallout are considered with the following variables:

Case Number	Initial Concentration (mg/l)	Initial Plume Width (feet)	Basin Current Speed (ft/s)
1	70	60	0.05
2	70	60	0.1
3	40	300	0.05
4	40	300	0.1

For the case studies two initial plume conditions and two current speeds within the basin were selected. The 0.05 ft/s current speed is considered reasonably representative of average, long duration flow across the harbor, considering flood and ebb tide reversals, groundwater inflow, wind and other variables whose effect on the harbor currents are beyond the scope of this study to quantify. In actuality, this current speed is likely

TABLE IV-4. RELATIVE CHANGE IN CONCENTRATION OF SUSPENDED SOLIDS DUE TO FALLOUT WITH TIME AND AVERAGE GRAIN SIZE OF THE SUSPENDED SOLIDS (WATER DEPTH = 38 FEET)

Time (hrs)	Grain Size (ϕ)									Average Grain Size (mm)
	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	All	
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0254
1	0.52	0.72	0.85	0.92	0.96	0.98	0.99	1.00	0.86	0.0188
2	0.27	0.52	0.72	0.85	0.92	0.96	0.98	0.99	0.75	0.0187
3	0.14	0.38	0.62	0.79	0.89	0.94	0.97	0.99	0.66	0.0181
4	0.08	0.27	0.52	0.72	0.85	0.92	0.96	0.98	0.57	0.0169
5	0.04	0.20	0.45	0.67	0.82	0.90	0.95	0.98	0.51	0.0167
6	0.02	0.14	0.38	0.62	0.79	0.89	0.94	0.97	0.45	0.0161
7	0.01	0.10	0.32	0.57	0.76	0.87	0.93	0.97	0.40	0.0158
8	0.01	0.07	0.27	0.53	0.72	0.85	0.92	0.96	0.36	0.0161
9	0.00	0.05	0.23	0.48	0.70	0.83	0.91	0.96	0.32	0.0152
10	0.00	0.04	0.20	0.45	0.67	0.82	0.90	0.95	0.29	0.0142
11	0.00	0.03	0.17	0.41	0.64	0.80	0.90	0.95	0.27	0.0158
12	0.00	0.02	0.14	0.38	0.62	0.79	0.89	0.94	0.24	0.0146
24	0.00	0.00	0.02	0.14	0.38	0.62	0.79	0.89	0.10	0.0116
48	0.00	0.00	0.00	0.02	0.15	0.38	0.62	0.79	0.04	0.0076

TABLE IV-5. RELATIVE CONCENTRATION OF SUSPENDED SOLIDS DUE ONLY TO THE FALLOUT AND AVERAGE GRAIN SIZE OF THE SUSPENDED SOLIDS (WATER DEPTH = 20 FEET)

Time (hrs)	Grain Size (φ)									Average Grain Size (mm)
	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	All	
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0254
1	0.29	0.54	0.74	0.86	0.93	0.96	0.98	0.99	0.76	0.0182
2	0.09	0.29	0.54	0.74	0.86	0.93	0.96	0.98	0.59	0.0175
3	0.03	0.16	0.40	0.63	0.80	0.89	0.94	0.97	0.47	0.0169
4	0.01	0.09	0.29	0.54	0.74	0.86	0.93	0.96	0.38	0.0158
5	0.00	0.05	0.22	0.47	0.68	0.83	0.91	0.95	0.31	0.0155
6	0.00	0.03	0.16	0.40	0.63	0.80	0.89	0.94	0.26	0.0155
7	0.00	0.01	0.12	0.34	0.59	0.77	0.88	0.94	0.22	0.0151
8	0.00	0.01	0.09	0.29	0.54	0.74	0.86	0.93	0.18	0.0129
9	0.00	0.00	0.06	0.25	0.50	0.71	0.84	0.92	0.16	0.0143
10	0.00	0.00	0.05	0.22	0.47	0.68	0.83	0.91	0.14	0.0135
11	0.00	0.00	0.03	0.19	0.43	0.66	0.81	0.90	0.12	0.0114
12	0.00	0.00	0.03	0.16	0.40	0.63	0.80	0.89	0.11	0.0110
13	0.00	0.00	0.02	0.14	0.37	0.61	0.78	0.88	0.10	0.0104
14	0.00	0.00	0.01	0.12	0.34	0.59	0.77	0.87	0.09	0.0100
15	0.00	0.00	0.01	0.10	0.32	0.59	0.75	0.87	0.08	0.0098
16	0.00	0.00	0.01	0.09	0.30	0.54	0.74	0.86	0.07	0.0096
17	0.00	0.00	0.01	0.07	0.27	0.52	0.72	0.85	0.07	0.0087
24	0.00	0.00	0.00	0.03	0.16	0.40	0.63	0.80	0.04	0.0074
48	0.00	0.00	0.00	0.00	0.03	0.16	0.40	0.63	0.02	0.0062

conservative with regard to uniform, overall flow. The 0.1 ft/s current speed is representative of the highest speed, or worst case, flow across the harbor basin. It represents current speed measured in the basin during the peak ebb tide flow. The use of this speed to represent average uniform flow in the harbor is very conservative.

Table IV-6 presents the results of the case studies for suspended solids concentration and turbidity changes with time within the harbor basin. The results are given in terms of centerline concentrations along the plume transport path. Isolines of the concentrations in excess (above) the ambient in the plume are shown on Figures IV-1 to IV-4. Although currents in the harbor are primarily tide-driven flows, as discussed in the previous paragraph the model considers only a uniform flow of unlimited duration toward the harbor mouth, and ignores tide changes (i.e. flood tide) which would slow transport across the harbor basin. The results are thus conservative with regard to suspended sediment transport away from the dredge area.

The excess concentration of suspended solids and turbidity above ambient conditions at the harbor mouth is shown on Table IV-7. The results illustrate that with a current speed of 0.05 ft/s the turbid plume would not reach the harbor mouth with suspended solids concentrations greater than 0.7 mg/l (0.13 NTU) above the ambient concentration. With a current speed of 0.1 ft/s the turbid plume would have a concentration less than about 2.6 mg/l (0.8 NTU) above ambient at the harbor mouth.

The mean ambient turbidity at the harbor mouth in December 1993 was 0.7 NTU, with measured variations between 0.6 and 0.9 NTU. Thus, under typical harbor basin current conditions, the dredging would be expected to result in turbidity changes at the harbor mouth that are about the same as the natural variability in ambient conditions. Even under worst case current and initial concentration conditions, the dredging is predicted to result in only an approximate doubling of the turbidity value above existing ambient conditions at the harbor mouth. However, this must be taken in context with regard to the natural variability in turbidity in harbor and coastal waters. For example, the average 1982 preconstruction turbidity at the harbor mouth was 3.3 NTU, about 5 times greater than was measured in 1993 during this study. Ship movements in the harbor can also result in more than doubling of turbidity within the harbor basin, as was measured during this study. In addition, for reasons not known, during the field investigations for this study the turbidity in the harbor basin was observed to increase by an averageof 0.8 NTU simply during the course of the day. Thus, the estimated dredging impace on turbidity is within the typical limits of natural variability for this site.

In addition, in order to minimize the opportunity for turbidity increase in the basin, excavation of the 1,100 by 1,100 foot basin expansion will be accomplished behind a dike of existing land as was done during initial harbor construction. Removal of the dike will occur as the last stage of the project, and is expected to require approximately one month to complete.

The excavation of approximately 56,000 cubic yards from Area B, at the south corner of the existing harbor basin, would be expected to have impacts of similar magnitude (or less due to the smaller volume to be excavated) than the removal of the dike.

Nearshore Coastal Waters (Model Step 2)

Using the results of Step 1 to define the initial suspended solids concentration in the nearshore coastal water at the harbor mouth, coupled with the detailed current speed and direction data available for the area near the harbor entrance and a different diffusion coefficient applicable to coastal water, the model is again used to evaluate the change in suspended solids concentration due to diffusion and settling as the material is transported by coastal currents.

TABLE IV-6. TURBIDITY AND SUSPENDED SOLIDS CONCENTRATION FOR THE CASE STUDIES (IN THE HARBOR)

Time (hours)	Cases 1 & 2		Cases 3 & 4	
	Peak Concentration (mg/l)	Turbidity (NTU)	Peak Concentration (mg/l)	Turbidity (NTU)
0	70.00	42.85	40.00	23.98
1	29.20	17.18	30.70	18.13
2	14.56	7.98	20.76	11.88
3	8.715	4.30	14.53	7.96
4	5.607	2.36	10.30	5.30
5	3.954	1.46	7.768	3.71
6	2.857	0.93	5.895	2.53
7	2.137	0.63	4.579	1.79
8	1.653	0.44	3.649	1.31
9	1.284	0.31	2.903	0.95
10	1.030	0.23	2.376	0.72
11	0.858	0.18	2.014	0.58
12	0.689	0.13	1.640	0.43
24	0.125	0.013	0.325	0.046

TABLE IV-7. EXCESS CONCENTRATIONS OF SUSPENDED SOLIDS FROM A DREDGING OPERATION IN THE HARBOR (AT THE HARBOR MOUTH)

Case No.	At Harbor Mouth		Elapsed Time (hours)
	Peak Concentration (mg/l)	Turbidity (NTU)	
1	0.3	0.04	18.9
2	1.2	0.28	9.4
3	0.7	0.13	18.9
4	2.6	0.82	9.4

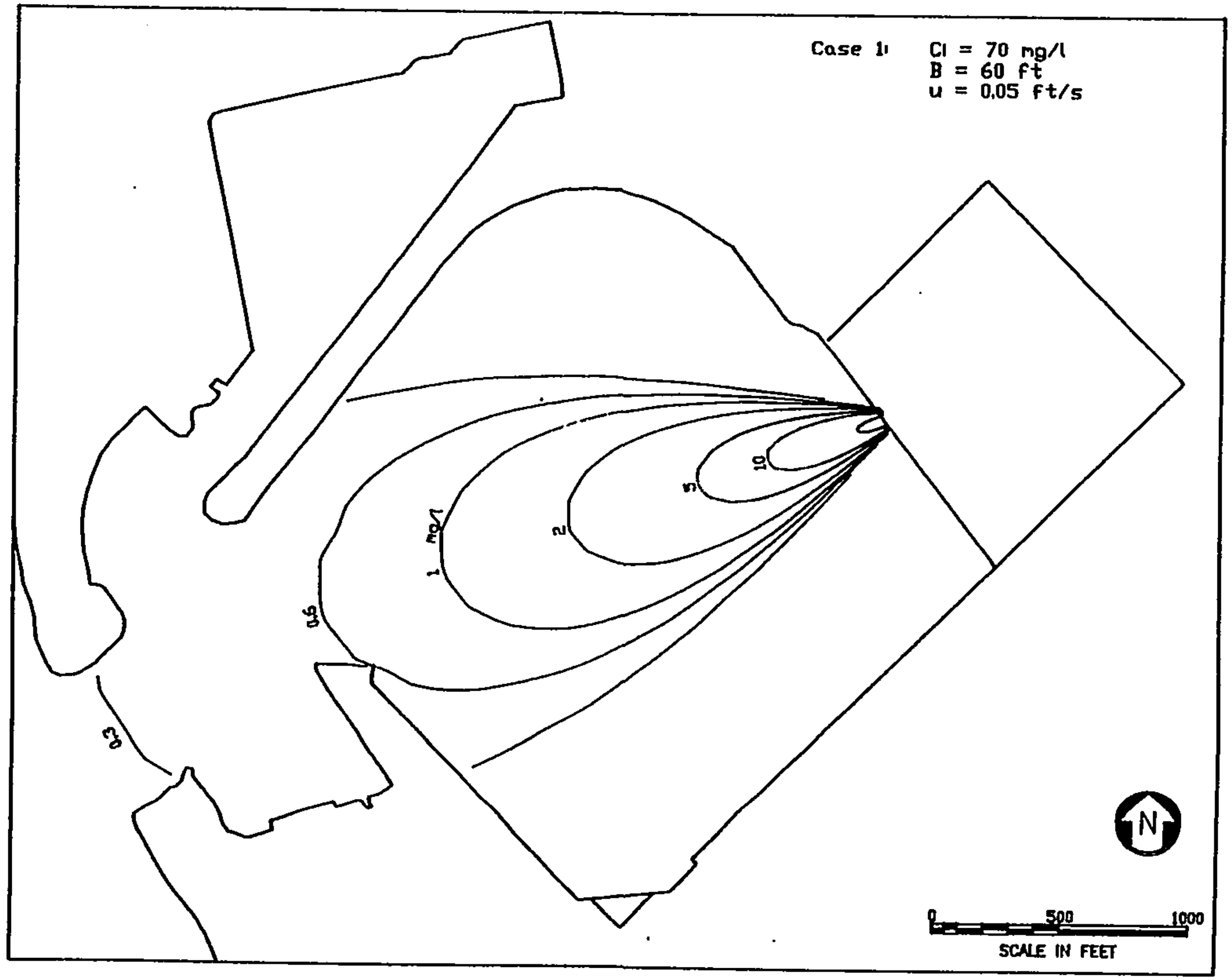

FIGURE IV-1. HARBOR BASIN/MODEL CASE 1: ISOLINES OF EXCESS SUSPENDED SOLIDS CONCENTRATION ABOVE AMBIENT

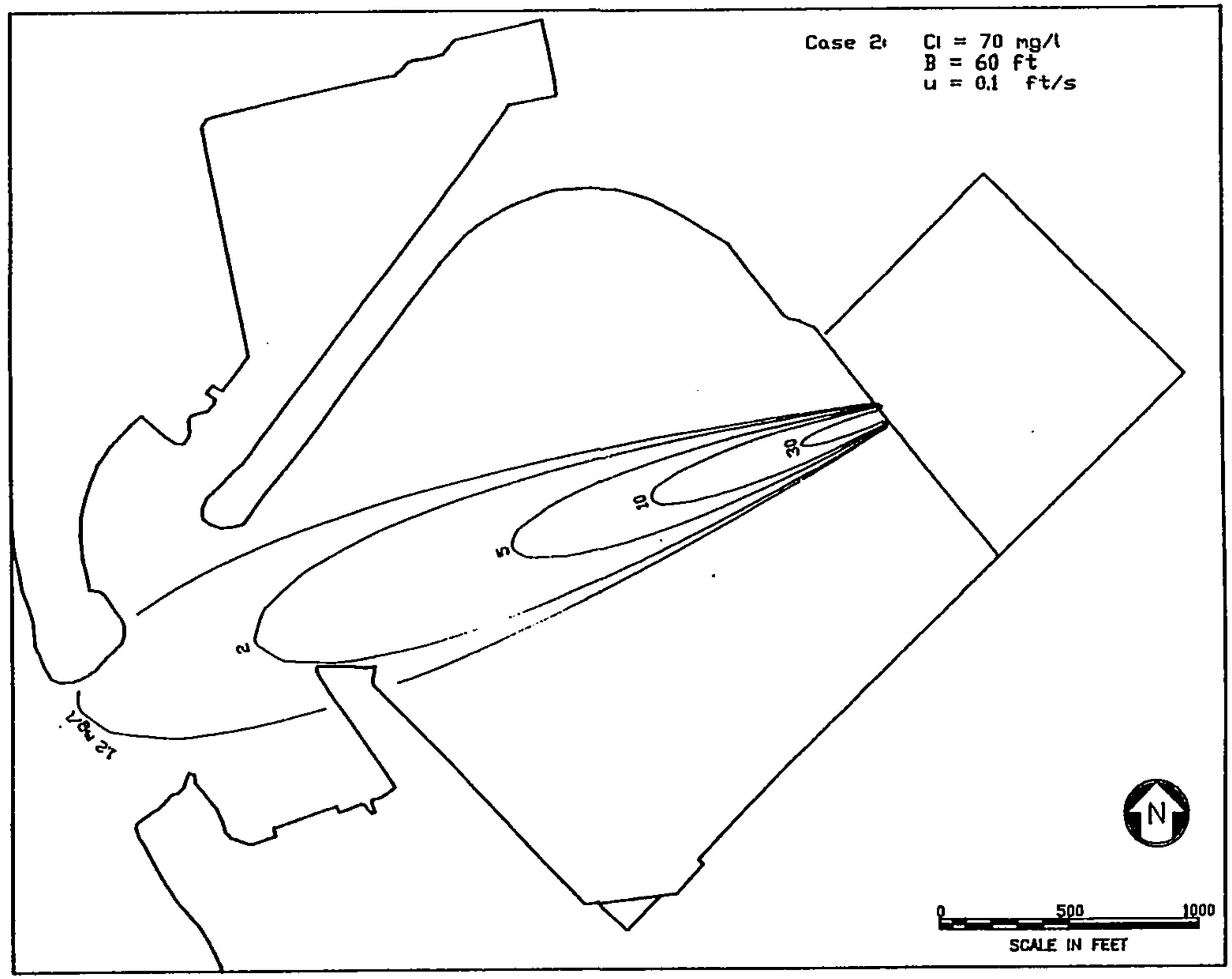

FIGURE IV-2. HARBOR BASIN/MODEL CASE 2: ISOLINES OF EXCESS SUSPENDED SOLIDS CONCENTRATION ABOVE AMBIENT

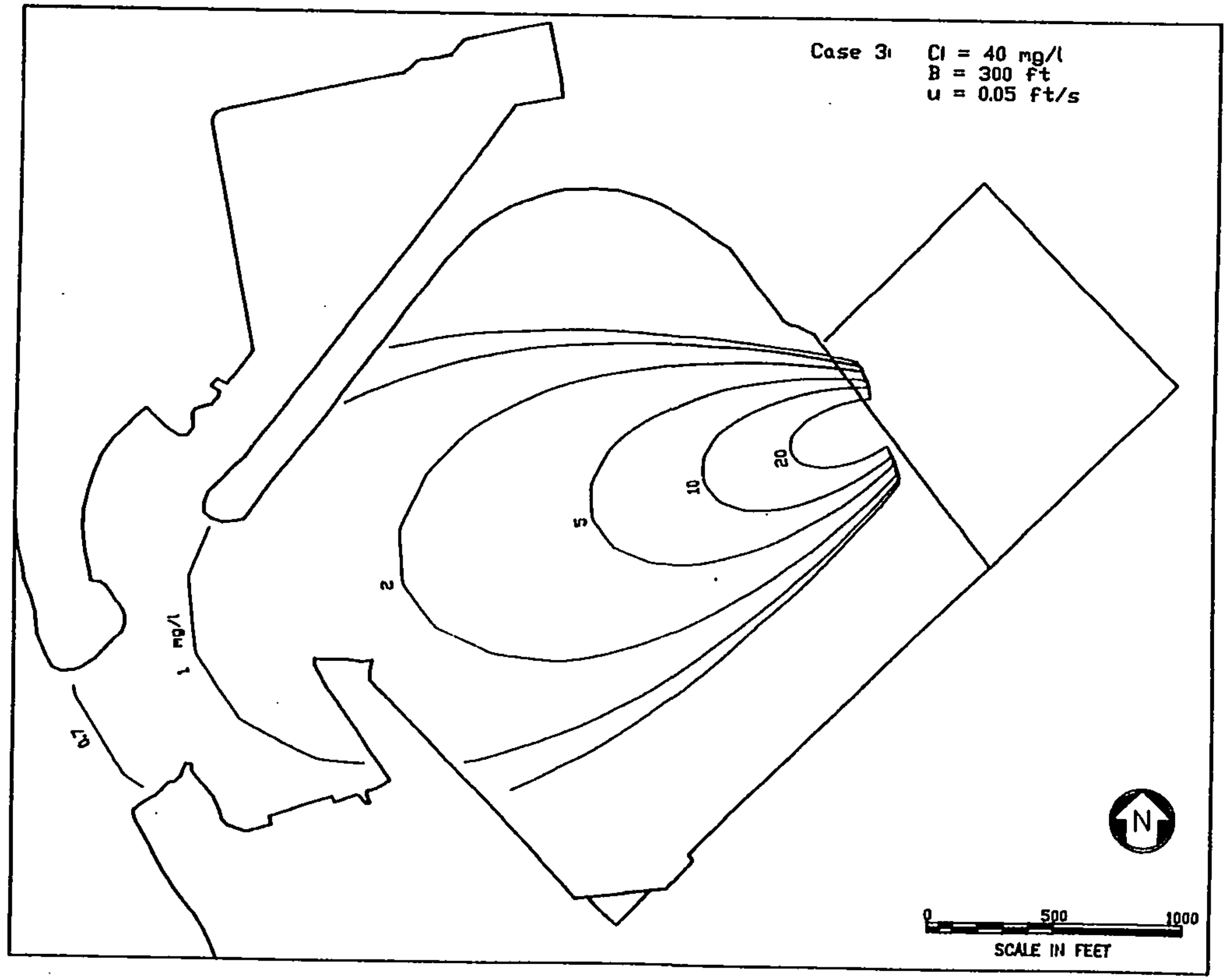

FIGURE IV-3. HARBOR BASIN/MODEL CASE 3: ISOLINES OF EXCESS SUSPENDED SOLIDS CONCENTRATION ABOVE AMBIENT

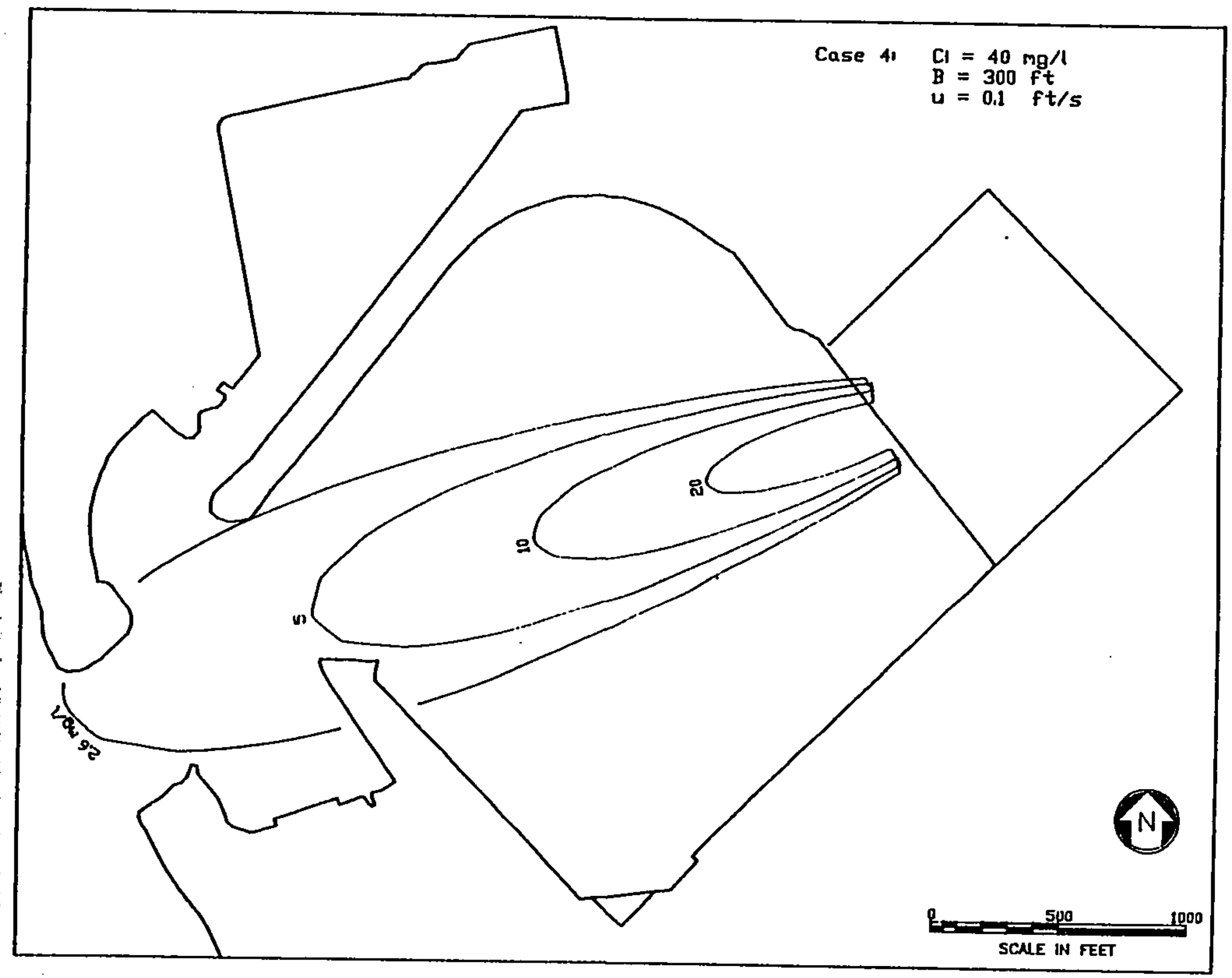

FIGURE IV-4. HARBOR BASIN/MODEL CASE 4: ISOLINES OF EXCESS SUSPENDED SOLIDS CONCENTRATION ABOVE AMBIENT

The excess suspended solids concentration at the harbor mouth estimated by Step 1 for the four cases is summarized on Table IV-7. The total elapsed time that it took for the suspended solids generated by the dredging activity to travel from the dredge site to the harbor mouth is also shown on the table. This points out another facet of the model that is very conservative. The model assumes continuous dredging activity and a steady source of suspended solids. In reality, dredging will probably be intermittent, maybe only during daylight hours. Thus there will not be a steady source, and the dilution and sedimentation rate will be less than predicted by the model.

Table IV-8 provides an estimate of the concentration, average grain size and the respective fall velocity as a function of transport time away from the harbor mouth. The average starting grain size at the harbor mouth at time T=0 hours is a function of the current speed (and thus transport time) within the harbor basin.

TABLE IV-8. RELATIVE CONCENTRATION DUE ONLY TO THE SUSPENDED SOLID FALLOUT AND AVERAGE GRAIN SIZE AND ITS FALL VELOCITY (OUTSIDE THE HARBOR)

Time (hours)	Case No.'s					
	1 & 3			2 & 4		
	Relative Peak Concentration	Average Grain Size (mm)	Fall Velocity (m/hr)	Relative Peak Concentration	Average Grain Size (mm)	Fall Velocity (m/hr)
0	1.0	0.0135	0.70	1.0	0.0155	0.92
0.5	0.90	0.0114	0.50	0.90	0.0155	0.92
1	0.86	0.0110	0.46	0.84	0.0155	0.92
2	0.76	0.0104	0.41	0.71	0.0151	0.87
3	0.68	0.0100	0.38	0.58	0.0132	0.67
4	0.61	0.0098	0.37	0.52	0.0143	0.78
5	0.56	0.0096	0.35	0.45	0.0135	0.70
6	0.51	0.0087	0.29	0.39	0.0114	0.50
7	0.46	0.0086	0.28	0.34	0.0110	0.46
8	0.44	0.0084	0.27	0.31	0.0104	0.41

The model results are shown on Table IV-9 as excess suspended solids concentrations and turbidity above ambient, as a function of transport time from the harbor mouth. The two parameters decrease with time, as would be expected, as a result of diffusion due to mixing during plume transport and particle settling with time. Table IV-10 presents the theoretical sedimentation rate due to the settling process. It must be cautioned that this theoretical sedimentation only considers fallout as a function of particle size and fall velocity. In reality, there are other forces (eg. waves and currents) and coastal processes that would re-suspend, scour and otherwise effect the diffusion and distribution of sediment in shallow coastal waters. Thus the theoretical sedimentation rate would not be expected to result in continued accumulation of sediment on the ocean bottom adjacent to the harbor mouth.

TABLE IV-9. SUSPENDED SOLIDS CONCENTRATION AND TURBIDITY ABOVE AMBIENT DUE TO THE DIFFUSION AND SEDIMENT SETTLING PROCESS (OUTSIDE THE HARBOR)

Time (hours)	Suspended Solids Concentration (mg/l) and Turbidity (NTU)							
	Case 1		Case 2		Case 3		Case 4	
	(mg/l)	(NTU)	(mg/l)	(NTU)	(mg/l)	(NTU)	(mg/l)	(NTU)
0	0.300	0.042	1.20	0.283	0.700	0.135	2.60	0.819
0.5	0.254	0.033	1.02	0.226	0.592	0.107	2.20	0.651
1	0.199	0.024	0.78	0.156	0.463	0.076	1.68	0.449
2	0.119	0.012	0.44	0.071	0.277	0.038	0.96	0.208
3	0.077	0.006	0.26	0.034	0.180	0.021	0.57	0.102
4	0.053	0.004	0.18	0.021	0.124	0.012	0.39	0.060
5	0.039	0.003	0.13	0.013	0.091	0.008	0.27	0.036
6	0.029	0.002	0.09	0.008	0.068	0.005	0.19	0.022
7	0.022	0.001	0.07	0.006	.0.052	0.004	0.14	0.015
8	0.019	0.001	0.05	0.004	0.044	0.003	0.11	0.011

TABLE IV-10. SEDIMENTATION RATE IN THE PLUME FROM THE DREDGING OPERATION (OUTSIDE THE HARBOR)

Time (hours)	Sedimentation Rate (g/m^2-hr)			
	Case 1	Case 2	Case 3	Case 4
0	0.209	1.10	0.489	2.39
0.5	0.126	0.94	0.295	2.02
1	0.092	0.72	0.215	1.55
2	0.049	0.39	0.115	0.84
3	0.029	0.17	0.069	0.38
4	0.020	0.14	0.046	0.31
5	0.014	0.09	0.032	0.19
6	0.008	0.05	0.020	0.10
7	0.006	0.03	0.015	0.07
8	0.005	0.02	0.012	0.05

A graphical representation of turbidity changes and sedimentation rates for the four case studies as a function of the coastal current speed and direction distribution is shown on Figures IV-5 through IV-8. The figures summarize all possible current directions, and thus represent an envelope of possible turbidity changes from ambient rather than a "snapshot" at any particular point in time.

As discussed in report Section II, there is considerable natural variability in nearshore coastal water turbidity in the vicinity of the harbor mouth. The variability has been well documented, and has been noted to be independent of obvious causes such as construction activity or rainfall events. Field investigations in December 1993 showed nearshore (less than 20-foot depth) turbidity to vary from 0.2 to 0.8 NTU over the course of a single day. Inspection of Figures IV-5 through IV-8 shows that all four cases of initial construction generated suspended solids and turbidity increases at the dredging site within the harbor would not result in turbidity outside the harbor that is greater than the existing natural variability. Predicted turbidity impacts within about 1,000 and 2,000 feet of the harbor entrance either north or south are as summarized on Table IV- 11 for the four cases modeled.

TABLE IV-11

SUMMARY OF PREDICTED DREDGING RELATED TURBIDITY (NTU)

INCREASE IN NEARSHORE COASTAL WATERS

	DISTANCE FROM HARBOR MOUTH	
	1,000 feet	2,000 feet
Case 1	<0.03	<0.02
Case 2	<0.2	<0.1
Case 3	<0.1	<0.07
Case 4	<0.6	<0.4

Even Cases 2 and 4, the worst case scenarios for turbidity increase at the harbor mouth, would only result in turbidity increases which are within the order of existing turbidity variability in the nearshore waters. Based on the model predictions, and the historical as well as recent measurements and data for the project vicinity, the proposed dredging activity inside Barbers Point Harbor should not result in significant turbidity impacts outside of the harbor. Possible sedimentation as a result of suspended solids fallout is also predicted by the modeling and will be used by marine biologists to assess any potential for impact to corals and other benthic organisms.

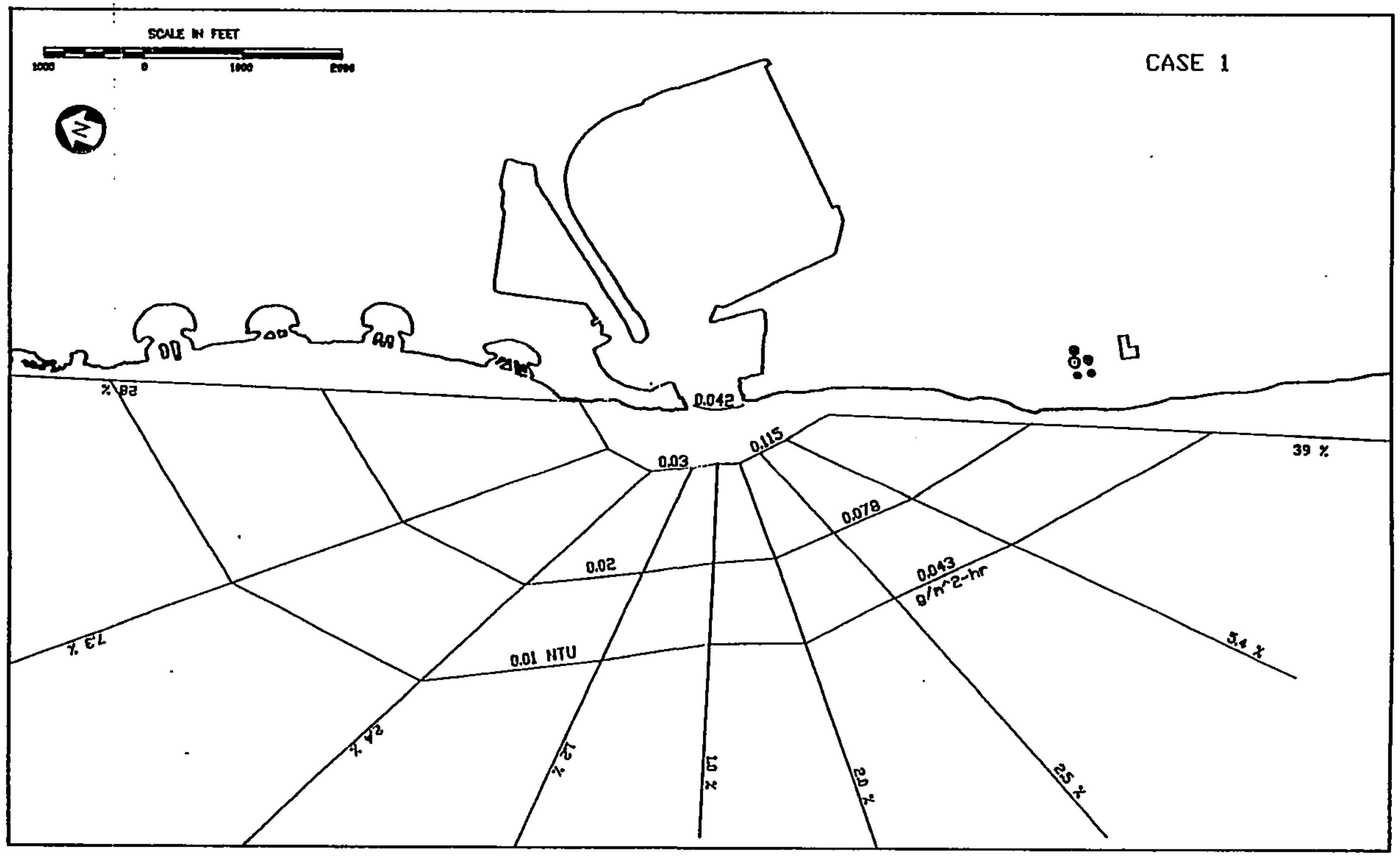

FIGURE IV-5. COASTAL WATER - MODEL CASE 1: ENVELOPE OF POTENTIAL TURBIDITY INCREASE ABOVE AMBIENT AND POSSIBLE SEDIMENTATION RATE

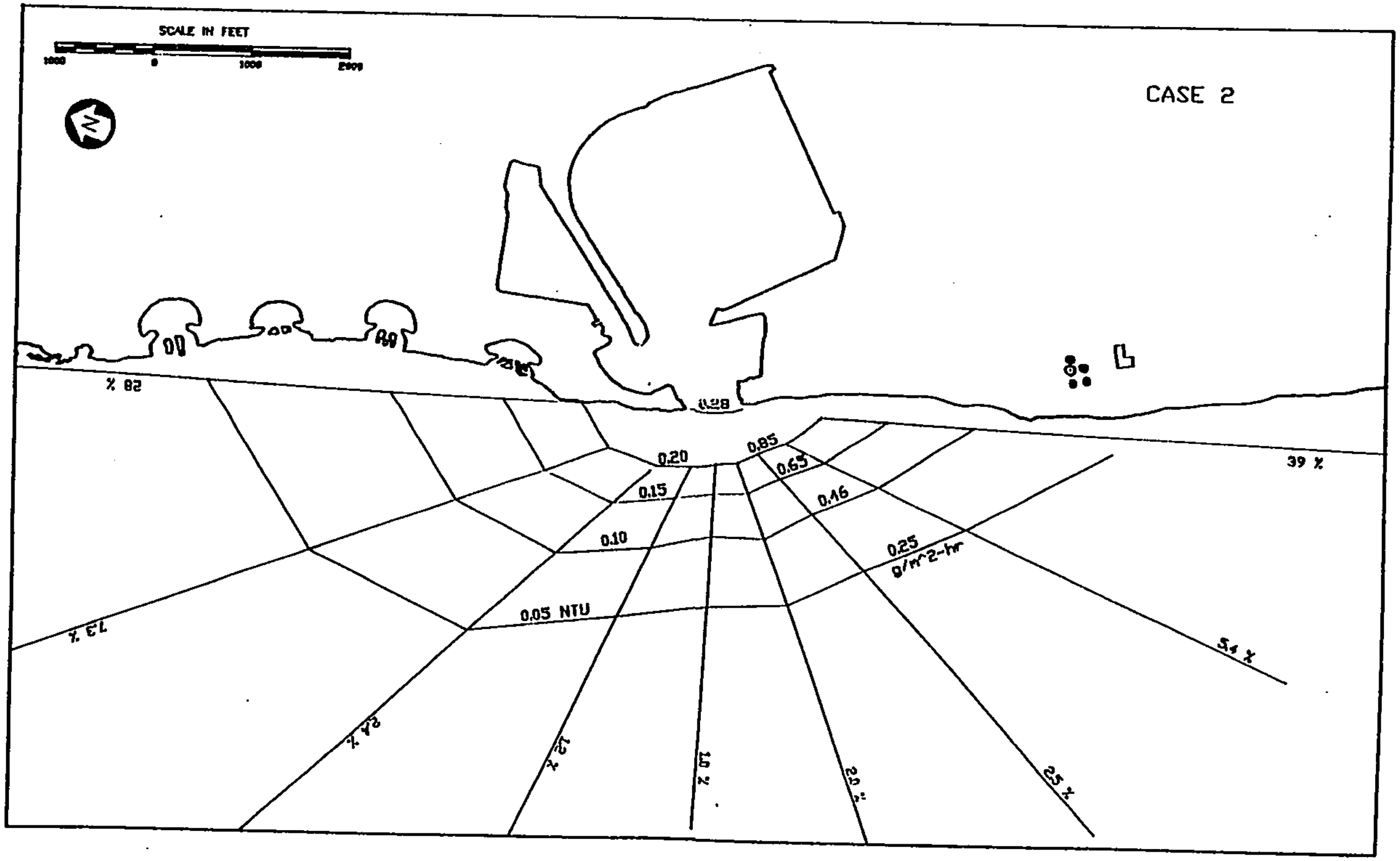

FIGURE IV-6. COASTAL WATER - MODEL CASE 2: ENVELOPE OF POTENTIAL TURBIDITY INCREASE ABOVE AMBIENT AND POSSIBLE SEDIMENTATION RATE

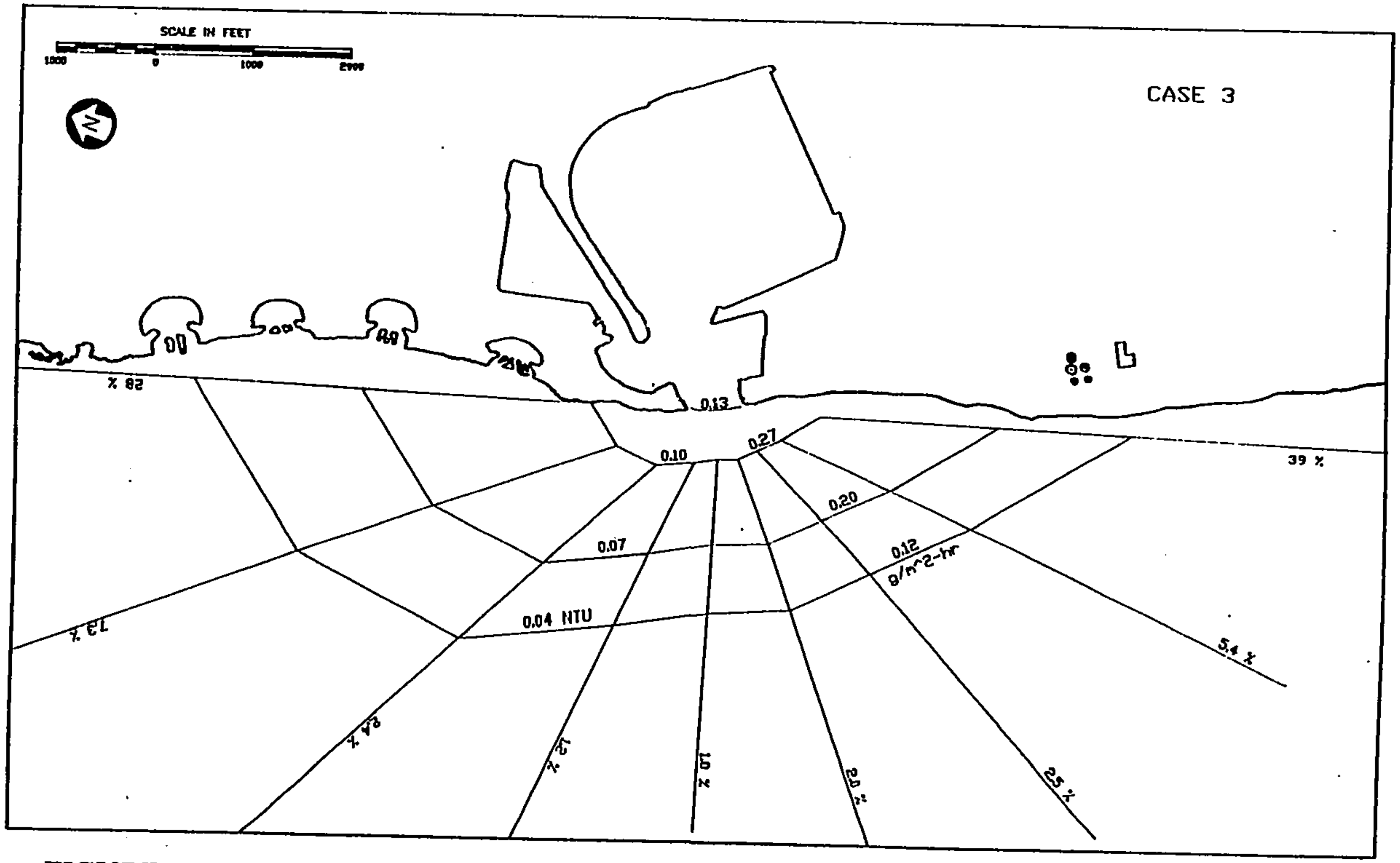

FIGURE IV-7. COASTAL WATER - MODEL CASE 3: ENVELOPE OF POTENTIAL TURBIDITY INCREASE ABOVE AMBIENT AND POSSIBLE SEDIMENTATION RATE

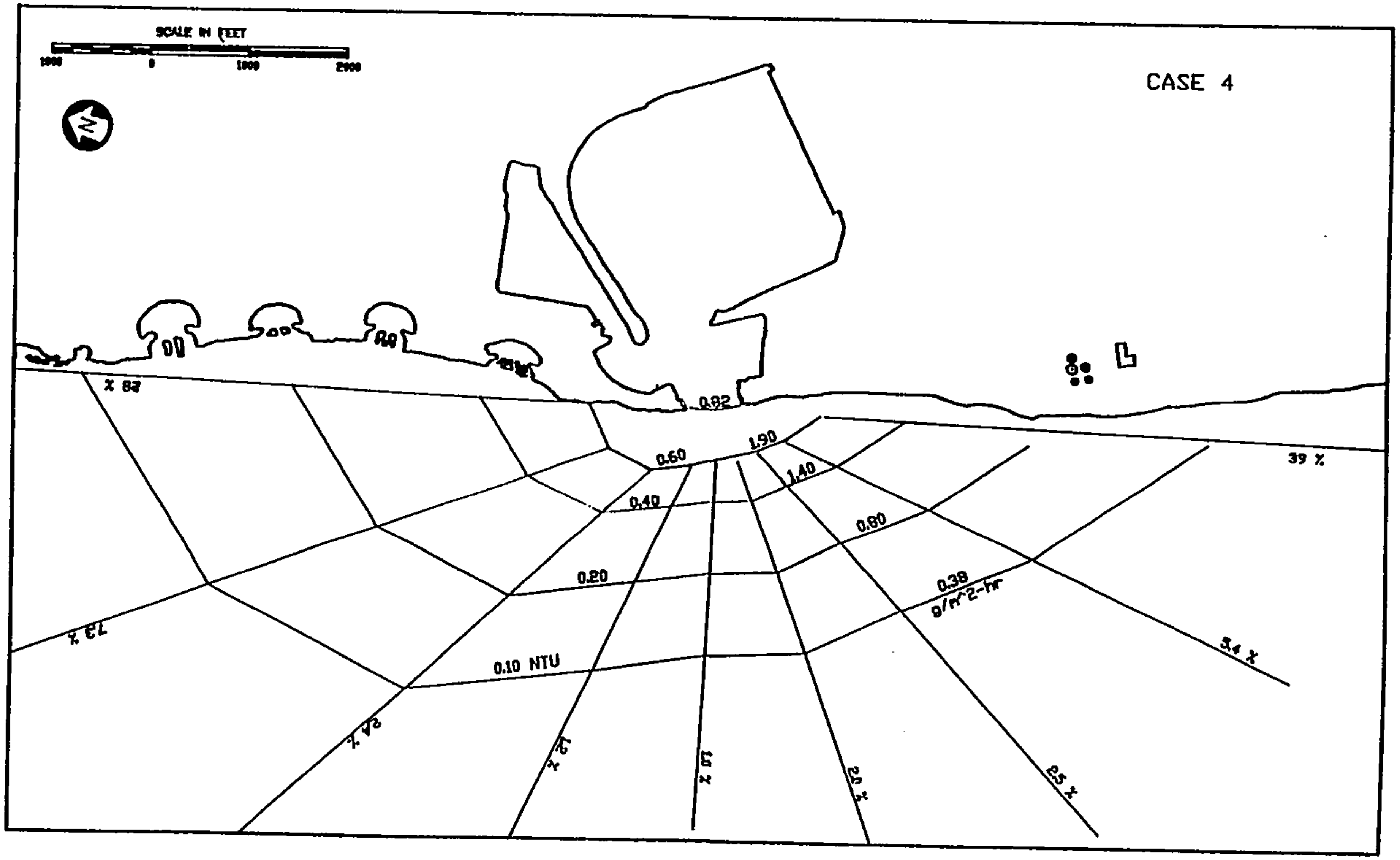

FIGURE IV-8. COASTAL WATER - MODEL CASE 4: ENVELOPE OF POTENTIAL TURBIDITY INCREASE ABOVE AMBIENT AND POSSIBLE SEDIMENTATION RATE

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APPENDIX A-4

CIGUATERA ASSESSMENT

FINAL REPORT TO PBQD:

SURVEY OF CIGUATERA:
BARBERS POINT HARBOR AND CHANNEL ENTRANCE

Presented by: **Yoshitsugi Hokama, Ph.D.**
For: **Asian Pacific Research Foundation**
320 Ward Avenue Suite 200
Honolulu, HI 96814

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SURVEY OF CIGUATERA: BARBERS POINT HARBOR

Executive Summary

The Barbers Point Harbor and the ocean side entrance to the channel were examined for ciguatera fish poisoning irrespective of the causative marine toxin, although ciguatoxin and its congeners have been implicated as the major causes of ciguatera fish poisoning.

In this survey the following factors have been examined based on the food chain concept of the disease ciguatera (Figure 1): A) The examination and identification of the macro-algae; B) The collection of *Gambierdiscus toxicus* by sieving; C) Procurement of various fishes by spearing and line fishing; D) Chemical extraction of gut and flesh tissue of each species; E) Analysis of each extract in the mouse toxicity; and F) Analysis of each extract in the guinea pig atrium assay.

The conclusions based on the data gathered are as follows:

A) A total of fourteen species of algae was identified from Stations A-E. One alga, *Halymenia formosa*, found in Stations A and B, has been associated with inhibition of *G. toxicus* growth. However, three species have been associated with *G. toxicus*. These are: *Laurencia rachyclados* (Station A), *Jania sp.* (Station C), and *Padina australis* (Stations D and E).

B) In this survey no *G. toxicus* was found in the five stations examined. Therefore, this suggests that the major ciguatera producing toxins (ciguatoxin and its congeners) are lacking within Barbers Point Harbor and the ocean area at the channel entrance.

C) The immunological results suggested the presence of polyether and other lipid type toxin(s) unrelated to ciguatoxin as shown by the mouse toxicity and guinea pig atria assay. Upon examination of the 130 fishes collected, 35% were found to be in the rejection level (borderline and positive), while 65% were negative or in the edible range. The areas with the higher rejection levels were Stations B, C, and E, resulting in approximately 40-43% rejections. These results are slightly higher than the 1982-83 survey of Barbers Point Harbor, conducted during the original expansion. The differences may be attributable to differences in antibody and test procedures. The 1982-83 antibody used was prepared in sheep, while the antibody used in 1994 was the monoclonal produced in mice.

D) The mice toxicity data proved to be interesting. Of the 14 gut extracts, 11 caused death of the mice injected IP, while only 4 mice died from the injection of the flesh extracts. The 4 flesh extracts causing death were from

Acanthurus nigrosis, Acanthurus sandvicensis, Ctenochaetus strigosus, and *Zanclus cornutus.*

E) The guinea pig atrium analysis showed a myriad of inotropic patterns both in intensity and drug inhibition. Most all of the extracts appeared to be inhibited by verapamil, a calcium channel inhibitor. Little or no effect was shown by tetrodotoxin (TTX), the sodium channel inhibitor. This suggests little or no presence of ciguatoxin or its congeners. Additionally, this observation correlates with the lack of presence of *G. toxicus* in the environment

In summary, there is a lack of *Gambierdiscus toxicus,* a dinoflagellate from which ciguatoxin and its congeners originate, at the Barbers Point Harbor. These toxins are the major causative factors in ciguatera outbreaks. This dinoflagellate was not found in the Barbers Point Harbor or on the ocean side of the channel entrance. These findings support the facts or issues that ciguatera caused by ciguatoxin and its congeners pose no serious problems at Barbers Point Harbor and the ocean side of the channel entrance. During the expansion of the Barbers Point Harbor the risk of ciguatera increase is nil. *G. toxicus* do not thrive in turbid water, which is the case at the Barbers Point Harbor. It was also shown that the water temperatures within the Harbor (less than 25°C) are not conducive for *G. toxicus* growth. In addition, intrusion of underground fresh water is also inhibitory to *G. toxicus* growth.

It was also shown during the early Barbers Point Harbor development (1980's through the mid '80's) in our survey of fish at the channel entrance, no increase in toxicity or outbreaks of ciguatera was noted. It has been demonstrated in studies at Tuvalu in the Pacific, that development of channels and small harbors had a small impact on the increase of *G. toxicus* in areas where they existed prior to development. Astronomical increases in *G. toxicus* occur only following massive destruction of reef areas due to hurricanes and other natural destructive forces (Kaly and Jones, "The construction of boat channels across coral reefs: assessment of ecological impact," Report to New Zealand Ministry, June 1990). To date, there have been no toxicity reports to the Department of Health from the Barbers Point area since 1991.

Toxins which showed toxicity in mice were noted, particularly those from viscera extracts of surgeonfish studied. This a new finding, since the sources and whether they contribute to the ciguatera problem have not yet been demonstrated. Such toxins appear to be either absent or present in insufficient amounts in fish flesh to cause any outbreaks of toxicity in humans.

INTRODUCTION

In recent years ciguatera fish poisoning has been more frequently reported in the State of Hawaii. Two factors appear to account for this increased recognition: (1) The increase in knowledge and awareness of the public to fish poisoning; and (2) A genuine increase after World War II, due to the ballast of transport ships containing *Gambierdiscus toxicus* arriving from the Pacific. Additionally, various marine life, including *G. toxicus*, may become attached to the sides of the ships coming from endemic areas of the Pacific to Hawaii.. Increases of ciguatera poisoning have been noted, especially in the leeward side of the Hawaiian Islands, including Oahu (see map for ciguatera fish poisoning for the Island of Oahu compiled from toxicity data provided by the Department of Health, Epidemiology Branch, Figure 3).

To determine the status of ciguatera in a given area, we have established (1, 2) a systematic means of survey for fish poisoning in the State of Hawaii. This type of survey is particularly of value in assessing a reef area before and after development. This will afford a truer understanding of altered ciguatera conditions post development. Data from pre- and post- development regarding ciguatera assessment would best serve the public and minimize controversies between developers and environmentalists. This report presents the methodologies and approach to understanding ciguatera associated in man-made changes near reefs, such as the development of a channel and harbor or other developmental changes.

Algae Assessment

Algae were collected from 50 - 150 ft. distance from the shoreline. Approximately 1 kg of algae were scraped or pulled off the coral and immersed in 1 liter of seawater in a ziplock plastic bag. For identification, a portion of the alga was taken and immersed into 50 ml of a 2% formalin solution in a 50 ml conical centrifuge tube. These were submitted to Dr. Isabella A. Abbott (Wilder Professor of Botany, Department of Botany, University of Hawaii) for identification and classification. Algae samples were collected in this manner for each section (Stations A, B, C, D, and E) of the channel and Harbor (Figure 2). Consequently, twenty-one species of algae were identified (Table 1). Of these, three species have been shown to be associated with *Gambierdiscus toxicus* (7), these included; *Laurencia, Jania,* and *Padena* species. Also of great interest is the presence of the *Halymenia sp.* This genus has been shown to suppress *G. toxicus* growth (8)

Gambierdiscus toxicus Assessment

The algae samples collected in the 1 liter of seawater in the ziplock plastic bag were shaken vigorously for 2 minutes to remove the epiphytic *G. toxicus* attached to the macro-algal thallus. After shaking, the alga/*Gambierdiscus toxicus* suspended in seawater was first passed through a 125 µm size pore mesh sieve to remove the larger algal fragments and debris. After the seawater passes through the larger pore mesh, the smaller particles including *G. toxicus* were collected in a 37 μm size pore mesh sieve. The residues retained on the 37 μm sieve were washed with filtered seawater medium, transferred into a 100 ml sterile glass bottle and capped loosely to provide aeration. The *G. toxicus* in the 100 ml bottle were then shaken gently and a 1 ml sample was transferred onto a Sedgewick Rafter cell counting slide. Cell counting was carried out in triplicate and the average number of *G. toxicus* determined per ml in the 100 ml bottle. The weights of the wet algae were taken and the number of *G. toxicus*/gm of alga determined. Although algae reported previously to be associated with *G. toxicus* were found (Table 1), in this survey no *G. toxicus* dinoflagellates were observed in all stations A - E. It was interesting to note that a species shown to be inhibitory for *G. toxicus* growth (*Halymenia formosa*) was found in Stations A-B.

Immunological Assay

Monoclonal anti-ciguatoxin antibody (Mab-CTX) was prepared according to the method reported previously by Hokama et. al. (3).

Solid-phase immunobead assay (SPIA) designated Latex Antibody Test (LAT) consisted of a bamboo paddle coated with an organic base solvent correction fluid (Pentel of America, Ltd., Torrance, CA 90503). The immunobead consisted of blue and red colored latex 0.314 and 0.100 μm in diameter (Seradyn, Inc., Particle Technology Division, Inc., IN), respectively, coated with MAb-CTX.

The LAT test was determined as follows: a) An inch deep incision was made in the fillet portion near the head region of the fish; b) The coated paddle end was inserted into the tissue of the fish and removed; c) After removal and air dried for 10 min. the stick was immersed quickly (0.5 sec) into absolute methanol; d) The coated and methanol fixed end of the paddle was then immersed into 0.5 ml of the lavender immunobead colored suspension; e) The paddle was removed from the immunobead solution after 5 min. and read. Any distinctive purple coloration after washing was scored as positive and no color as negative. The stick was immersed in the immunobead solution again and after another 5 min (10 min total), removed, washed and read. A positive was indicated by a distinctive purple coloration. A borderline was scored when a paddle showed a slight purple coloration, generally without a distinctive demarcation. A negative generally showed a distinct white background or a very faint diffused color with no distinct demarcation of the meniscus area of the purple suspension. When in doubt, the procedure was repeated with a bamboo stick in another area of the fish. Additionally, both a negative and a positive control stick were examined prior to testing the unknown fish to insure the proper workings of the test system. The procedure used was published in 1990 (4).

The stations in which fish were obtained are shown in the diagrammatic map (Figure 2). A and B represents the stations outside the Harbor at the entrance of the channel. Stations C, D, and E represent the areas within the Harbor. Table 2 - 6 represent the degrees of fish toxicity based on the Latex Antibody Test procedure. The less toxic fishes were found in stations A and D while stations B, C, and E showed a higher toxicity level. Stations C, D, and E were not evaluated in 1982-83. These are the initial data for these stations. Stations A and B were previously surveyed in 1982-83, when the initial Barber Point Harbor development began. Table 7 summarizes the total fish obtained and the distribution of levels of toxicity by the LAT. These represented 65% negative, 27 % borderline and 8% positive from a total of 130 fish samples.

The assay for ciguatera by ELISA using a sheep anti-CTX was carried out in 1982-83 when the initial expansion and enlargement of the Barbers Point Harbor were carried out. The fish analyzed were from Stations A and B. Though the numbers of fish are small for the 1994 data and not necessarily of the same species the differences of the results are not astronomical. This comparison is shown in Table 8. In part, however, some of the differences may be explained by the sensitivity of the test procedure and especially the antibody used. The data from the mouse and guinea pig reported in the following paragraphs gives us a clearer view of the nature of the toxins and the degrees of toxicity. Unfortunately, data in mouse and guinea pig assay were not obtained in the 1982-83 period.

A detailed study by a graduate student at the University of Michigan prepared a report in the summer of 1993 while in our laboratory. A report of his findings is attached to this final report as an appendix.

The incidence of toxicity is relative and based on the immunological values obtained through the SPIA procedure developed in 1990 (4). The general interpretation of toxicity is that fishes testing in the range of borderline and positive have caused ciguatera fish poisoning, especially those in the positive range. Based on this interpretation, the test procedure has never shown any false negatives. However, false positives may occur for the following reasons: 1) individuals vary in the degree of susceptibility to the toxins by virtue of their genetic make-up; 2) duration of previous exposures to low levels of toxins in fish; 3) diversity in strength of the toxins; some congeners may be more toxic than others within a family of toxins; and 4) variation of toxicity among different toxins. For example, okadaic acid is considered 300 to 400 times less toxic than ciguatoxin, while maitotoxin and palytoxin are considered more toxic than ciguatoxin in mice toxicity studies (see below).

Degree of toxicity in mice of various known marine toxins

Toxin	Lethal Dose (LD_{50}) in Mice (μg/kg)
Ciguatoxin	0.45 (I.P)
Palytoxin	0.15
Maitotoxin	0.125
Okadaic acid	135

Based on comparable LAT (SPIA) testing, the toxicity of fish at Barbers Point Harbor is much less than fish at Puako on the Big Island (40-50% inedible) and about 50% less than fish at Waianae Boat Harbor, where *G. toxicus* are present throughout the year, since first examined in 1992.

Some level of toxicity is to be expected. In all our studies, we have never observed a 0% toxicity level. The lowest percentage we have measured has been about 5-10% inedible fish levels.

In comparison with the 1982-1983 study of Barbers Point, the January 1994 data suggest an increase in the level of inedible fishes, from 16% to 35%. As indicated, however, the following should be considered: 1) the difference in antibodies used in the immunological tests (sheep anti-ciguatoxin, 1982-1983 vs. mouse monoclonal anti-ciguatoxin, 1994); 2) the differences in the procedure (enzyme immunoassay (EIA, 1982-1983 vs. SPIA, 1994); 3) the variation in fish species and the area covered (only the outside entrance areas of Barbers Point Harbor were evaluated in 1982-1983, while the areas within the Harbor were also studied in January 1994); and 4) in 1994, the mouse toxicity and guinea pig atrium assays were used to determine toxicity, as compared to only the EIA in 1982-1983.

Extraction Procedure

All borderline and positive LAT fish of the same species were pooled and extracted. The viscera, including, liver, gastrointestinal tract, roe and all tissues in the cavity were pooled and extracted separately from the flesh of each species. Each species was separated according to its sector. The method of extraction was described in a previous report by Kimura, et. al., (5). The extracts were used for both the mouse and guinea pig assays.

Mouse Toxicity Bioassay

The procedure and criteria for toxicity used were described by Kimura et. al., (5). One hundred mg of the oily crude fish extract suspended in 1 ml of 1% Tween 60 saline was given intraperitoneally (IP) into each mouse (Swiss Webster) weighing 20-25 gm. The mice were observed for up to 48 hrs and the results were scored as follows:

MOUSE BIOASSAY RATING SYSTEM

RATING	SYMPTOMS
0	No toxic symptoms. Any reduced activity returns to normal in 15-30 minutes.
1	Reduced activity, occasional lumbar muscle contractions (flexion), unsteady walk, symptoms lasting between 30 minutes to 3 hours.
2	Very reduced activity, breathing difficulties, occasional flexions, diarrhea, difficulty walking, cyanosis, symptoms lasting between 3-6 hours.
3	Inactivity, frequent bowel movements or diarrhea, very labored breathing, severe tremors, paralysis, reduced reflexes, difficulty walking, symptoms persisting longer than 6 hours.
4	Death between 6 and 48 hours.
5	Death within 1-6 hours.

THESE SYMPTOMS ARE CHARACTERISTIC FOR CRUDE LIPID EXTRACTS FROM TOXIC FISHES CAUGHT IN THE PACIFIC REGION

The mouse toxicity results are presented in Table 9. This table lists the station, the tissue extract, species, and the degree of toxicity with the time of death in hrs and min after IP injection. Toxicity values and survivors, if any, are also indicated in the last column. Fifteen out of a total of 28 fish extracts in which toxicity was demonstrated by the immunological test (inedible) showed high to moderate toxicity. The gut extracts of the various surgeon fishes proved to be the most toxic. Eleven of the 14 gut extracts killed mice within 24 hr. This is compatible with our recent findings associated with hindleg paralysis(9). Four of the 14 flesh extracts showed moderate to high toxicity. These results were again associated with the herbivorous surgeon fishes. The toxins appear to be a sodium channel blocker(s) as shown by the guinea pig assay in our previous studies of ciguatera surveys (10). Fortunately, the public has been alerted to the fact that all viscera (liver, eggs and other organs) of reef fished should not be consumed. Therefore, incidents of fish poisoning due to consumption of visceral tissue have recently been rare or limited. Luckily, at present these toxins in gut tissues are usually not found in tissues at sufficient levels as to create potential toxic incidents. The nature of these toxins in gut tissue is presently being investigated in our laboratory. Two possibilities may be either a sodium channel inhibiting toxin(s) or palytoxin, which has not accumulated in sufficient levels in fish flesh to pose a serious health problem at this time.

Guinea Pig Atrium Assay

The procedure described by Miyahara et. al., (6) on the effect of the fish extracts on the guinea pig atria was used in this study. The method, in brief, is as follows: Guinea pig of either sex weighing 300-500 gm was used in the experiment. After the animal was sacrificed, the whole heart was removed quickly and immersed into an oxygenated Krebs-bicarbonate physiological solution. The atrium was separated into left and right, with the left dissected into two parts. Each piece (2 left and 1 right atria) were tied onto tissue holders connected to electrodes in the physiological bath containing Krebs-bicarbonated physiological solution (25 ml) with continuous oxygenation from a 5% CO_2-95% O_2 cylinder. The right atrium was prepared to study the effects of the fish extracts on spontaneously induced contractions and the left atrium on electronically stimulated tissue. Electrically induced contraction was evoked by regular pulses, 1.5 threshold voltage, 4m sec duration at *1.5 HZ*, delivered through a Gras SD9 stimulator.

The action of the fish extracts on the atrium was determined by adding 100 µl of a 100 mg/ml fish extract in 1% Tween 60 saline into the 25 ml Krebs-bicarbonate physiological solution in the physiobath. The reaction was scored by the polygraph recorder. The response caused by the fish extracts were further characterized by using inhibitors of the inotropic response. These included 12.5 µl M^{-3} solution in distilled H_2O of tetrodotoxin (TTX), 12.5 µl M^{-3} solution in distilled H_2O verapamil (verap) and 12.5 µl M^{-3} solution in distilled H_2O, and the adrenergic inhibitors, phentolamine (phen.) and propranolol (prop.).

The guinea pig atria assay data are summarized in Tables 10 a, b, c, and Figures 4 through 9 for all the flesh and gut extracts. Tables 10 a, b, c analyzes the inotropic patterns depicted in Figures 3 through 9. A myriad of inotropic and drug inhibition patterns were noted. There appears to be little or no ciguatoxin pattern associated with TTX blockage. The drug most commonly affecting the inotropic response by blockage appears to be the verapamil (Ca ++ channel affecting drug). This suggested the presence of palytoxin or a maitotoxin-like toxin(s). Evidence for the presence of the newly found sodium channel blocker has been shown by kole gut extract (Figure 11 p1).

Blocking of the ciguatoxin inotropic response is shown in Figure 11. The kole samples, particularly the gut extract, show a good sodium channel block (SCB).

In summation, there appears to be little or no ciguatoxin-like compounds as deduced by the guinea pig atria study. The majority of the immunological positive fishes show toxicity, which may be the sodium channel blocker associated with the micro-biota. Other toxins may be palytoxin or maitotoxin or as yet undetermined toxins from the micro-biota. At present, these toxins have not caused any serious ciguatera outbreaks, because: 1) they tend to be restricted to the gut tissue of fish; and 2) they appear to be present in low levels in fish flesh tissues. The chemical and biological properties of these toxins are now being further examined.

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TABLE 1
ALGAE IDENTIFICATION AND ANALYSIS
BARBERS POINT HARBOR AND CHANNEL ENTRANCE
(JANUARY 15 AND 22, 1994)

STATION	ALGAE TYPE
A	*Halymenia formosa* (-)
	Amansia glomerata with: *Laurencia brachyclados*(+) *Herposiphonia*
B	*Halymenia formosa* (-)
C	*Jania sp.* (+) turf with following: *Hypnea pannosa* (lots of different diatoms attached) *Dictyota friabilis* *Centroceras clavulatum*** *Polysiphonia sp.*
D	*Acanthophora spicifera*
	Padina australis (+)
	Codium edule
	Polysiphonia sp.
E	*Amphiroa turf* with the following: *Centroceras clavulatum*** *Erythrotichia carnea* *Caulerpella ambigua* *Gelidiella sp.* *Ceramium sp.* *Padina australis* (+)

* The algae were identified by Dr. I.A. Abbott, Wilder Professor of the Department of Botany, University of Hawaii

\+ Algae previously reported to be associated with *G. toxicus*

** Highly toxic (extracts) in the mouse toxicity bioassay

TABLE 2
ANALYSIS OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

STATION A
(NORTH ENTRANCE OF CHANNEL)

SPECIES		NUMBER	LATEX ANTIBODY TEST NEGATIVE	BORDERLINE	POSITIVE
Flounder	(*Bothus mancus*)	1	1	0	0
Papio	(*Caranx melampygus*)	1	0	1	0
Moano	(*Parupaneus multifasciatus*)	1	1	0	0
Brown Surgeonfish	(*Acanthurus nigrofuscus/nigororis*)	3	3	0	0
Orange-Spot Surgeonfish	(*Acanthurus olivaceus*)	1	1	0	0
Manini	(*Acanthurus sandvucensis*)	6	5	1	0
Taape	(*Lutjanus kasmira*)	5	3	2	0
TOTAL		**18**	**14**	**4**	**0**
PERCENT			**78%**	**22%**	**0%**

TABLE 3
ANALYSIS OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

STATION B
(SOUTH ENTRANCE OF CHANNEL)

SPECIES		NUMBER	LATEX ANTIBODY TEST NEGATIVE	BORDERLINE	POSITIVE
Wrasse	(*Lethrinus sp.*)	1	1	0	0
Orange-Spot Surgeonfish	(*Acanthurus olivaceus*)	3	2	1	0
Kole	(*Ctenochaetus strigosus*)	2	1	0	1
Oio	(*Albula vulpus*)	1	1	0	0
Weke	(*Upencus arge*)	1	1	0	0
Taape	(*Lutjanus kasmira*)	4	2	1	1
Rockfish	(*Cirrhitus pinnulatus*)	1	1	0	0
Maiko	(*Acanthurus nigrosus*)	3	0	3	0
Table Boss	(*Bodianus bilunulatus*)	3	1	0	2
Manini	(*Acanthurus sandivicensus*)	2	2	0	0
TOTAL		**21**	**12**	**5**	**4**
PERCENT			**57%**	**24%**	**19%**

TABLE 4
ANALYSIS OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

STATION C
(TUGBOAT PIER)

SPECIES		NUMBER	LATEX ANTIBODY TEST NEGATIVE	BORDERLINE	POSITIVE
Papio	(*Caranx ignobilis*)	2	2	0	0
Half-Beak	(*Hemiramphidae sp.*)	2	1	1	0
Kole	(*Ctenochaetus strigosus*)	1	0	0	1
Brown Surgeonfish	(*Acanthurus nigrofuscus/nigororis*)	1	1	0	0
Aholehole	(*Kuhlia sandvicensis*)	1	0	0	1
Moorish Idol	(*Zanclus cornutus*)	4	2	1	1
Manini	(*Acanthurus sandivicensis*)	8	5	2	1
Awa awa	(*Elops hawaiensis*)	1	1	0	0
TOTAL		**20**	**12**	**4**	**4**
PERCENT			**60%**	**20%**	**20%**

TABLE 5
ANALYSIS OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

STATION D
(EASTRIDGE)

			LATEX ANTIBODY TEST		
SPECIES		**NUMBER**	**NEGATIVE**	**BORDERLINE**	**POSITIVE**
Papio	(*Caranx ignobilis*)	1	1	0	0
Moorish Idol	(*Zanclus cornutus*)	5	3	2	0
Manini	(*Acanthurus sandvicensis*)	11	11	0	0
Half-Beak	(*Hemiramphidae sp.*)	3	2	0	1
TOTAL		20	17	2	1
PERCENT			85%	10%	5%

TABLE 6
ANALYSIS OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

STATION E
(NORTHRIDGE)

SPECIES		NUMBER	LATEX ANTIBODY TEST NEGATIVE	BORDERLINE	POSITIVE
Kole	(*Ctenochaetus strigosus*)	6	3	3	0
Maiko	(*Acanthurus nigrosus*)	2	0	2	0
Manini	(*Acanthurus sandvicensis*)	33	22	11	0
Weke	(*Mulliodichthys samoensis*)	2	1	1	0
Uhu	(*Scarus dubius*)	2	1	1	0
Aholehole	(*Kuhlia sandvicensis*)	2	0	1	1
Orange-Spot Surgeonfish	(*Acanthurus olivaceus*)	1	0	1	0
Pebble butterflyfish	(*Chaetodon meleagris*)	1	0	1	0
Kumu	(*Parupeneus porphyreus*)	2	2	0	0
TOTAL		51	29	21	1
PERCENT			57%	41%	2%

TABLE 7
SUMMARY OF FISH FROM BARBERS POINT DEEP DRAFT HARBOR AND ENTRANCE CHANNEL
(JANUARY 15 AND 22, 1994)

		LATEX ANTIBODY TEST		
	# of fish	Negative	Borderline	Positive
GRAND TOTAL	130	84	36	10
PERCENT		65%	27%	8%

TABLE 8

COMPARISON OF BPH FISH ASSAY OF 1982-83 BY ELISA (ANTIBODY-SHEEP) AND FISHES OF JANUARY 1994 BY LAT (MONOCLONAL ANTIBODY)

YEAR	LOCATION	TOTAL FISH	NEGATIVE	BORDERLINE/POSITIVE
1982-83	STATION A & B	479	405 (85%)	74 (15%)
1994	STATION A & B	130	84 (65%)	46 (35%)

TABLE 9
MOUSE TOXICITY OF FISH FLESH AND GUT EXTRACTS
(JANUARY 15 AND 22, 1994)

STATION	EXTRACT	SPECIES	MOUSE TOXICITY VALUE	TIME OF DEATH (POST-IP INJECTION)
A	FLESH	*Bothus mancus* (Flounder, Mo-e-o-ne)	1	Survived
	GUT		5	1 hour, 7 minutes
A	FLESH	*Caranx sp.* (Jack, Papio, Ulua)	1	Survived
	GUT		1	Survived
AB	FLESH	*Acanthurus olivaceous* (Orange spot surgeon fish, Na-e'-na-e')	0	Survived
	GUT		5	6 minutes
AB	FLESH	*Lutjanus kasmira* (Blue lined snapper, Taape)	1	Survived
	GUT		1	Survived
A,B,E	FLESH	*Acanthurus nigrosis* (Brown surgeon fish, Maiko)	5	2 minutes
	GUT		5	7 minutes
B	FLESH	*Bodianus bilunulatus* (Black spot wrasse, Table boss, 'A-a'-wa)	0	Survived
	GUT		5	1 hour, 6 minutes
A,B,C,D	FLESH	*Acanthurus sandivicensis* (Sandwich island surgeon fish, Manini)	5	53 minutes
	GUT		5	3 minutes
B,C,E	FLESH	*Ctenochaetus strigosus* (Yellow eyed surgeonfish, Kole)	5	3 hours, 27 minutes
	GUT		5	2 hours, 38 minutes
C	FLESH	*Elops hawaiiensis* (Hawaiian tarpon, A-wa-a-wa)	0	Survived
	GUT		4	25 hours
C,D	FLESH	*Zanclus cornutus* (Morish idol, Ki-hi-ki-hi)	5	2 hours, 38 minutes
	GUT		5	5 hours, 5 minutes
C,E	FLESH	*Hemiramphus depauperatus* (Tropical half beak, I-he i-he)	1	Survived
	GUT		5	32 minutes
C,E	FLESH	*Kuhlia sandvicensis* (Hawaiian flag tail, A-ho-le)	0	Survived
	GUT		5	1 hour, 14 minutes
E	FLESH	*Mulloidichthys samoensis* (Samoan goat fish, Weke)	2	Survived
	GUT		5	26 minutes
E	FLESH	*Scarus dubius* (Parrotfish, Uhu)	0	Survived
	GUT		0	Survived

TABLE 10
INOTROPIC ANALYSIS OF GUINEA PIG ATRIUM ASSAY In Vitro
(JANUARY 15 AND 22, 1994)

STATION	SPECIES	EXTRACT	LAT RESULTS (FLESH)	INOTROPIC RESPONSE	TTX	VERAP.	PROP./PHEN.	PARALYSIS (HL)
A	*Bothus mancus* (Flounder, Mo-e-o-ne)	FLESH	-	ST	SL	ST	ND	NEG
		GUT		VST	MOD	VST	VSL	POS
A	*Caranx sp.* (Jack, Papio, Ulua)	FLESH	±	MOD	VSL	SL	ND	NEG
		GUT		VSL	NEG	NEG	ND	NEG
A,B	*Lutjanus kasmira* (Blue-lined snapper, Taape)	FLESH	+1, ±3, -5	SL	NEG	VSL	NEG	NEG
		GUT		SLOPE-MOD	NEG	MOD	SL	NEG
A,B	*Acanthurus olivaceus* (Orange spot surgeon fish, Na-e'-na-e')	FLESH	+	VST	NEG	VST	NEG	NEG
		GUT		VST (PALYTOXIN-LIKE)	NEG	NEG	NEG	NEG
A,B,E	*Acanthurus nigrosis* (Brown surgeon fish, Maiko)	FLESH	+	ST	NEG	MOD	NEG	NEG
		GUT		VST	SL	ST	NEG	NEG
A,B,C,D,E	*Acanthurus sandvicensus* (Sandwich island surgeon fish, Manini)	FLESH	+2, ±13, -45	VST	NEG	VST	NEG	POS
		GUT		ST	NEG	SL	MOD	NEG
B	*Bodianus bilunulatus* (Black spot wrasse, Table boss, 'A-a'-wa)	FLESH	+2, -1	SLOPE-MOD	NEG	ST	ND	NEG
		GUT		SLOPE-MOD	NEG	SL	NEG	POS
B,C,E	*Ctenochatus strigosus* (Yellow-eyed surgeon fish)	FLESH	+2, +3, -4	SLOPE-MOD	SL	MOD	NEG	NEG
		GUT		SLOPE-MOD	NEG	SL	NEG	POS
C,D	*Hemiramphus depauperatus* (Tropical half beak, I-he i-he)	FLESH	+1, ±1, -2	MOD	SL	MAD	NEG	NEG
		GUT		ST-BIPHASIC	HEG	ST	NEG	NEG
C	*Elops hawaiiensis* (Hawaiian tarpon, A-wa-a-wa)	FLESH	-	NEG	NEG	SL	ND	NEG
		GUT		SLOPE-SL	SL	SL	NEG	POS
C,D	*Zanclus cornutus* (Moorish idol, Ki-hi-ki-hi)	FLESH	+1, ±3, -5	NEG	NEG	NEG	ND	NEG
		GUT		SLOPE-MOD	NEG	MOD	NEG	±

STATION	SPECIES	EXTRACT	LAT RESULTS	INOTROPIC RESPONSE	TTX	VERAP.	PROP./PHEN.	PARALYSIS (HL)
C,E	*Kuhlia sandvicensis* (Hawaiian flag tail, A-ho-le)	FLESH	+2, ±1	MOD	NEG	SL	ND	NEG
		GUT		SLOPE-MOD	NEG	SL	ND	POS
E	*Scarus dubius* (Brown parrotfish, Uhu)	FLESH	±1, -1	MOD	SL	SL	SL	NEG
		GUT		SLOPE-MOD	NEG	SL	NEG	NEG
E	*Mulloidichthys samoensis* (Samoan goat fish, Weke)	FLESH	±1, -1	SLOPE-MOD	NEG	SL	SL	NEG
		GUT		SLOPE-SL	NEG	SL	NEG	NEG

ABBREVIATION

MOD = Moderate
SL = Slight
VSL = Very Slight
ND = Not Determined
NEG = Negative
POS = Positive
ST = Strong
VST = Very Strong
LAT = Latex Antibody Test
TTX = Tetrodotoxin
VERAP. = Verapamil
PROP. = Propranolol
PHEN. = Phentolamine
HL = Hind Leg Paralysis

FIGURE 1

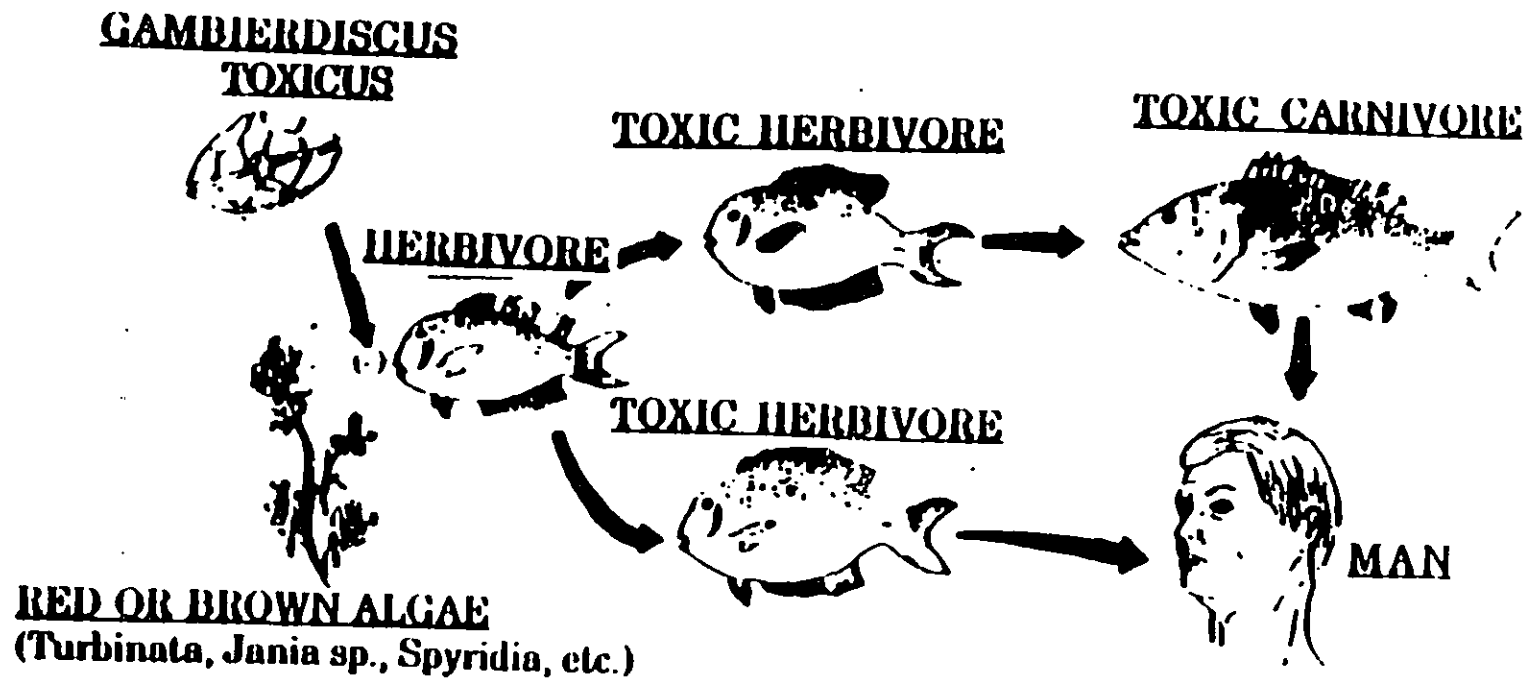


Figure 1 Transmission path of ciguatera toxin from the marine dinoflagellate Gambierdiscus toxicus through herbivorous and carnivorous fishes to man

FIGURE 2
DIAGRAMMATIC MAP OF BARBERS POINT HARBOR SHOWING THE STATIONS

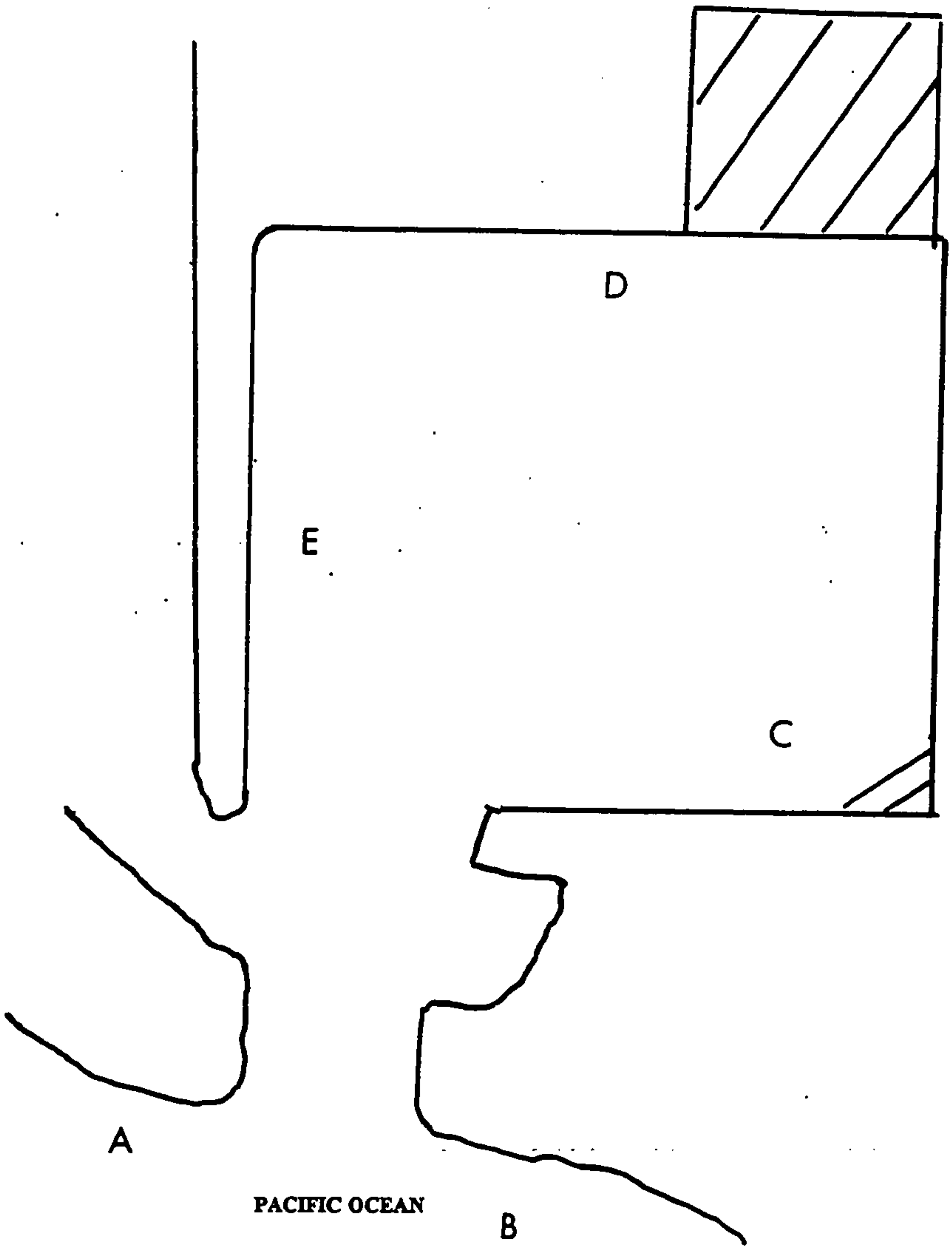
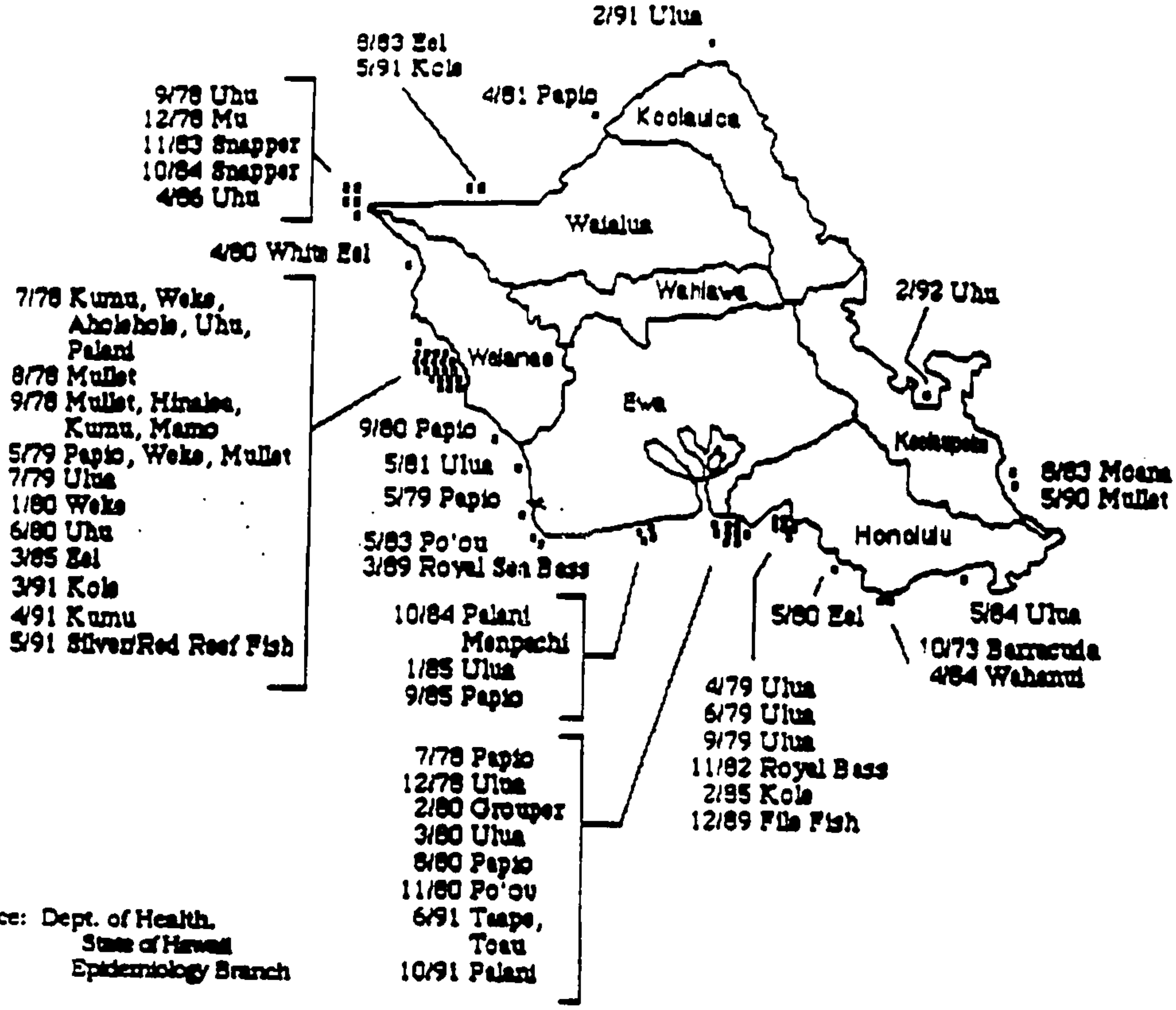


FIGURE 3

Incidents of Ciguatera Poisoning from 1973-1992 Island of Oahu As of March 8, 1992



Source: Dept. of Health, State of Hawaii Epidemiology Branch

Unspecified Areas of Ciguatera Poisoning in Waianae:

1/79 Palani	3/85 Eel	2/91 Po'ou	7/91 Uhu
8/79 Papio	9/86 Snapper	3/91 Palani	9/91 Ulua
10/79 Ulua	2/91 Mullet	5/91 Unknown	1/92 Rock Fish, Eel
7/82 Snapper	2/91 Mullet	5/91 White/Red Fish	3/92 Snapper
8/84 Palani	2/91 Po'ou	6/91 Taape	
2/85 Weke	2/91 Po'ou	6/91 Palani	

• Represents 1 fish

FIGURE 4: Guinea pig atrium assay--inotropic patterns

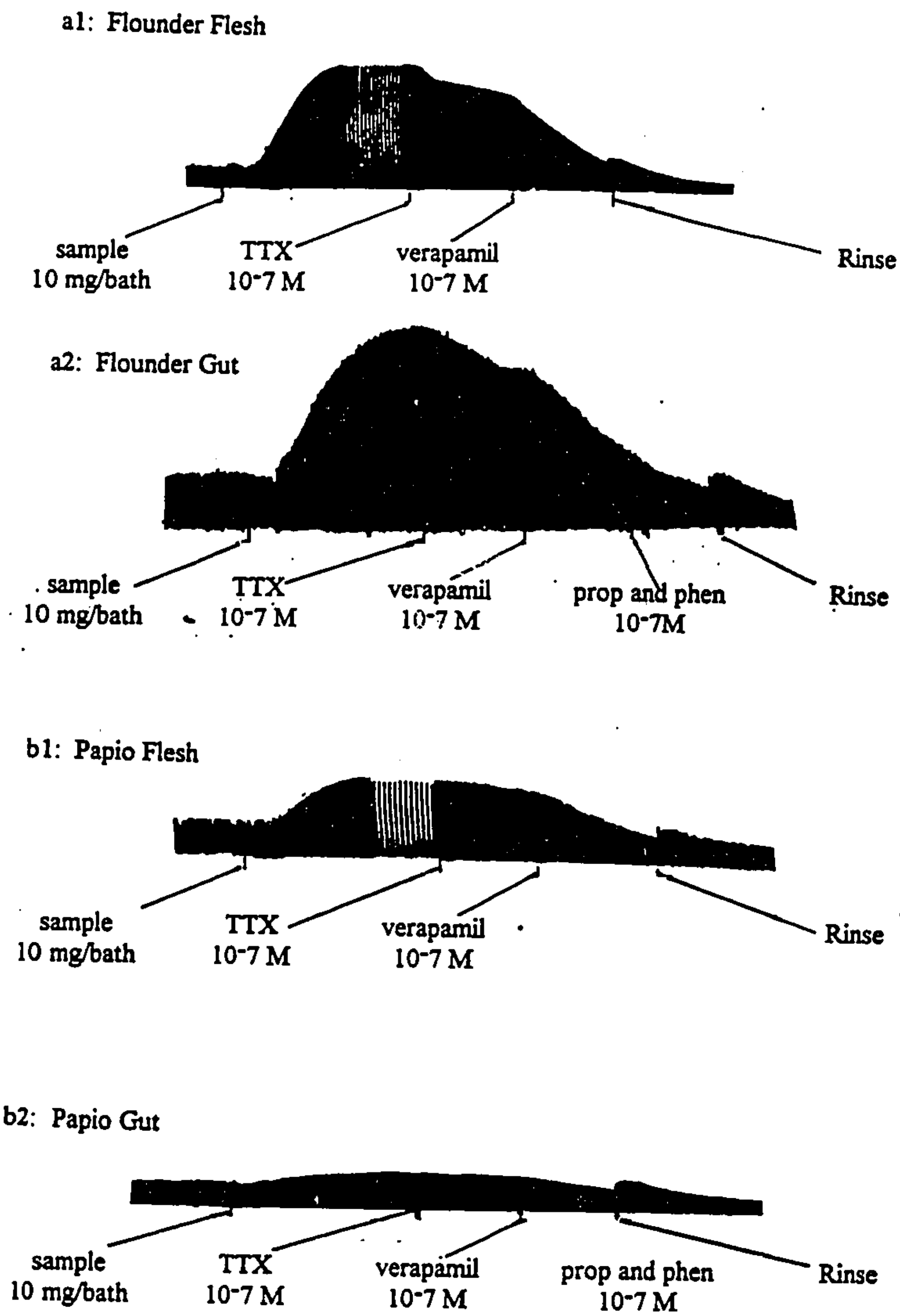


FIGURE 5: Guinea pig atrium assay--inotropic patterns

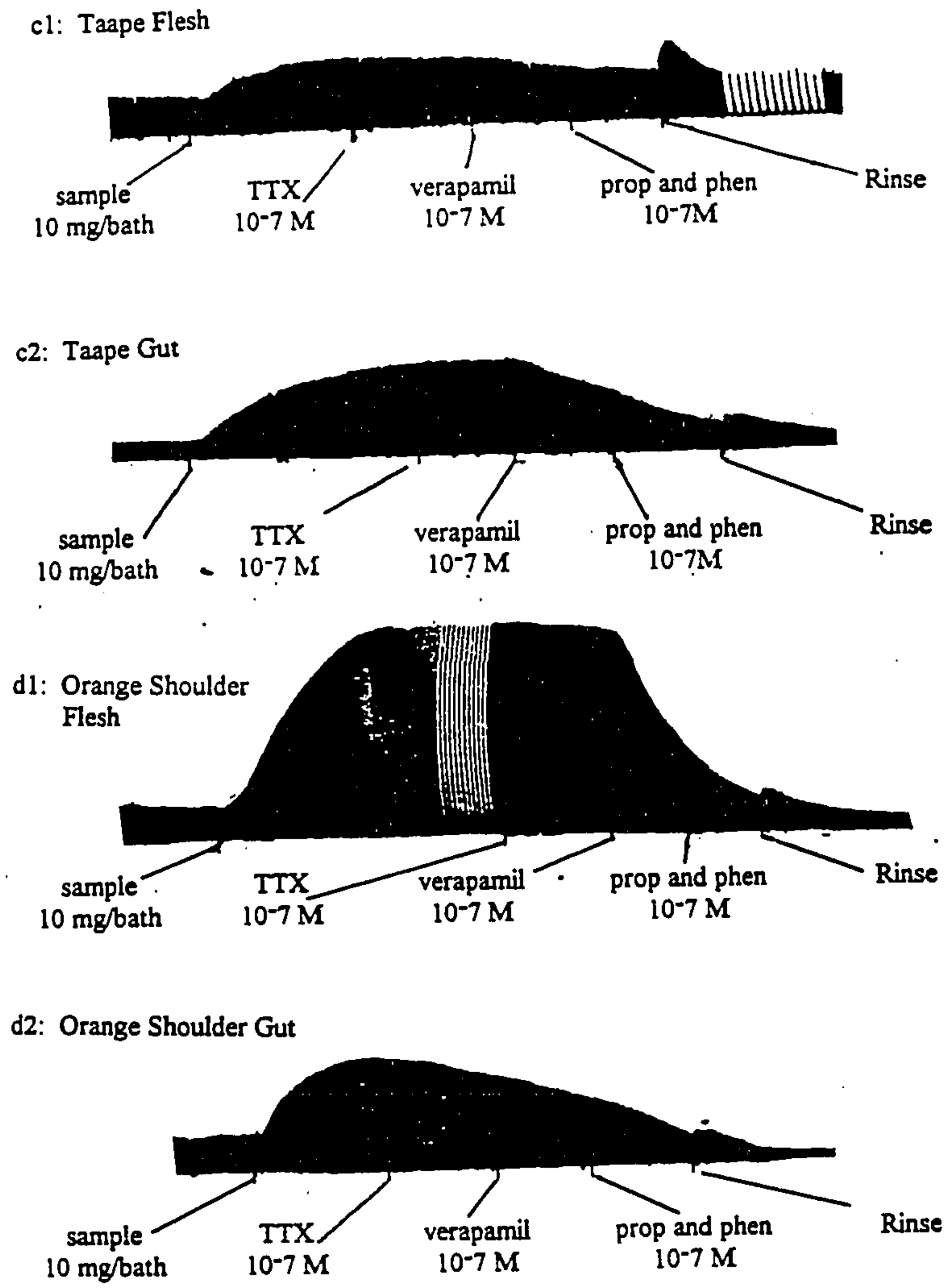


FIGURE 6: Guinea pig atrium assay--inotropic patterns

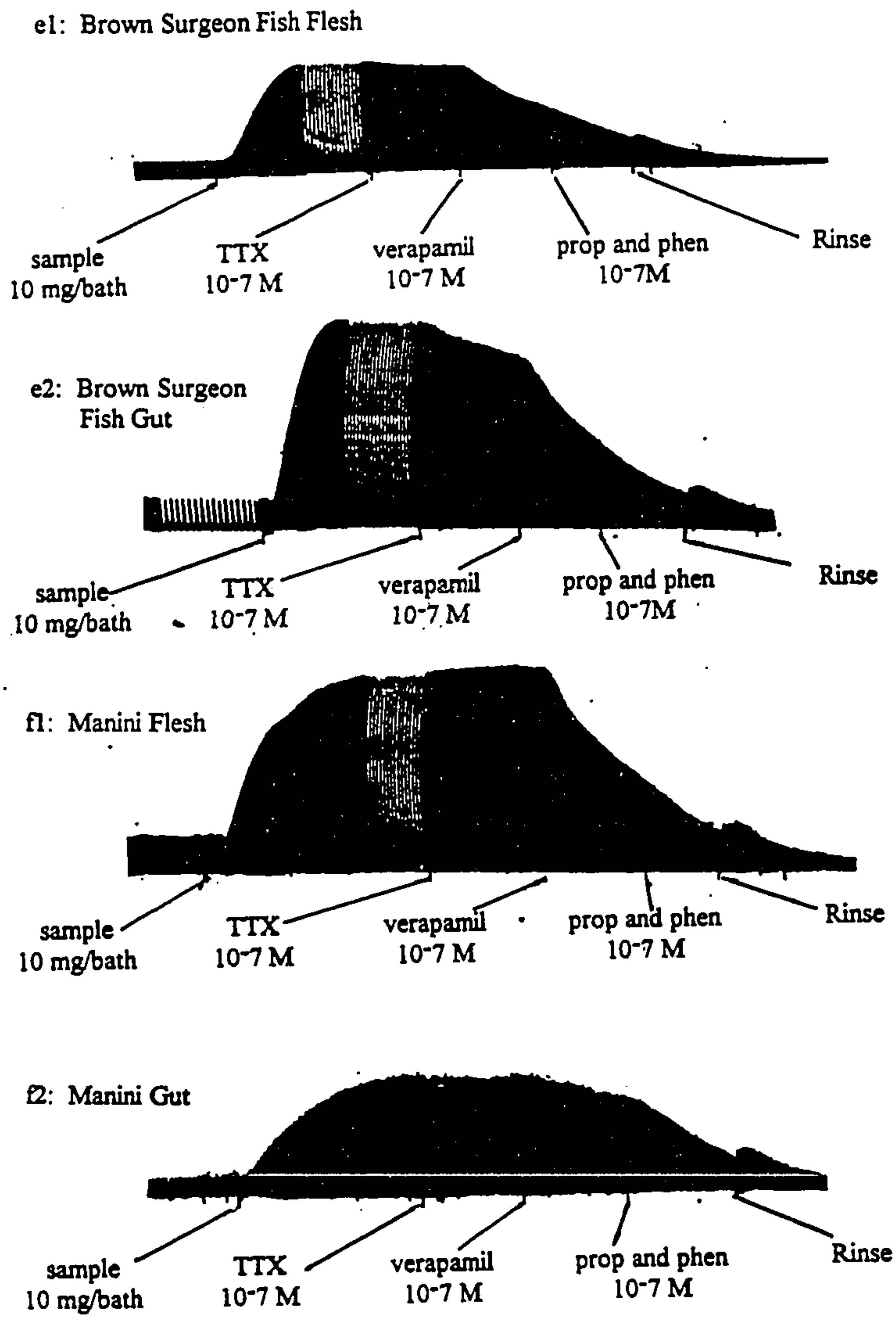


FIGURE 7 : Guinea pig atrium assay--inotropic patterns

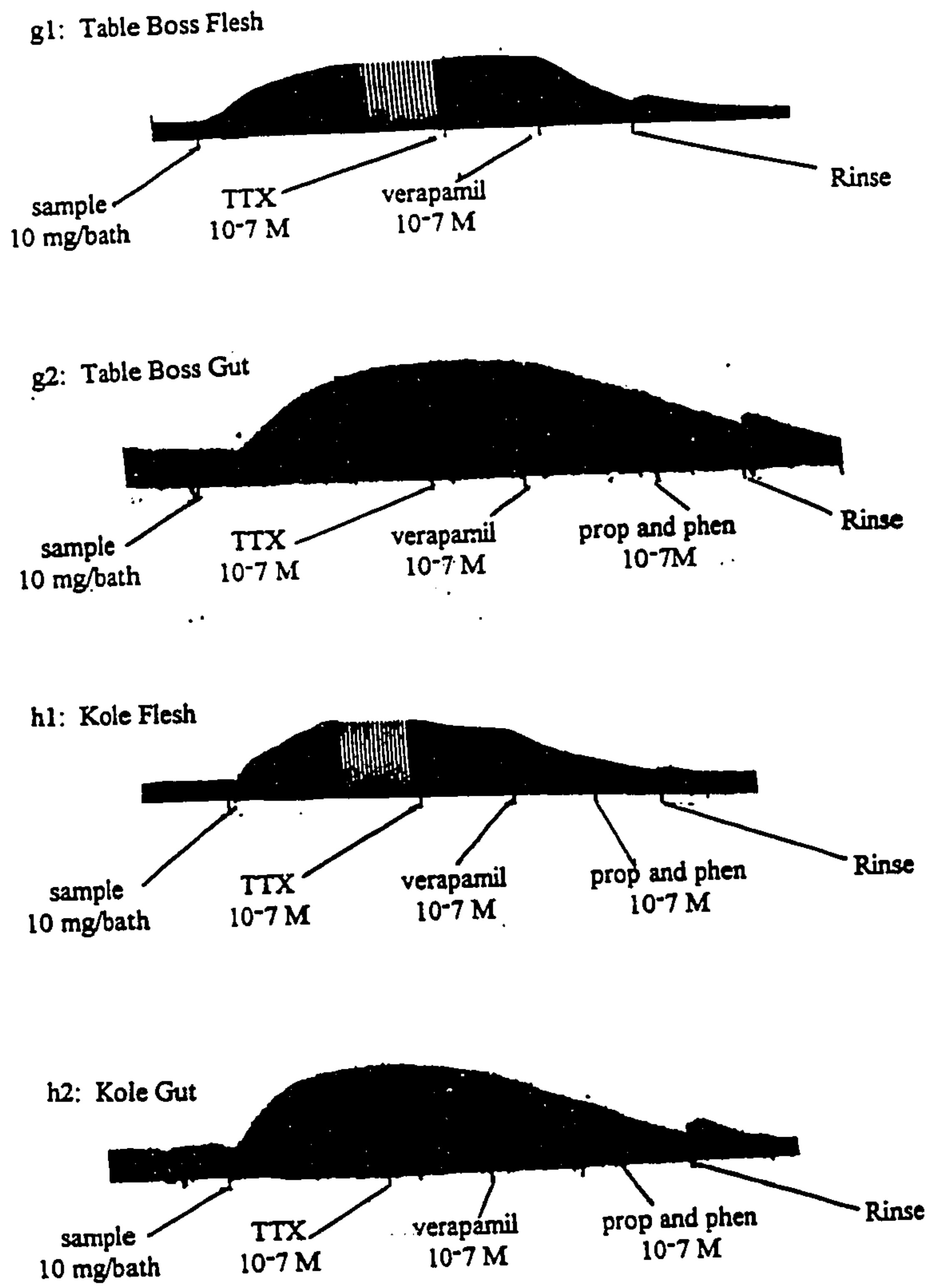


FIGURE 8: Guinea pig atrium assay--inotropic patterns

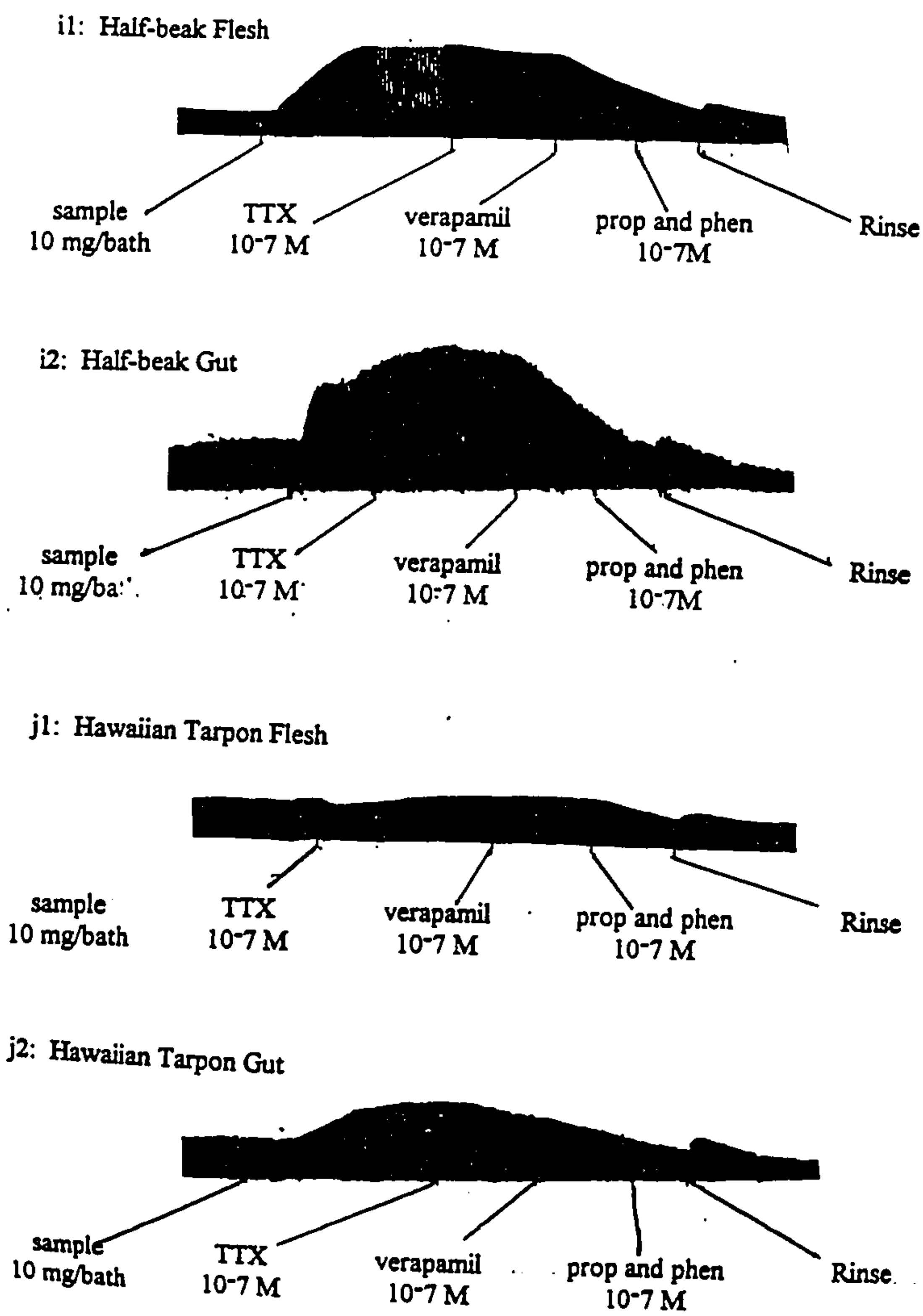


FIGURE 9: Guinea pig atrium assay--inotropic patterns

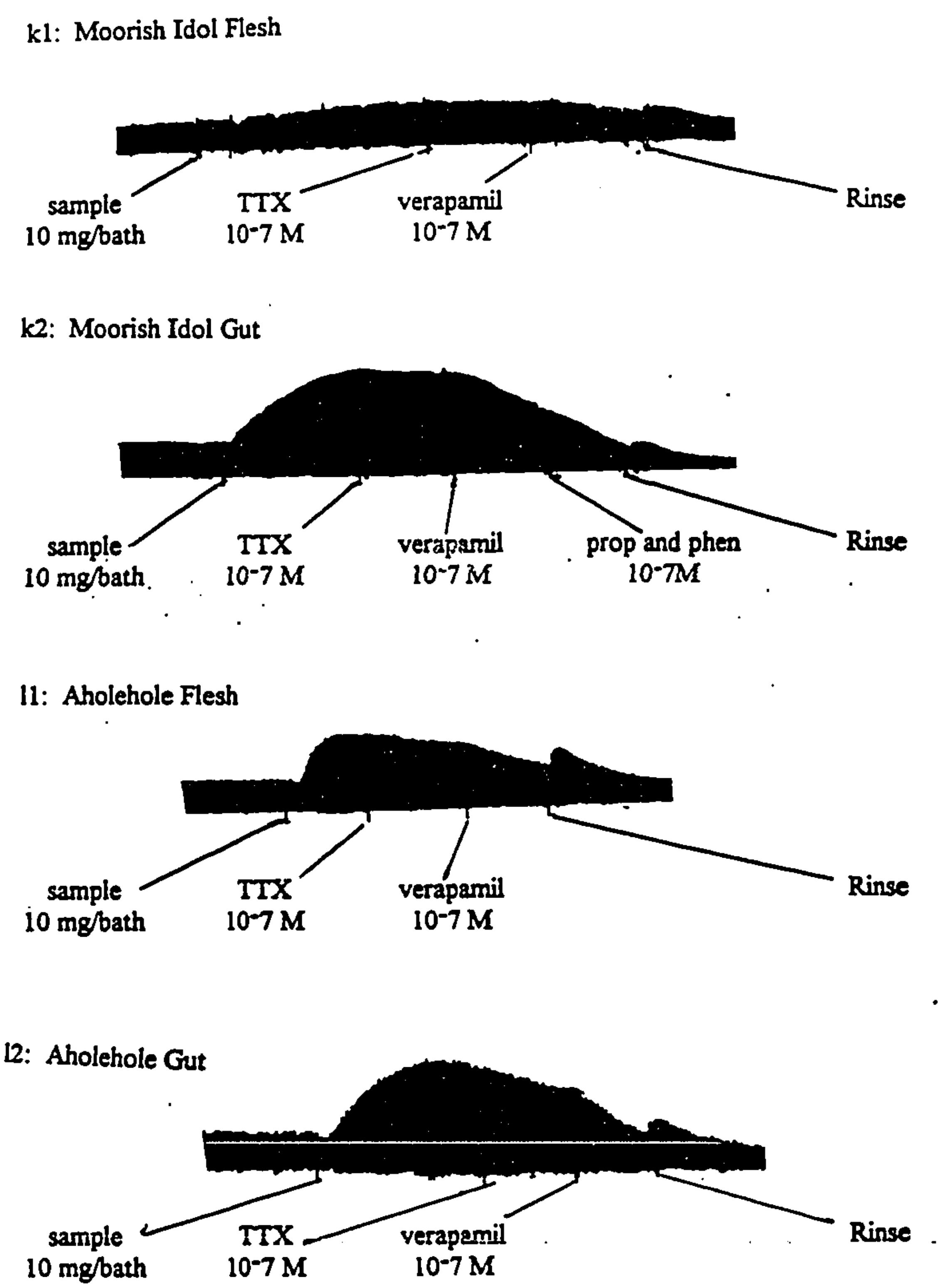


FIGURE 10: Guinea pig atrium assay--inotropic patterns

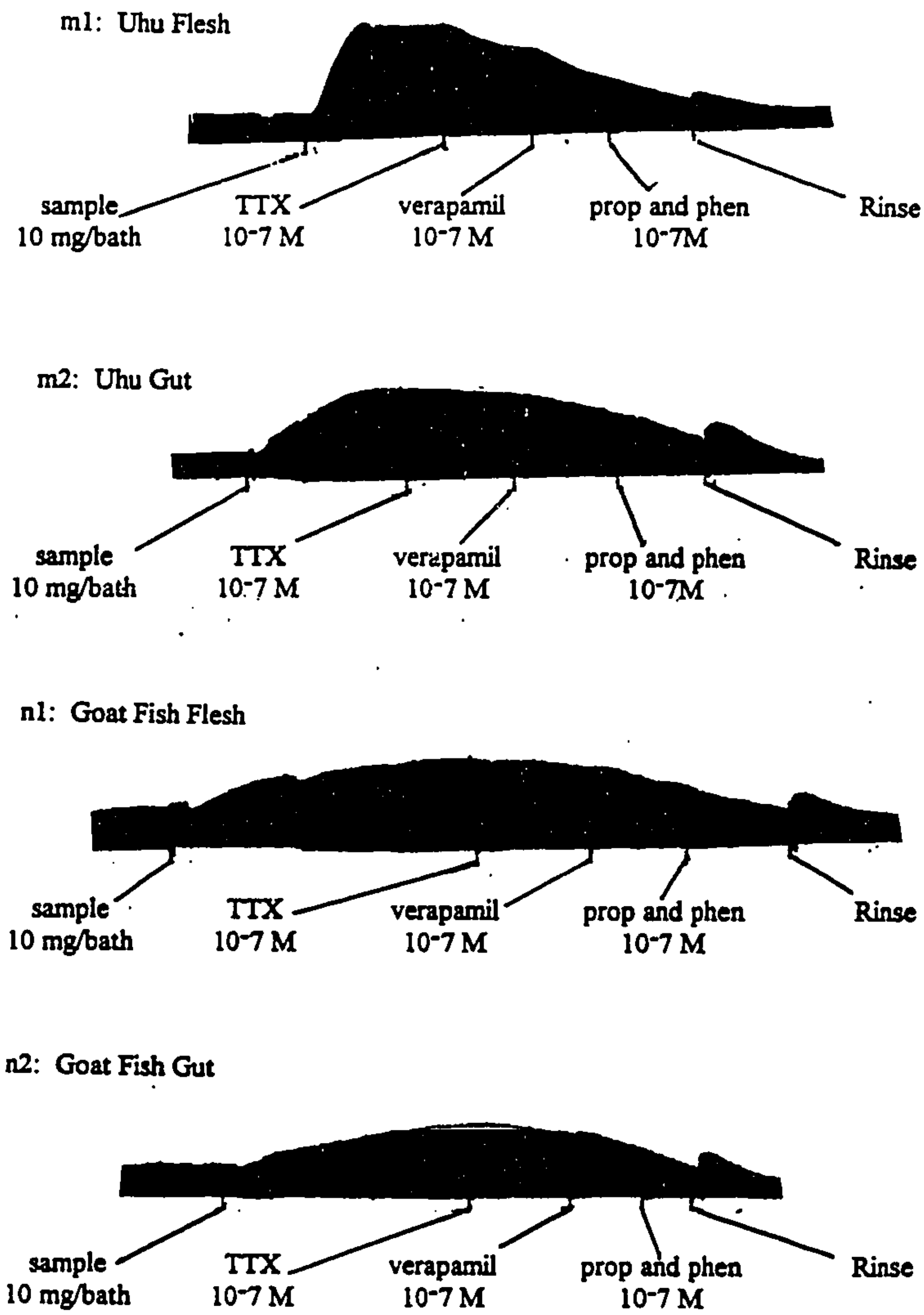
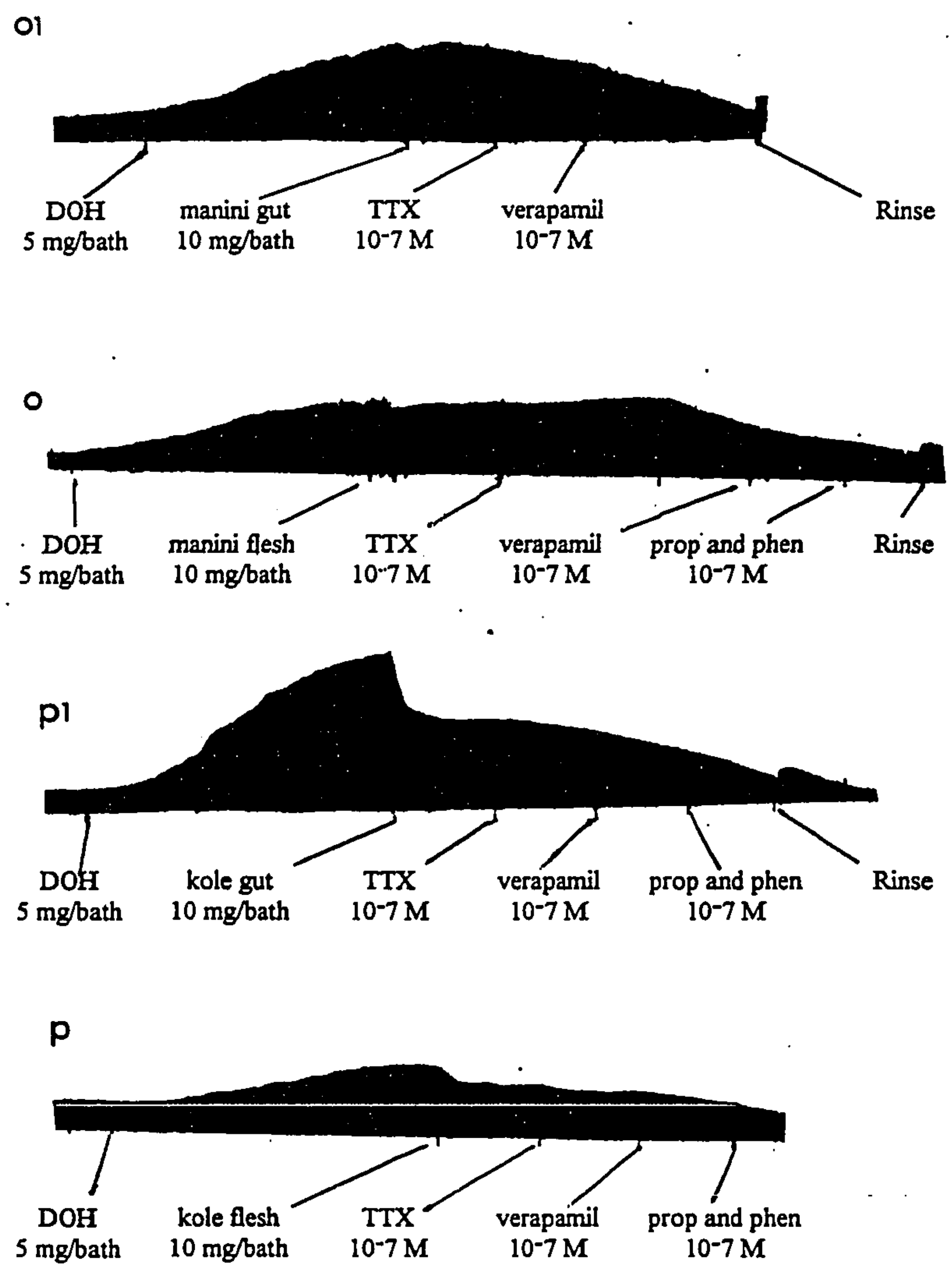


Figure 11 : Guinea pig atrium assay--blocking patterns



Comments on the survey following the completion of the expansion of Barbers Point Harbor (1996 or 1997):

The second survey for ciguatera evaluation will be performed between six months and 1 year after the completion of the expansion of Barbers Point Harbor.

The purpose of this second survey is to determine whether changes in fish toxicity levels have occurred following excavation and expansion of Barbers Point Harbor.

The scope of this survey will cover all of the studies deemed relevant in the initial survey of January 1994. These will include: 1) survey of algae; 2) examination for the presences of *G. toxicus* (include culture if any are present); 3) collection of fish (species similar to those of the January 1994 survey; 4) extraction of algae, fish flesh and gut separately; and 5) assessment of toxicity in mouse toxicity, guinea pig atrium or mouse neuroblastoma cell assays (to determine the effect on sodium ion channels). The surveyors will perform samplings as before, designated on the Barbers Point Harbor map (Figure 2, January 1994 Barbers Point Harbor Report). A final report will be prepared for the second survey, including a comparison of data with the pre-excavation survey (January, 1994) as to whether changes have occurred or not. This second survey should be completed within three months after initiation of the collection of samples. That is, a final report should be available three months after the start of the survey.

Appendix: Allan Chun, The effect of dredging on ciguatoxin levels in various fish species from September, 1982 to May, 1983.

THE EFFECT OF DREDGING ON CIGUATOXIN LEVELS IN VARIOUS FISH SPECIES FROM SEPTEMBER 1982 TO MAY 1983

Allan Chun
University of Michigan
School of Public Health
Department of Toxicology
August 1983

INTRODUCTION

Ciguatera, a disease characterized by digestive, neurological and cardiovascular symptoms, is caused by the ingestion of fish containing ciguatoxin (Banner et al., 1960; Halstead, 1970; Banner, 1976; Bagnis,1979). The source of this lipid soluble toxin is the photosynthetic, benthic dinoflagellate Gambierdiscus toxicus (Yasumoto et al., 1977; Adachi et al., 1979). Yasumoto (1981) reports a good correlation between toxicity of the fish in an area and the population density of G. toxicus. No specific nutrient or environmental factor has been found that stimulates benthic blooms of the dinoflagellate in nature. However, construction on coral reefs or various types of environmental change in coral reefs often trigger outbreaks of fish poisoning (Yasumoto et al., 1981). Although a number of bioassays have been utilized for testing tissues for the presence of ciguatoxin (Bagnis, 1973; Banner et al., 1961: Grande et al., 1976), it was not until a highly purified ciguatoxin preperation was made available by Scheuer, who initally isolated the principal toxin of ciguatera (1967), that a radioimmunoassay and an enzyme-immunoassay was developed for the direct examination of fish tissue for ciguatoxin (Hokama et al., 1977 and 1982). To evaluate whether the incidence of ciguatoxin in fish changes during and after dredging , the enzyme-immunoassay, because of its ease and expediency over the radioimmunoassay, was selected to monitor ciguatera levels in fish. Various fish species were sampled from an ongoing construction project at Barber's Point harbor and from a comparable control site at Ewa Beach and submitted to ciguatera analysis.

METHODS AND MATERIALS

Sources of Fish

Fish were collected once a week by the Aquatic Resources Division of the Department of Land and Natural Resources from Barber's Point, where dredging was taking place, and from control sites at Nanakuli and Ewa Beach. Flesh tissue samples were taken from 2 sites (B and E) on each fish. The B sample was taken from the midsection and the E sample was taken from the posterior-ventral region. Each B or E sample was tested in quadruplicate.

Antibody to Ciguatoxin

Sheep anti-ciguatoxin was prepared and purified by DEAE-cellulose chromatography as described by Hokama et al. (1977). Purified ciguatoxin (Scheuer et al., 1967) isolated from livers of toxic eels was conjugated by the carbodiimide procedure (Oliver et al., 1968) to human serum albumin. The latter is the carrier for the lipid hapten, ciguatoxin. The antibody to ciguatoxin-human serum albumin was raised in sheep given three weekly subcutaneous injections of a ciguatoxin-human serum albumin Freunds complete adjuvant mixture (1:1). A total of 500μg of ciguatoxin and 50 mg of ciguatoxin-human serum albumin was administered to the sheep in a period of 7 weeks. The sheep was bled 10 days after the last injection and the serum removed and stored in 30 ml aliquots at -20°C. The details of the determination for the presence of anti-ciguatoxin-human serum albumin by immunoelectrophoresis and mouse studies have been described by Hokama et al. (1977).

Sheep-anti-ciguatoxin-horseradish Peroxidase Conjugate

The purified IgG fraction of sheep-anti-ciguatoxin was coupled to horseradish peroxidase (Type VI, RZ:3.3, Sigma Chemical Co., St. Louis, MO) according to the one-step glutaraldehyde method of Voller et al. (1980). The sheep-anti-ciguatoxin-horseradish peroxidase conjugate was divided into aliquots and stored at 4° C. Each aliquot was thawed only once and the remaining excess conjugate discarded.

Reagents for Enzyme-Immunoassay

Tris buffer contained 0.05 M Tris(hydroxymethyl)aminomethane, pH 7.5 ± 0.05, with 0.1% human serum albumin and 0.01% sodium azide. The H_2O_2-methanol fixative contained 0.3% H_2O_2 in absolute methanol prepared just before use (stable 1 hr. at room temperature). The 4-chloro-1-naphthol substrate was prepared fresh just before use. Twenty-five ml of 0.3% H_2O_2 in Tris buffer without human serum albumin and sodium azide was added to 10 mg of 4-chloro-1-naphthol crystals dissolved in 0.125 ml absolute ethanol. After thorough mixing, the substrate was filtered through Whatman #1 filter paper.

Enzyme-Immunoassay

The enzyme-immunoassay was used as Hokama et al. (in print) described: fish tissue samples for testing were cut into uniform 3-mm in diameter, and each disc was placed in a well of a 96-well polystyrene microtiter plate (Flow Laboratories, Inc., Hamden, CT). Samples were washed once with 0.2 ml Tris buffer. After the wash solution was aspirated, each sample was fixed in 0.2 ml of H_2O_2-methanol fixative for 30 minutes at room temperature. Samples were then transferred to clean wells and 0.2 ml of a 1:100 dilution of sheep-anti-ciguatoxin-horseradish peroxidase conjugate in Tris buffer was added to each well. The plate was then incubated at room temperature for 1 hour. The sheep-anti-ciguatoxin-horseradish peroxidase was removed by aspiration, and the tissues were immersed for 5 minutes in 0.2 ml Tris buffer. Each sample was transferred to clean wells and incubated for 5 minutes at room temperature with 0.2 ml of 4-chloro-1-naphthol substrate. The final steps involved removal of the tissue and addition of 0.015 ml of 3 M sodium hydroxide to stop the enzymatic reaction. Absorbance readings at 405 nm of each well were obtained in the Titertek Multiskan (Flow Laboratories, Inc., Hamden CT).

In each microtiter plate, quadruplicate samples of known toxic (positive) and nontoxic (negative) control fish tissues were tested in parallel with the unknown samples.

Interpretation of results

For samples of species collected in sufficient number (greater than 38 fish per species), the absorbance reading at 405 nm of each sample was divided by the mean absorbance reading of all fish of that particular species. For fish of species collected in smaller numbers, each sample absorbance reading was divided by 0.233 which is the mean absorbance of 109 determinations on 76 marketed *Seriola dumerili*. Based on earlier studies with clinically documented toxic and commercial non-toxic fish, tentative toxicity ranges have been established:

Ratio	Toxicity Level
< 1.30	negative
1.30-1.49	borderline
≥ 1.50	positive

For the purpose of evaluating fish from current surveys, these ranges have been used to designate potential toxicity of the samples tested (Hokama *et al.*, in print).

RESULTS

A total of 1067 fish representing 72 different species of fish have been tested (Table 1). Of these fish, 58 (5.4%) gave positive values, 78 (7.3%) gave borderline values and 931 (87.3%) gave negative values. Only 5 species accounted for most of the positive and borderline results: Acanthurus nigroris, Ctenochaetus strigosis, Lutjanus kasmira, Myripristis kuntee, and Parupeneus multifasciatus (Table 2). Except for the above mentioned fish along with Acanthurus abdominalis and Acanthurus olivaceus, fewer than 20 fish have been collected for each species at either the Barber's Point or Ewa Beach control sites.

It is difficult to determine if the frequencies of positive or borderline results in certain species are greater due to the larger numbers of those species being tested or because certain species are more receptive to ciguatoxin. Table 2 shows the most populous fish and their toxicity (percentage of fish with positive or borderline results) while Table 3 lists the high toxicity species. There is only one species, A. olivaceus that appears in both tables. The percent of toxic fish from the most populous fish species ranges from 4.2 to 17.1, with the exception of A. olivaceus . It has a 30.8 percent toxicity rate. In comparison, the high toxicity species have percent toxicity rates ranging from 20 to 60 percent.

A comparison of samples taken between October and December 1982 with samples taken between January and May 1983 (Table 5) shows an overall increase in toxic levels. Further indications of increased toxicity at the survey sites are seen in the analysis of toxic levels of the two most populous fish species sampled: C. strigosis and L. kasmira (Fig. 1). A marked increase in toxicity occurred in January with both species at the Ewa site. In March and May , C. strigosis toxicity levels increased at the

Barber's Point site.

DISCUSSION

The enzyme-immunoassay employed in this survey enabled the detection of an overall increase of ciguatera levels in fish species tested (Table 5 and Fig. 1). However , any direct or indirect effects of dredging on the incidence of ciguatoxin in fish are difficult to substantiate. As seen in Fig. 1, toxicity levels have increased in the two targeted species at both the Barber's Point and Ewa Beach survey sites.

Since the causative organism of ciguatera is G. toxicus (Yasumoto et al., 1977; Adachi et al., 1979), it is unfortunate that measurement of population densities of this organism could not have been included in this study. Yasumoto (1980) also suggests that the cause of a G. toxicus bloom should be sought in the benthic community consisting of corals, benthic macroalgae, and benthic microalgae. In regards to corals, Randall (1958) was the first to mention that any environmental changes that cause death of corals might be followed by increased outbreaks of ciguatera. He hypothesized that the death of corals would create newly denuded surfaces on which toxin producing alga could grow. Although he assumed the toxin producer to be a blue-green alga, the hypothesis needs only a minor correction about the orgin of the toxin.

One possible explanation to increased toxicity levels at both survey sites may be a common environmental factor that causes the death of corals. Hurricane Iwa, which hit Hawaii in November 1982, may qualify as such a factor. Overall toxicity increases between January and May 1983 and marked toxicity increases in January, March and May for C. strigosis and L. kasmira would correlate well with the occurance of this environmental factor. This does not exclude the possibility that dredging has also contributed to increased toxicity levels in the Barber's Point survey site. Further testing is needed to clarify this point.

The conclusion that ciguatoxin levels increased was based, in part, on increased toxicity levels in C. strigosis and L. kasmira. However, the utility of the most populous fish as the best indicator of toxicity levels may be questionable. Of the ten most populous species of fish, only one species, A. olivaceus, also belongs to the group of fish species having the highest percentages of toxicity. The small sample size of the high toxicity species does not allow for a detailed monthly analysis to determine any fluctuations in ciguatera levels in these species. Perhaps increased attention to the collection of these species will increase both sample size and the regularity with which they can be monitored. In this way, a more sensitive indicator of ciguatera levels may be found in a fish species that appear to have an increased affinity toward the bioaccumulation of ciguatera.

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Table 1. Summary of Enzyme-Immunoassay Results for Barber's Point and Ewa Site Survey: September 1982 to May 1983.

Species	Total Samples	Enzyme-Immunoassay Results Positive[a]	Borderline	Negative
Acanthurus abdominalis	24	0	1	23
Acanthurus achilles	2	0	0	2
Acanthrus dussumieri				
BP	2	0	1	1
Control	1	0	0	1
Acanthurus mata				
BP	2	0	0	2
Control	1	0	0	1
Acanthurus nigrofuscus	4	0	2	2
Acanthurus nigroris				
BP	11	1	2	8
Control	24	0	3	21
Acanthurus olivaceus				
BP	10	3	2	5
Control	16	0	3	13
Acanthurus thompsoni	5	0	0	5
Acanthurus triostegus				
Control	2	0	0	2
Acanthurus xanthopterus	1	0	0	1
Aulostoma chinensis	1	0	0	1
Bodianus bilunulatus				
BP	7	0	0	7
Control	2	0	0	2
Bothus mancus				
Control	5	1	0	4
Calotomus spinedens	6	0	0	6
Caranx ignobilis	5	0	0	5
Caranx melampygus	4	0	0	4
Cephalopholis argus	1	0	0	1

Table 1. (Continued)

Species	Total Samples	Enzyme-Immunoassay Results Positive	Borderline	Negative
Chaetodon fremblii	1	0	0	1
Chaetodon lunula	1	0	0	1
Chaetodon multicinctus	4	0	0	4
Chaetodon ornatissimus	3	0	0	3
Chaetodon quadrimaculatus	3	0	0	3
Chaeilinus rhodochrous				
BP	2	1	0	1
Control	2	1	0	1
Cheilio inermis	2	0	0	2
Chromis ovalis	2	0	0	2
Chromis verator				
BP	6	0	0	6
Control	14	0	0	14
Cirrhitops fasciatus	1	0	0	1
Cirrhitus pinnulatus	17	0	2	15
Ctenochaetus strigosus[b]				
BP	186	15	20	151
Control	215	8	14	193
Dascyllus albisella	3	0	0	3
Delapterus sp.	4	0	0	4
Exallias brevis	1	0	0	1
Fistularia petimba	4	0	0	4
Gymnothorax flavimarginatus	3	0	0	3
Gymnothorax meleagris				
Control	4	0	0	4
Gymnothorax undulatus				
BP	1	0	0	1
Control	1	0	0	1

Table 1. (Continued)

Species	Total Samples	Enzyme-Immunoassay Results Positive	Borderline	Negative
Halichoeres ornatissimus	4	0	0	4
Lutjanus kasmira [c]				
BP	100	10	3	87
Control	99	8	12	79
Monotaxis grandoculis	6	0	0	6
Melichthys niger	2	0	0	2
Mulloidichthys flavolineatus	1	0	0	1
Mulloidichthys vanicolensis	3	0	0	3
Myripristis amaenus	5	0	0	5
Myripristis kuntee [d]				
BP	23	5	1	17
Control	42	0	2	40
Myripristis murdjam	19	1	2	16
Naso brevirostris	1	0	0	1
Naso hexacanthus	1	0	0	1
Naso lituratus				
BP	5	0	0	5
Control	1	0	0	1
Naso unicornis	1	0	0	1
Novaculichthys taeniourus	1	0	0	1
Paracirrhites arcatus	6	1	1	4
Paracirrhites forsteri	3	0	0	3
Parupeneus multifasciatus [e]				
BP	26	1	3	22
Control	23	0	0	23
Parupeneus pleurostigma	2	0	0	2
Parupeneus porphyreus	10	0	0	10
Pomacentrus jenkinsi	1	0	0	1

Table 1. (Continued)

Species	Total Samples	Enzyme-Immunoassay Results Positive	Borderline	Negative
Priacanthus cruentatus	3	0	0	3
Priacanthus meeki	2	0	0	2
Rhinecanthus rectangulus	7	1	2	2
Scarus perspicillatus	1	0	0	1
Scarops rubroviolaceus	1	0	0	1
Seriola dumerili	1	0	0	1
Stegastes fasciolatus	3	0	0	3
Sufflamen bursa	4	0	0	4
Sufflamen capistratus	7	0	0	7
Sufflamen fraenatus	1	0	0	1
Synodus variegatus	2	0	0	2
Thallosoma balleri	7	1	0	6
Thallosoma duperreyi				
BP	13	0	1	12
Control	4	0	0	4
Trachiurups crumeniphthalmus	9	0	0	9
Xanthicthys mento	1	0	0	1
Total	1071	56 (5.2%)	80 (7.5%)	935 (87.3%)

Table 1. (Continued)

[a]Ratios (R) were calculated for all absorbance ($O.D._{405\ nm}$) values. Fish were designated positive, borderline or negative according to the following criteria:

R	Result
≥ 1.50	Positive
1.30-1.49	Borderline
< 1.30	Negative

Unless otherwise noted, R = $\bar{x}$ $O.D._{405}$ of 8 samples ÷ 0.233 (the $\bar{x}$ of 109 S. dumerili).

[b] $\bar{x}$ O.D. of test fish ÷ 0.191 (the $\bar{x}$ of samples from 124 C. strigosus).

[c] $\bar{x}$ O.D. of test fish ÷ 0.191 (the $\bar{x}$ of samples from 69 L. kasmira).

[d] $\bar{x}$ O.D. of test fish ÷ 0.161 (the $\bar{x}$ of samples from 38 M. kuntee).

[e] $\bar{x}$ O.D. of test fish ÷ 0.176 (the $\bar{x}$ of samples from 40 P. multifasciatus).

(Used with permission from Hokama, 1983)

Table 2. The Most Populous Fish in the Barber's Point and Ewa Site Survey

Species	Total Samples	Number Toxic (Positive or Borderline)	Percent
Ctenochaetus strigosus	401	57	14.2
Lutjanus kasmira	199	33	16.6
Myripristis kuntee	65	8	12.3
Parupeneus multifasciatus	47	3	6.4
Acanthurus nigroris	35	6	17.1
Acanthurus olivaceus	26	8	30.8
Acanthurus abdominalis	24	1	4.2
Chromis verator	20	0	0
Myripristis murdjam	19	3	15.8
Thallosoma duperreyi	17	1	5.9

Table 3. The High Toxicity Species in the Barber's Point and Ewa Survey.

Species	Total Samples	Number Toxic (Positive or Borderline)	Percent
Rhinecanthus rectangulus	5	3	60.0
Acanthurus nigrofuscus	4	2	50.0
Chaeilinus rhodochrous	4	2	50.0
Acanthurus dussumieri	3	1	33.3
Paracirrhites arcatus	6	2	33.3
Acanthurus olivaceus	26	8	30.8
Bothus mancus	5	1	20.0

Table 4. Monthly Enzyme-Immunoassay Results for Selected Fish Species from Barber's Point and Ewa Survey: September 1982 to May 1983

Acanthurus nigroris

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.	1	1		1					5
bor.		1							
pos.		2							
% toxic[a]	0	75		0					0
Control									
neg.		1		2				18	
bor.				1				2	
pos.									
% toxic[a]		0		33.3				10	

Acanthurus olivaceus

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.	1								4
bor.									2
pos.				3					
% toxic[a]	0			100					33.3
Control									
neg.		2		7				4	
bor.				2					1
pos.									
% toxic[a]		0		22.2				0	100

[a]Positive or borderline enzyme-immunoassay results.

Table 4. (Continued)

Ctenochaetus strigosus

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.	5	60		31	18		5		32
bor.	4	4		1	1		3		7
pos.		1					13		1
% toxic[a]	44.4	7.6		3.1	5.3		76.2		20
Control									
neg.		44	95		18	16			20
bor.		8	5			1			
pos.		2	3		2	1			
% toxic[a]		18.5	7.8		10	11.1			0

Lutjanus kasmira

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.	5	58					14		10
bor.	1	1							1
pos.		1							9
% toxic[a]	16.6	3.3					0		50
Control									
neg.			48	1	4		11		15
bor.					11				1
pos.					5		1		2
% toxic[a]			0		80		8.3		16.7

[a]Positive or borderline enzyme-immunoassay results

Table 4. (Continued)

Myripristis kuntee

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.		4			3		2	8	
bor.		3						2	
pos.								1	
% toxic [a]		42.8			0		0	27.3	
Control									
neg.			19	10		3			8
bor.									
pos.		1	1						
% toxic [a]		0	5	0		0			0

Parupeneus multifasciatus

BP	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
neg.	1	14					2		5
bor.	2	1							
pos.	1								
% toxic [a]	75	6.7					0		0
Control									
neg.			16	5	2				
bor.									
pos.									
% toxic [a]			0	0	0				

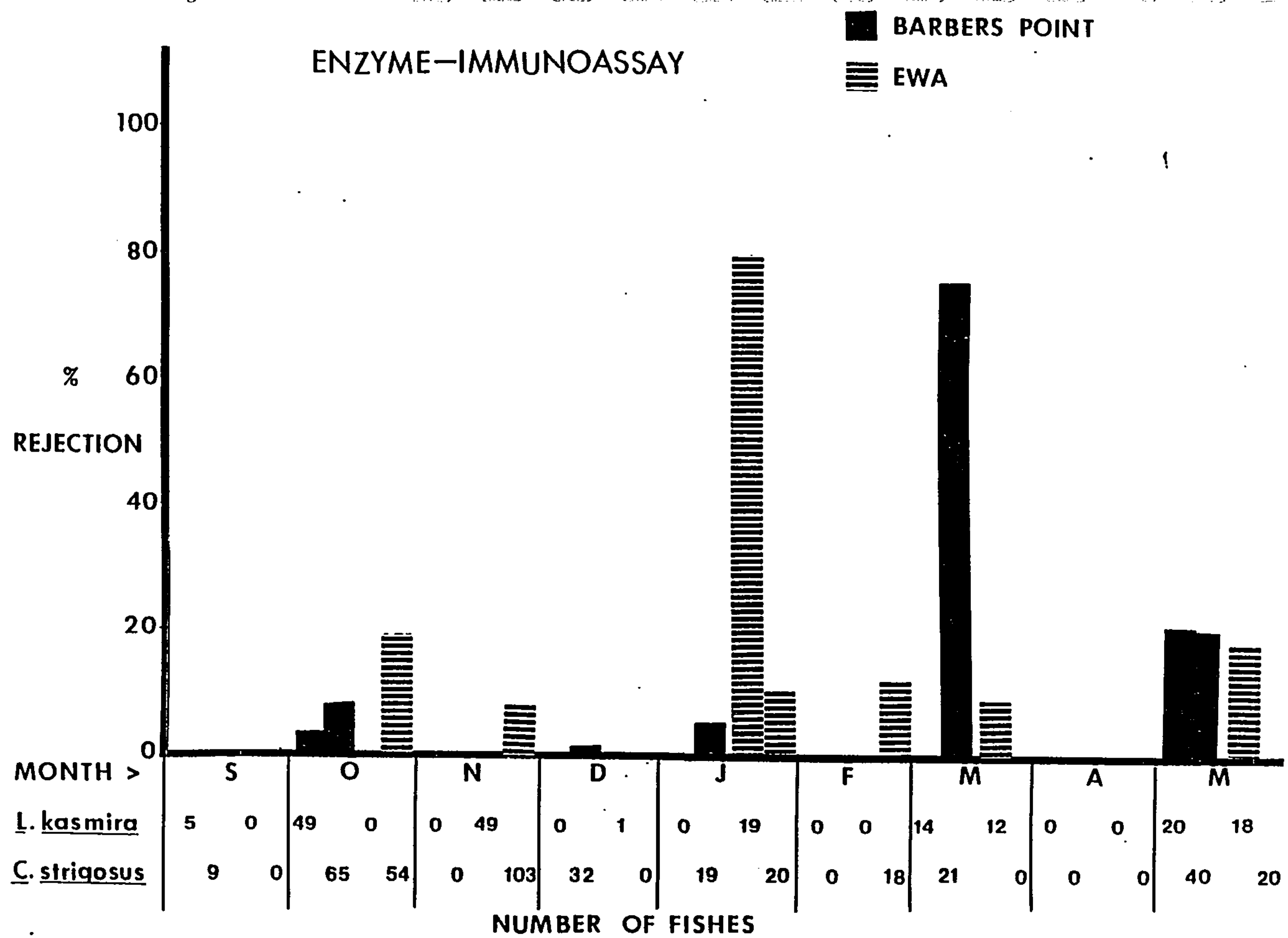
[a] Positive or borderline enzyme-immunoassay results.

Table 5. Comparison of toxicity levels between October 1982 to December 1982 versus January 1983 to May 1983.

Period	Total Samples	Enzyme-Immunoassay Results % Positive	Enzyme-Immunoassay Results % Borderline	Enzyme-Immunoassay Results % Negative
October-December 1982	751	2.0	6.0	92.0
January-May 1983	320	12.3	11.4	76.3

(Modified from Hokama, 1983)

Fig. 1.



(Used with permission from Hokama, 1983)

APPENDIX A-5

HYDROGEOLOGICAL IMPACTS PROPOSED EXPANSION OF THE BARBERS POINT HARBOR

HYDROGEOLOGICAL IMPACTS

PROPOSED EXPANSION of the BARBERS POINT HARBOR

PREPARED by

MINK & YUEN, Inc.

HONOLULU, HAWAII

PREPARED for

DEPARTMENT of TRANSPORTATION

STATE of HAWAII

JULY, 1993

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PROPOSED EXPANSION OF THE BARBERS POINT HARBOR

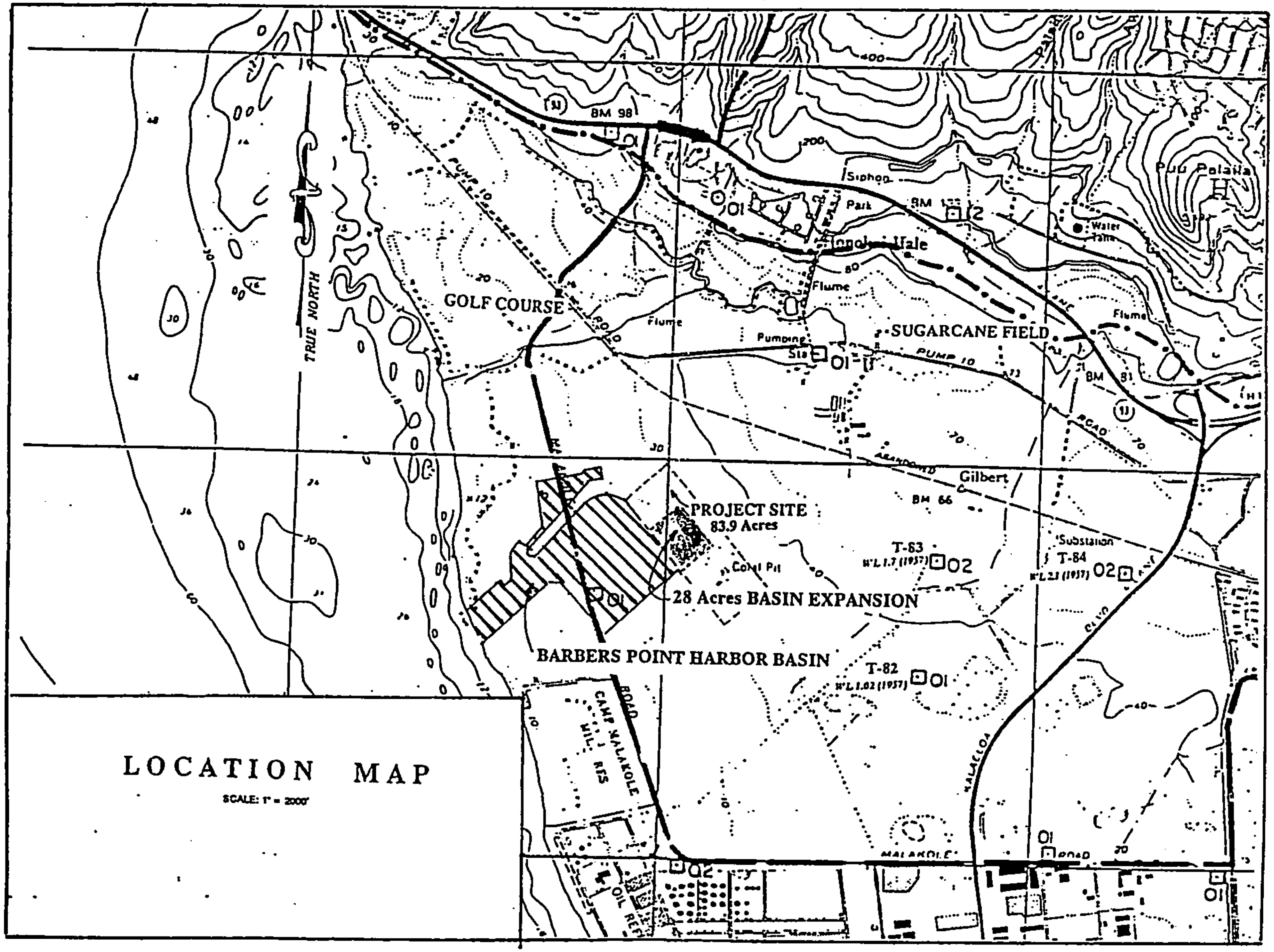
Hydrogeological Impacts

INTRODUCTION AND EXECUTIVE SUMMARY:

The proposal to extend the Barbers Point Harbor approximately 1100 feet inland will affect the groundwater flow net in the limestone aquifer into which the existing harbor is dredged and into which the extension will also be dredged. This limestone aquifer constitutes the uppermost stratum of the "caprock", a succession of sedimentary formations overlying and confining the Waianae basalt aquifer.

The limestone is separated from the much deeper Waianae aquifer by impermeable to poorly permeable strata of marine and terrestrial clays. Interaction between groundwater in the Waianae aquifer and in the caprock is restricted to a low rate of upward seepage into the deepest caprock stratum. Groundwater occurrence and behavior in the upper limestone is not influenced by this weak interaction.

The Waianae aquifer is a source of drinking water four miles to the east and up-gradient of the harbor. The quality of groundwater in the Waianae aquifer nearer the harbor is too brackish to be used for municipal supply, but it is an important source for irrigation. An Oahu Sugar Company pumping station (State no. 2006 - 1 to 11) 0.7 miles from the harbor continues to pump an average of 7 mgd of groundwater with less than 1000 mg/l chloride for sugar irrigation, and several new irrigation wells serve the Ko Olina golf course



LOCATION MAP

SCALE: 1" = 2000'

The sugar cane fields near the harbor apparently will be abandoned in two years time, and the need for irrigation will cease. Pumpage for the golf courses and landscaping will continue.

Groundwater in the limestone aquifer west of the Barbers Point Naval Air Station is too brackish for most irrigation purposes. Near the harbor its salinity is considerably greater than 1000 mg/l chloride. Sugar cane can tolerate salinity to about 1000 mg/l chloride. Nevertheless the water is pumped for industrial purposes such as cooling and washing. One well supplies brackish water to the State-Campbell Estate pilot desalinization plant.

The above brief description of groundwater resources within several miles of the harbor emphasizes the absence of a low salinity source in either the deep Waianae basalt aquifer or the topmost limestone aquifer in the caprock. Extension of the harbor will not have an effect on the potable groundwater resources of southwestern Oahu. It will not affect irrigation quality water in the deep Waianae aquifer, but it will affect the groundwater flow net of the limestone aquifer. The effect on limestone groundwater will not significantly limit the utility of this resource, however. Later in this report the results of a numerical model of groundwater flow in the limestone aquifer will suggest to what extent the limestone aquifer will be affected.

Geology and Hydrology of the Limestone Aquifer

In a report prepared for the State Department of Land and Natural Resources (DLNR) in 1988 by George A.L. Yuen Associates, Inc., titled, Groundwater Resources and Sustainable Yield Ewa Plain Caprock Aquifer, the Ewa Plain is divided is divided into four management sectors, one of which is the Malakole Sector where the Barbers Point Harbor is located. The Malakole Sector starts at the flood control channel along the western boundary of the Barbers Point Naval Air Station and includes the Campbell Industrial Park, Ko Olina Resort and about 400 acres of sugar cane. The DLNR report points out that in the Malakole Sector the limestone groundwater is highly brackish and is used chiefly for washing coral and for industrial cooling. The sustainable yield is given as less than 1 mgd.

The caprock in the Ewa Plain reaches a maximum thickness of 1100 feet at the coastline near the community of Ewa Beach. In the Malakole Sector the maximum depth is extrapolated to be 630 feet at the coast at Barbers Point. Total thickness at the harbor is calculated to be 250 feet. At the inland extension of the harbor it will be about 200 feet. These estimates are based on an average slope for the bottom of the caprock of 2.6 degrees as determined from wells that penetrate to the volcanic basement.

Only the uppermost stratum of coral in the caprock can be considered an aquifer carrying groundwater having less than sea water salinity. In the DLNR report this limestone is referred to as Aquifer 1.

The limestone has a maximum thickness of 200 feet. Its base slopes gently upward at a grade of .0085 inland until it interfingers with alluvium. Figure 1 in the Appendix illustrates the arrangement of the aquifers and aquicludes in the caprock in the Puuloa Sector near Ewa Beach where two deep wells were drilled all the way through the caprock for research purposes. Figure 2 shows the arrangement in the Industrial Park in the Malakole Sector based on the record of two moderately deep wells, which do not, however, reach the volcanics. All of the other wells and borings in the Plain are shallow and restricted to the top limestone.

In the Malakole Sector the limestone starts at the ground surface and extends to a depth greater than 60 feet below sea level. Exploratory borings drilled for the main harbor ended in limestone at 60 feet below sea level, and expectably in the harbor extension a similar depth will prevail because the slope of the limestone-clay interface is very small (.0085). Thus limestone Aquifer 1 is at least 60 feet thick in the vicinity of the harbor.

The clay layer on which Aquifer 1 rests is about 40 feet thick and, like Aquifer 1, has been encountered in all Sectors of the Ewa Plain. It constitutes an effective aquiclude.

Beneath this aquiclude (called Aquiclude 1 in the DLNR Report) is a second limestone aquifer, which carries highly brackish to saline groundwater. Between this aquifer and the volcanic basement a series of clay and coralline strata are saturated with saline water.

The original harbor was excavated to depth 38 feet below sea level. At this depth the floor of the harbor is in the Aquifer 1 limestone. This will be the case in the harbor extension also.

<u>Limestone Aquifer 1 Parameters</u>

The limestone aquifer reaches a maximum thickness of more than 60 feet at the harbor. Inland its base rises at a gentle slope of .0085, and the aquifer terminates about 8000 feet from the coast where its thickness has decreased to about 50 feet. The elevation of the base of the aquifer becomes shallow enough at some distance inland to lie above the theoretical depth of a brackish water-sea water interface. In the vicinity of the harbor, however, groundwater in the aquifer exists as a brackish basal lens floating on sea water.

The limestone is highly permeable and as a result groundwater heads (water table elevation above sea level) are low, less than 2.0 feet. Consequently the brackish lens is thin.

Although hydraulic conductivities as high as 25,000 ft/day have been suggested (Dale, R.H., 1968, Probable Effects on the Groundwater Reservoir by Enlarging the Harbor at Barbers Point, Oahu, Hawaii: U.S. Geological Survey Report to the U.S. Army Corps of Engineers), a more realistic value is on the order of 5000 ft/day. At the higher value, derived from tidal data but constrained by numerous fundamental assumptions, the total calculated discharge of water from the caprock would exceed actual flux by a factor of five.

In the Malakole Sector a reasonable groundwater gradient is .0002, based on head data, much of which is unreliable. Employing a hydraulic conductivity of 5000 ft/day, a gradient of .0002, and average head of 1.5 feet (lens thickness 60 feet), the flux of groundwater toward the coast is 450 gallons per day (gpd) per unit width of one foot (450 gpd/ft). For lower conductivities, the flux would be proportionately less. For example, at hydraulic conductivity of 3000 ft/day, flux = 270 gpd/ft. The actual value probably lies between 200 and 500 gpd/ft; the data base does not allow finer discrimination.

The sources of the groundwater in Aquifer 1 are leakage from the Waianae basalt aquifer where it interfaces with alluvium and limestone, rainfall and infiltration from surplus irrigation.

In the Malakole Sector rainfall is less than 20 inches per year, of which perhaps one fourth becomes infiltration; return irrigation is substantial, probably somewhat more than 1 mgd, but eventually this source will terminate when sugar cane cultivation is abandoned; and leakage from the basalt aquifer is significant, probably on the same order as return from surplus irrigation. However, in all places Aquifer 1 is brackish and unfit for irrigation, and this condition will be accentuated when irrigation recharge ceases.

Numerical Model of Aquifer 1 Groundwater Behavior

In order to understand the effect that the original harbor construction had and the extension will have on the groundwater flow net in limestone Aquifer 1, a variety of scenarios incorporating a range of aquifer parameters were simulated with a numerical model. The computer program employed is Aquifem-Salt 2-D Finite Element. In view of the fact that the aquifer parameters of the limestone are estimates and that hydrologic conditions tributary to the harbor have been and will be modified in response to land use changes, in particular those caused by irrigation practices, a total of 18 scenarios were modeled to assure that the predictions of change due to the harbor expansion are realistic.

Two values of hydraulic conductivity were assigned to the defining scenarios, one of 5000 ft/day and the other of 3000 ft/day.

Groundwater response to tidal fluctuations suggests that the higher value is representative, but water balance calculations favor the lower value. Rainfall recharge in the key scenarios was set as 25 percent of average annual rainfall, but in a few a 33 percent proportion was used. Irrigation return infiltration was assigned a value of either 40 inches/year (furrow irrigation) or 22 inches/year (drip irrigation). A maximum of 2 mgd was allowed as leakage from the Waianae basalt aquifer, but in many scenarios no leakage was assumed. The potentiometric surface was plotted from data given in the DLNR report. Maps of the potentiometric surfaces with flow nets to the harbor are given in the Appendix (Figs. 4-8). Also included is the potentiometric surface in 1957 before the harbor was constructed (Fig. 3).

The results of the simulations are summarized below. The landward position of the 1.0 foot head contour and the outflow rate into the harbor are employed as the defining criteria of changes in groundwater behavior since 1957. In all cases rainfall recharge is taken as 4.75 inches, 25 percent of average rain. The scenarios in this summary were selected to illustrate the full range of possible conditions.

Year	Status	Hyd.Con. ft/day	Irr.Rech. in/yr	Har.Flow mgd	h=1 ft ft.inland
1957	Pre-harbor	3000	40	0.5	4000
1990	Harbor	3000	22	0.7	6000
1990	Harbor	5000	40	1.1	6000
1995	Exp.Harbor	3000	22	0.7	6300
1995	Exp.Harbor	3000	0	0.3	>5000
1995	Exp.Harbor	5000	0	0.4	>5000

Excavation of the harbor had the effect of shifting the coastline about 3000 feet inland and altering the groundwater flow net so that the 1.0 foot head contour withdrew 2000 feet inland of the natural position. Groundwater flowed into the present harbor at a rate of about 1 mgd when furrow irrigation was practiced in contrast to a flow of 0.5 mgd at the equivalent natural coastline. The change to drip irrigation has decreased flow into the harbor by about 0.3 mgd.

If sugar continues to be grown and is irrigated by the drip method, expansion of the harbor will push the 1 foot head contour inland by another 300 feet. Thus, under natural conditions the 1 foot head contour lay 4000 feet inland, the original harbor set it at 6000 feet inland, and the expanded harbor, under conditions of continuing irrigation, will drive it to 6300 feet inland.

However, sugar irrigation and its recharge component will cease within several years. Some of the lost recharge will be made up by return irrigation from the Ko Olina golf course, but the loss of recharge from sugar irrigation will decrease water levels in the entire Malakole Sector. Inland of the expanded harbor the head will not reach a level of 1.0 foot. Groundwater flow into the harbor will diminish to 0.3 mgd for hydraulic conductivity of 3000 ft/day, and to 0.4 mgd for hydraulic conductivity of 5000 ft/day.

Clearly, the loss of sugar irrigation recharge will produce the dominant changes in limestone Aquifer 1 in the harbor vicinity over the coming years.

Summary and Conclusions

The Malakole Sector of the Ewa Plain before the harbor was built carried brackish water in a limestone aquifer at the top of the caprock column. Only this aquifer among the several in the sedimentary succession contained water at that time of low enough salinity to be useful for the irrigation of salt-tolerant plants. This water source was not exploited, however. The source of the irrigation supply has been the Waianae basalt aquifer, which lies about 200 feet below the surface in the vicinity of the harbor. The limestone aquifer is not hydraulically connected to the Waianae aquifer.

When sugar cane covered the fields in the western part of the Ewa Plain and was irrigated by the furrow method, limestone Aquifer 1 had a moderately strong flow field, but nevertheless the salinity of its water exceeded 1000 mg/l chloride. The utility of the water even at that time was limited. Today the water is used only for industrial cooling and washing.

The construction of the harbor modified the groundwater flow field by extending the coastline 3000 feet inland of the natural coast. The potentiometric surface for pre-harbor conditions had a maximum head of 2.6 feet at the inner margin of the limestone aquifer.

The harbor reduced the maximum head to 2.0 feet and pushed the 1.0 foot head contour 2000 feet inland of its natural location. Groundwater flow into the harbor at about 1 mgd was about twice that along the equivalent undisturbed coast.

Expanding the harbor 1100 feet further inland would still allow for a maximum head of 2.0 feet as long as sugar cane irrigation continued. Abandonment of sugar irrigation will result in an eventual maximum head of only about 1.0 feet. Recharge from surplus irrigation of golf courses may add a small increment to the ultimate maximum head.

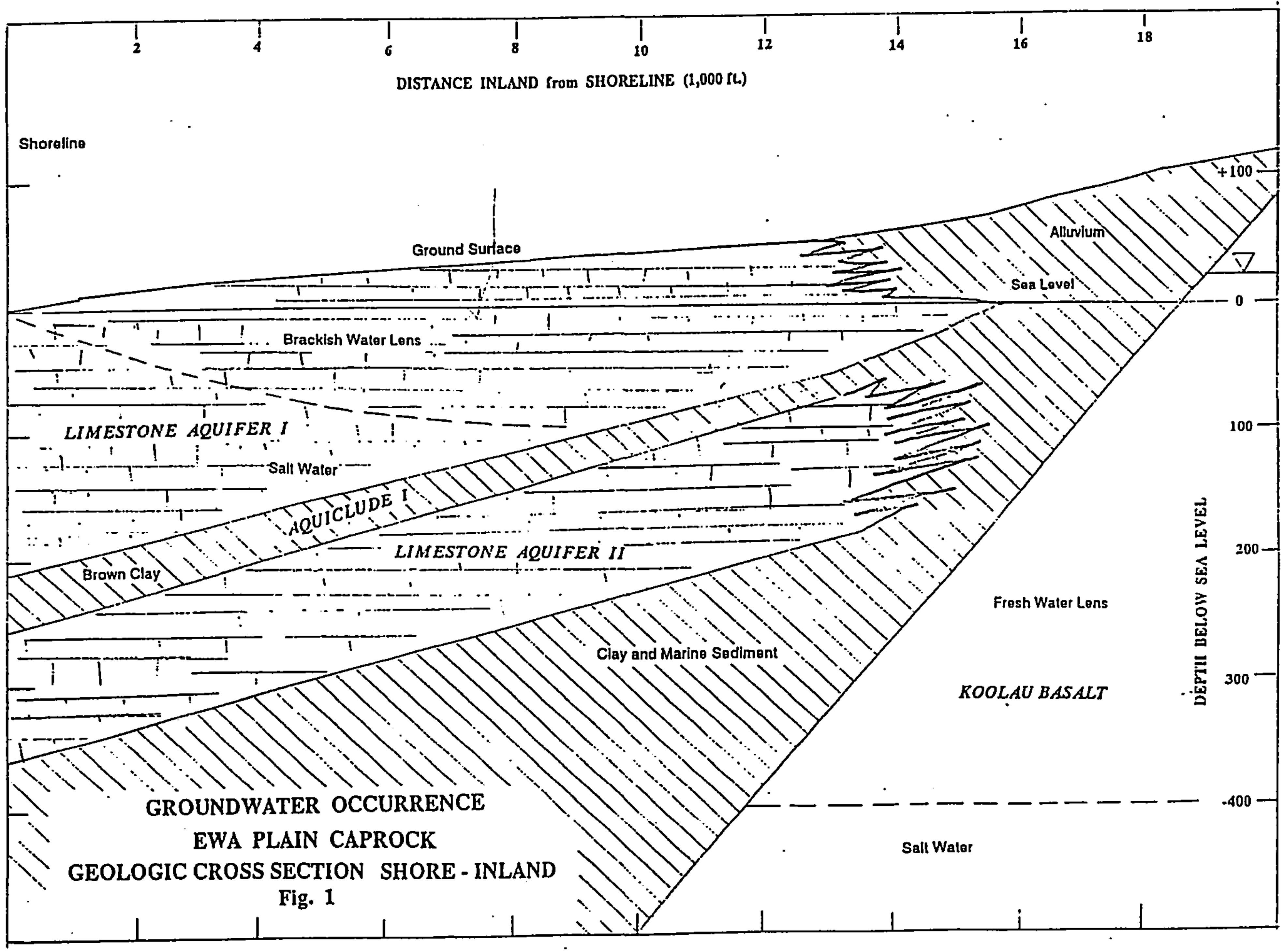
Although changes in groundwater behavior will result when the harbor is expanded, these changes will be less severely degrading than the changes that will be wrought by the abandonment of sugar cane irrigation. The current quality of the limestone groundwater is already too saline for irrigation useage, but when recharge from irrigation ceases the water will become much saltier.

Long-range plans may call for increasing the depth of the harbor from 38 feet to 45 feet below sea level. This increase in depth will not significantly affect the hydrology of the area beyond that described on page 2 of this report.

HYDROGEOLOGICAL IMPACTS

PROPOSED EXPANSION of the BARBERS POINT HARBOR

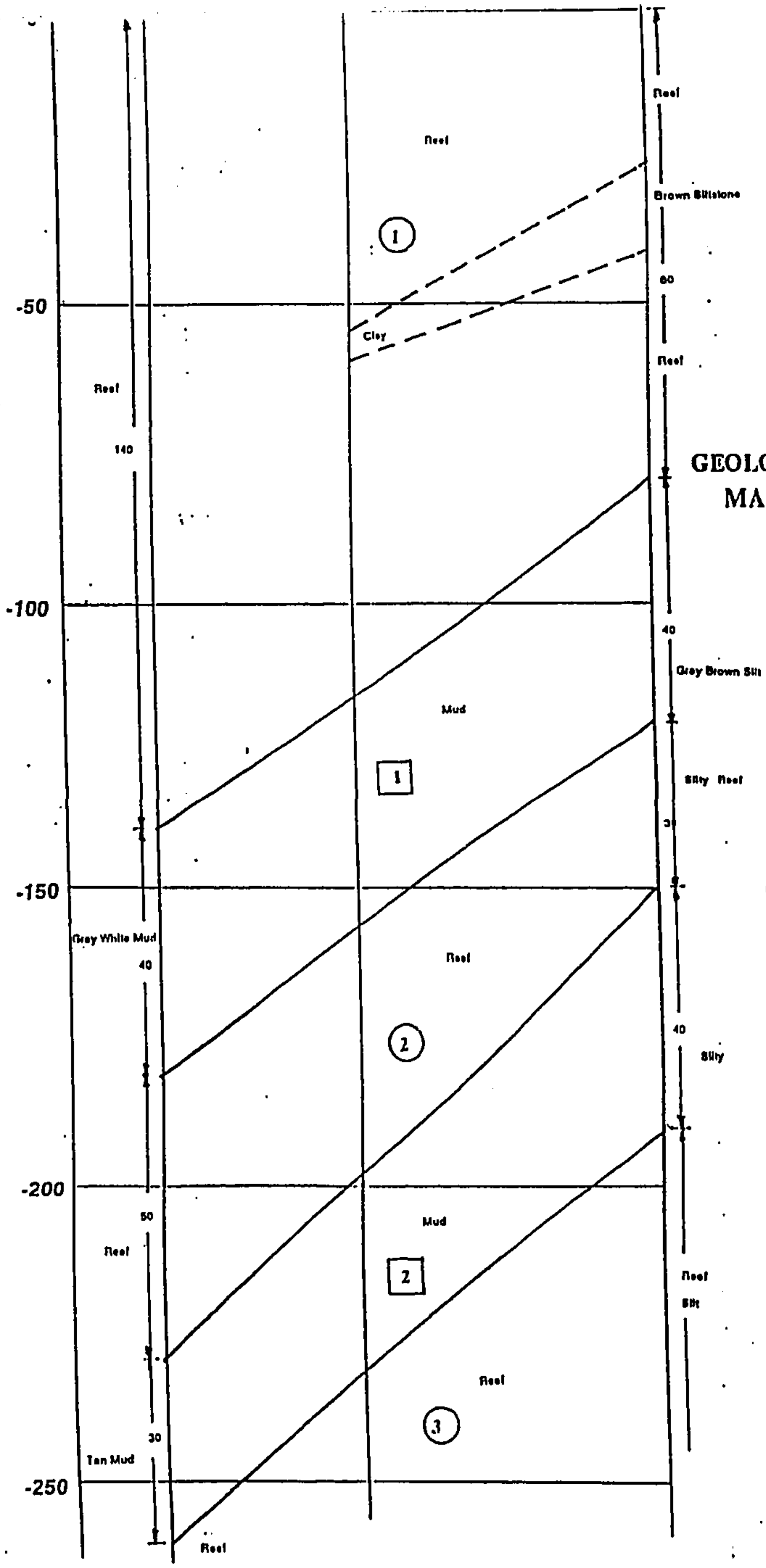
APPENDIX

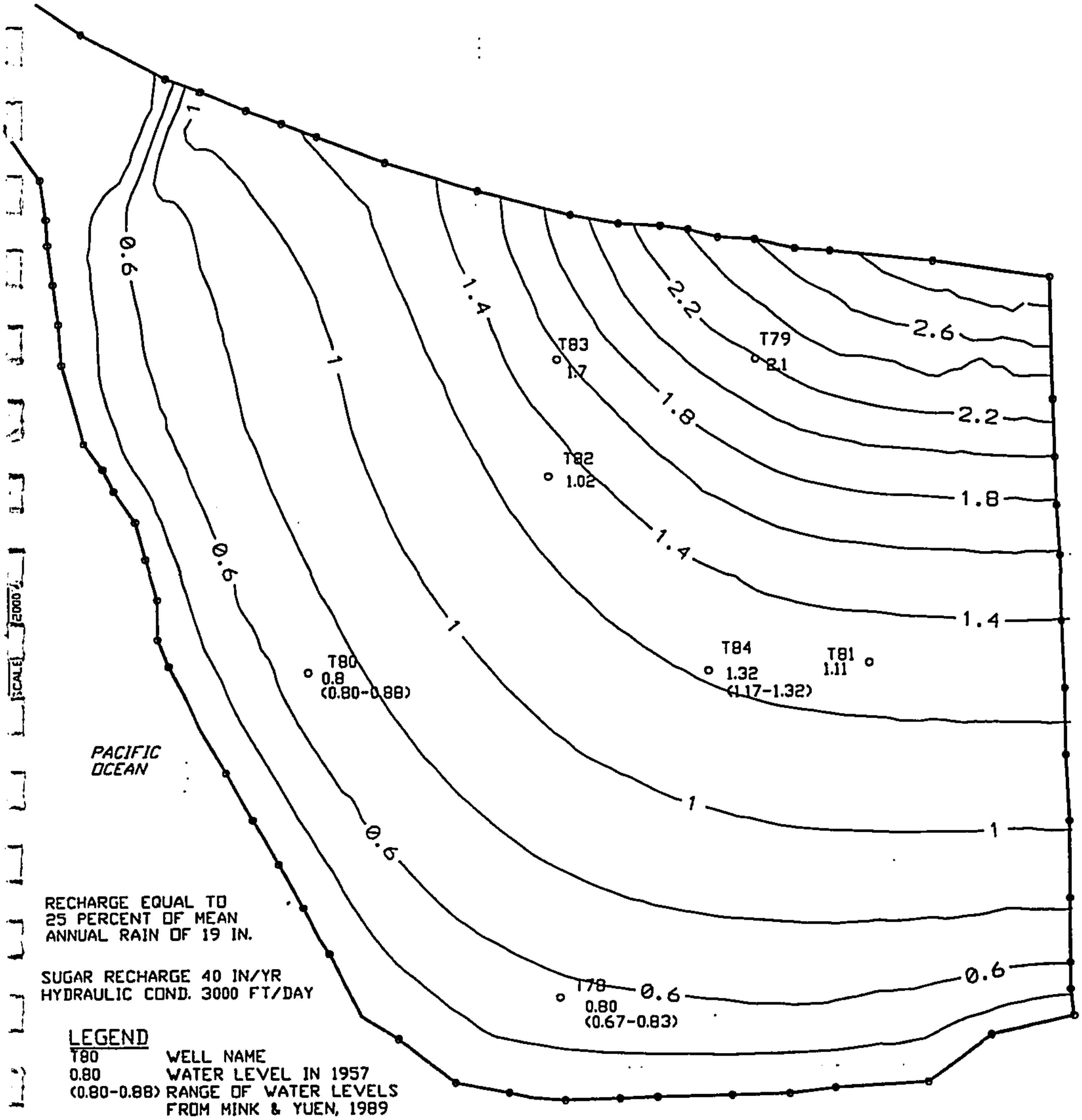


GROUNDWATER OCCURRENCE
EWA PLAIN CAPROCK
GEOLOGIC CROSS SECTION SHORE - INLAND
Fig. 1

GEOLOGIC CROSS SECTION MALAKOLE SECTOR

Fig. 2





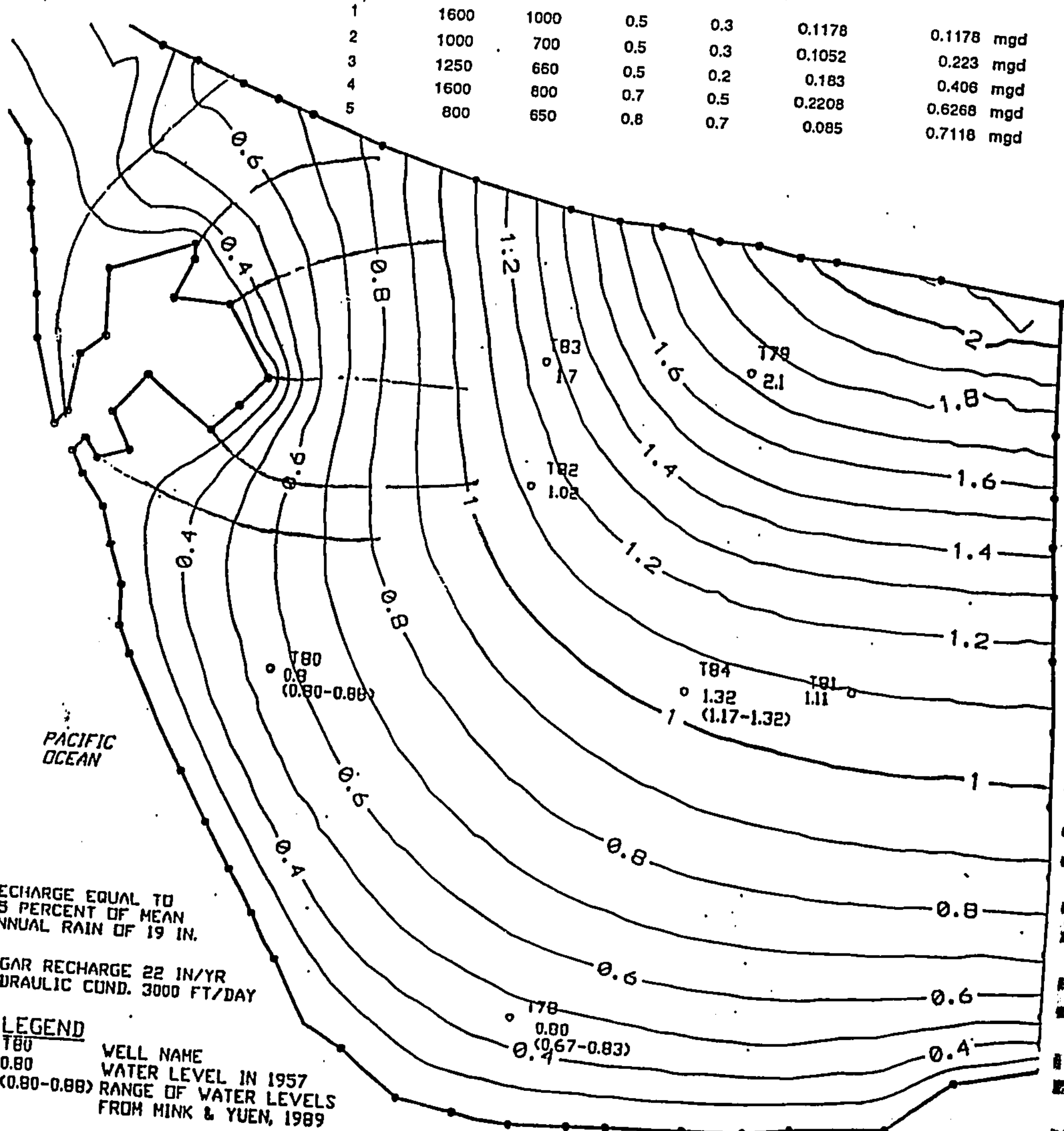
MALAKOLE TOP CAPROCK AQUIFER
SIMULATED WATER LEVEL CONTOUR MAP 1957

NBAR12.DWG

SCALE: 1"=2000'

Fig. 3

SECTION	LENGTH	ΔX	h2	h1	Q (mgd)	Cummulative Q
1	1600	1000	0.5	0.3	0.1178	0.1178 mgd
2	1000	700	0.5	0.3	0.1052	0.223 mgd
3	1250	660	0.5	0.2	0.183	0.406 mgd
4	1600	800	0.7	0.5	0.2208	0.6268 mgd
5	800	650	0.8	0.7	0.085	0.7118 mgd



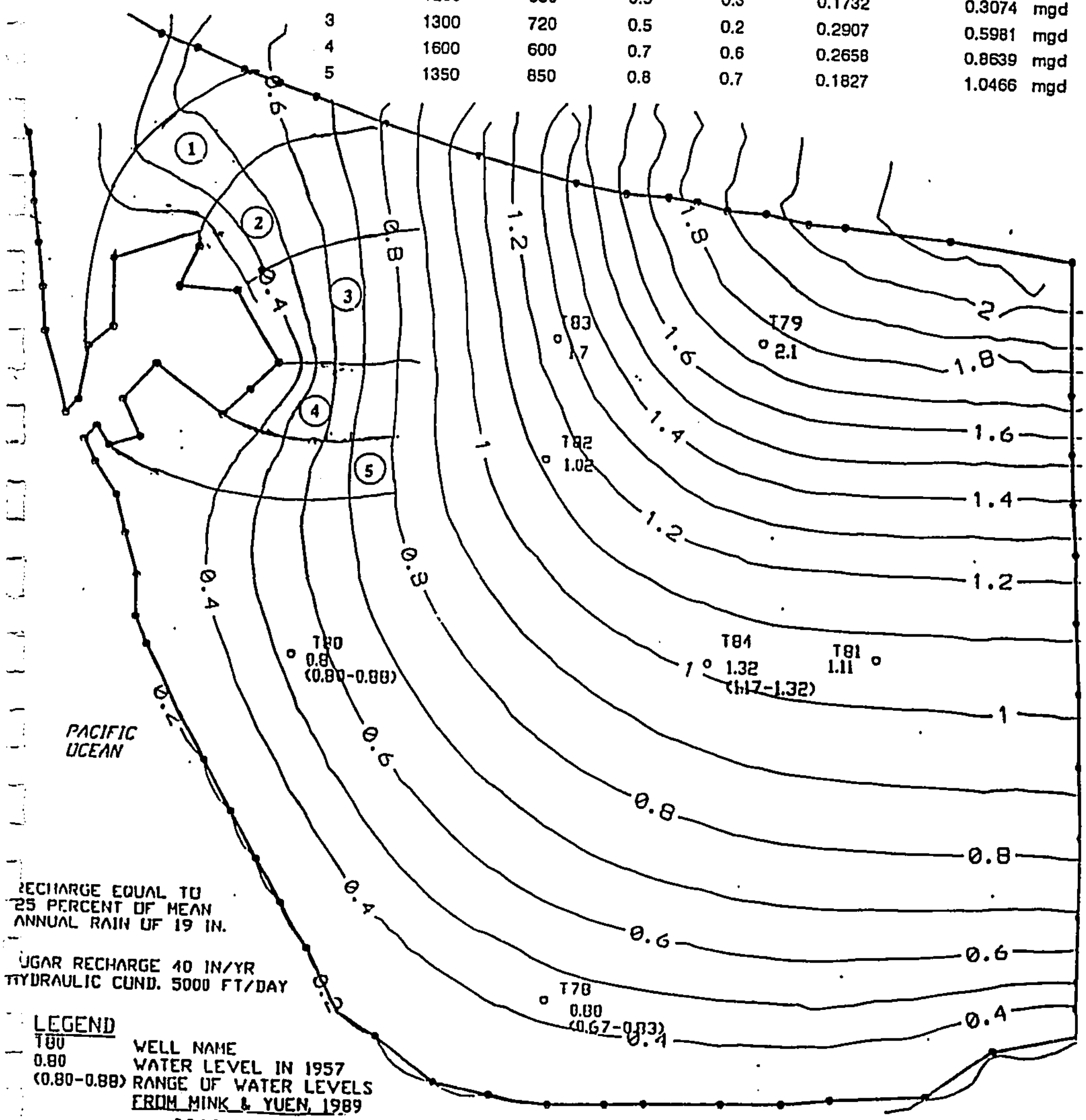
MALAKOLE TOP CAPROCK AQUIFER
SIMULATED WATER LEVEL CONTOUR MAP 1990

SCALE: 1"=2000'

HBARI.DWG

Fig. 4

SECTION	LENGTH	X	h2	h1	Q (mgd)	Cumulative Q
1	1400	560	0.4	0.3	0.1342	0.1342 mgd
2	1200	850	0.5	0.3	0.1732	0.3074 mgd
3	1300	720	0.5	0.2	0.2907	0.5981 mgd
4	1600	600	0.7	0.6	0.2658	0.8639 mgd
5	1350	850	0.8	0.7	0.1827	1.0466 mgd



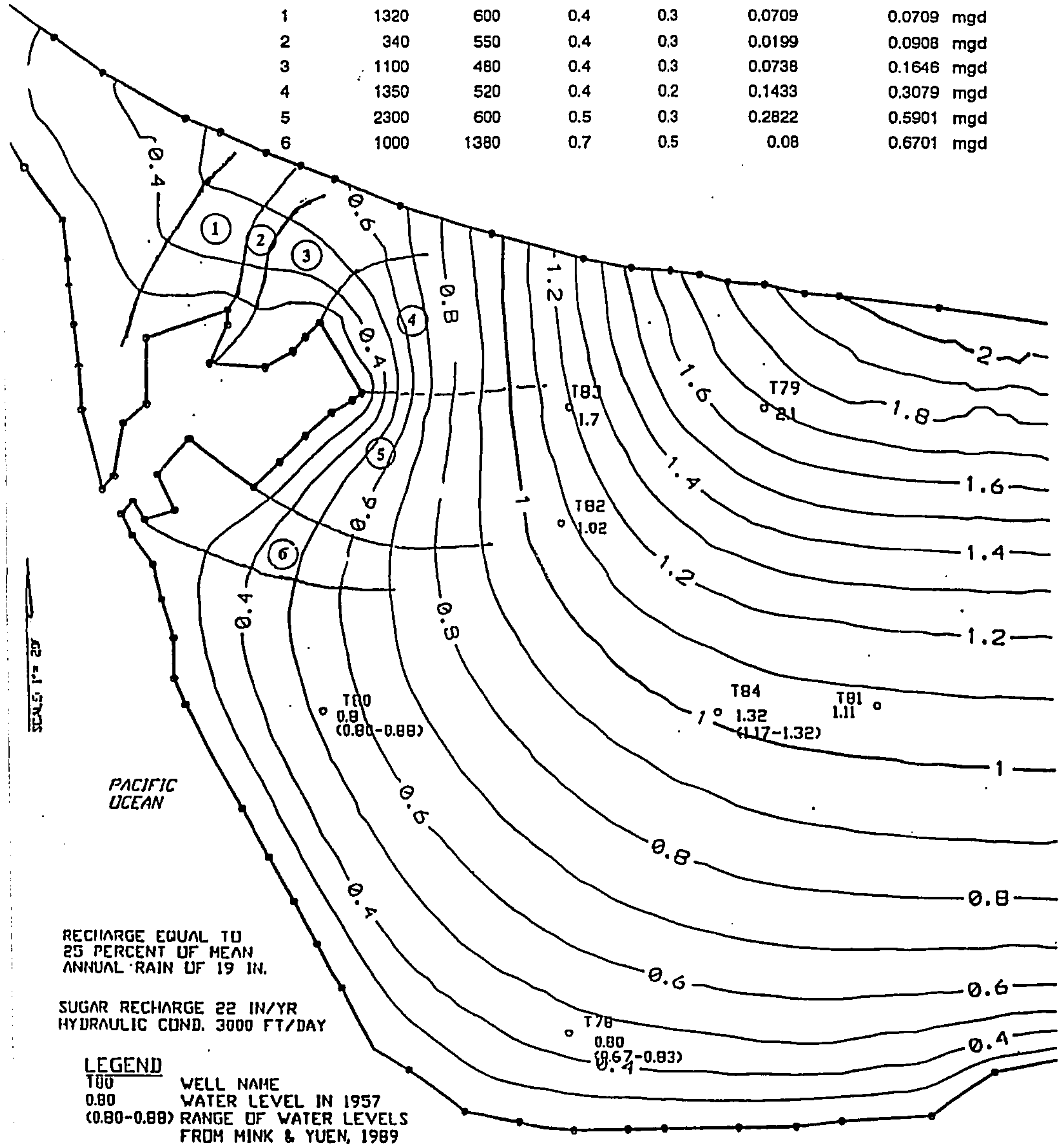
MALAKOLE TOP CAPROCK AQUIFER
SIMULATED WATER LEVEL CONTOUR MAP 1990

SCALE: 1"=2000'

HBAR1.DWG

Fig. 5

SECTION	LENGTH	ΔX	h2	h1	Q (mgd)	Cumulative Q
1	1320	600	0.4	0.3	0.0709	0.0709 mgd
2	340	550	0.4	0.3	0.0199	0.0908 mgd
3	1100	480	0.4	0.3	0.0738	0.1646 mgd
4	1350	520	0.4	0.2	0.1433	0.3079 mgd
5	2300	600	0.5	0.3	0.2822	0.5901 mgd
6	1000	1380	0.7	0.5	0.08	0.6701 mgd



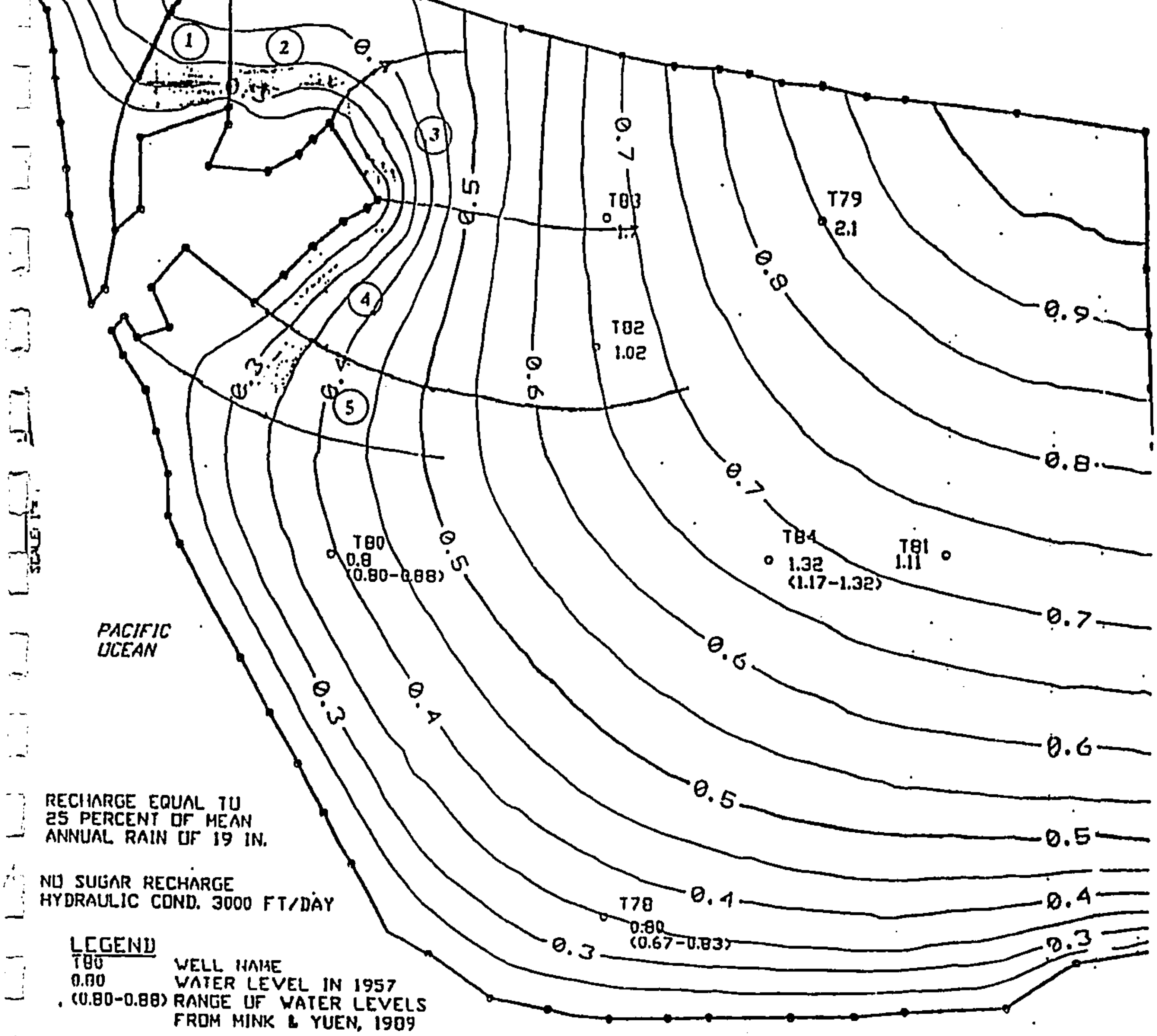
MALAKOLE TOP CAPROCK AQUIFER FBAR2.DWG

SIMULATED WATER LEVEL CONTOUR MAP EXP. HARBOR

SCALE: 1"=2000'

Fig. 6

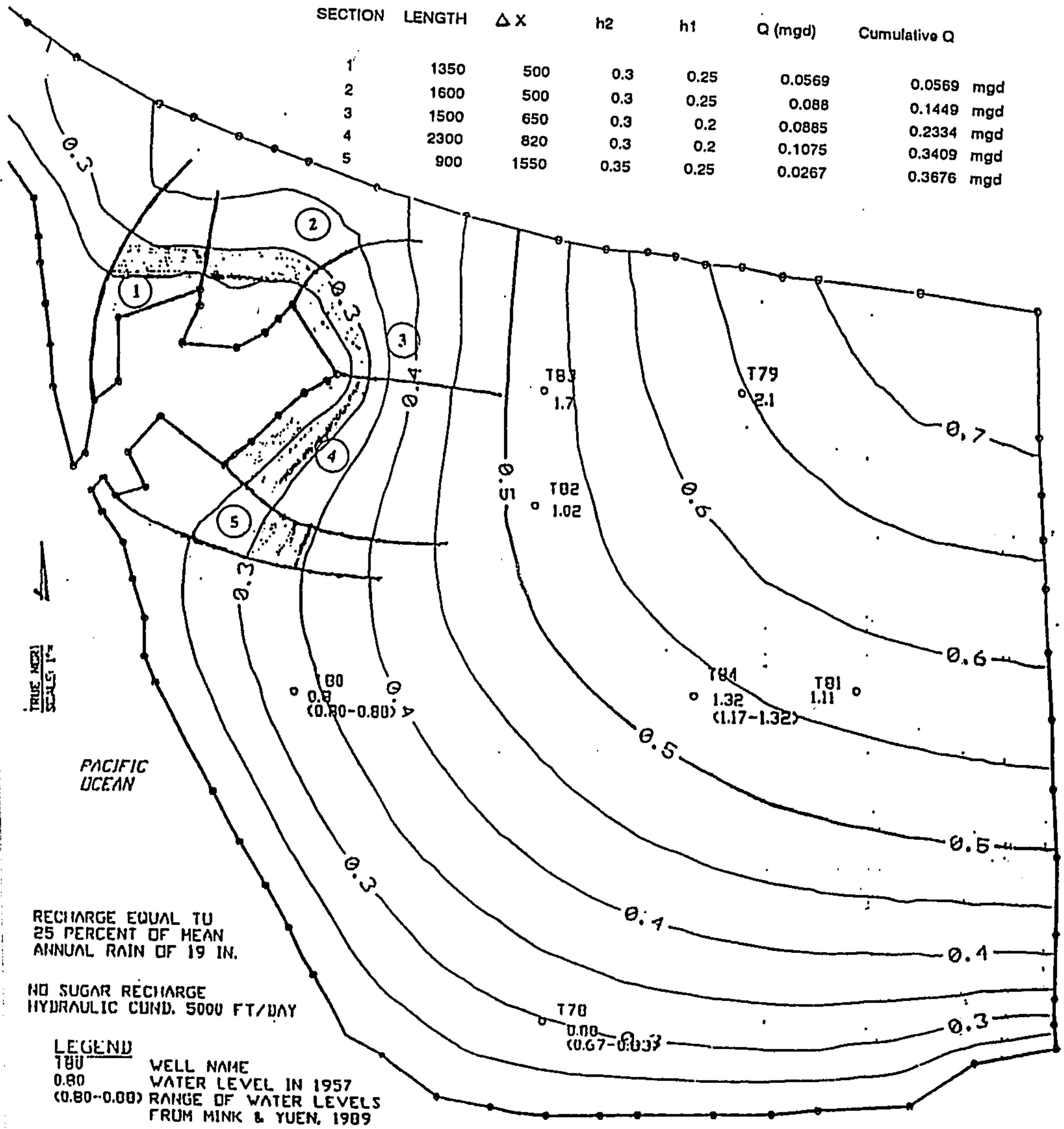
SECTION	LENGTH	ΔX	h2	h1	Q (mgd)	Cumulative Q
1	1300	700	0.35	0.25	0.0513	0.0513 mgd
2	1750	320	0.35	0.3	0.0818	0.1331 mgd
3	1400	450	0.3	0.2	0.0716	0.2047 mgd
4	2250	520	0.3	0.2	0.0995	0.3042 mgd
5	1200	1000	0.4	0.3	0.0386	0.3428 mgd



MALAKOLE TOP CAPROCK AQUIFER
SIMULATED WATER LEVEL CONTOUR MAP EXP. HARBOR
SCALE: 1"=2000'

Fig. 7

SECTION	LENGTH	Δ X	h2	h1	Q (mgd)	Cumulative Q
1	1350	500	0.3	0.25	0.0569	0.0569 mgd
2	1600	500	0.3	0.25	0.088	0.1449 mgd
3	1500	650	0.3	0.2	0.0885	0.2334 mgd
4	2300	820	0.3	0.2	0.1075	0.3409 mgd
5	900	1550	0.35	0.25	0.0267	0.3676 mgd



MALAKOLE TOP CAPROCK AQUIFER FBAR3.DWG

SIMULATED WATER LEVEL CONTOUR MAP EXP. HARBOR

SCALE: 1"=2000'

Fig. 8

APPENDIX A-6

REPRODUCTION OF EISPN COMMENT LETTERS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

DEC 22 1993

December 20, 1993 F/SW033:ETN

Copies
D. Ostini
S. Wu
D. Ziemann
J. Yazawa

Mr. Paul Wolf
Project Manager
Barbers Point Deep Draft
  Harbor Expansion
Parsons Brinckerhoff
Two Waterfront Plaza, Suite 220
500 Ala Moana Blvd.
Honolulu, Hawaii 96813-4990

Dear Mr. Wolf:

This responds to your letter of November 24, 1993, to John Naughton requesting a list of threatened and endangered species that may be affected by the proposed Deep Draft Harbor Expansion.

List of Species That May Occur in the Activity Area

Humpback whale (Megaptera novaeangliae) - endangered
Green turtle (Chelonia mydas) - threatened

North Pacific humpback whales are the second most depleted endangered cetacean in the Pacific, second numerically only to the right whale, which is assumed to be nearing biological extinction (Braham 1984). Humpback whales concentrate during the winter breeding season in shallow waters, usually less than 100 fathoms, and are regularly observed off the south shore of Oahu.

Green turtles are found throughout the Hawaiian Archipelago. Their distribution, however, has been reduced in recent historical times, with breeding aggregations being eliminated and certain foraging areas no longer utilized in the main Hawaiian Islands (Balazs 1980). Feeding and resting areas, where adult Hawaiian Chelonia live the greater portion of their lives during non-breeding periods, are located in coastal waters of both the main islands and the NWHI. Significant resting and foraging habitats for Chelonia have been documented in the proposed project area between Kahe Point and the recently approved Ewa Marina project.

I am the coordinator for all protected species matters in Hawaii and the western Pacific for the National Marine Fisheries Service. I can be reached at (808) 955-8831 or FAX (808) 949-7400 for further information on the effects of noise, vibration and blasting on protected species and the Section 7 consultation process.

Sincerely,

Eugene T. Nitta
Eugene T. Nitta
Protected Species Program
Coordinator

cc: F/SW03 - Lecky

References

Balazs, G.H. 1980. Synopsis of biological data on the green turtle in the Hawaiian Islands. U.S. Dept. of Commerce, NOAA. Tech. Memo., NMFS, NOAA-TM-NMFS, SWFC-7. 141 pp.

Braham, H.W. 1984. The status of endangered whales: an overview. Mar. Fish. Rev. 46(4):2-6.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Office
P.O. Box 50167
Honolulu, Hawaii 96850

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PARSONS BRINCKERHOFF
HONOLULU, HAWAII

copies
Paul
Sarah
David
Marshall via fax

In Reply Refer To: KAE

MAY 26 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 South King Street, Suite 400
Honolulu, Hawaii 96813

Re: Basin Expansion, Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu, Hawaii; Environmental Impact Statement (EIS) Preparation Notice

Dear Governor Waihee:

The U.S. Fish and Wildlife Service (Service) has reviewed the Environmental Assessment (EA) and EIS Preparation Notice for the proposed Basin Expansion and Pier and Storage Yard Improvements at Barbers Point Harbor, Ewa, Oahu, Hawaii. The proposing agency is the State Department of Transportation, Harbors Division (DOT). Project consultants for the DOT are Parsons Brinckerhoff Quade & Douglas, Inc. (Parsons Brinckerhoff).

Federal and State EISs were published in the 1970s, which addressed development of the Barbers Point Harbor. Because conditions have changed in the vicinity of the harbor since these documents were published, the DOT has decided to prepare a Supplemental EIS for the project. The Service supports the DOT's decision to prepare the Supplemental EIS.

Service biologists have met with representatives of Parsons Brinckerhoff to discuss potential impacts of the proposed project on fish and wildlife resources. The Service provided information on federally endangered and threatened species in the project area and expressed concern for the protection of marine resources and water quality during and after construction of the harbor.

The following information on endangered and threatened species adds to our previous comments and provides the official list of federally endangered and threatened species under Service jurisdiction that should be addressed in the Supplemental EIS. The National Marine Fisheries Service should be contacted for a list of endangered and threatened species under their jurisdiction that may occur within the project area.

The Service previously provided information that the endangered Hawaiian stilt, *Himantopus mexicanus knudseni*, and the endangered plant, *Achyranthes splendens* var. *rotundata*, occur in the project area. One additional plant, the endangered 'Akoko, *Chamaesyce skottsbergii* var. *skottsbergii*, should be added to the list of endangered and threatened species addressed in the Supplemental EIS.

Surveys for *Achyranthes* and *Chamaesyce* should be conducted since suitable habitats for these species have been identified within project site boundaries. Descriptions of historical and current known habitats occupied by these plant species are identified in the Service's Draft Recovery Plan for *Chamaesyce skottsbergii* var. *skottsbergii* and *Achyranthese splendens* var. *rotundata* (Recovery Plan). A copy of the Draft Recovery Plan will be provided to Parsons Brinckerhoff.

The Service has observed low numbers of Hawaiian stilts using the artificial ponds created by the ongoing coral crushing/sand washing operation located adjacent to the project site. The EA states that this area may be used to stockpile the excavated and dredged material generated by the project. The Service will continue to monitor and assess the use of these ponds by stilts during the 1994 stilt breeding season (March through August).

The Service will also continue to coordinate with the DOT and Parsons Brinckerhoff as the potential locations of the stockpile sites are further defined. The Service's primary objective in this effort is the protection of Hawaiian stilts and populations of *Achyranthes* and *Chamaesyce* in the Barbers Point area. Recommendations to insure the protection of these species will be provided to the DOT for incorporation into the Draft Supplemental EIS.

The Service appreciates the opportunity to provide these comments and looks forward to continued coordination with the DOT as the Draft Supplemental EIS is prepared for public review and comment. If you have questions concerning these comments or additional information is needed, please contact Wetlands Branch Chief, Karen Evans, at (808) 541-3441.

Sincerely,

Karen W Rosa
for/ Brooks Harper
Acting Field Supervisor
Pacific Islands Office

cc: DOT, Honolulu
Parsons Brinckerhoff, Honolulu
NMFS, Honolulu
COE, Honolulu
DOFAW, Honolulu

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P O BOX 621
HONOLULU, HAWAII 96809

KEITH W. AHUE
CHAIRPERSON

JOHN C. LEWIN, M.D.
ROBERT S. NAKATA
J. DOUGLAS ING, ESQ.
RICHARD H. COX, P.E.
GUY K. FUJIMURA

RAE M. LOUI, P.E.
DEPUTY

MAY 16 1994

MAY 13 1994

Dr. David Atkin, Ph.D
Environmental Task Leader
Parsons, Brinkerhoff, Quade and Douglas, Inc.
Two Waterfront Plaza, Suite 220
Honolulu, Hawaii 96813-4990

Dear Dr. Atkin:

This is in response to your EIS Preparation Notice for the proposed Basin Expansion, Pier and Storage Yard Improvements at Barbers Point Harbor, Oahu.

The Commission on Water Resource Management concurs with the EISPN that a supplemental EIS would be appropriate for this project. The Department of Transportation should be aware that a Water Use Permit pursuant to Section 13-171-11, Hawaii Administrative Rules, may be required prior to construction.

We appreciate the opportunity to review and comment on this EISPN. Should you have any questions regarding this letter, please call Ed Sakoda, at 587-0225.

Sincerely,

RAE M. LOUI
Deputy Director

c. Department of Transportation
Office of Environmental Quality Control

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Parsons Brinckerhoff Quade & Douglas, Inc.
500 Ala Moana Blvd., Suite 220
Honolulu, HI 96813-4990

Attention: Mr. David Atkin, Ph.D./Environmental Task Leader

RE: Barbers Point Harbor Basin Expansion, Pier and Storage Yard Improvements

Dear Mr. Atkin,

I have read and reviewed the documents sent to me regarding the expansion and improvements to the Barbers Point Harbor and as Chairman of the Barbers Point User's Group wholeheartedly support the measures under consideration. As agents for over 90% of the ships calling the harbor Waldron Steamship fully recognizes the importance of following through with these enhancements, "now".

As representatives for the majority of shippers at the harbor we are constantly striving towards the goal of minimizing delays and disruptions to the vessels operations. At present we must "juggle" the arrivals of several ships a month (8-10) in order to accommodate them. When the Hawaiian economy picks up and the need also arises for the 2nd coal power plant these improvements are going to more that come to fruition.

The ongoing loss of available berthing space at Honolulu Harbor further emphasizes the need for the expansion to Barbers Point harbor. In the future the calling to the port by container vessels is eminent and will require the use of these improvements.

In closing, without proceeding with these improvements Hawaii's shippers are going to be eventually faced without the availability of piers to off load their ship's cargo which results in delays. In the shipping business extra time equates to additional costs to shippers which are eventually passed down to consumers. Please take all necessary action toward the goal of approving the proposed enhancements and improvements to Barbers Point Harbor so we may have the first class port required for the shipping needs of Hawaii.

Very Sincerely Yours,

Bill Thayer
President & General Manager

ALAN C. ZIEGLER, Ph.D.
Zoological Consultant

45-636 Liula Place
Kāne'ohe, Hawai'i 96744

Telephone:
(808) 247-5318

M E M O R A N D U M

DATE: 21 November 1988

TO: Interested Folks

FROM: Alan C. Ziegler

SUBJECT: Proposed Sinkhole Park at Campbell Industrial Park, 'Ewa, O'ahu

The purpose of the proposed park is twofold: (1) to provide a landscaped picnic and rest area for employees of Campbell Industrial Park firms and the general public, and (2) to preserve an invaluable group of limestone sinkholes and their contained prehistoric bird bones for educational and scientific purposes.

The area involved, approximately eight acres in extent and zoned Agricultural, is a presently unused and unimproved remnant of a much larger area that the owner, Campbell Estate, set aside for stockpiled of coral reef rubble dredged in construction of the nearby Deep Draft Harbor.

Although a wide swath through the central portion of this area has been bulldozed and the ancient raised reef and its sinkholes there covered with soil, on the exposed limestone surface of the remaining area, the openings of perhaps as many as 50 sinkholes of at least a yard in diameter--as well as a number of smaller sinkholes in earlier stages of development--are still evident.

The flask-shaped sinkholes, the deeper of which are up to at least ten feet, resulted from millennia of rainwater solution of the 120-thousand-year-old emerged coral reef, with concurrent partial filling by wind- and water-borne soil deposits. Within the Hawaiian Islands, such sinkholes have been found only in the southwestern portion of O'ahu.

In conjunction with Environmental Impact Statement studies carried out since the mid-1970's, excavations of the sinkhole deposits by several groups of university and museum scientists have yielded numerous scattered bones of a variety of extinct and extant native bird species, including such prehistoric birds as a flightless goose and rail, a long-legged bird-catching owl, and a Hawaiian eagle.

In the last few years, with the permission of Mr. Walter Yoshimitsu, Campbell Estate Industrial Properties Manager, supervised educational field trips including sample excavations of bird bones have been taken by The Kamehameha Schools' Hui Lama, Hawaii Audubon Society, and Hawaii Nature Center, as well as by some City Council members, their staff, and media representatives. A DOE-sponsored tour for Leeward teachers is scheduled for next January, and the Moanalua Gardens Foundation has recently also expressed interest in a similar educational opportunity for its docents.

As shown on the attached map, the entire proposed park project would include both a central improved "Park", and a peripheral "Reserve" area. The Park portion would consist largely of a grassed lunch and leisure area with shade trees and accompanying picnic tables and benches (--there presently being no such inviting "green area" publicly available in this heavily industrialized area).

A small portion of the Park near its entrance, however, would be left unlandscaped as an educational device to show an area of small developing sinkholes in the exposed limestone reef substrate, as well as to allow examination (through a wire safety cover) of a fully developed sinkhole or two. The remaining unfilled sinkholes in this central area would have their ground openings covered by coral-reef boulders, both for safety reasons and to permanently mark their locations for possible future investigative purposes.

A prominently placed interpretive display board in the Park, would explain the original formation of the sinkholes, the buildup of their soil deposits, and their role in preserving the remains of the various kinds of birds that had died in them through many thousands of years, with a representative sample of identified excavated bones also shown.

The Reserve area--surrounding the Park on three sides and serving as a buffer zone between the adjoining abandoned industrial dumps, coral stockpile, and heavily used "Powerline Road"--would be fenced all around. It would remain unimproved, with its sinkholes left open and the several types of native, Polynesian, and historically introduced trees and smaller plants currently present allowed to continue to grow naturally.

Access to this Reserve area would be through normally locked gates for purposes of scheduled educational field trips and sinkhole excavations by school classes, local and visiting natural history groups, and university or other scientific researchers.

• • •

ALAN C. ZIEGLER, Ph.D.
Zoological Consultant

45-636 Liula Place
Kāne'ohe, Hawai'i 96744

Telephone:
(808) 247-5318

29 March 1990

Mr. Calvin M. Tsuda
Deputy Director for Harbors
State Department of Transportation
Harbors Division
79 S. Nimitz Hwy.
Honolulu, Hawai'i 96813-4898

Dear Mr. Tsuda,

Thank you for your letter of 19 March 1990 (File # HAR-EP 2473) concerning the location of remaining sinkholes in the Barbers Point Harbor area of 'Ewa, O'ahu.

There are two groups of sinkholes involved. The first comprises those on a plot of land about 8 acres or slightly less in size (the sinkholes of my testimony on S.R. 35/S.C.R. 38 and S.R. 36/S.C.R. 39, as well as the "Proposed Sinkhole Park" of my memorandum with map dated 21 November 1988) on the northwest corner of the junction of Malakole and "Powerline" Roads. This particular piece of land is on Campbell Estate property relatively distant from the Harbor and, as far as I know, would not be involved in any presently envisioned State-related expansion of the Harbor or its neighboring State facilities. I have, nevertheless, marked the location of this ca. 8-acre plot on the Tax Map 9:1:14 you provided me, and have enclosed the map copy with this letter.

The second lot of sinkholes, however, are on land in which your Harbors Division is interested. This general sinkhole area is situated in the 56.5 acres of Campbell Estate land that DOT has an option to purchase for "future expansion" of the Harbor or related facilities (see "Parcel 4" in the agreement appearing as Exhibit A of your November 1989 Development Plan Application and Environmental Assessment titled *Proposed Barbers Point Harbor Expansion*).

Presently, much of this parcel is still covered with kiawe forest, and has never been <u>intensively</u> surveyed for presence and location of sinkholes. However, from a preliminary general survey carried out by, primarily, the Bishop Museum a dozen or so years ago, as well as from recent personal observation, I can say there are at least a dozen sinkholes remaining there, most on the border of, or just within, the kiawe, ranging from 10 to 50 yards or so distant (to the northeast) of the edge of the present coral quarry. Most of these sinkholes seem to lie within about 150 or 200 yards of one another.

As originally noted by Bishop Museum archaeologists, two of these sinkholes seem of special importance: Bishop Museum Site No. (50-Oa-) B6-22 and B6-137 (the sinkholes of my testimony on S.C.R. 50/S.R. 44; I understand the equivalent State Site Nos. for these are [50-80-12-] 9545 and 9633, respectively.) I have marked the approximate location of these two sites on the enclosed Tax Map, as well as on a similarly enclosed copy of the map from Exhibit A of the November 1989 DOT Development Plan Application and Environmental Assessment referred to above, the latter of which maps shows the 56.5-acre DOT option parcel.

As explained in my testimony, B6-22 has undergone only a relatively small amount of testing but this work was sufficient to show that this is an extremely valuable and important prehistoric Hawaiian site, and should eventually be much more extensively--perhaps completely--excavated. Because of its proximity to present coral quarrying operations, at the suggestion of O'ahu State Archaeologist Dr. Joyce Bath, Campbell Estate has enclosed this possibly unique culturally related sinkhole with a protective chainlink fence after clearing much of the surrounding kiawe. (Recent photographs and further information regarding B6-22 may be found in the December 1989 Draft Environmental Impact Statement titled *Kapolei Business-Industrial Park*, prepared by William E. Wanket for Campbell Estate--see, especially, Appendix E.)

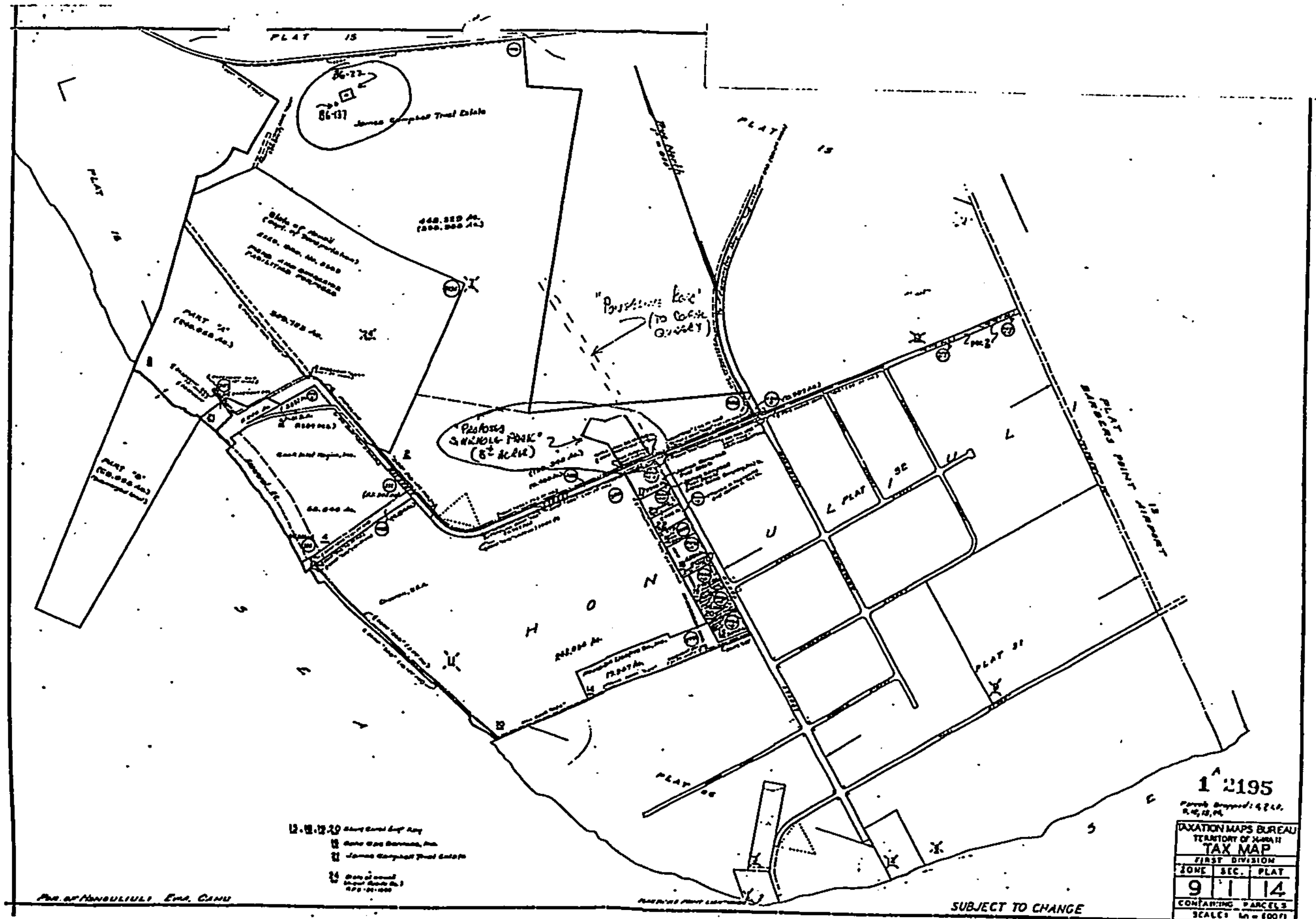
B6-137, situated only 40 or so yards southwest of B6-22 but outside of its fence, has apparently never been excavated but I recently briefly inspected the human bones previously reported lying on the floor of its short side passages, finding that they represent the remains of at least two adult individuals, with some separated and scattered small bone fragments indicating that at least one more person may possibly have originally been present.

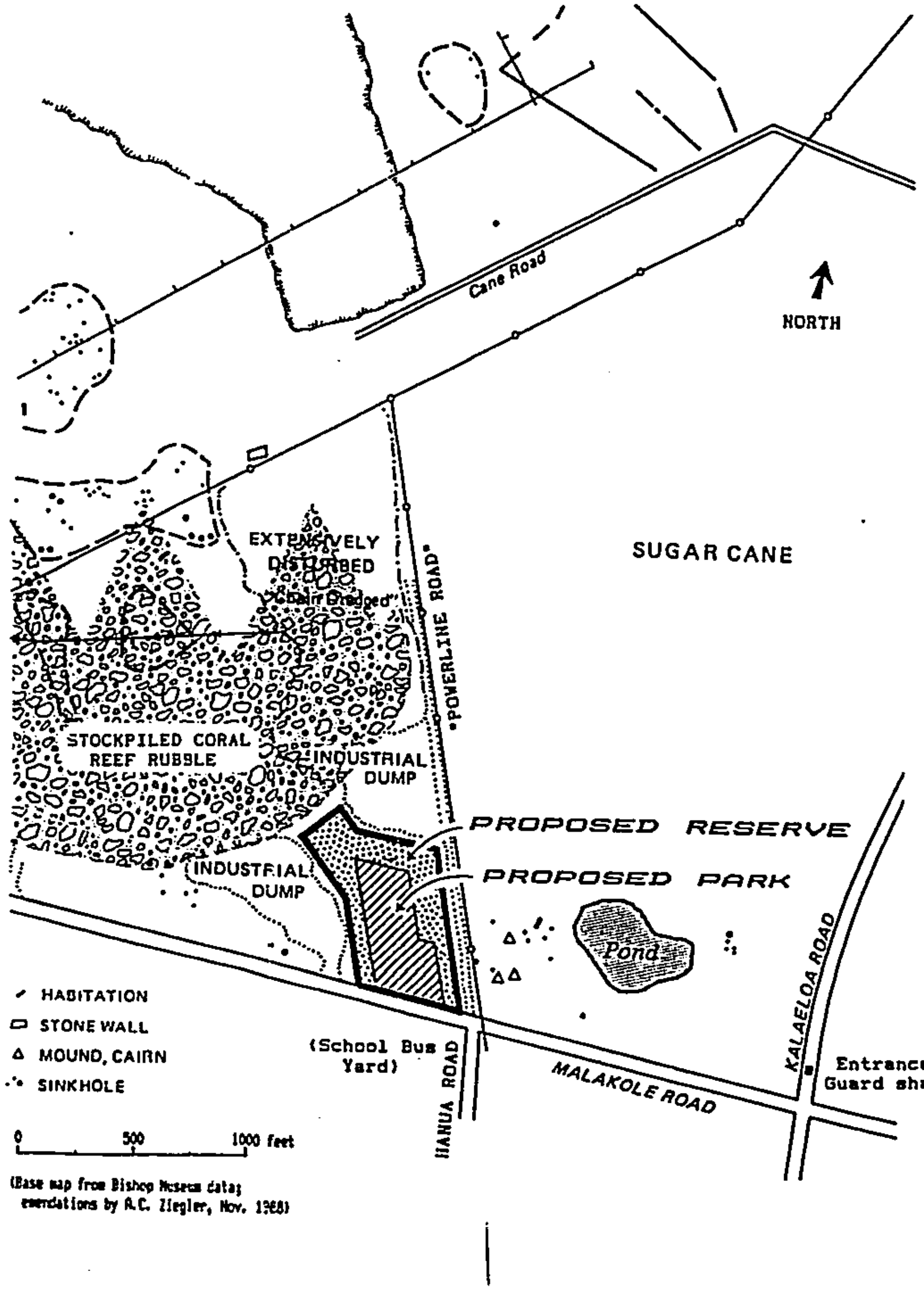
I hope this information may be of interest and use to you in your Harbor expansion work. Please just let me know if it seems there is more information I might provide you. Continued best in everything!

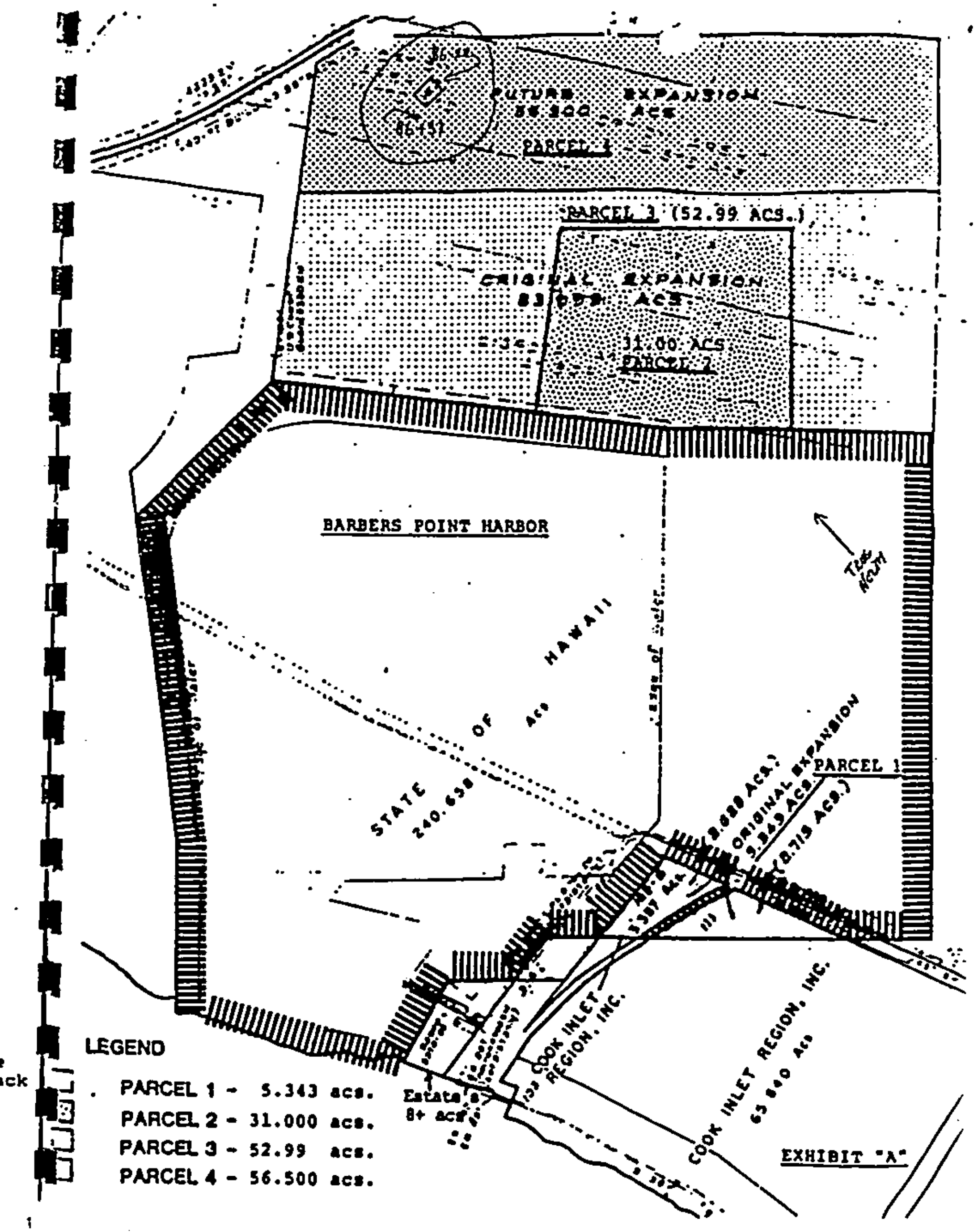
Sincerely,

Alan C. Ziegler

encls.


PLAT 15
PLAT 16
PLAT 13
BARBERS POINT AIRPORT
PLAT 21
PLAT 32
PLAT 22
H O N O U L I U L I
"Proposed SHORELINE PARK" (8± acres)
"Proposed Road" (to Coral Quarry)
86-22
86-137
James Campbell Trust Estate
1^2195
TAXATION MAPS BUREAU
TERRITORY OF HAWAII
TAX MAP
FIRST DIVISION
ZONE 9 SEC. 1 PLAT 14
SUBJECT TO CHANGE
Por. of Honouliuli, Ewa, Oahu


Cane Road
NORTH
SUGAR CANE
EXTENSIVELY DISTURBED
"POWERLINE ROAD"
STOCKPILED CORAL REEF RUBBLE
INDUSTRIAL DUMP
INDUSTRIAL DUMP
PROPOSED RESERVE
PROPOSED PARK
Pond
KALAELOA ROAD
Entrance Guard shack
(School Bus Yard)
HANUA ROAD
MALAKOLE ROAD
HABITATION
STONE WALL
MOUND, CAIRN
SINKHOLE
0 500 1000 feet
(Base map from Bishop Museum data; emendations by R.C. Ziegler, Nov. 1988)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PARCEL 3 (52.99 ACS.)
31.00 ACS
PARCEL 2
BARBERS POINT HARBOR
STATE OF HAWAII
240.638 Acs
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COOK INLET REGION, INC.
COOK INLET REGION, INC.
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LEGEND
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PARCEL 2 - 31.000 acs.
PARCEL 3 - 52.99 acs.
PARCEL 4 - 56.500 acs.
EXHIBIT "A"

JOHN WAIHEE
GOVERNOR OF HAWAII

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STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

KEITH AHUE, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
JOHN P. KEPPELER II
DONA L. HANAIKE

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AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION DIVISION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

February 28, 1994

LOG NO: 10936
DOC NO: 9402TD35

David Atkin, Ph.D.
Environmental Task Manager
Parsons Brinckerhoff
Two Waterfront Plaza, Suite 220
500 Ala Moana Boulevard
Honolulu, Hawaii 96813-4990

Dear Dr. Atkin:

SUBJECT: **Basin Expansion and Tug Pier at Barbers Point Harbor, State Department of Transportation, Harbors Division Job No. H.C. 1823**
Honouliuli, 'Ewa, O'ahu
TMK: 9-1-14: por. 2; 9-1-15: por. 1

Thank you for the opportunity to provide input to the environmental documentation that you are preparing for this project. A review of our records indicates that undisturbed portions of Areas 2 and 3 contain numerous historic sites, most of which were identified and described during archaeological surveys conducted in the late 1970s. Reports describing survey results are available in our library, which is open for public use between 7:45 AM and 4:30 PM on workdays. In general, these surveys fall short of current standards for inventory survey, and we believe it is likely that additional unrecorded historic sites are present in undisturbed portions of Areas 2 and 3. These sites are most likely concentrated in natural sinkholes, and would include various traditional Hawaiian uses, including human burial, and paleontological deposits.

Discussions between Harbors Division and Campbell Estate concerning revisions to the boundary of Area 2 in order to exclude undeveloped land containing sinkhole sites are, in our view, premature. Absent an inventory of historic sites in Area 2 and the surrounding lands there can be no assurance that revised boundaries will exclude significant historic sites. As indicated in an August 1992 letter from Calvin Tsuda, Deputy Director for Harbors, Harbors Division was at that time planning to conduct an inventory survey of a portion of 9-1-14: 2. However, we have not received any report of this work and do not know whether the survey was in fact carried out. In any event, an acceptable inventory survey report for these lands will be needed to evaluate the potential effects on historic sites of alternative designs for the proposed project.

Although a large portion of Area 3 was previously used for stockpiling dredged material, some portions were not. The southeastern corner of Area 3 appears to encompass an approximately eight acre area containing intact sinkholes that has been fenced off to protect these significant sites. Other undisturbed areas might also be present. At this early stage in the planning process we urge you and Harbors Division to develop alternatives that minimize or eliminate potential effects to the eight acre sinkhole parcel.

Much of the information on historic sites that you will need for the environmental documentation is available in geographic information system (GIS) format. Please contact us if you desire access to the GIS data.

Also, please be aware that, should the harbor expansion require any permit from the Army Corps of Engineers or other Federal Agency, the project will need to complete the Section 106 review process, in accordance with 36 CFR 800.

If you have any questions please call Tom Dye at 587-0014.

Sincerely,

DON HIBBARD, Administrator
State Historic Preservation Division

TD:jt

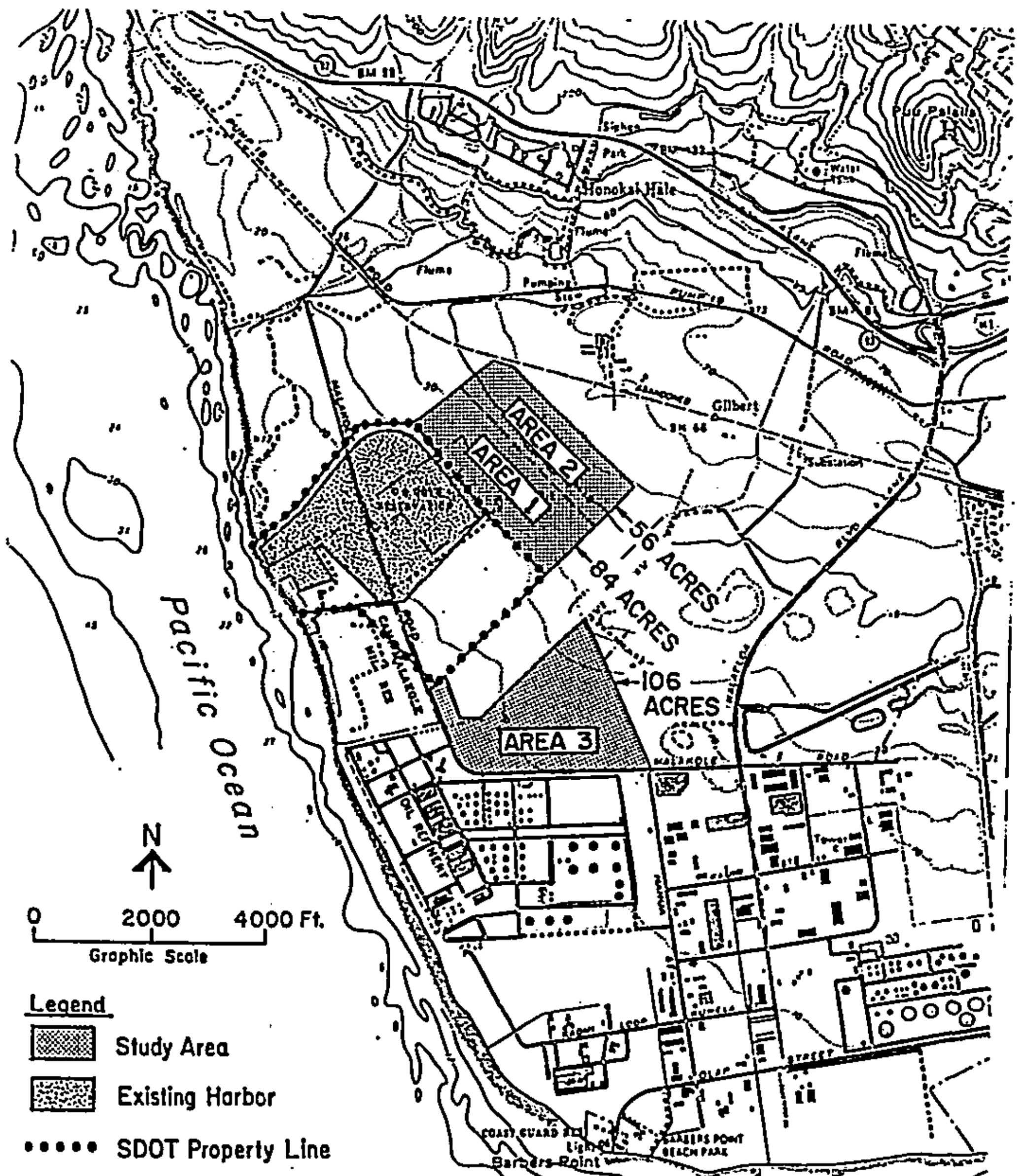


Exhibit B
Barbers Point Harbor Expansion Project
Environmental Assessment Study Area
Base Map: USGS Topographic Map for Ewa, Hawaii

CULTURAL SURVEYS HAWAII

Archaeological Studies
Hallett H. Hammatt, Ph.D.
733 N. Kalaheo Avenue
Kailua, Hawaii 96734
FAX: (808) 262-4950, Bus: 262-9972

COVER SHEET FOR FAX COMMUNICATION

TO: David Atkin ~~5452753~~ 5282368

PROJECT: Barbers Point

DATE/TIME SENT: Feb 21, 94

FROM: Hal Hammatt

REMARK: David - This is the Sept 2, 92 letter from DLNR

Thanks

Hal

PLEASE CALL (808) 262-9972 IF YOU DID NOT RECEIVE _ PAGE(S) INCLUDING THIS COVER SHEET OR IF TRANSMISSION WAS RECEIVED INCOMPLETE.

MAHALO!

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

SEP 24 1992

FILE NO.: 93-138
DOC. ID.: 1459

TO: The Honorable Rex D. Johnson, Director
Department of Transportation

ATTN: Calvin M. Tsuda
Deputy Director for Harbors

FROM: William W. Paty, Chairperson
Department of Land and Natural Resources

SUBJECT: Proposed Land Use Reclassification for
Barbers Point Harbor Expansion
TMK: 9-1-14: 02 por., Ewa, Oahu, Job H.C. 1709

Thank you for giving our Department the opportunity to comment on this matter. We have reviewed the materials you submitted and have the following comments.

Brief Description:

The DOT is requesting comments on their proposal to reclassify 140.5 acres of lands mauka of the subject harbor from agricultural to industrial. Any comments received would be used to prepare a Land Use District Boundary Amendment (LUDBA). Reclassification of subject fast lands would enable the DOT to enlarge the water basin, construct additional piers, create additional storage yards, construct a commuter ferry terminal, and other ancillary facilities. The current use for the subject parcel is stockpiled coral dredgings from the initial harbor construction.

Division of Aquatic Resources Comments:

According to the DOT, this proposed harbor expansion will likely include harbor basin expansion, deepening, entrance channel deepening and widening. The LUDBA is not likely to include an assessment of impacts to aquatic resources since it only deals with proposed fast land (land use) amendments. However, because this proposal is likely to involve construction in navigable waters and in the conservation zone, the DOT will be submitting general permit application to the Army Corps of Engineers and a Conservation District Use Permit

Application to our Department (R. Nagao, personal communication). As such, we reserve our comments on anticipated impacts to aquatic resources until we have opportunity to review applications that deal more directly with proposed uses of submerged lands (marine environment).

Division of Land Management Comments:

We ask that the applicant obtain the required Federal, State, and County permits and question as to how the DOT Plans to encumber the additional lands.

Commission on Water Resources Comments:

In the attached letter from the Department of Transportation to Mr. Paty, no mention is made of any Ground Water Impact Report to be included in the application for a State Land Use Boundary Amendment. We recommend that such a study be made.

Further impacts on brackish caprock water by the enlargement of the harbor must be addressed by the applicant. The original deep-draft harbor, in effect, brought the ocean inland and altered the pattern of brackish water leakage along the harbor shoreline. Increasing the harbor's size will influence the caprock water resource in the same manner.

Historic Preservation Division:

We have not received a report of a recent inventory survey for the proposed expansion of the Barber's Point Harbor. We expect that this inventory survey will identify previously un-recorded historic sites. Thus, historic sites inventory for this project location is not complete, all significant sites have not been identified, and mitigation commitments have not been agreed upon. It is our opinion that this review must be concluded for this area prior to its reclassification.

A brief reconnaissance survey of this area some years ago inventoried 24 historic sites, including two large sinkholes (sites 50-80-12-9545 and -9633) that we strongly believe should be passively preserved. Campbell Estate has erected a fence around site -9545 and has agreed to make the lands on which these sites are found available for purchase, at reduced value, to the State of Hawaii. Without a commitment to preservation of the area around these sites, we believe that the land should not be re-classified.

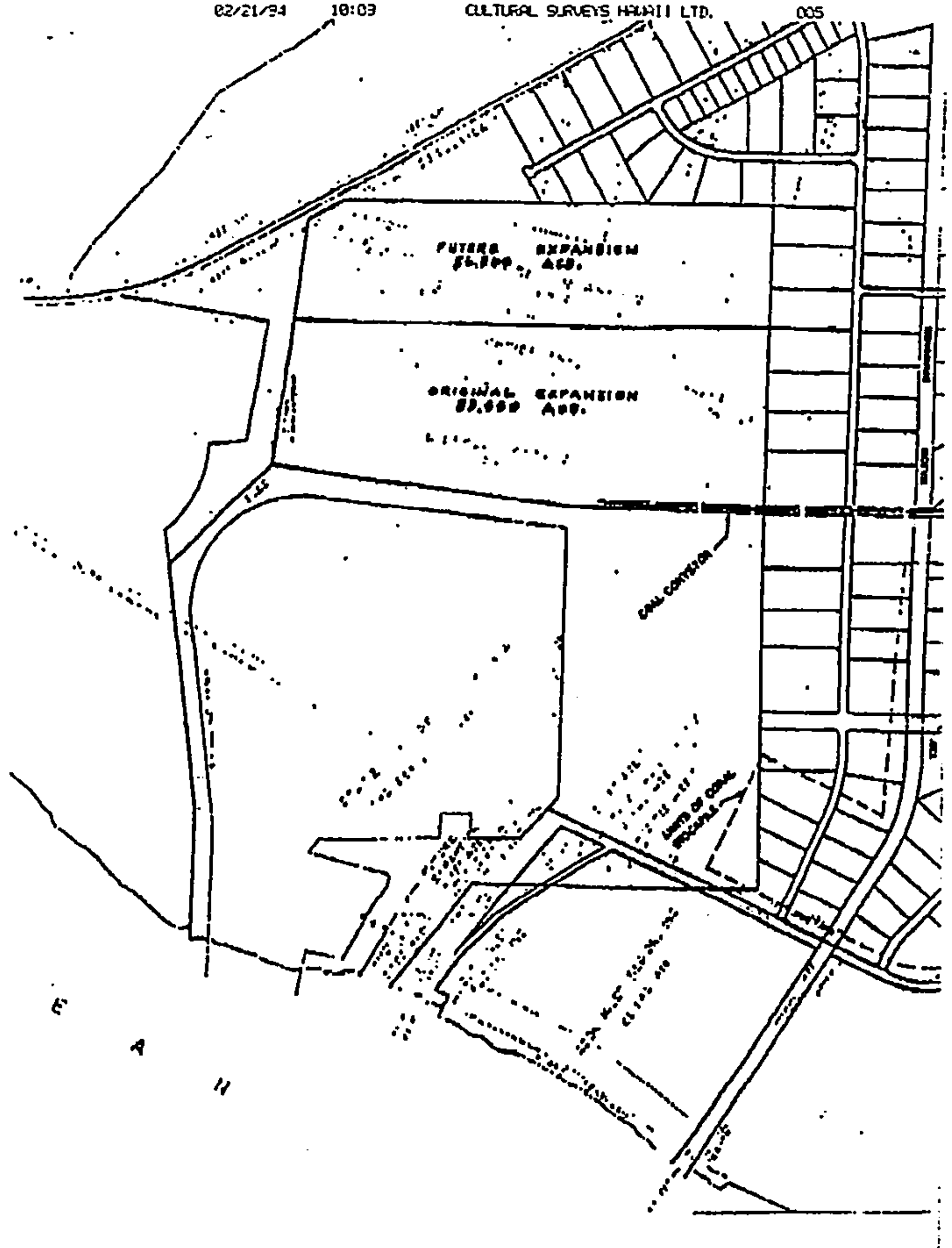
In brief, an inventory survey has not been completed for this area, all significant sites have not been identified, and mitigation commitments have not been agreed upon. Until these steps are complete we oppose reclassification of these lands.

Memo to R. Johnson - 3 - File No: 93-138

Thank you for your cooperation in this matter. Should you have any question, please feel free to contact Sam Lemmo of our Office of Conservation and Environmental Affairs at 587-0377.

Very truly yours,

WILLIAM W. PATY



'AHAHUI SIWILA HAWAI'I O KAPOLEI

P.O. Box 422 • Barbers Point, Hawai'i • 96862-0422
Member of the O'ahu Council, Association of Hawaiian Civic Clubs

MAY 12 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 S. King Street, Ste. 400
Honolulu, HI 96813

Dear Sir:

Thank you for your letter requesting comments on the basin expansion, pier and storage yard improvements at Barbers Point Harbor.

'Ahahui Siwila Hawai'i O Kapolei is a chartered member of the Oahu Council of the Association of Hawaiian Civic Clubs, and as such is a non-profit organization committed to cultural, educational, health and social benefits for Native Hawaiians. All fauna, historic preservation, and traditional and customary native rights of ethnic Hawaiians. Several clubs have curatorships over heiau and/or historic sites.

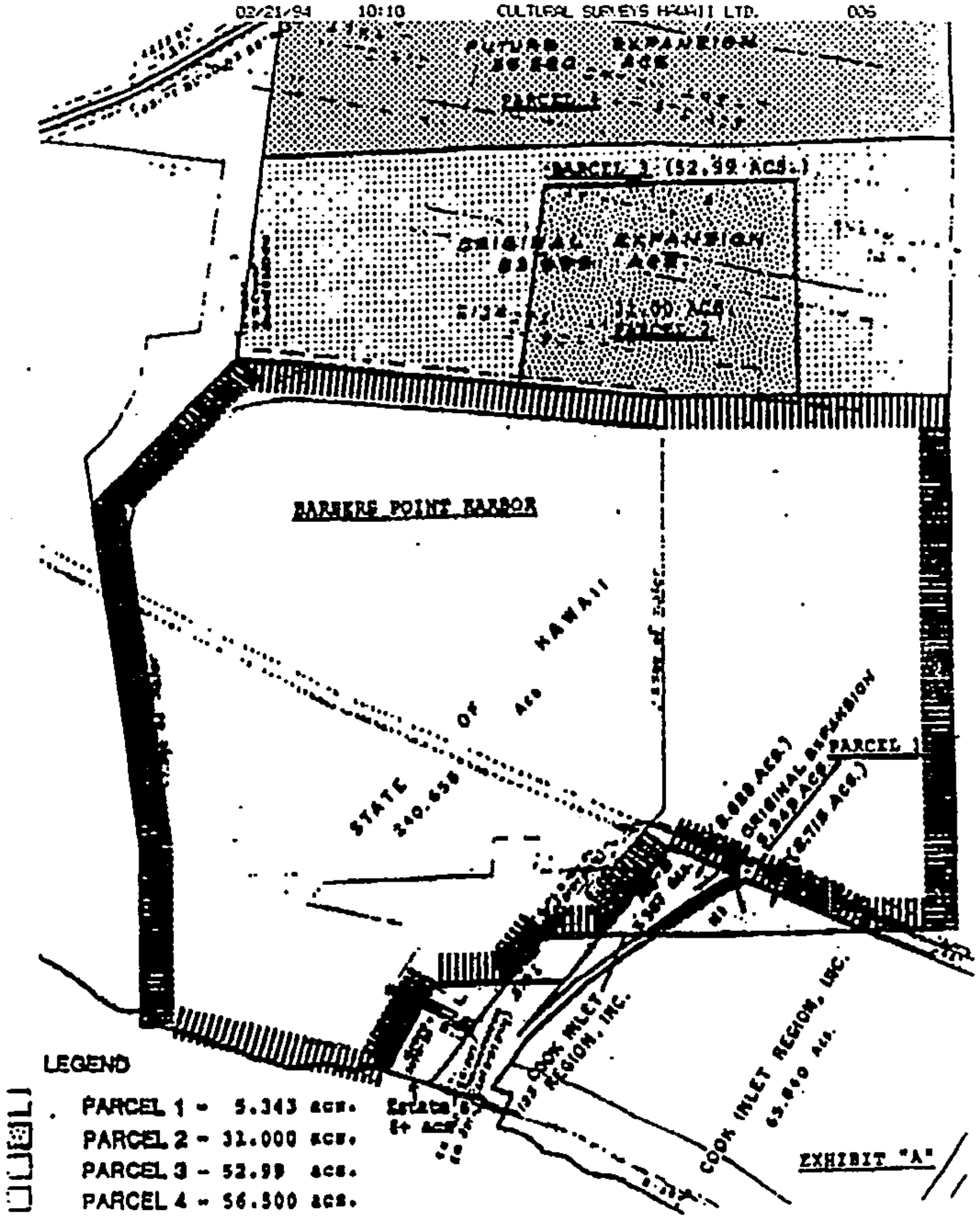
The 'Ahahui meets monthly in Kapolei, and our members primarily are residents of West Oahu. We are, therefore, very interested in the preservation of significant archaeological and historical resources referenced in the EIS, or any new finds as excavation and construction proceeds. We are also concerned that access for shoreline fishing shall be continued, and that appropriate measures to protect endangered and threatened species shall be taken.

We appreciate the opportunity to respond to your letter and to provide comments on the basin expansion, pier and storage yard improvements at Barbers Point Harbor. Please continue to keep us informed as the project moves forward.

Sincerely,

La Verne R. Hatch
Pelekikena

cc: Parsons Brinckerhoff Quade and Douglas, Inc.
Attn: Dr. David Atkin
Two Waterfront Plaza, Suite 220
500 Ala Moana Blvd.
Honolulu, HI 96813



THE ESTATE OF JAMES CAMPBELL

May 9, 1994

RECEIVED MAY 11 1994 PARSONS BRINCKERHOFF HONOLULU, HAWAII

BY TELECOPY AND MAIL

Mr. Marshall Ando
Harbors Division
State Department of Transportation
789 South Nimitz Highway
Honolulu, HI 96813

Dr. David Atkin
Parsons Brinckerhoff Quade & Douglas, Inc.
Two Waterfront Plaza, Suite 220
500 Ala Moana Boulevard
Honolulu, HI 96813-4990

Gentlemen:

Basin Expansion, Pier and Storage
Yard Improvements at Barbers Point Harbor
Environmental Impact Statement Preparation Notice
and Environmental Assessment

Thank you very much for the opportunity to provide comments on your Environmental Assessment ("EA"). The Estate of James Campbell supports efforts aimed at the expansion and further development of Barbers Point Harbor. This support extends to the planned basin expansion, pier and storage yard improvements.

We do have the following comments on the EA. To ease your review we use the page numbers and paragraph designations as set forth in the EA (e.g., Section 1, Paragraph 1.1, EA-1).

1. Section 1, Paragraph 1.2, EA-1. It is true that the Barbers Point Harbor is located in Ewa which many now refer to as Kapolei. To avoid confusion, we suggest that you refer to both areas and change the sentence to read in part as follows: "...located in Ewa "where the rapid urbanization of Kapolei has started . . . .".

2. Figure 1, Barbers Point Harbor Location Map (the "Map"), EA-2. We suggest that the Map be revised after consultation with Campbell Estate's Land Planning Coordinator, Mr. Chuck Ehrhorn (674-3284).

1001 Kamokila Boulevard, Kapolei, Hawaii 96707 Phone (808) 674-6674 Facsimile (808) 674-3111

Specifically, the Map shows possible stockpile sites for excavated material and should be revised to incorporate existing land uses, as many cannot be relocated. For example, the storage area as depicted would block access from Malakole Road to the Estate's future 63-acre Maritime Industrial subdivision, cover an existing energy corridor that currently runs the length of Malakole Road, displace existing Estate lessees and cover the sinkhole preserve located at the corner of Hanua Street and Malakole Road. It is my understanding that a map was being prepared by Mr. Ehrhorn after consultation with both Parsons Brinckerhoff and the State Harbors Division. Perhaps that map could be used by you to depict existing land uses.

Generally, discussions regarding coral storage on Estate land are at a very preliminary stage and no agreement has been entered into between the State and the Campbell Estate. This is due in part to uncertainty over both the method of coral extraction and the acreage requirements for the storage of any excavated materials. Our comments regarding the map and its use in the EA should not be interpreted as the Campbell Estate's agreement to store the excavated material on Campbell Estate property.

3. Figure 1, EA-2 (cont). Your Map shows a dotted line as a boundary in the vicinity of the former Camp Malakole military reservation. The Estate continues to own 8-acres of land located between what is now the Kenai Industrial Park and the original barge harbor area. Please depict this Campbell Estate land on the Map.

4. Figure 2, Elements of Proposed Action, EA-3. We suggest that you show the overland pipe conveyor on this map and that you depict the location of the Campbell Estate's temporary access to the future Maritime Industrial subdivision.

5. Section 2, EA-4. Please check your flood maps to confirm that the project site as indicated is not within a flood plain or erosion-prone area.

6. Section 2, Paragraph 2.2, EA-6 subparagraph Existing Land Uses. We suggest that you change the third sentence to read in part as follows: "The harbor is adjacent to the Campbell Industrial Park, Kapolei Business Park, and the Ko Olina Resort." Also, in the second to the last sentence, we suggest that you change the sentence to read in part as follows: "Makakilo, and the City of Kapolei are approximately 2 miles away."

7. Figure 3, EA-9. We suggest that an "s" be added to the word "Document" in the title.

Once again, thank you for the opportunity to comment on the EA. We look forward to the incorporation of our comments.

If you have any questions, require any further information or if we can be of further service to you on this or any related matter, please feel free to call me directly at 674-3176.

Sincerely,

David H. Franzel
Manager, Residential/Resort Properties

cc: Mr. David H. McCoy
Mr. Charles Ehrhorn

fgr:01031400\K10021

HOUSE OF REPRESENTATIVES
STATE OF HAWAII
STATE CAPITOL
HONOLULU, HAWAII 96813

May 4, 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 S. King Street, Suite 400
Honolulu, Hawaii 96813

Dear Sir:

With regard to a request for comments that I received from Parsons Brinckerhoff Quade and Douglas, Inc. on the basin expansion, pier and storage yard improvements at Barbers Point Harbor, my response follows:

(1) Judging from the topographic map attached to the Evironmental Impact Statement Preparation Notice, the northwest boundary of the proposed expansion will be very close to the existing railroad tracks. I would like to point out that the Hawaii Railway Society has plans to run tours from their depot in Ewa to Ko'olina Resort, and ask that you keep this future venture in mind.

(2) When Barbers Point Harbor was first constructed, the Community Associations of Honokai Hale and Nanakai Gardens asked for mitigation of blasting, noise, dust, vibrations and other disturbances connected with construction. Since the residents have been contacted, I expect that you will work together prior to construction to make the situation as congenial as possible. If you need help in this regard please let me know as I am working with them on another project.

(3) I am concerned about the impact that excavation and construction may have on ciguatera and other toxins that develop in fish that may, or may not, be transferred to humans. Not much is known as to the origins of ciguatera outbreaks, or massive fish die-offs, but they have at times been connected to shoreline construction and development. Fish is an important part of the diet of the West Oahu population, so I am concerned for the health and welfare of people who include fish in their diets regularly. **I suggest the establishment of at least one sampling station at the harbor, and/or other appropriate site, to provide baseline data relative to ciguatera and other toxins as a basic preventive measure. In the event of a ciguatera outbreak, or a fish die-off, immediate notice could go out to fishermen and consumers, and the baseline data would be invaluable to investigating the causes.**

(4) It is my understanding that excavation will not take place until the project area becomes property of the State. It is my further understanding that if the excavated material is sold, 20% of the revenue must go to the Office of Hawaiian Affairs, and I wish to protect that probability. I am concerned, therefore, at the proposed uses of the excavated material as described in Project Description, I.3, last paragraph. I believe the language in number (3) is ambiguous and does not adequately explain whether the material will be sold, given, exchanged, discounted or through some other means become the "...responsibility of the contractor." This should be better explained.

(5) Will the expansion of Barbers Point Harbor include the installation of large overhead lights similar to those at Honolulu Harbor that burn all night? This could be a disturbing factor to the residents of Honokai Hale/Nanakai Gardens and should be addressed early.

Thank you for the opportunity to include my concerns on this issue. Please don't hesitate to contact me if you have any questions.

Sincerely,

Annelle C. Amaral

Annelle C. Amaral
State Representative, 42nd District

cc:
Parsons Brinckerhoff Quade and Douglas, Inc.
Attn: Dr. David Atkin
Two Waterfront Plaza, Suite 220
500 Ala Moana Blvd.
Honolulu, HI 96813

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED
MAY 20 1994
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HONOLULU, HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF AQUATIC RESOURCES
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

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LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

May 18, 1994

Governor, State of Hawaii
c/o Office of Environmental Quality Control
220 S. King Street, Suite 400
Honolulu, HI 96813

Dear Sir:

We have reviewed the Environmental Impact Statement Preparation Notice on the State Department of Transportation proposed improvements to the Barbers Point harbor. Our comments follow.

There are four subject areas where new data being collected should address the following concerns:

1. Noise and vibration: Blasting may be needed to facilitate the excavation process for the expanded basin. If needed, a blasting plan needs to be carefully formulated. During the construction period of the deep-draft harbor, residents of the nearby Honokai Hale community complained of structure damage to their homes that resulted from shock waves created by the blasting. The proposed harbor basin expansion would bring construction closer to residential areas, thus heightening the problems associated with explosive shock waves.

   During the excavation of the outer entrance channel, blasting was also reported to attract large sharks that presumably fed on dead fish. The presense of sharks coupled with heightened turbidity of harbor and coastal waters could present a public safety problem.

2. Water quality: The proposed expansion of the harbor would add approximately 28 acres and its construction would generate a lot of turbidity. If approved, the construction procedure should leave a berm intact (across the expanded area, using the existing fast land border of the harbor) while excavation takes place behind or mauka of the berm.

   Once project depth is obtained, (before the berm is torn down) vacuuming of the basin expansion should be accomplished to remove fines and sediment and reduce problems associated with resuspension.

3. Water quality: Long-term turbidity of the harbor basin needs to be addressed. Recent inspection of the harbor's waters revealed highly turbid conditions that may be associated with ship manuvering operations. This turbidity eventually reaches adjacent shoreline areas degrading water quality and potentially becoming a public safety hazard. Long term mitigation of turbidity needs to be addressed for harbor operation.

4. Water quality: Stockpile sites for dredged spoils presently proposed may be a source of dust blowing into the sea during strong prevailing tradewinds. Stockpiles should be landscaped, especially on windward sides to control wind erosion.

If there are any questions, please call Mr. Francis Oishi at 587-0094.

Yours truly,

HENRY M. SAKUDA, Administrator

cc: Marshall Ando, DOT
√David Atkin, Parsons Brinckerhoff

APPENDIX A-7

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EWA BEACH PUBLIC AND SCHOOL LIBRARY	EWA	1
HAWAII KAI PUBLIC LIBRARY	HONOLULU	
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KAILUA PUBLIC LIBRARY	KOOLAUPOKO	
KALIHI-PALAMA PUBLIC LIBRARY	HONOLULU	
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MANOA PUBLIC LIBRARY	HONOLULU	
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- The Honorable John Desoto	1
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- Ahahui Siwila O Kapolei	1
- Alan Ziegler	1

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OEQC requests that a fifth copy of the Final Environmental Impact Statement be mailed to the Office when the general distribution takes place, to insure timely receipt by all parties.

PLEASE TYPE AND FILL IN ALL INFORMATION

( ) APPLICANT ACTION *(X) AGENCY ACTION*

TITLE: Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu Job H.C. 1823, and Future Pier and Storage Yard Improvements at Barbers Point Harbor

LOCATION (DISTRICT/ISLAND): Ewa, Oahu

TMK: Portion of 9-1-14:02, and Portion of 9-1-14:24

PROPOSING AGENCY/APPLICANT: Harbors Division, State Department of Transportation

ACCEPTING AUTHORITY/APPROVING AGENCY: The Governor, State of Hawaii

PUBLICATION DATE: January 23, 1995

COPY OF DISTRIBUTION LIST SENT TO:
Marshall Andc
Harbors Division, SDOT
79 S. Nimitz Highway
Honolulu, HI 96813

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PHONE NUMBER: 587-1959

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KAILUA PUBLIC LIBRARY	KOOLAUPOKO	
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LILIHA PUBLIC LIBRARY	HONOLULU	
MANOA PUBLIC LIBRARY	HONOLULU	
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WAIALUA PUBLIC LIBRARY	WAIALUA	
WAIANAE PUBLIC LIBRARY	WAIANAE	1
WAIKIKI-KAPAHULU PUBLIC LIBRARY	HONOLULU	
WAIMANALO PUBLIC AND SCHOOL LIBRARY	KOOLAUPOKO	
WAIPAHU PUBLIC LIBRARY	EWA	1

HAWAII LIBRARIES ** (Distribution to Libraries on Hawaii should be according to District of the proposed action.)

BOND MEMORIAL (KOHALA) LIBRARY	KOHALA	
HOLUALOA PUBLIC LIBRARY	KONA	
HONOKAA PUBLIC LIBRARY	HAMAKUA	
KAILUA-KONA PUBLIC LIBRARY	KONA	
KEAAU COMMUNITY SCHOOL LIBRARY	PUNA	
KEALAKEKUA PUBLIC LIBRARY	KONA	
LAUPAHOEHOE COMMUNITY SCHOOL LIBRARY	HILO	
MOUNTAIN VIEW COMMUNITY SCHOOL LIBRARY	PUNA	
PAHALA COMMUNITY SCHOOL LIBRARY	KAU	
PAHOA COMMUNITY SCHOOL LIBRARY	PUNA	
THELMA PARKER MEMORIAL LIBRARY	KOHALA	

MAUI LIBRARIES ** (Distribution to Libraries on Maui should be according to District of the proposed action.)

HANA PUBLIC & SCHOOL LIBRARY	HANA	
KIHEI PUBLIC LIBRARY	WAILUKU	
LAHAINA PUBLIC LIBRARY	LAHAINA	
MAKAWAO PUBLIC LIBRARY	MAKAWAO	
WAILUKU PUBLIC LIBRARY	WAILUKU	
MOLOKAI PUBLIC LIBRARY (ISLANDWIDE)		
LANAI COMMUNITY SCHOOL LIBRARY (ISLANDWIDE)		

KAUAI LIBRARIES ** (Distribution to Libraries on Kauai should be according to District of the proposed action.)

HANAPEPE PUBLIC LIBRARY	KOLOA/WAIMEA	
LIHUE PUBLIC LIBRARY	LIHUE	
KAPAA PUBLIC LIBRARY	KAWAIHAU	
KOLOA COMMUNITY SCHOOL LIBRARY	KOLOA	
WAIMEA PUBLIC LIBRARY	WAIMEA	

* Copy required if project involves Agency's responsibility.
** Copy required if project is in respective County.

List of Consulted Parties:	# of Copies
Federal Agencies:	
U.S. Army Corps of Engineers	1
U.S. Fish and Wildlife Services	1
State Legislators:	
The Honorable Paul Oshiro	1
The Honorable Annelle Amaral	1
The Honorable Michael P. Kahikina	1
The Honorable Brian Kanno	1
The Honorable James Aki	1
State of Hawaii:	
Department of Business, Economic Development, and Tourism	1
Department of Defense	1
Department of Land and Natural Resources	1
State Historic Preservation Officer (DLNR)	1
Office of State Planning	1
Department of Health	1
City and County of Honolulu:	
The Honorable John DeSoto	1
Department of Public Works	1
Board of Water Supply	1
Department of General Planning	1
Fire Department	1
Department of Transportation Services	1
Community Associations:	
Honokai Hale/Nanakai Gardens Community Asso.	2
Makakilo Community Association	1
Villages of Kapolei Community Association	1
Ewa Neighborhood Board	1
Friends for Ewa	1
Private Organizations:	
Sierra Club Legal Defense Fund	1
West Beach Estates	1
Ka Lahui Hawaii	1
American Lung Association	1
The Estates of James Campbell	1

APPENDIX A-8

LIST OF FINAL SEIS PREPARERS

Appendix A-8

List of Final SEIS Preparers

Those listed below were primarily responsible for preparing the Final Supplemental Environmental Impact Statement.

DOCUMENT PREPARATION

Parsons Brinckerhoff Quade and Douglas, Inc. (Environmental Consultant)

Paul Wolf, Project Manager

David Atkin, Environmental Task Leader

Sarah Wu, Deputy Environmental Task Leader

Deneitra Green, Environmental Planner

Crystal Johnson, Environmental Planner

Jan Reichelderfer, Geologist

Edie Sagarang, Graphic Artist

Jason Yazawa, Planner

TECHNICAL STUDIES

Parsons Brinckerhoff Quade and Douglas, Inc. (Noise and Vibration Impact Assessment)
Balu Balachandran

Oceanic Institute Consultants, Inc. (Marine Environmental Assessment)
David A. Ziemann

Sea Engineering, Inc. (Turbidity Investigations)
Scott Sullivan

Asian Pacific Research Foundation (Survey of Ciguatera)
Yoshitsugi Hokama

APPENDIX A-9

REPRODUCTION OF SIGN-IN SHEETS FROM PUBLIC HEARINGS

DEPARTMENT OF TRANSPORTATION

HARBORS DIVISION

PUBLIC HEARING SIGN-IN SHEET

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
H.C. 1823
and
Future Pier and Storage Yard Improvements at Barbers Point Harbor

JAMES CAMPBELL OFFICE BUILDING — LAULIMA ROOM — OCTOBER 13, 1994

NAME	REPRESENTING	ADDRESS	TELEPHONE NO.*
ROY WICKRAMARATNA	MAKAKILO COMMUNITY ASSOCIATION	92-755 MAKAKILO DR #50 EWA BEACH HI 96707	[redacted]
CHIP WANNER	Pacific Connection	Facilitator for workshop	[redacted]
BILL THAYER	KALAERUA STEWARDSHIP & BARBERS PT USERS GROUP	PIER 1 CONTROL TOWER HONOLULU, HI 96813	[redacted]
Sen. Brian Kanno	State Senate	235 S. Beretania St. #403 Hon. 96813	[redacted]
John DeLong	Hawaiian Cement	91-055 Kaomi Loop, Kapolei HI 96707	[redacted]
EMOGENE MARTIN	FRIENDS FOR EWA	91-857 HANAPOULI CIR APT 18-F	[redacted]

* Phone numbers withheld

DEPARTMENT OF TRANSPORTATION

HARBORS DIVISION

PUBLIC HEARING SIGN-IN SHEET

Basin Expansion and Tug Pier at Barbers Point Harbor, Oahu
H.C. 1823
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Future Pier and Storage Yard Improvements at Barbers Point Harbor

JAMES CAMPBELL OFFICE BUILDING — LAULIMA ROOM — OCTOBER 19, 1994

NAME	REPRESENTING	ADDRESS	TELEPHONE NO *
Tim Curtin	Healy Tibbitts Civil Engineering Contractors	99-994 Iwaena St. Suite A. Aiea, Hawaii 96701	[redacted]
Paul O'Connor	Barbers Point NAS Reuse Committee	250 S. Hotel St. Honolulu, Hi 96811	[redacted]
Tomi D. Chong	" " or (DAGS)	" "	[redacted]
Ken Williams	West Beach Estates	91-100 Kamoana Pl 96707	[redacted]
Martha Makaiwi	Honokai Hale/Nanakai Garden Com Assn	92-783 Laaloa Pl.	[redacted]
Benton & Christy Ching	Corps of Engineers	91-1175 Kupipi Ewa Beach	[redacted]

* Phone numbers withheld

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HARBORS DIVISION

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JAMES CAMPBELL OFFICE BUILDING — LAULIMA ROOM — OCTOBER 19, 1994

NAME	REPRESENTING	ADDRESS	TELEPHONE NO*
TERRY GAETA	MARINE PATROL	WAIANAE HARBOR, WAIANAE	[redacted]
PAM WITTY-OAKLAND	CITY COUNCILMEMBER JOHN DESOTO	CITY HALL	[redacted]
FRED MASUDA		1857 KAPIOLANI BLVD	[redacted]
[illegible] YONAMINE	SELF	47-[illegible] [illegible] ST.	[redacted]
Darell Young	Self	91-133 Nohoihoewa Way	[redacted]
Jane A. Ross	Honokai Hale/Nanakai Gardens Comm Assoc	92-783 Laaloa Pl.	[redacted]
Doris Domingo	Self	92-668 Malahuna Loop, Kapolei	[redacted]

* Phone numbers withheld