United States
Environmental Protection
Agency

Oil and Special Materials
Control Division
Marine Protection Branch
Washington DC 20460

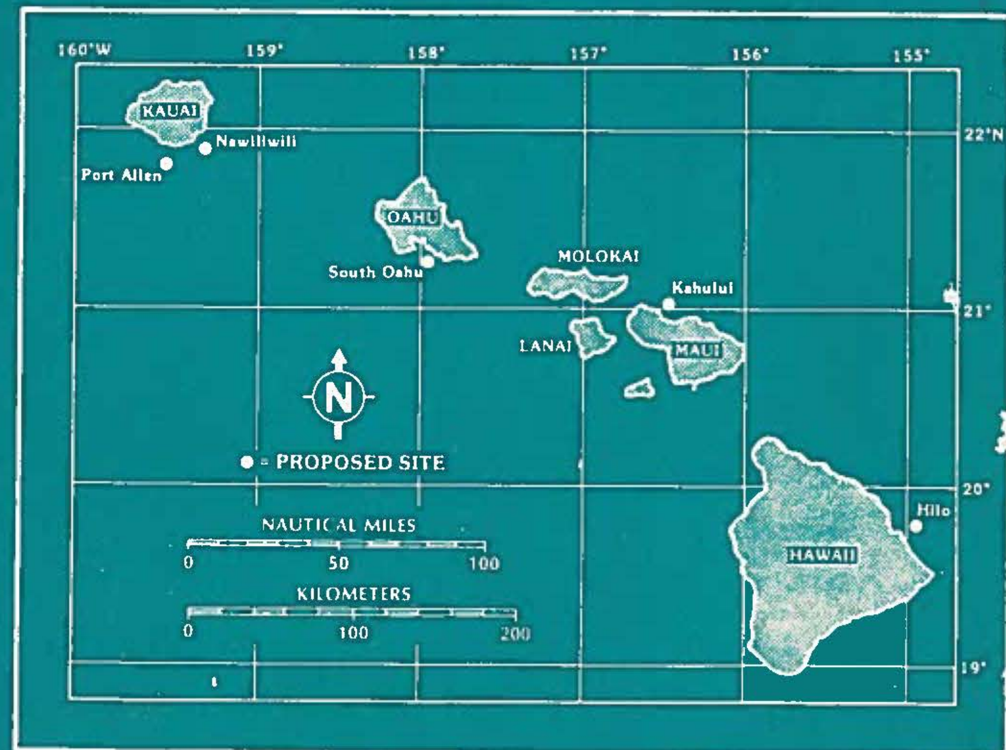
September 19[illegible]

Water

EPA

Environmental Impact Statement (EIS) for Hawaii Dredged Material Disposal Sites Designation

Final



United States
Environmental Protection
Agency

Oil and Special Materials
Control Division
Marine Protection Branch
Washington DC 20460

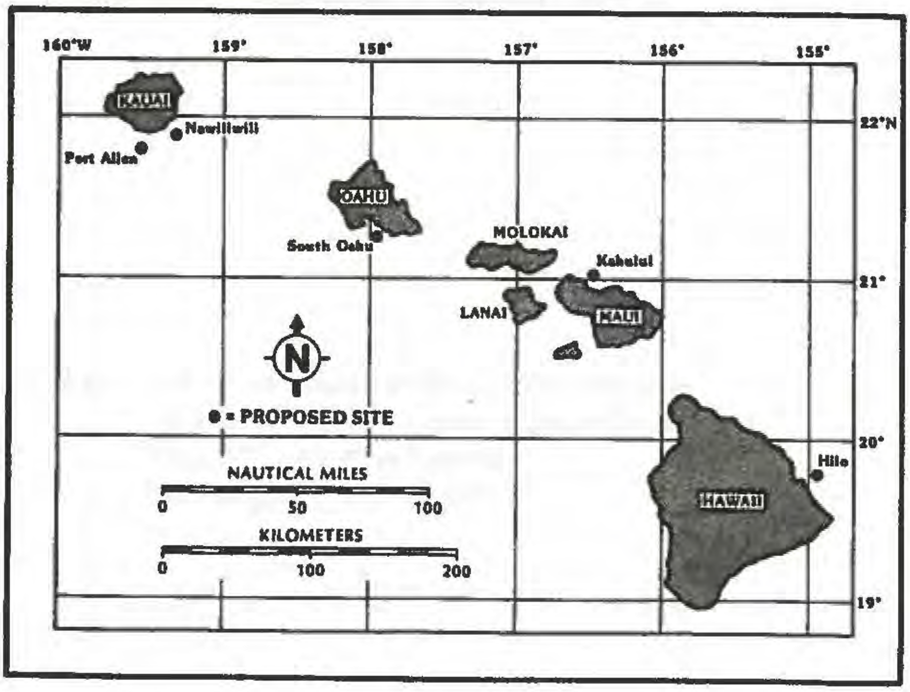
September 1980

Water

EPA

Environmental Impact Statement (EIS) for Hawaii Dredged Material Disposal Sites Designation

Final



ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
MARINE PROTECTION BRANCH

(X) Administrative/Regulatory action
( ) Legislative action

The 30-day comment period on the Final EIS ends on 10 November 1980.

Comments should be addressed to:

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D.C. 20460

Copies of the Final EIS may be obtained from:

Environmental Protection Agency
Marine Protection Branch (WH-548)
Washington, D.C. 20460

Environmental Protection Agency
Pacific Islands Contact Office
P.O. Box 50003
300 Ala Moana Blvd., Room 1302
Honolulu, Hawaii 96850
Telephone - 808/546-8910

The Final EIS may be reviewed at the following locations:

Environmental Protection Agency
Public Information Reference Unit, Room 2404 (rear)
401 M Street, S.W.
Washington, D.C.

Environmental Protection Agency
Region IX, Library
215 Fremont St.
San Francisco, California

Approved By: ______________________________ ______________
T. A. Wastler **Date**
Project Officer

SUMMARY

This Environmental Impact Statement (EIS) considers the designations of five deep-ocean sites in the Hawaiian Islands for the continued disposal of dredged material. The proposed sites for designation are: South Oahu (Oahu), Port Allen (Kauai), Nawiliwili (Kauai), Hilo (Hawaii), and Kahului (Maui). By a thorough evaluation of the proposed action, the alternatives, and environmental consequences of the proposed action, the EIS tentatively concludes that there are few significant unavoidable adverse environmental effects which are irreversible or require an irretrievable commitment of resources. The EIS documents the decision-making process and supports the tentative decision to designate the proposed sites.

ORGANIZATION OF THE ENVIRONMENTAL IMPACT STATEMENT

The Summary highlights all EIS chapters included herein, and explains major points of the document. The text contains reduced technical information, with brief chapter descriptions at the beginning of each chapter. Appendices contain supplemental technical data and information.

Chapter 1 specifies the purpose of and need for the proposed action, followed by background information relevant to ocean disposal of dredged materials. Legal framework is included, by which the Environmental Protection Agency (EPA) selects, designates, and manages disposal sites, and by which the U.S. Army Corps of Engineers (CE) grants permits for the ocean disposal of dredged materials.

Chapter 2 presents alternatives to designating the proposed sites, describes procedures by which alternatives were chosen and evaluated, then compares the merits and deficiencies of each alternative site with those of proposed sites.

Chapter 3 describes the environment of the proposed sites, with histories of dredged material disposal at the proposed sites.

Chapter 4 analyzes environmental consequences of implementing the proposed action.

Chapter 5 lists the EIS authors and commenters on the Draft EIS, and Chapter 6 contains a glossary, a list of abbreviations, and a list of references cited.

Several appendices are included: Appendix A is a compendium of site-specific technical environmental data. Appendix B presents an overview of dredged material disposal practices. Appendix C contains supplemental data and text to support the discussions in Chapter 4 on the environmental consequences of implementation of the proposed action. Appendix D describes the future data requirements based upon environmental studies. Appendix E presents the Ocean Dumping Regulations applicable to dredged material disposal, and Appendix F contains the public comments received on the Draft EIS and the resultant responses.

PROPOSED ACTION

The proposed action discussed in this EIS considers the designations of five deep-ocean sites for the continuing disposal of maintenance dredged materials. The action, as proposed, fulfills the need for an ocean location which will (1) provide for expedient disposal of dredged materials resulting from the maintenance dredging of six harbors in Hawaii approximately every 5 or 10 years (more often at Pearl Harbor), and (2) experience no significant adverse impacts from dredged material disposal. The proposed action does not exempt the use of these sites from additional environmental review nor does it exempt the dredged material from compliance with the Ocean Dumping Regulations and Criteria prior to disposal at a designated site.

The proposed action amends the 1977 interim designation of the EPA Ocean Dumping Regulations and Criteria by altering the locations of three sites (South Oahu, Nawiliwili, and Port Allen), adding two new sites (Kahului and Hilo), and making final designations of all five sites. Each proposed site received dredged material during the 1977-1978 dredging cycle. The proposed South Oahu Site merges two sites used in 1977-1978 by the CE and the Department of Navy.

MAJOR ALTERNATIVES CONSIDERED

The major alternatives to designating the proposed sites are (1) no action, thereby forcing the use of other disposal methods (primarily land-based) or forcing the cessation of dredging because interim site designation expires before the next scheduled dredging cycle, and (2) use of alternative sites previously studied or used before the 1977-1978 dredging cycle.

Fourteen sites were considered before selecting the five proposed sites for designation. The sites were evaluated primarily for environmental acceptability because monitoring and surveillance requirements and associated economic burdens are essentially the same for the proposed and alternative sites. Each alternative site was eliminated because various site features had higher potentials for adverse environmental effects. Additional data, obtained before and after the previous disposal cycles at the proposed sites, further substantiated the final selections.

AFFECTED ENVIRONMENT

The center of the proposed South Oahu Site is 3.3 nmi (6.1 km) offshore, on the shelf-slope junction. The proposed site is 1.1 by 1.4 nmi (2.0 by 2.6 km), and is oceanic in nature; it is deep (400 to 475 m), and biota are low in abundance compared to those inshore. The bottom terrain is a vast sloping plain, dropping approximately 75 m in 2,000 m across the proposed site, and sediment composition is primarily silty sand. The proposed site now incorporates two sites: the former Pearl Harbor and former Honolulu Sites. Dredged materials to be dumped at the proposed South Oahu Site originate from Honolulu Harbor approximately every five years, and from Pearl Harbor as needed. The proposed site is foreseen as receiving the greatest portion of all Hawaiian dredged material.

There are two proposed sites off Kauai: the Nawiliwili and Port Allen Sites. The proposed Nawiliwili Site is 4.0 nmi (7.4 km) offshore, in deep waters ranging from 840 to 1,120 m. The bottom is primarily silty sand. This site is expected to receive dredged material approximately every five years, with an estimated quantity (in 1986) of 80,000 yd^3. The proposed Port Allen Site receives dredged material from Port Allen Harbor approximately every five years with an estimated volume of 200,000 yd^3 to be dumped in 1986. The center of this proposed site is 3.8 nmi (7.0 km) offshore, and 1,460 to 1,610 m deep, with a silty clay bottom. The proposed Kauai Sites are oceanic, with a lower biomass than that found inshore. The seaward slope at each site is quite steep.

The proposed Kahului Site is 5.6 nmi (10.4 km) off the Maui coast, in depths ranging from 345 to 365 m. Sediments at the proposed site are primarily silty clay. Dredging operations in Kahului Harbor occur approximately every ten years, with an estimated volume of 40,000 yd^3 to be dumped in 1986.

The proposed Hilo Site is projected to receive dredged material from Hilo Harbor approximately every ten years; the quantity to be dumped in 1986 is approximately 100,000 yd^3. The proposed site is 4.5 nmi (8.3 km) offshore, over a silty clay bottom; water depths are 330 to 340 m.

The proposed Nawiliwili, Port Allen, Kahului, and Hilo Sites are circular, with radii of 920 m (1,000 yd).

ENVIRONMENTAL CONSEQUENCES

Environmental consequences of deep-ocean disposal of dredged material are minimal. The proposed disposal sites can receive dredged materials without jeopardizing the life support systems of marine biota due to the extent of dilution which occurs (approximately 1:1,000,000). Flora and fauna, while sensitive to outside influences, are low in abundance in the deep ocean. The deep oceans do not produce significant quantities of food for man, and generally do not support as much biota as the inshore shallow water environments. This is particularly true of Hawaii's proposed deep subtropical disposal sites.

The sites proposed for designation were selected in preference to alternative sites because of their environmental acceptabilities. However, differences between proposed and alternative sites were not significant; dredged material disposal at the alternative sites would not present major environmental impacts.

Since there are no significant differences between the proposed and alternative sites, environmental consequences are discussed primarily for the proposed South Oahu Site. However, factors used in the selection of proposed versus alternative sites are nevertheless described for each proposed site. Environmental consequences of dredged material disposal at the proposed sites were assessed on the bases of past studies by the CE and the Department of the Navy. The proposed sites are identified as the best of all assessed alternatives for the following reasons:

- The depths of waters and physical environments of the proposed sites provide dilution and transport alongshore or offshore.

- The proposed sites are not near any existing commercial fisheries or resources. Three of the proposed sites have water depths within the range of commercially valuable shrimp. However, shrimp are not present in commercially valuable concentrations, thus no commercial shrimp fishing is practiced. Dredged material disposal will not endanger fisheries, other existing commercial resources, or human health by contaminating edible fish and/or shellfish.

- The proposed sites are not in any prohibited or limited usage zones.

- The reduced biological productivity typical of the proposed sites on the slope (compared to the shallower shelf) makes dredged material disposal less likely to affect indigenous organisms.

- Extensive data exist for predicting and monitoring effects of future dredged material disposal at the proposed sites. Since 1972, Federal agencies, academic institutions, and commercial firms have studied the proposed and alternative sites and the consequences of past disposal activities.

- The dredged materials comply with the interim criteria in effect prior to the EPA/CE bioassay procedures manual (1977) for minimizing environmental impacts.

An adverse impact of disposal is periodic smothering of some benthic fauna within the proposed sites; however, the biota have been shown to repopulate the area shortly after disposal. Other negative consequences of disposal operations are:

- Short-term local increases of suspended particulate matter.

- Possible modification of the normal sediment size distribution by dumping dredged materials of dissimilar sizes.

CONCLUSIONS

After carefully evaluating all reasonable alternatives and environmental consequences of dredged material disposal, EPA proposes to designate the five proposed sites for continued disposal of maintenance dredged material. However, dredged materials must comply with Ocean Dumping Regulations and Criteria which are specifically applicable to dredged materials. Efforts will be made during advanced planning to schedule disposal to avoid periods when the disposal sites are visited by humpback whales or migrating and spawning fish, until additional pertinent data are available.

CONTENTS

CONTENTS (continued)

CONTENTS (continued)

CONTENTS (continued)

FIGURES

CONTENTS (continued)

TABLES

NOTE: Each appendix is preceded by its own Table of Contents

Chapter 1

PURPOSE OF AND NEED FOR ACTION

Shipping is Hawaii's lifeline to the mainland and provides several million tons of goods annually to the State. To maintain the operating depths of six harbors throughout the State, dredging is required in approximate 5- to 10-year cycles (more often at Pearl Harbor). Ocean disposal is the most viable means for disposal of the dredged material. The five sites proposed for designation provide Hawaii with effective areas for dredged material disposal at minimal cost and environmental risks. This chapter provides (1) the background information defining the proposed action in view of the need for dredged material disposal, and (2) the legal regime for establishing options.

INTRODUCTION

The proposed action presented in this Environmental Impact Statement (EIS) considers the designation of five deep-ocean sites for the continued disposal of dredged material resulting from maintenance dredging of six harbors (Honolulu, Pearl, Nawiliwili, Port Allen, Hilo, and Kahului Harbors). The five proposed sites (Figure 1-1) are adjacent to the named harbors, with two sites off Kauai (Nawiliwili and Port Allen), and one each off Oahu (South Oahu), Maui (Kahului), and Hawaii (Hilo).

This EIS documents the decision-making process leading to the tentative decision on site designation only. Dumping of dredged material will be carried out on a case-by-case basis; all dredged material will be evaluated in accordance with U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (CE) procedures to determine if it meets the Final Ocean Dumping Regulations and Criteria. The purpose and need for this action are as follows:

- Maintenance dredging is required regularly for Pearl Harbor, approximately every 5 years for Honolulu, Nawiliwili, and Port Allen Harbors, and approximately every 10 years for Hilo and Kahului Harbors to maintain sufficient operating depths for ship traffic.

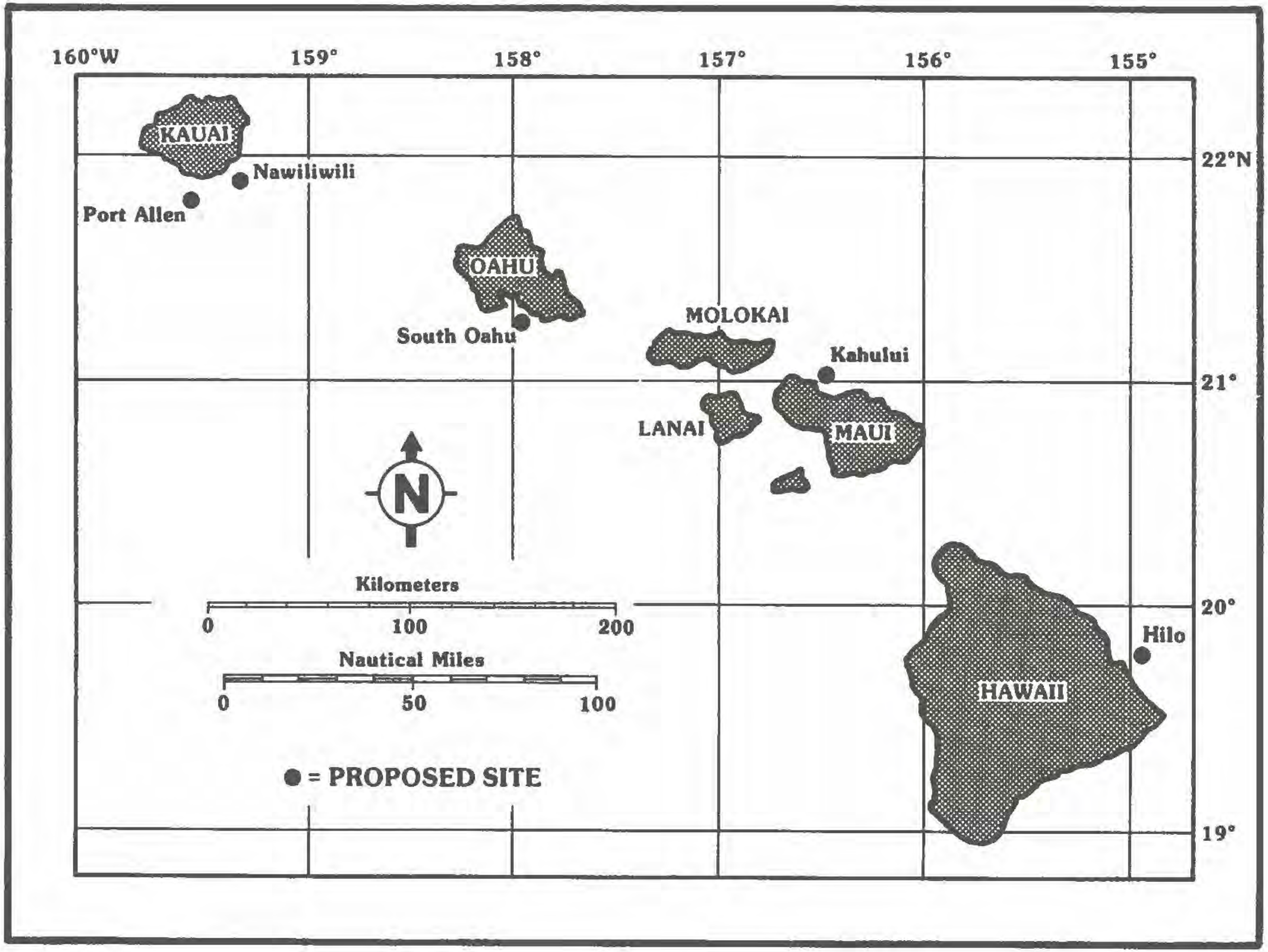


Figure 1-1. Proposed Dredged Material Disposal Sites

- Maintaining operating depths is critical to keeping the harbors open and sustaining the State's economy. Shipping is Hawaii's lifeline to the mainland, with over 8 million tons of cargo imported annually. Alternatives which eliminate dredging or ocean disposal (no action), or make disposal too costly, or involve too great a public health risk (e.g., landfills) are unacceptable.

- The U.S. Army Engineer District published an EIS (1975) entitled Harbor Maintenance Dredging in the State of Hawaii which concludes that ocean disposal of dredged material is the best method at least cost, and presents the lowest risks to public health compared to land disposal, improved land management techniques, or shallow-water disposal.

- The EPA designated the Honolulu, Nawiliwili, and Port Allen Harbor Disposal Sites in 1973 as interim ocean locations to dispose of dredged materials in compliance with the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA, PL #92-532, as amended). The proposed action amends the interim designation by adding two sites (Kahului and Hilo), altering the locations of three sites (South Oahu, Nawiliwili, and Port Allen), and making final designation of the five sites.

The following sections present information on Federal legislation, control programs, and international considerations which govern or affect dredged material ocean disposal.

FEDERAL LEGISLATION AND CONTROL PROGRAMS

Despite legislation dating back almost 100 years for controlling disposal into rivers, harbors, and coastal waters, ocean disposal of dredged and other materials was not specifically regulated in the United States until passage, in October 1972, of the MPRSA.

Prior to the enactment of MPRSA, there was very little regulation of ocean waste disposal. Limited regulation was primarily provided by the Supervisors' Act of 1888, which empowered the Secretary of the Army to prohibit disposal of wastes, except flows from streets and sewers, into the harbors of New York, Hampton Roads, and Baltimore. The Refuse Act of 1899 further prohibited disposing into waters materials which would impede safe navigation. Under these acts, selection of disposal locations by the CE and the issuance of permits for ocean disposal were based primarily on transportation and navigation factors rather than on environmental concerns.

A growing concern about the environmental effects of dredged material disposal and water resource projects led to the passage of the Fish and Wildlife Coordination Act in 1958. Although this law initially referred to inland tidal waters, it emphasized consideration of the effects of dredged material disposal on commercially important marine species, and was the first step towards concern for ocean areas. After the passage of this law, the CE (backed by judicial decisions) was able to refuse permits if the dredging or filling of a bay or estuary would result in significant, unavoidable damage to the marine ecosystem.

Passage of the National Environmental Policy Act (NEPA) in 1969 reflected the public's concern over the environmental effects of man's activities. Subsequently, particular attention was drawn to the effects of dredged materials by the Rivers and Harbors Act of 1970 (PL 91-611). This act initiated a comprehensive nationwide study of dredged material disposal problems. Thus, the CE established the Dredged Material Research Program (DMRP) in 1973. The DMRP was a 5-year research effort, initiated in March 1973, (1) to understand why and under what conditions dredged material disposal might result in adverse environmental impacts, and (2) to develop procedures and disposal options to minimize adverse impacts (CE, 1977).

Two important legislative acts were passed in 1972, that specifically addressed the control of waste disposal in aquatic and marine environments: (1) the Federal Water Pollution Control Act Amendments (FWPCAA), later amended by the Clean Water Act of 1977, and (2) the MPRSA. The FWPCAA, together with the Water Quality Improvement Act of 1970, set up specific water quality criteria to be used as guidelines in controlling waste discharges from point sources into marine and aquatic environments. The application of these criteria to dredged material disposal was limited to those situations where fixed pipelines were used for transport and the dredged material entered the environment at discrete points.

A summary of MPRSA, outlining the purpose and intent of the Act follows. The Federal control programs initiated in response to MPRSA by EPA and the CE are described in greater detail as they govern ocean disposal.

Effective international action and cooperation in protecting the marine environment was accomplished through the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (hereafter "the Convention" or "the Ocean Dumping Convention"), discussed below.

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

MPRSA regulates the transport and ultimate disposal of waste materials in the ocean. This EIS is concerned only with Title I of the Act. Title I, the primary regulatory vehicle of the Act, establishes the permit program for the disposal of dredged and non-dredged materials, mandates determination of impacts, and provides for enforcement of permit conditions.

MPRSA has been amended several times since its enactment in 1972, and most of the amendments are concerned with granting annual appropriations for administration of MPRSA. Passage of an amendment in March 1974 (PL #93-254), brought the Act into full compliance with the Convention.

FEDERAL CONTROL PROGRAMS

Several Federal departments and agencies participate in MPRSA regulations, with the lead responsibility given to EPA (Table 1-1). In October 1973, EPA implemented its responsibility for regulating ocean dumping under MPRSA by issuing the Final Ocean Dumping Regulations and Criteria (hereafter the Regulations or Ocean Dumping Regulations), revised in January 1977 (40 CFR Parts 220 to 229). These regulations establish procedures and criteria for review of ocean disposal permit applications (Part 227), assessment of impacts

TABLE 1-1
RESPONSIBILITIES OF FEDERAL DEPARTMENTS AND AGENCIES FOR REGULATING OCEAN DISPOSAL UNDER MPRSA

Department/Agency	Responsibility
U.S. Environmental Protection Agency	Issuance of waste disposal permits, other than for dredged material
	Establishment of criteria for regulating waste disposal
	Enforcement actions
	Site designation and management
	Overall ocean disposal program management
U.S. Department of the Army Corps of Engineers	Issuance of dredged material disposal permits
	Recommending disposal site locations
U.S. Department of Transportation Coast Guard	Surveillance
	Enforcement support
	Issuance of regulations for disposal vessels
	Review of permit applications
U.S. Department of Commerce National Oceanic and Atmospheric Administration	Research on alternative ocean disposal techniques
	Long-term monitoring and research
	Comprehensive ocean dumping impact and short-term effect studies
	Marine Sanctuary designation
U.S. Department of Justice	Court actions
U.S. Department of State	International agreements

of ocean disposal and alternative disposal methods, enforcement of permits, and designation and management ocean disposal sites (Part 228). Each of these issues is described briefly in the following sections.

THE PERMIT PROGRAM

The Ocean Dumping Regulations are specific about the procedures used to evaluate permit applications, and to grant or deny a permit. EPA and the CE evaluate permit applications principally to determine (1) whether there is a demonstrated need for ocean disposal, and that no other reasonable alternatives exist, and (2) compliance with the environmental impact criteria (40 CFR Part 227, Subpart B). Under Section 103 of the MPRSA, the Secretary of the Army is given the authority, with certain restrictions, to issue permits for the transportation of dredged material for ocean disposal associated with non-CE projects. The Secretary of the Army issues these permits after determining compliance of the material with EPA's environmental impact criteria (40 CFR Part 227, Subpart B), pursuant to Section 102 of the MPRSA, and subject to EPA's concurrence (Figure 1-2). The CE is responsible for evaluating disposal applications and granting permits to dumpers of dredged materials; however, dredged material disposal sites are designated and managed by EPA Administrator or his designee.

For CE projects involving dredged material disposal, Section 103(e) of MPRSA provides that "the Secretary of the Army may, in lieu of the permit procedure, issue regulations which will require the application (to such projects) of the same criteria, other factors to be evaluated, the same procedures, and the same requirements which apply to the issuance of permits..." for non-CE dredging projects involving disposal of dredged material. Maintenance dredging of CE projects in the Hawaiian Islands are conducted by the CE, and disposal of the dredged material at the interim designated sites does not require a permit. The Department of the Navy maintains Pearl Harbor and applies to the CE for a permit to dump. The Secretary of the Army has applied the criteria outlined in MPRSA and the Regulations in his determination to allow continued use of the proposed sites exclusively for the disposal of material dredged from the six Hawaiian harbors.

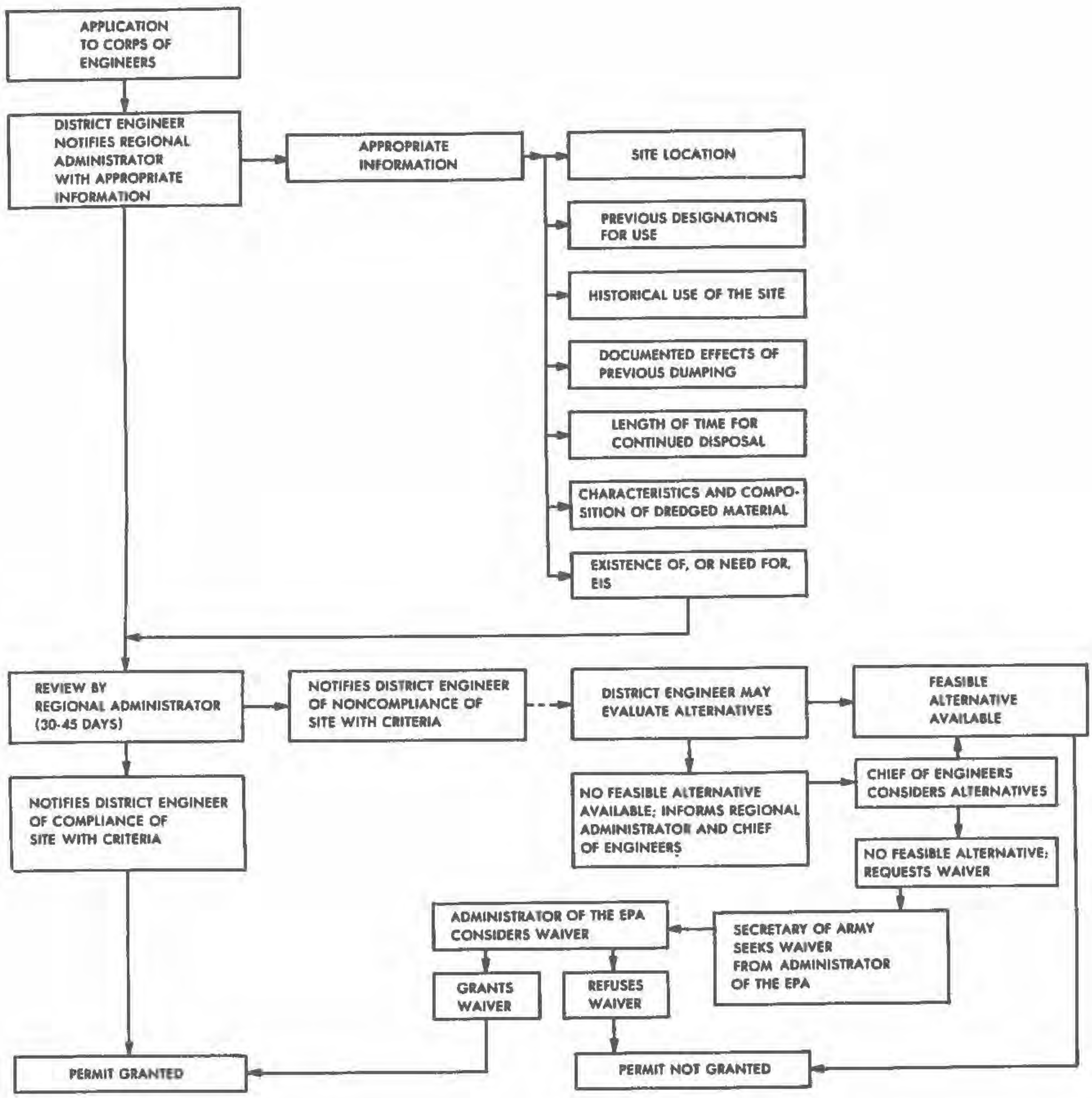


Figure 1-2. Dredged Material Permit Cycle - Non-CE Permits (40 CFR Part 225)

ENVIRONMENTAL IMPACT CRITERIA

The ocean disposal of dredged materials from both Federal and non-Federal projects must not unduly degrade or endanger the marine environment. The disposal operation must present no unacceptable adverse human health effects and no significant damage to the marine environment. Also, there are to be no persistent or permanent effects from dumping the approved quantities, and there are to be no site-use conflicts.

To ensure that ocean dumping will not unduly degrade or endanger public health and the marine environment, Title I restricts the dumping of some materials. These restrictions apply to all materials for ocean disposal:

- Prohibited materials: High-level radioactive wastes; materials produced or used for radiological, chemical, or biological warfare; materials insufficiently described; and persistent floatable materials which interfere with other uses of the ocean.

- Materials present as trace contaminants only: Organohalogens, mercury and mercury compounds, cadmium and cadmium compounds, oil, and known or suspected carcinogens, mutagens, or teratogens.

Dredged material is environmentally acceptable for ocean disposal without further testing if it satisfies any one of the following criteria:

- "Dredged material is composed predominantly of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, and the material is found in areas of high current or wave energy..."

- "Dredged material is for beach nourishment or restoration..."

- "When...the material proposed for dumping is substantially the same as the substrate at the proposed disposal site... and...the [proposed dredging] site...is far removed from known...historical sources of pollution so as to provide reasonable assurance that such material has not been contaminated..." (40 CFR Section 227.13[b])

When the dredged material does not meet one of the above criteria, the permit applicant must demonstrate that trace contaminants in the liquid, suspended-particulate, and solid phases meet the following criteria:

- Dredged material is non-toxic and non-bioaccumulative upon disposal and thereafter, or

- Dredged material will be rapidly rendered non-toxic and non-bioaccumulative upon disposal and thereafter, and the contaminants so rendered will not make edible marine organisms unpalatable and will not endanger human health or that of domestic animals.

It the permit applicant cannot demonstrate that the dredged material meets the above criteria, then further testing of the liquid, suspended-particulate, and solid phases is required to verify that:

- Trace contaminants in the liquid fraction do not exceed the Water Quality Criteria (EPA, 1976). For those trace contaminants which do not comply with Water Quality Criteria (i.e., certain organo-halogens) further testing (bioassay) is required to verify that such compounds are not present in concentrations great enough to cause significant undesirable effects, due either to chronic toxicity or to bioaccumulation in marine organisms.

- Major constituents in the liquid fraction do not exceed the Water Quality Criteria (EPA, 1976). When some major constituents do not comply with Water Quality Criteria, or there is reason to suspect synergistic effects of certain contaminants, further testing (bioassay) is required to verify that the dredged material can be discharged without exceeding the limiting permissible concentration as defined is 40 CFR Section 227.27.

- Bioassays on suspended particulate or solid fractions do not indicate occurrences of significant mortality or significant adverse sublethal effects, including bioaccumulation, due to dumping of dredged material.

Permit Enforcement

The U.S. Coast Guard (USCG) has responsibility for surveillance of ocean dumping to ensure that no dumping violations occur. At the request of EPA, the Department of Justice initiates relief actions in court for violations of the terms of MPRSA. When necessary, injunctions to cease dumping are issued. Civil and criminal fines, plus jail sentences, may be levied.

OCEAN DISPOSAL SITE DESIGNATION

By means of this and other EIS's, EPA is conducting intensive studies of various dump sites in order to determine their acceptability. The agency has designated for use a number of existing dump sites on an interim basis until studies are complete and formal designations or terminations of the sites are decided (see 40 CFR Section 228.12, as amended January 16, 1980, 45 CFR 3053-3055). The Hawaiian dredged material disposal sites are covered by interim designations.

Under Section 102(c) of the MPRSA, EPA is authorized to designate sites and times for ocean disposal of acceptable materials. Therefore, EPA established criteria for site designation in the Regulations. These include general and specific criteria for site selection and procedures for designating the sites for disposal. Specific criteria for site selection relate more closely to conditions at the proposed sites by treating the general criteria in detail. If it appears that a proposed site can satisfy the general criteria, then the specific criteria for site selection will be considered. These criteria for site selection are detailed in Chapter 2.

Once designated, the site must be monitored for adverse disposal impacts. For the Hawaiian dredged material disposal sites, monitoring will be funded and administered by the Pacific Ocean Division of the CE. The following types of effects are monitored to determine to what extent the marine environment has been affected by dredged material disposed at the site:

(1) Movement of materials into estuaries or marine sanctuaries, or onto oceanfront beaches, or shorelines.

(2) Movement of materials toward productive fishery or shellfishery areas.

(3) Absence from the disposal site of pollution-sensitive biota characteristic of the general area.

(4) Progressive, non-seasonal changes in water quality or sediment composition at the disposal site, when these changes are attributable to materials disposed of at the site.

(5) Progressive, non-seasonal changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site, when these changes can be attributed to the effects of materials disposed of at the site.

(6) Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site. (40 CFR)

INTERNATIONAL CONSIDERATIONS

The principal international agreement governing ocean dumping is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Ocean Dumping Convention), which became effective in August 1975, upon ratification by 15 contracting countries including the United States. Designed to control dumping of wastes in the ocean, the Convention specifies that contracting nations will regulate disposal in the marine environment within their jurisdiction, disallowing all disposal without permits. Certain other hazardous materials are prohibited (e.g., biological and chemical warfare agents and high-level radioactive matter). Certain other materials (e.g., cadmium, mercury, organohalogens and their compounds, oil, and persistent, synthetic materials that float) are also prohibited, except when present as trace contaminants. Other materials - arsenic, lead, copper, zinc, cyanides, fluorides, organosilicon, and pesticides - while not prohibited from ocean disposal, require special care. Permits are required for ocean disposal of materials not specifically prohibited. The nature and quantities of all waste material, and the circumstances of disposal, must be periodically reported to the Inter-Governmental Maritime Consultative Organization (IMCO) which is responsible for administration of the Convention.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

> **Maintenance dredging in the Hawaiian Islands is performed approximately every 5 to 10 years (or as needed for Pearl Harbor) to maintain the operating depths of several harbors. Harbor depths are reduced as a result of the buildup of materials washed into harbors from surface water runoff and streams. Ocean disposal of dredged materials from six deep-draft harbors should continue as the most practical method of disposal. The proposed sites are selected for designation on the basis of their environmental acceptability over the alternative sites.**

The Hawaiian Islands are uniquely located. The absence of continental shelves and slopes causes deep ocean water close to shore, thus providing optimal locations for dredged material disposal. The sites proposed for designation were selected for their environmental acceptability, as determined from previous environmental studies conducted at the sites by the CE and Department of the Navy, in consultation with EPA (Chave and Miller, 1977a,b, 1978; Neighbor Island Consultants, 1977; Tetra Tech, 1977; Goeggel, 1978; USAED, 1975).

The proposed and alternative sites which were studied are near the dredging operations and are similar, environmentally acceptable areas. The selection of the sites for designation over alternative sites was based on site characteristics (e.g., water depth, location, topography, biological diversity or other factors) and comparative evaluation of all alternatives leading to and resulting in the least environmental impact.

Normally, the discussion of each alternative to the proposed site would rely on information presented in Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences). However, the differences between proposed and alternative sites are minor and do not allow for clear bases of choice among the options based on site characteristics. Except at Alternative

Site 9A, which was rejected for environmental reasons during early studies, dredged material disposal is not expected to produce significant adverse environmental impacts. The proposed and alternative sites are near each other, therefore the comparison of economic factors between sites are minimal.

The alternatives considered in this EIS include:

- No action (includes land disposal)
- Designation of the proposed sites
- Designation of the alternative sites

THE PROPOSED SITES

The proposed sites are in subtropical waters 330 m (Hilo Site) to 1,610 m (Port Allen Site) deep. The sites are on the shelf-slope junction in predictable current regimes, with the predominant net flows directed offshore or alongshore. They range in distance from 3.3 nmi (6.1 km), South Oahu Site, to 5.6 nmi (10.4 km), Kahului Site, offshore. The biological communities at the proposed sites are predominantly oceanic in nature, and biomass is low compared to shallow neritic or coastal ecosystems.

PROPOSED SOUTH OAHU SITE

The center of the proposed South Oahu Site is 3.3 nmi (6.1 km) offshore, with a mean water depth of 450 m and a smooth bottom covered with sand-sized calcareous sediment. Current velocities are generally between 8 and 15 cm/sec, with the predominant flow directionally variable. The proposed South Oahu Site is intended to receive dredged material from Pearl Harbor when needed, and from Honolulu Harbor approximately every 5 years.

In considering the proposed South Oahu Site for designation, four alternative sites (Figure 2-1) were evaluated:

- Former Honolulu Harbor CE Site No. 3 (used in 1977 and located 3.9 nmi [7.3 km] seaward of Honolulu Harbor entrance).

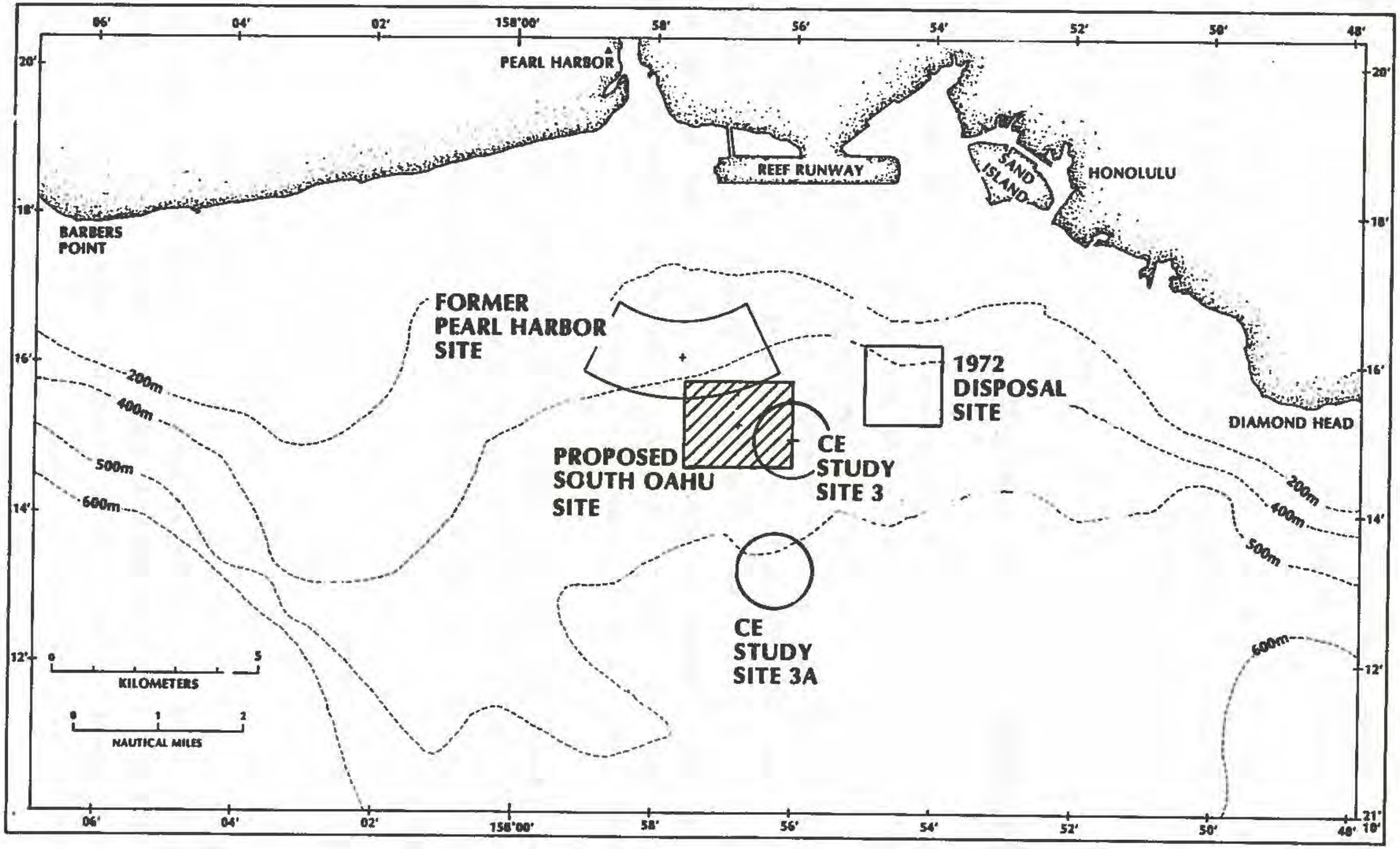


Figure 2-1. Proposed and Alternative Sites - South Oahu

- Former Pearl Harbor Site (used in 1977 and located 2.7 nmi [5 km] south of Pearl Harbor).

- 1972 Disposal Site (active in 1972 and located 3.4 nmi [6.3 km] seaward of Honolulu Harbor) which was previously designated as an interim site in 1977.

- CE Site No. 3A (5.6 nmi [10.4 km] from Honolulu Harbor entrance).

PROPOSED NAWILIWILI AND PORT ALLEN SITES

Two proposed sites are off the coast of Kauai. It is intended that dredged materials from Nawiliwili Harbor be disposed of at the proposed Nawiliwili Site (4.0 nmi [7.4 km] offshore) approximately every 5 years. Site depths range from 840 to 1,120 m, and southerly surface current velocities range from 20 to 30 cm/sec. The bottom is composed of silty sand. The proposed Port Allen Site, 3.8 nmi (7 km) offshore, is intended to receive dredged material from Port Allen Harbor approximately every 5 years. The site has water depths ranging from 1,460 to 1,610 m, and northwesterly current velocities of 5 to 50 cm/sec. The bottom is primarily silty clay.

Two alternative sites (one each) are considered in designating the proposed Nawiliwili and Port Allen Sites: Site 1A and Site 2A, respectively. Both of the proposed sites off Kauai and their alternative sites are shown in Figures 2-2 and 2-3.

PROPOSED KAHULUI SITE

The proposed Kahului Site 7A is 5.6 nmi (10.4 km) off the Maui coast, in water depths of 345 to 365 m. The site has strong westerly currents with velocities from 50 to 110 cm/sec, and a silty clay bottom. The proposed site is intended to receive dredged material from Kahului Harbor approximately every 10 years. There is one alternative site (Site 7). Both sites are illustrated in Figure 2-4.

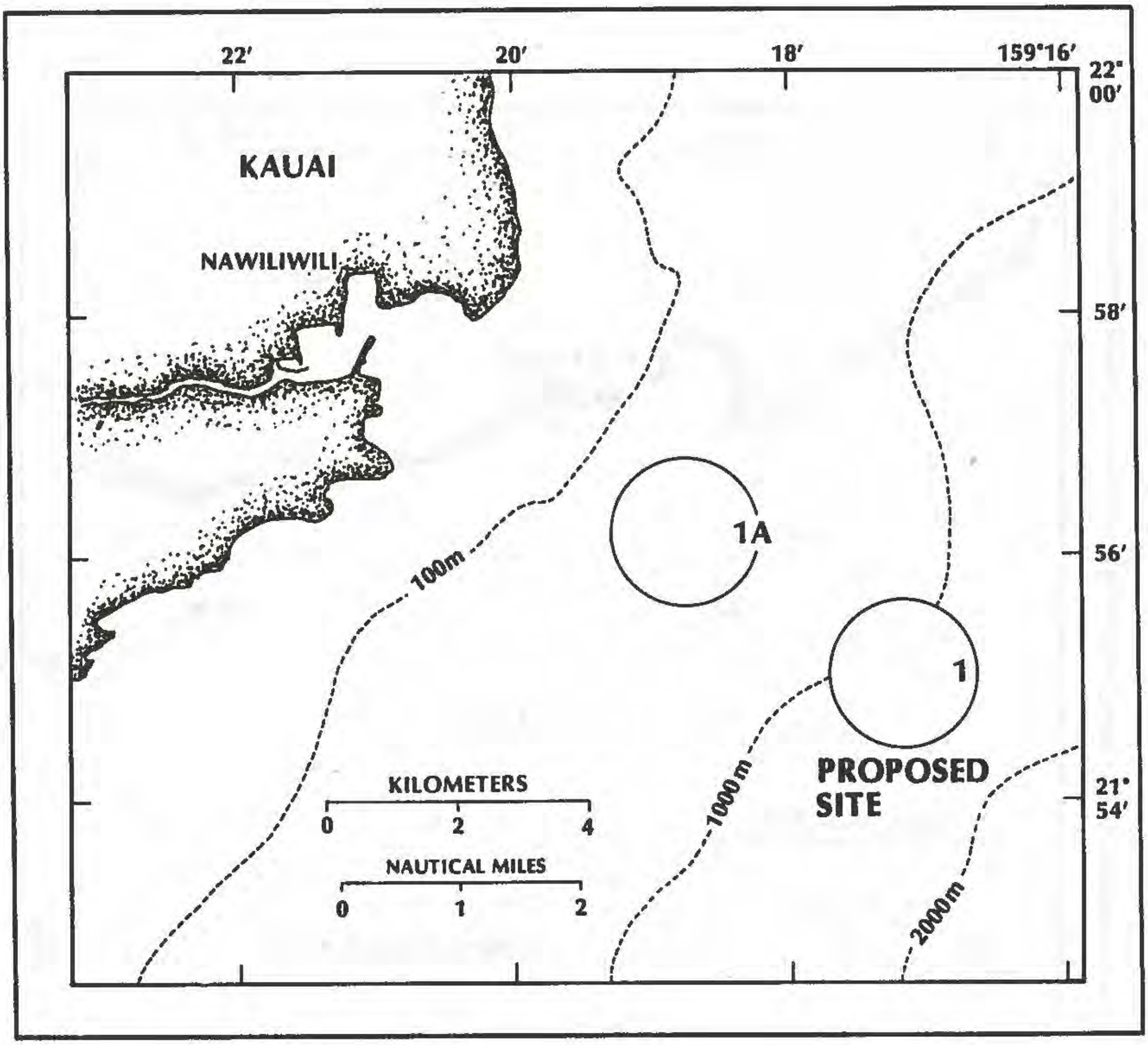


Figure 2-2. Proposed and Alternative Sites - Nawiliwili

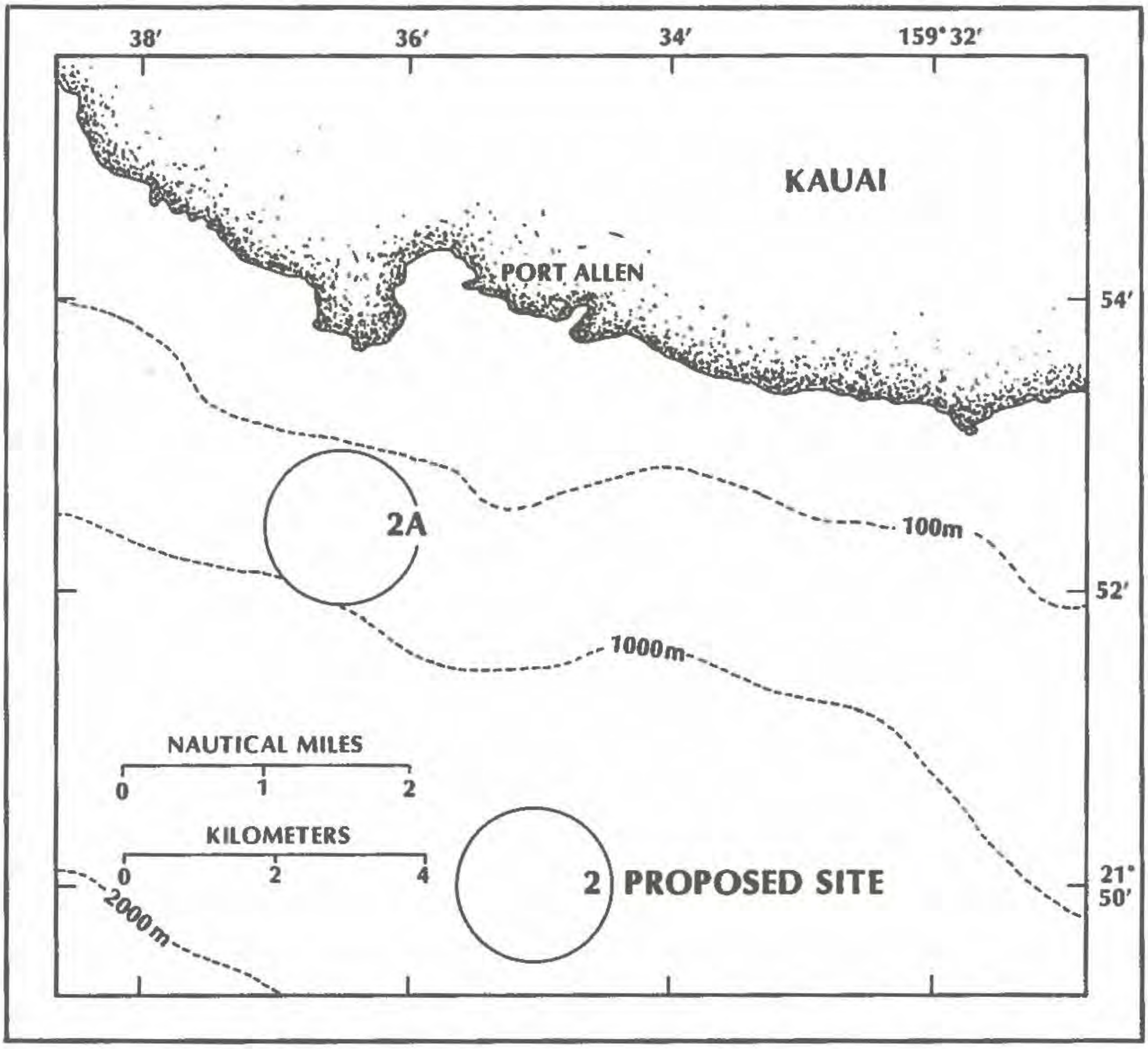


Figure 2-3. Proposed and Alternative Sites - Port Allen

#'s reversed, error!

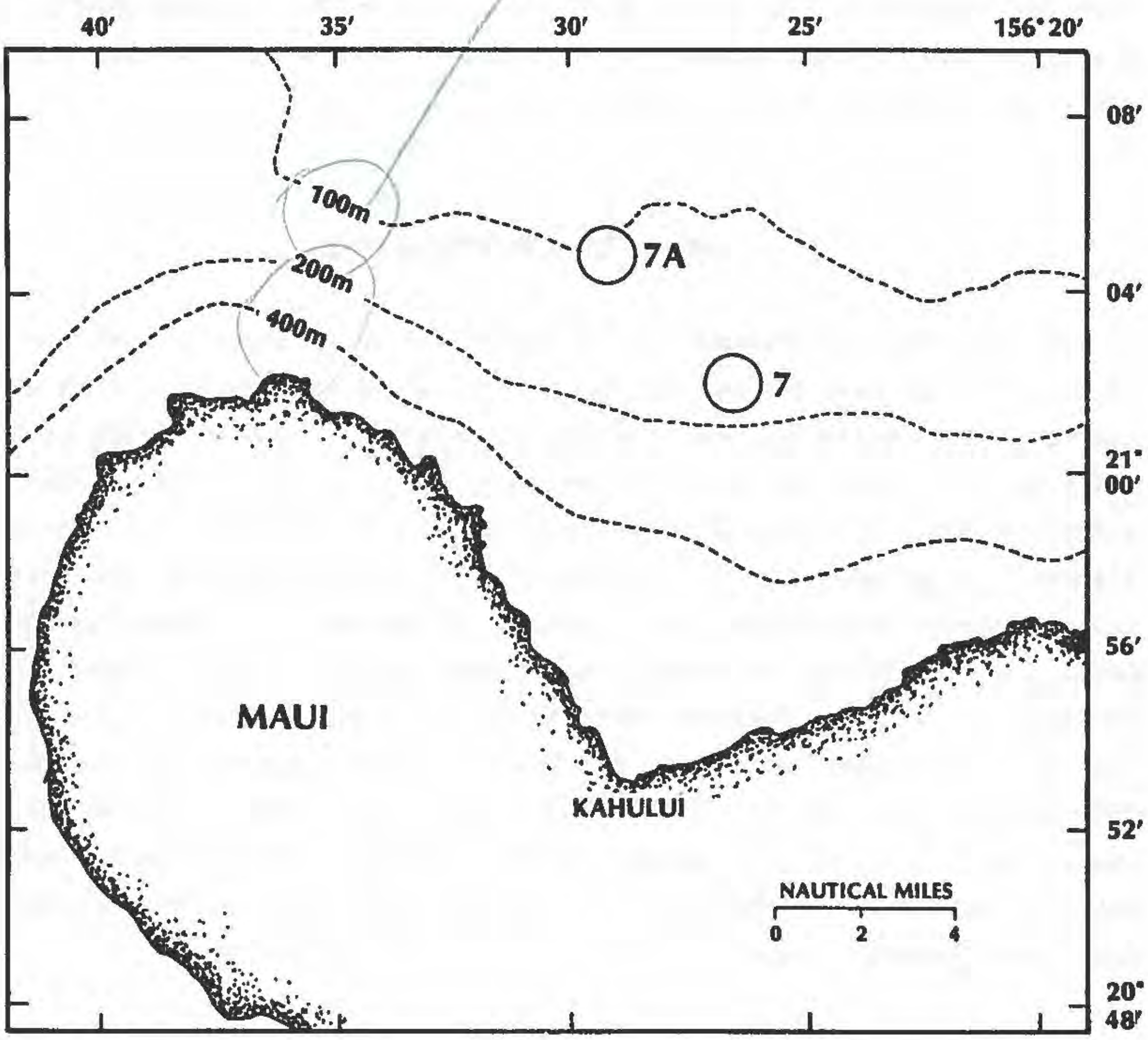


Figure 2-4. Proposed and Alternative Sites - Kahului

PROPOSED HILO SITE

The proposed Hilo Site 9 is intended to receive dredged material approximately every 10 years from Hilo Harbor. The site is 4.5 nmi (8.3 km) off the island of Hawaii, in depths ranging from 330 to 340 m, with surface currents ranging in velocity from 15 to 36 cm/sec, predominantly northwesterly. The bottom sediment is silty clay. Site 9 and the two alternative sites, 9A and 9B are shown in Figure 2-5.

NO-ACTION ALTERNATIVE

The no-action alternative would result in no designation of deep-ocean sites and would lead to the expiration of interim designation for three sites (South Oahu, Nawiliwili, and Port Allen) before the next dredging cycle, and postpone or cancel the selection of five disposal sites (South Oahu, Port Allen, Nawiliwili, Kahului, and Hilo). This alternative would require disposal of dredged material by means other than deep-ocean disposal. If other disposal alternatives are unfeasible because of prohibitive costs or public health risks, dredging operations would terminate. The no-action alternative would be pursued under either of two conditions: (1) evidence that ocean disposal at any location would cause such severe environmental consequences that ocean disposal is totally precluded, (2) existence of technologically, environmentally, and economically feasible land-based disposal methods. Shallow-water or nearshore disposal (as an alternative to deep-ocean disposal) is not environmentally feasible in Hawaii.

The purpose and need for ocean disposal of dredged material was presented in Chapter 1. The feasibility of using land-based alternatives for disposal of dredged material in Hawaii is discussed in detail in the 1975 Corps of Engineers document, FINAL ENVIRONMENTAL STATEMENT-HARBOR MAINTENANCE DREDGING IN THE STATE OF HAWAII. This document states:

> The immediate available use for dredged spoil is cover material for sanitary landfills...The dewatering requirement necessitates the use of a retention pond structure and a considerable length of time for de-

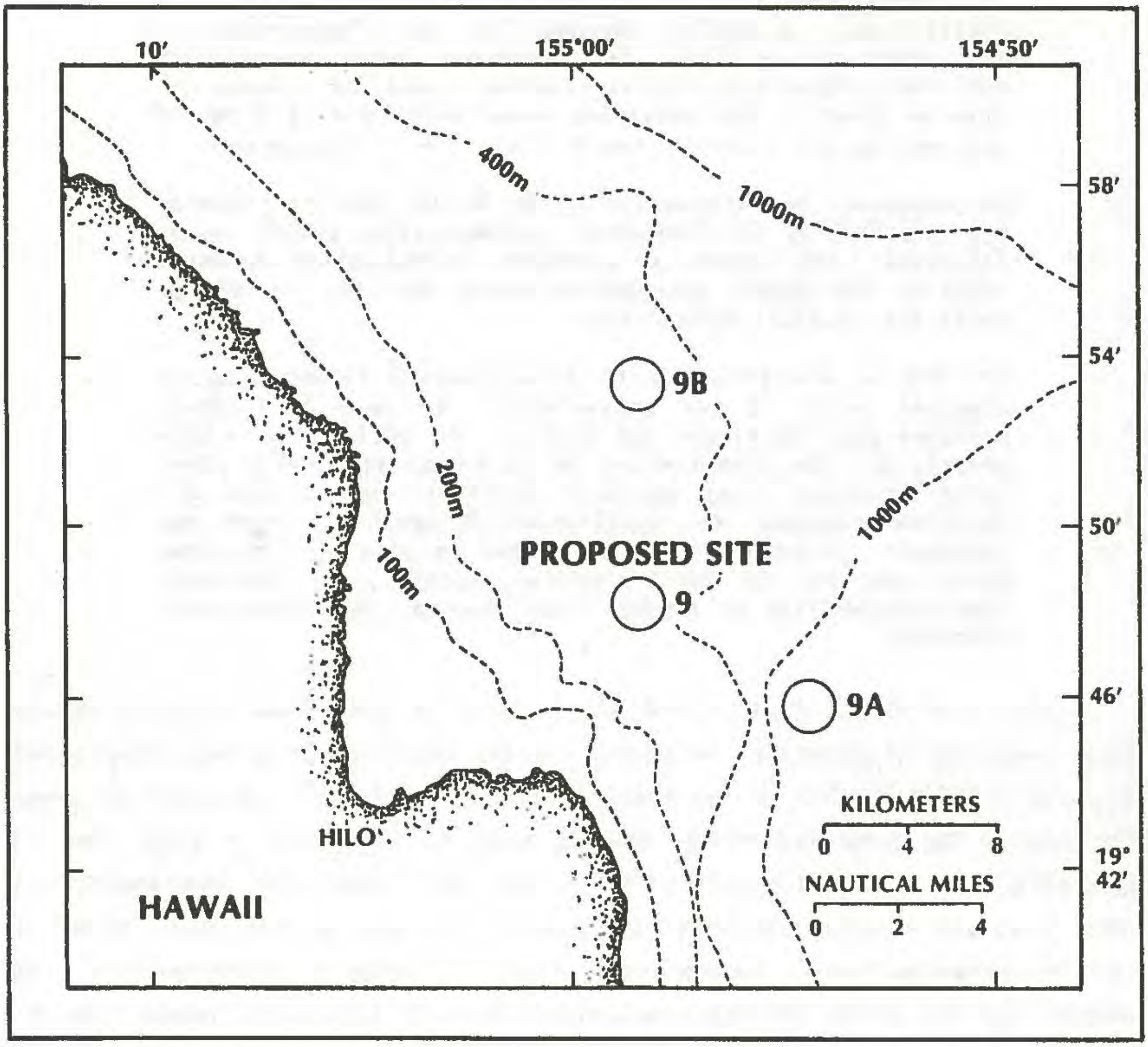


Figure 2-5. Proposed and Alternative Sites - Hilo

> watering...At present, the cost of land acquisition, the retention pond, and post-dredging operations, discourages the consideration of land disposal (emphasis added). The necessary drying time, and time required to locate users and remove the spoil from the retention area, would prolong the commitment of land resources for spoil retention utilization. Aesthetic degradation, and destruction of vegetation and habitats for retention pond construction could be irrevocable and irretrievable, and the presence of clay material at the retention area could cause unforeseen engineering and construction difficulties in the future.
>
> The chemical characteristics of the dredge spoil introduces the possibility of leachates contaminating ground water resources...The impact of possible contamination of water supplies for human consumption makes the use of dredge spoil for landfill undesirable.
>
> The future availability of [land-based] dredged spoil disposal sites is not guaranteed. As land development utilizes parcels around the harbor, the ability to obtain parcels for the construction of retention and drying ponds would decrease. As sanitary landfills are filled and locations changed, the utilization of spoil for cover may decrease. Technological changes may be able to find some other uses for the spoil material; however, the continued land availability to support land disposal operations will decrease.

It should be stated further that the subject of land-based disposal or any other feasible alternatives mentioned in the Ocean Dumping Regulations and Criteria (40 CFR 227.15) is not being permanently set aside in favor of ocean disposal. The need for ocean dumping must be demonstrated each time an application for ocean disposal is made. At that time, the availability of other feasible alternatives must be assessed. Because of the small volume or type of dredged material, land-based disposal and other alternatives have been adopted for the other federally maintained harbors in Hawaii, precluding the need for ocean disposal. All of these other harbors, except Kawaihae Deep Draft Harbor, are shallow draft, small-boat harbors.

Field studies conducted at the proposed sites before, during, and after disposal documented the effects at the proposed sites to be short-term and minor (R.M. Towill Corp., 1972; Tetra Tech, 1977; Goeggel, 1978; Chave and Miller, 1977b, 1978). The denser dredged materials settle rapidly to the bottom, while finer silts and sands are quickly dispersed by currents directed alongshore or offshore, eventually settling to the ocean floor. Subsequently, the only significant potential environmental consequence of dredged material disposal at the proposed deep ocean disposal sites is the smothering of a portion of the benthic community. However, recolonization by benthos was determined to be rapid and substantial, based on post-disposal observations (Chave and Miller, 1978; Goeggel, 1978). In summary, the no-action conditions previously stated are not pertinent to the proposed and alternative sites.

CONTINUED USE OF THE PROPOSED SITES IN RELATION TO ALTERNATIVE SITES

The proposed action is to designate for continuing use five deep-ocean dredged material disposal sites. This section presents a summary of projected impacts of the proposed action, forming the basis of comparison with the alternative sites.

ENVIRONMENTAL ACCEPTABILITY

PROPOSED SOUTH OAHU SITE

In 1976 and 1977, the CE studied Sites 3 and 3A (Figure 2-1) to select a site beyond the 200-fathom (365 m) contour. At that time, deepwater sites were required for evaluation to avoid damage to potential bottom fishing resources that the U.S. National Marine Fisheries Service, U.S. Fish and Wildlife Service, and State Division of Fish and Game generally consider to be present within the 200-fathom isobath (Maragos, 1979). When this generalization was made, bottom fisheries information at the study sites had not been collected and the presence or absence of bottom fishing resources was not documented.

The historical Honolulu Site is shallower than either Site 3 or Site 3A (Figure 2-1). After the pre-disposal survey at Sites 3 and 3A, the CE relocated disposal operations to Site 3. This decision is relevant to the discussion of site selection because the historical Honolulu and the former

Pearl Harbor Sites (inside the 200-fathom contour) are not viable alternative sites (Chave and Miller 1977a,b and 1978; R.M. Towill Corp., 1972). Therefore, the only two viable alternatives remaining for comparison are the proposed site and Site 3, both located seaward of the 200-fathom contour.

The environmental conditions at both sites are essentially identical. Considering the volumes to be dumped from both harbors, the size of Site 3 is not sufficient to accommodate the estimated amount of future dredged material for both Pearl and Honolulu harbors. In addition, the proposed South Oahu Site is, on the average, 25 m deeper than Site 3 and would further ensure sufficient dispersion of the dredged material. On this basis, the proposed South Oahu Site is the most feasible alternative.

The proposed South Oahu Site which overlaps half of Site 3 and a portion of the former Pearl Harbor Site, merely represents an expansion of this site where no adverse environmental impacts have occurred.

PROPOSED NAWILIWILI SITE

Sites 1 and 1A (Figure 2-2) were considered by Neighbor Island Consultants (1977) for disposal of dredged material from Nawiliwili Harbor before the 1977 dredging operations. Site 1A was used for dredged material disposal in 1972. The proposed site (Site 1) is preferable to Site 1A for several reasons:

- The proposed site is deeper (840 to 1,120 m) than Site 1A (380 to 580 m).

- The proposed site is 1.5 nmi (2.7 km) farther from Nawiliwili Harbor than Site 1A.

- Bottom photographs of Site 1A (Neighbor Island Consultants, 1977) indicated the presence of strong bottom current action, whereas bottom photographs at the proposed site showed only moderate bottom current activity.

- Grain-size distribution at Site 1A is more variable than at the proposed site, indicating that the proposed site is a more stable depositional site (Neighbor Island Consultants, 1977).

- Site 1A has a higher standing crop of micromollusks (3.6 shells/cm^3) than does the proposed site (1.2 shells/cm^3; Neighbor Island Consultants, 1977).

- Site 1A has 65% more diversity in polychaete species distribution than does the proposed site.

PROPOSED PORT ALLEN SITE

The proposed Port Allen Site (Site 2) is 3.8 nmi (7.0 km) from Port Allen Harbor and was used for dredged material disposal in 1972 and 1977; however, another site was considered as an alternative (Site 2A, 1.7 nmi [3.1 km] from Port Allen Harbor) in 1977 (Figure 2-3). The proposed site is preferred over Site 2A for designation for the following reasons:

- Video imagery taken by Neighbor Island Consultants (1977) showed that Site 2A has irregular topography with ledges and silty areas; the presence of shrimps, lobsters, octocorals, and holothurians was also noted.

- Trawls at Site 2A produced samples of gold coral.

- Site 2A (190 to 500 m depth) encompasses the depth ranges of both species of commercially valuable shrimp (<u>Heterocarpus</u> <u>ensifer</u> and <u>H. laevigatus</u>), whereas the proposed site (1,460 to 1,610 m) is beyond the depth range of these shrimp.

- Site 2A is biologically richer than the proposed site.

PROPOSED KAHULUI SITE

Two sites (Site 7 and Site 7A) were considered for dredged material disposal off Kahului before the 1977 dredging operations (Figure 2-4). The proposed site (Site 7A) is 11.8 nmi (21.8 km) from Kahului Harbor and was used for disposal in 1977. The proposed site is preferred over Site 7 for several reasons:

- Benthic samples showed Site 7 to be over 25% more diverse in polychaete species than the proposed site.
- The proposed site is deeper (345 to 365 m) than Site 7 (209 to 238 m), and bottom photography (Neighbor Island Consultants, 1977) showed it to have a relatively smooth bottom, whereas Site 7 showed large rocks and outcrops in the southwest quadrant of the site.
- Demersal bottom samples showed fewer of the commercially valuable shrimp, Penaeus marginatus at the proposed site than at Site 7.

PROPOSED HILO SITE

Sites 9, 9A, and 9B (Figure 2-5) were considered for dredged material disposal in the Hilo Harbor area before the 1977 dredging operations. Site 9A was dropped from consideration during early studies since (1) the western edge of the site is on a very steep cliff and in an area of strong upwelling, and (2) the majority of the commercial fishing in the Hilo area is along the western edge of Site 9A.

The proposed site (Site 9) is 5.0 nmi (9.3 km) from Hilo Harbor, and was last used for disposal in 1977. It is selected for designation over Site 9B because half of Site 9 is a flat plain and the other half has very irregular, mounded topography; whereas only one-third of Site 9B is a flat plain, and two-thirds are troughs and low-relief, hilly topography.

In general, Site 9B supports more diverse invertebrate fauna than the proposed site and is over 50% more diverse in polychaete distribution. Additionally, the proposed site is approximately 9 m deeper than Site 9B.

MONITORING, SURVEILLANCE, AND ECONOMIC CONSIDERATIONS

Despite their greater depths, the proposed and alternative sites are close to shore and the costs for monitoring transportation are comparable to those for continental U.S. sites. However, because of infrequent dredging, disposal of small volumes, and disposal of relatively clean material, significant adverse impacts are not likely to occur, and site measurements would provide sparse data on environmental effects. Future monitoring will be considered at the South Oahu Site (since it receives the greatest volume of dredged material) to add to evidence already gathered on benthic community recovery. If monitoring data at the proposed South Oahu Site indicate evidence of adverse effects, the other disposal sites will be considered for monitoring at the discretion of the CE. Further details of the monitoring program are provided below and in Appendix D.

There are no significant differences between the proposed and alternative sites concerning the surveillance of disposal operations. The proposed sites are close to shore, thus hopper dredge vessels can be observed or tracked by USCG vessels to ensure that disposal occurs within site boundaries.

Economic considerations are comparable for the proposed and alternative sites. All sites under consideration are adjacent to the dredging operations. There are no site-use conflicts whereby dumping would interfere with, or degrade economic resources. Most commercial fishing at the present time is for surface and midwater fish; trawling for demersal shrimp is presently not practiced commercially in Hawaii. If and when commercial bottom shrimp trawling is reestablished in Hawaii, it is important to note that the proposed sites have no commercial potential because of low concentrations of shrimp (Goeggel, 1978; Maragos, 1979, in consultation with National Marine Fisheries Service).

DETAILED BASIS FOR THE SELECTION OF THE PROPOSED SITE

Part 228 of the Ocean Dumping Regulations describes general and specific criteria for selection of sites to be used for ocean dumping. In brief, the general criteria stat that site locations will be chosen "...to minimize the interference of disposal activities with other activities in the marine environment..." and so chosen that "...temporary perturbations in water quality or other environmental conditions during initial mixing...can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery." In addition, ocean disposal site sizes "...will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts." Finally, whenever feasible, EPA will "...designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used." The proposed sites satisfy all of these criteria.

The 11 specific site selection criteria are presented in Section 228.6 of the Ocean Dumping Regulations. Each factor is briefly discussed in turn below to document why the proposed sites were selected over the other alternatives. More detailed information for the 11 factors is contained elsewhere in this EIS and will be cited as appropriate.

"GEOGRAPHICAL POSITION, DEPTH OF WATER, BOTTOM TOPOGRAPHY AND DISTANCE FROM COAST"

The proposed South Oahu Site is located over the shelf-slope break. Its center coordinates are latitude 21°15'10"N and longitude 157°56'50"W. Water depths range from 400 to 475 m. The bottom slopes gently towards the south-southwest. Seafloor investigations performed at the former Pearl Harbor and Honolulu Sites show the bottom topography to be smooth and covered primarily with sand-sized calcareous sediment. The nearshore side of the proposed site is approximately 3.3 nmi (6.1 km) from the nearest land. The proposed site is 1.1 nmi (2.0 km) long and 1.4 nmi (2.6 km) wide.

The four remaining proposed sites (Nawiliwili, Port Allen, Kahului, and Hilo) are located over the shelf-slope break (Figure 2-6). These sites are circular, having radii of approximately 920 m.

The proposed Nawiliwili Site has center coordinates of latitude 21°55'00"N and longitude 159°17'00"W. Water depths range from 840 to 1,120 m. The shelf slopes to the southeast, with the slope increasing near the deepest portion of the site. Bottom photographs show a rolling topography strewn with rocks and boulders. The proposed site is approximately 4.0 nmi (7.4 km) from the nearest land.

The proposed Port Allen Site has center coordinates of latitude 21°50'00"N and longitude 159°35'00"W. Water depths range from 1,460 to 1,610 m, with the shelf sloping towards the southwest. Bottom photographs show a flat, sandy bottom with rocks, boulders, and cobbles. The nearest land is approximately 3.8 nmi (7 km) from the site.

The proposed Kahului Site has center coordinates of latitude 21°04'42"N and longitude 156°29'00"W. The depths within the proposed site range from 345 to 365 m, and the bottom slopes gently to the north-northeast. Bottom topography is smooth, undulating, and primarily composed of silty clay. The nearest land is approximately 5.6 nmi (10.4 km) from the site.

The proposed Hilo Site has center coordinates of latitude 19°48'30"N and longitude 154°58'30"W. Depths at the proposed site range from 330 to 340 m. The bottom is generally flat in the western portion of the proposed site with a gradual slope towards the south. The topography of the eastern half is irregular and the slope is steeper than that of the western portion. The bottom is covered with granular material, occasional large rocks and pebbles. The nearest land is approximately 4.5 nmi (8.3 km) from the site.

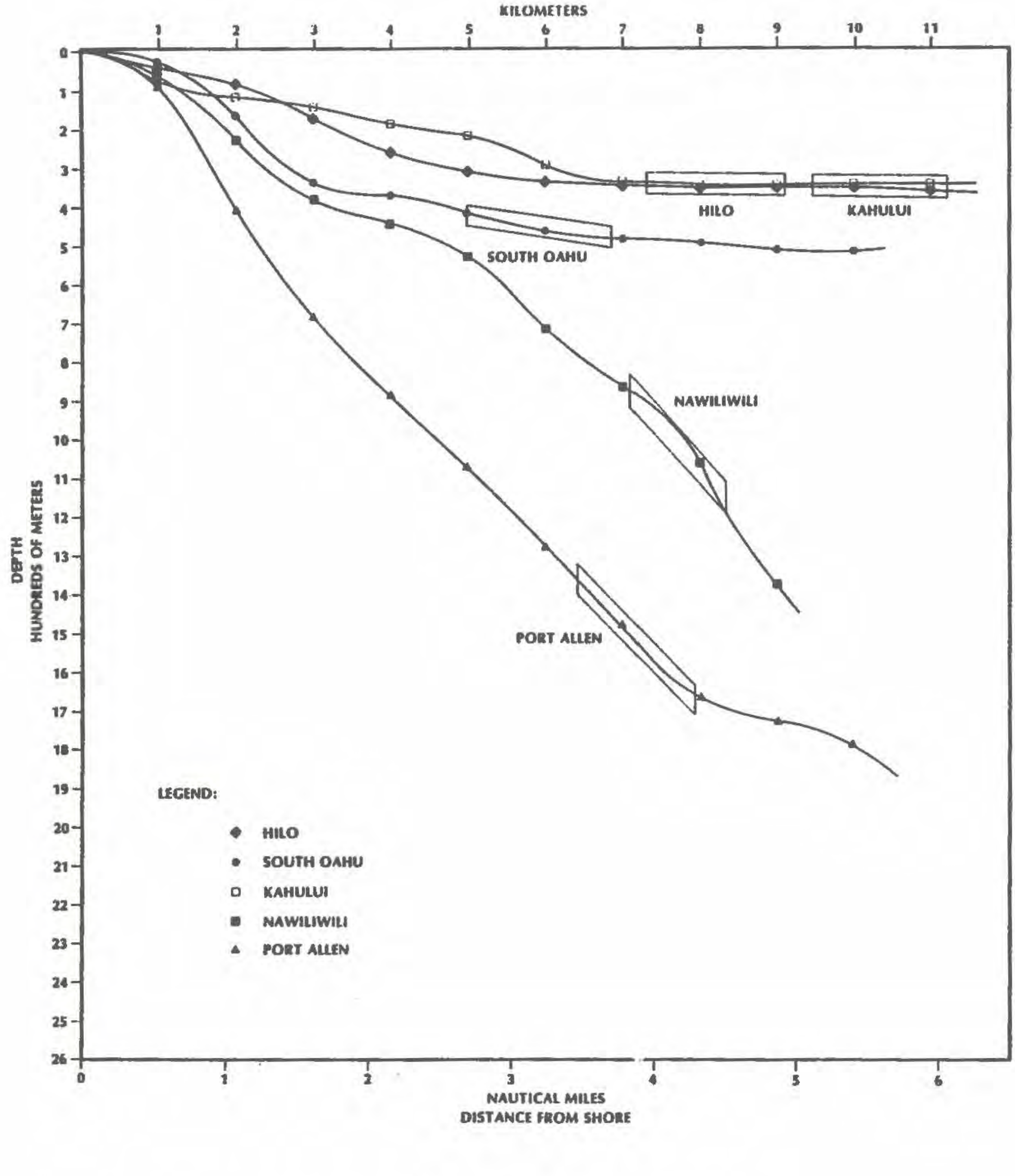


Figure 2-6. Depth Profiles of the Proposed Sites
(vertical scale = 5x horizontal scale)

"LOCATION IN RELATION TO BREEDING, SPAWNING, NURSERY, FEEDING, OR PASSAGE AREAS OF LIVING RESOURCES IN ADULT OR JUVENILE PHASES"

All of the listed activities occur to some degree within the oceanic regions of the proposed sites. However, no stage in the life histories of any of the region's commercially valuable organisms is known to be dependent on the proposed sites or their respective vicinities. Little is known about summer fish migration or spawning, but available information does not suggest these are important at the sites. However, disposal operations will be scheduled, when possible, to avoid periods when the disposal sites are visited by humpback whales or migrating and spawning fish until additional pertinent data are available.

"LOCATION IN RELATION TO BEACHES AND OTHER AMENITY AREAS"

The center of the proposed sites range from 3.3 to 5.6 nmi (6.1 to 10.4 km) in distance from the nearest land and nearest recreational areas. These distances ensure that the dredged material will either be swept farther from the coast by offshore currents, or will be diluted and dispersed by the longshore currents, which will eventually transport the material to offshore areas. The surface turbidity plume will not be visible from shore. Therefore, the use of the proposed sites will not adversely affect recreation, coastal development, or any other amenities associated with the shoreline.

"TYPES AND QUANTITIES OF WASTES PROPOSED TO BE DISPOSED OF, AND PROPOSED METHODS OF RELEASE, INCLUDING METHODS OF PACKING THE WASTE, IF ANY"

Dredged material to be disposed of at the proposed sites must comply with EPA Environmental Impact Criteria outlined in Part 227 Subparts B, C, D, and E of the Ocean Dumping Regulations. In all cases, in accordance with Subpart C, the need for ocean disposal must be demonstrated. Upon designation of the proposed sites, the types and quantities of wastes currently disposed of will be permitted.

All dredged material now projected for disposal following site designation will be dredged from six Hawaiian harbors. In addition, the State of Hawaii or counties in Hawaii may also consider the disposal of similar types of dredged material from other coastal areas at the designated sites. Hopper dredge vessels with capacities of at least 2,680 yd^3, and having subsurface release mechanisms will be used to transport and dispose of the dredged material. The dredged material will not be packaged in any way.

"FEASIBILITY OF SURVEILLANCE AND MONITORING"

Although the proposed sites are close to shore, they are located in deep water where open ocean conditions prevail. Strong winds and high waves are common factors, and all sites except the proposed South Oahu Site would be difficult to monitor because of the distance between research centers on Oahu and the outer islands. As a consequence, monitoring costs have been and will be high.

"DISPERSAL, HORIZONTAL TRANSPORT AND VERTICAL MIXING CHARACTERISTICS OF THE AREA, INCLUDING PREVAILING CURRENT DIRECTION AND VELOCITY"

The dredged material is dispersed rapidly at all proposed sites. The surface plume has a width of approximately 100 m which persists for less than an hour (Smith, 1979). The heavier components of the dredged material sink to the ocean bottom immediately (within 4 minutes), while the finer material is carried away from the site before settling on the bottom (Chave and Miller, 1977b).

The currents at the proposed sites generally flow alongshore or offshore. Current velocities range from 5 to 100 cm/sec at the surface, 5 to 40 cm/sec at mid-depth, and 8 to 50 cm/sec at maximal depth. The physical oceanographic characteristics of the proposed sites are described in Chapter 3 and in Appendix A. The physical action of site environments on the materials dumped is described in Appendix C.

"EXISTENCE AND EFFECTS OF CURRENT AND PREVIOUS DISCHARGES AND DUMPING IN THE AREA (INCLUDING CUMULATIVE EFFECTS)"

Sites previously utilized for deep-ocean disposal of dredged material were investigated in studies sponsored by the CE and the Department of Navy. In addition, post-disposal surveys were conducted at the proposed sites. Significant adverse in situ effects of present or previous dredged material disposal activities have not been demonstrated at any of the proposed sites, nor at any other sites utilized for disposal.

"INTERFERENCE WITH SHIPPING, FISHING, RECREATION, MINERAL EXTRACTION, DESALINATION, FISH AND SHELLFISH CULTURE, AREAS OF SPECIAL SCIENTIFIC IMPORTANCE, AND OTHER LEGITIMATE USES OF THE OCEAN"

The use of the proposed sites does not interfere with the listed activities. Interference with shipping is negligible since, at most, disposal occurs about 10 times a day for a maximum of 90 days every 5 or 10 years (or as required at Pearl Harbor), and each disposal operation is accomplished in approximately 3 minutes. Interference with fishing and fish culture is insignificant since fishing near the proposed sites is minimal and presently limited to surface trolling, bottom fishing for deepwater snappers, and midwater fishing for akule and large tunas. The cyclic schedules of the disposal operations result in a maximal marine blockage at the proposed sites of approximately 45 hours every 5 or 10 years. The disposal operations do not interfere with recreational activities, since the proposed sites are only briefly occupied by the dredge vessel, and the disposal plume is short-lived (less than 1 hour). Mineral extraction and desalination do not currently occur at or near the proposed sites; the effect of dumping on future activities of this nature is not known.

"THE EXISTING WATER QUALITY AND ECOLOGY OF THE SITE AS DETERMINED BY AVAILABLE DATA OR BY TREND ASSESSMENT OR BASELINE SURVEYS"

Environmental studies were conducted before and after the 1977-1978 disposal cycle at all proposed sites. In addition, studies during disposal were conducted at the proposed South Oahu Site. (See Chapters 3 and 4, and Appendices A and C.) The water quality and ecology of the sites do not differ significantly from adjacent areas where disposal has not occurred, and no adverse environmental impacts have occurred as a result of dredged material disposal.

"POTENTIALITY FOR THE DEVELOPMENT OR RECRUITMENT OF NUISANCE SPECIES IN THE DISPOSAL SITE"

Survey work conducted at the proposed sites revealed no development or recruitment of nuisance species. Neither the effects of disposal nor any components in the dredged material would attract such fauna.

"EXISTENCE AT OR IN CLOSE PROXIMITY TO THE SITE OF ANY SIGNIFICANT NATURAL OR CULTURAL FEATURES OF HISTORICAL IMPORTANCE"

No such features exist at or near the proposed sites.

PROPOSED USE OF THE SITES

Any future use of the proposed sites for ocean dumping must comply with EPA Ocean Dumping Regulations and Criteria, requirements which bring prospective dumping into compliance with the Marine Protection, Research, and Sanctuaries Act (MPRSA) and the Ocean Dumping Convention.

RECOMMENDED ENVIRONMENTAL STUDIES

The purpose of monitoring a dredged material disposal site is to ensure that no long-term adverse impacts develop unnoticed, particularly adverse impacts which are irreversible or involve the irretrievable loss of resources. Some of the suggested studies may be necessary to evaluate the suitability of specific materials for dumping at the proposed sites; hence, they need not be duplicated in the monitoring program for ongoing ocean site evaluation. Ideally, effects are assessed by determining the degree to which the environmental conditions at the site vary from the pre-disposal (baseline) conditions after disposal operations. Therefore, an effective monitoring program is usually based on comprehensive pre-disposal baseline surveys of the sites, which have already been performed at all sites by the CE and the Department of Navy. The data collected to date indicate few significant adverse impacts. The suggested elements of further environmental studies are presented in Appendix D.

TYPES OF MATERIAL

Most dredged material is comprised of terrestrial silt and clay mixed with sand. Detailed characteristics of the material dredged in 1974 and 1977-1978 are presented in Appendix B.

The materials previously dumped were in compliance with the interim regulations in effect prior to the EPA/CE bioassay procedures manual (1977), with the possible exceptions of greater amounts of oil and grease found in Pearl Harbor sediments. However, oil sheens were not visible upon release at the disposal site. Trace metal contents in the dredged material were less than 50% greater than those found in sediments at the proposed sites, and no significant concentrations of chlorinated hydrocarbons have been reported. Representative samples should be collected periodically from the hoppers after filling and before disposal, and a complete physical and chemical profile should be performed on these materials. The dredged material must not contain any materials prohibited by MPRSA and must comply with the Ocean Dumping

Regulations and Criteria specifically applicable to dredged material. These studies will be performed during the evaluation to determine if the materials are suitable for dumping and need not be duplicated during routine operations.

To date, no adverse environmental effects of ocean dumping of dredged materials in Hawaii have been demonstrated. To alleviate any adverse effects which may be observed in later monitoring, disposal operations may be altered. However, materials other than the type dredged from Pearl, Honolulu, Nawiliwili, Port Allen, Kahului, or Hilo Harbors may not be acceptable for disposal at the proposed sites.

PERMISSIBLE MATERIAL LOADINGS

Since cumulative effects (either in the form of accretion of dredged material at the proposed sites or changes in the biota) have not been demonstrated at the proposed sites, the assignment of an upper limit beyond which adverse effects would occur is difficult. A total of 2,715,200 yd^3 of dredged material was ocean-dumped in 1977 and 1978 at the proposed sites, of which 87% was dumped at or near the proposed South Oahu Site. Post-disposal surveys did not indicate any significant mounding or adverse ecological impacts. Further, dredged material disposal operations occur approximately every 5 years at Honolulu, Nawiliwili, and Port Allen Harbors, and approximately every 10 years at Hilo and Kahului Harbors. Pearl Harbor is dredged whenever necessary. The projected volumes and cycles are presented in Table 2-1. The continued dumping at the proposed sites of the projected quantities will have insignificant adverse impacts.

DREDGING AND DISPOSAL OPERATIONS

The periodic dredging of sediment from harbor channels and basins previously involved the use of federally owned and operated hydraulic suction hopper dredges. The maintenance dredging of the harbors was last performed in 1977-1978 by the self-propelled hopper dredge vessel CHESTER HARDING.

TABLE 2-1
PROJECTED VOLUMES AND DREDGING SCHEDULES

Proposed Disposal Site	Dredging Location	Maintenance Cycle (years)	Last Dredged	Next Scheduled Dredging	Projected Volume (1,000 yd^3)
South Oahu	Honolulu	5	1977	1986	600
	Pearl Harbor	Whenever required	1978	1986	2,000
Nawiliwili	Nawiliwili	5	1977	1986	80
Port Allen	Port Allen	5	1977	1986	200
Kahului	Kahului	10	1977	1986	40
Hilo	Hilo	10	1977	1986	100

Sources: Neighbor Island Consultants, 1977; Chave and Miller, 1978.

Previous maintenance dredging was performed by the dredge vessels DAVISON and BIDDLE. Whether federally owned hopper dredges will again be used to dredge Hawaiian harbors depends on the result of competitive bids between Federal and private industry dredges.

The CHESTER HARDING measures 94 m in length, 17 m in beam, 6 m in loaded draft, and has eight hopper bins. The total capacity of the eight bins is 2,680 yd^3. Powerful hydraulic suction pumps on the vessel pull the water-sediment slurry from the harbor bottom into the hopper bins. After the bins are fully loaded, the two suction pipes are raised and the dredge vessel proceeds to the disposal site. The transit time from Honolulu Harbor to the proposed South Oahu Site is 25 to 30 minutes (Tetra Tech, 1977).

At the disposal site, the vessel slows to less than 2 knots and disposal operations commence. Water is pumped into the bins to produce a flushing head, hastening disposal. Pumps near the hoppers churn the contents of the bins to ensure complete flushing of the dredged material (Smith, 1979). Normally, the four aft and four forward bin doors are opened as two separate units (Johnson and Holliday, 1977). The release of the dredged material is usually accomplished in about 3 minutes (Neighbor Island Consultants, 1977).

Dredging operations continue 24 hours a day, with a 2-day break every 14 days for fueling and maintenance, until all scheduled areas of a harbor have been dredged (Chave and Miller, 1977b). Disposal methods practiced by the CE at the proposed sites are acceptable for future dumping activities.

DISPOSAL SCHEDULES

Dredged material disposal scheduling is entirely dependent upon the availability of a hopper dredge, which must be shared with other dredging projects on the Pacific Coast.

Efforts will be made (during advanced planning) to schedule disposal to avoid periods when the disposal sites are used by humpback whales (November to May) or by migrating and spawning fish (summer season); present-day information on these subjects is sparse and requires more investigation.

Chapter 3

AFFECTED ENVIRONMENT

In describing the affected environment, data are presented pertinent to (1) the oceanographic characteristics, (2) the aesthetic, recreational, and economic characteristics, and (3) inputs to the sites other than dredged material. More detailed site-specific information is included in Appendix A.

OCEANOGRAPHIC CHARACTERISTICS OF THE PROPOSED SITES

The five dredged material disposal sites proposed for designation are offshore of Honolulu (Oahu), Nawiliwili (Kauai), Port Allen (Kauai), Hilo (Hawaii), and Kahului (Maui).

Data have been compiled from numerous sources for the proposed sites. Collectively, these data have been reviewed to characterize a range of conditions indicative of a general oceanic site. Several oceanographic surveys were performed before and after the 1977-1978 dredging cycle near the proposed South Oahu Site, and at least one survey was conducted before and after disposal operations at each of the other sites. The Pacific Ocean Division (POD) of the CE funded studies at the proposed South Oahu Site (former Honolulu Site) before, during, and after disposal operations in 1977-1978. The Department of the Navy simultaneously funded similar studies at the proposed South Oahu Site (former Pearl Harbor Site). The study sites were near each other, overlapping the proposed South Oahu Site. The CE performed environmental studies before and after disposal operations at Nawiliwili, Port Allen, Kahului, and Hilo. At least two alternative sites for each harbor were evaluated as candidate sites before disposal, and active sites were surveyed after disposal in 1977.

The following discussion is supplemented with site-specific information where pertinent.

GEOLOGICAL CONDITIONS

The Hawaiian Islands were formed by gradual build-up of materials from volcanic activity. Basaltic flows and ejecta formed mountains which rise 9,100 m above the seafloor and 4,500 m above sea level, but erosion and subsidence have interacted to destroy and/or wear down the islands. Coral reefs surround the islands and grow upward as the islands submerge. Weathering by wind and rain contributes to the decay of the islands and causes much of the eroded material to be deposited in the inshore regions. Carbonate sands are formed by abrasion of adjacent coral reefs and accumulation of tests (shells) of neritic foraminifera as well as tests of pelagic foraminifera washed from the offshore waters.

Most geological studies performed in the marine environment surrounding the islands concentrated on the littoral zone, to depths of 150 m, and the deep ocean, at depths of about 2,000 m. Little work has been done between these two depths; most of the information used in this section is derived from studies performed to support the dredged material disposal site selection and monitoring surveys.

BATHYMETRY

Sonic depth recorders were used to obtain detailed bathymetric maps for each of five selected and five alternative sites during CE studies conducted before 1977 disposal operations (Neighbor Island Consultants, 1977). The proposed sites are offshore at depths greater than 330 m, over bottom areas which slope seaward. Bottom photography shows a typically flat or gently sloping, sandy or silty bottom strewn with rocks, cobbles, boulders, rock pavements, and occasional outcrops. Ripple marks, indicating moderate current activity, have been observed. The water depth ranges, sediment characteristics, and approximate distances offshore of proposed sites are presented in Table 3-1.

TABLE 3-1
PROPOSED SITE DEPTHS, OFFSHORE DISTANCES, AND SEDIMENT CHARACTERISTICS

Site/Island	Water Depth Range (m)	Distance From Shore (Site Center)	Sediment Characteristic
South Oahu/ Oahu	400 - 475	3.2 nmi (5.9 km)	Silty Sand
Nawiliwili/ Kauai	840 - 1,120	3.4 nmi (6.3 km)	Silty Sand
Port Allen/ Kauai	1,460 - 1,610	3.8 nmi (7.0 km)	Silty Sand
Kahului/ Maui	345 - 365	6.4 nmi (11.8 km)	Silty Sand
Hilo/ Hawaii	330 - 340	5.0 nmi (9.3 km)	Silty Sand

Sources: Neighbor Island Consultants, 1977; Chave and Miller, 1977a

Sediment analyses were performed by Neighbor Island Consultants (1977) before disposal of dredged material. A more recent study was performed by Goeggel (1978) after the disposal of dredged material; these data are therefore more representative of present site characteristics. Goeggel used cores, grabs, and dredges to collect sediment samples.

Offshore sediments are of two general types: carbonate and basaltic (Table 3-2). With the exception of the proposed Nawiliwili and Hilo Sites, carbonate is the dominant sediment constituent. Neighbor Island Consultants (1977) reported carbonate values of 74% and basalt values of 12% at the proposed Nawiliwili Site before dredged material disposal at this site, while Goeggel (1978) reported values of 29% and 46%, respectively. Goeggel (1978) suggested that this shift in sediment composition was due to introduction of dredged materials. Nawiliwili is the only proposed site where such a significant change (pre-disposal versus post-disposal surveys) in sediment composition has occurred.

TABLE 3-2
MEAN PERCENTAGES OF CARBONATE AND BASALT COMPOSITION AT THE PROPOSED SITES

Site	Carbonate (%)	Basalt (%)
South Oahu	89	6
Nawiliwili	30	46
Port Allen	43	6
Kahului	56	12
Hilo	17	42

Sources: Goeggel, 1978; Chave and Miller, 1977a; Neighbor Island Consultants, 1977.

GRAIN SIZE

Site sediments are principally sands with various amounts of silt, clay, and gravel. Grain-size distributions for each of the proposed sites are listed in Table 3-3.

TABLE 3-3
SEDIMENT MEDIAN DIAMETERS AT THE PROPOSED SITES

Sediment Type	Grain Size (%)				
	South Oahu*†	Nawiliwili*	Port Allen*	Kahului*	Hilo*
Gravel	12	6	1	11	1
Sand	75	92	63	80	77
Silt & Clay	13	2	36	9	22

Sources: *Neighbor Island Consultants, 1977; Goeggel, 1978 (pre-disposal and post-disposal)
†Chave and Miller, 1978 (post-disposal)

The proposed South Oahu, Port Allen, and Kahului Sites have sediments with similar characteristics before and after disposal (Goeggel, 1978). However, Nawiliwili post-disposal samples were much finer in comparison to pre-disposal samples; post-disposal sediments from Hilo show variable results. The analyses of the dredged material disposed of at Hilo showed that the dumped material had characteristically finer grain size than the pre-disposal sediment. No other observed evidence (e.g., discoloration, layering, microscopic analyses) indicated that dredged material had been deposited in the area.

PHYSICAL CONDITIONS

METEOROLOGY

Visibility

Visibility is usually excellent near the Hawaiian Islands. Decreased visibility is normally due to rain or mist, but rarely due to fog. Interference with shipping due to foul weather is rare (U.S. Dept. of Commerce, 1978). Visibility exceeding 10 nmi (18.5 km) occurs nearly 90% of the time. Visibility of less than 0.5 nmi (0.9 km) occurs most often during January, March, October, and November for the windward (northeast) side, and February and December for the leeward (southwest) side of the islands. The frequency of this decreased visibility is only 0.1%, or less than 1 hour per month, and annual frequency of visibility below 0.5 nmi (0.9 km) is less than 0.05%, or less than 4.5 hours a year (U.S. Navy Weather Service Command, 1971).

Winds and Storms

In general, higher wind velocities are more common on the windward (northeast) side, while periods of light winds occur more frequently on the leeward (southwest) side of the islands. High winds of less than hurricane classification usually occur during the late fall and winter months. On an annual basis, winds are generally easterly to windward (northeast), and evenly divided between northeasterly and easterly to leeward (southwest) of the islands. Southerly winds, especially southwesterly, called "Kona winds," increase in frequency from August to October until April or May (U.S. Navy Weather Service Command, 1971).

Hurricanes have been recorded for Hawaii since 1950. Between 1950 and 1974, 13 hurricanes passed within 430 nmi (800 km) of the State. A partial list of those hurricanes which influenced the State are listed in Table 3-4. August is the most likely month of occurrence; however, tropical storms have occurred in July, September, and December. The majority of the storms approached the islands from the east (Haraguchi, 1975).

TABLE 3-4
PARTIAL LIST OF HURRICANES

Hurricane	Month/Year	Effect
Hiki	Aug 1950	Sustained winds of 109 kph Heavy rains, flooding
Della	Sep 1957	High surf
Nina	Dec 1957	11-m surf Peak winds of 148 kph $100,000 damage
Unnamed	Aug 1958	$500,000 damage
Dot	Aug 1959	Wind gusts of 166 kph, heavy rain $5.7 million damage to crops and buildings
Diana	Aug 1972	9-m waves
Doreen	Jul-Aug 1973	High surf

Source: Haraguchi, 1975

PHYSICAL CHARACTERISTICS

Water Masses

There are three major water masse^ around the Hawaiian Islands: North Pacific Central (NPC), North Pacific Intermediate (NPI), and Pacific Deep Water (PDW) (Bathen, 1975; Sverdrup et al., 1942). The approximate depths, locations, and characteristic temperature and salinity ranges for each water mass are listed in Table 3-5.

TABLE 3-5
MAJOR WATER MASSES OF THE NORTH PACIFIC

Water Mass	Depth (m)	Temperature (°C)	Salinities (g/kg)
NPC	100-300	10 - 18	34.2 - 35.2
NPI	300-1,500	5 - 10	34.2 - 34.5
PDW	1,500-bottom	1.1 - 2.2	34.6 - 34.7

NPC= North Pacific Central
NPI= North Pacific Intermediate
PDW= Pacific Deep Water

Source: Bathen, 1975; Sverdrup et al., 1942

The NPC Water Mass has maximal salinity, while minimal salinity values are found at about 350 m depth in the NPI Water Mass.

Stratification

A strong thermocline extends to depths between 275 and 365 m in the offshore region (Neighbor Island Consultants, 1977). Below 300 m, the strength of the stratification decreases significantly. The weakest stratification occurs in February, while the strongest stratification develops in July and persists with little change until October (City and County of Honolulu, 1972).

Density profiles near the proposed South Oahu Site show the water to be usually stable above 25 m during most of the year, and always stable below 25 m (City and County of Honolulu, 1972).

Currents

Water circulation around the islands is driven by combinations of forces including tides, West Wind Drift, circulation of the Eastern Pacific Gyre, and local wind and eddy systems. Observed circulation, however, does not always correspond to predictive models. While currents appear to be tidally dominated at most locations around the islands, current reversals frequently do not correlate with tidal changes (Neighbor Island Consultants, 1977). The westerly drift through the islands (normally expected as a result of the Trade Winds) is observed at only a few locations. In some cases, mean flow in the inter-island channels opposes this westerly flow. The clockwise (anticyclonic) Eastern Pacific Gyre shifts north and south; however, the seasonal pattern is unclear and its influence on the islands is not well defined. Eddies have been observed on the leeward side of the islands, but these are poorly understood transient features of Hawaiian Islands circulation.

Current patterns at the proposed sites show a marked tidal influence, but some general trends are apparent. Surface currents range from 5 to 100 cm/sec, mid-depth currents range from 5 to 40 cm/sec, and bottom currents range from 8 to 50 cm/sec (Neighbor Island Consultants, 1977; Chave and Miller, 1977b; Bathen, 1974). Currents at all depths show a general offshore or alongshore flow.

CHEMICAL CONDITIONS

WATER COLUMN

Studies of the water chemistry of the proposed South Oahu Site show that the region is more oceanic than coastal in character (R.M. Towill Corp., 1972; Tetra Tech, 1977; Chave and Miller, 1977a). The other proposed sites are also regarded as oceanic in nature, since they are far enough offshore and not greatly influenced by the local land masses.

Dissolved Oxygen

The saturation level (solubility) of dissolved oxygen in seawater depends upon the temperature and salinity. At 25°C and 35 g/kg salinity, seawater is saturated with an oxygen concentration of 4.87 ml/liter. From September 1976 to April 1977, dissolved oxygen concentrations in the surface waters at the proposed South Oahu Site were supersaturated, increased slightly between depths of 25 and 100 m, then gradually decreased with depth. Most dissolved oxygen values at the proposed sites remain above 4 ml/liter (Chave and Miller, 1977a,b). Characteristic oxygen profiles for the Pacific Ocean show surface oxygen concentrations ranging from approximately 5 ml/liter to a minimum of less than 1 ml/liter between depths of 150 and 400 m, then increasing to approximately 3 ml/liter near the bottom (Sverdrup et al., 1942).

pH

During December 1976, the pH of surface waters at the proposed South Oahu Site averaged 8.1, increased to 8.2 between 25 and 50 m depth, then decreased to a minimum of 7.9 at 400 m depth. During April 1977, pH values were markedly lower, averaging 7.6 at the surface, increasing to 7.7 between 100 and 150 m depth, and finally decreasing to 7.6 at 400 m depth (Chave and Miller 1977a,b). In general, seawater pH ranges from 7.5 to 8.4, averaging about 8.2 (Horne, 1969).

Trace Metals

The total water column concentrations of silver, cadmium, chromium, and copper at the proposed South Oahu Site are below the minimum detection limit of 1 μg/liter. Lead and nickel are below the minimum detection limits of 5 μg/liter and 4 μg/liter, respectively. Analyses for mercury and zinc yielded abnormally high values believed to be caused by sample contamination (Chave and Miller, 1977a).

Nutrients

Nutrients are inorganic or organic compounds or ions, the main diet of primary producers, i.e., phytoplankton. Nutrients include inorganic phosphate, nitrate, nitrite, ammonium, and hydrated silicate, and are consumed by plankton in upper oceanic layers where light conditions favor photosynthesis and growth.

At the proposed South Oahu Site, nutrient concentration measurements of phosphate, total phosphorus, and nitrate-nitrite concentrations, are low in the surface layers, increasing with depth, with the greatest increases occurring below 150 m. These measurements are typical of oceanic waters. Ammonium concentrations vary, generally decreasing with depth (Chave and Miller, 1977a).

At leeward stations, nitrate was undetectable in surface waters, increasing with depth, and reaching a maximum of 40 μg-at N/liter at 800 m depth (Gundersen et al., 1972). Maximal nitrite concentrations of 0.06 to 0.07 μg-at N/liter are consistently found between 100 and 200 m depth, diminishing to undetectable levels with depth. Ammonium concentrations were usually greater in the upper water column. Typical nitrate profiles in the Pacific exhibit surface concentrations about 2 μg-at N/liter, increasing to approximately 38 μg-at N/liter at 1,000 m depth, remaining uniform with increasing depth (Gross, 1972).

SEDIMENTS

Trace Metals

Comparative Analyses of Variance (ANOVA) of pre-disposal trace metal concentrations in sediments of the proposed sites indicated no significant differences (95% confidence level) among the sites (see Appendix C). Cadmium concentrations in sediments ranged from 3.9 to 6.3 mg/kg, with a mean of 4.8 mg/kg. The highest cadmium concentrations occurred at the proposed South Oahu and Kahului Sites, while the lowest concentrations occurred at the proposed Hilo Site (Neighbor Island Consultants, 1977; Goeggel, 1978; Chave and Miller, 1978). Mercury concentrations in sediments ranged from 0.09 to 0.9 mg/kg, with a mean of 0.33 mg/kg. The highest mercury values were found at the proposed South Oahu Site, while the lowest concentrations occurred at the proposed Kahului Site (Neighbor Island Consultants, 1977; Goeggel, 1978). Copper concentrations in sediments ranged from 10.9 mg/kg at the proposed Kahului Site, to 45.5 mg/kg at the proposed South Oahu Site, averaging 31.1 mg/kg (Neighbor Island Consultants, 1977; Goeggel, 1978; Chave and Miller, 1978). Concentrations of lead in sediments ranged from 16.9 to 59 mg/kg, with a mean of 34.2 mg/kg. The highest lead concentrations were found at the proposed South Oahu Site, while the lowest lead concentrations occurred at the proposed Nawiliwili, Port Allen, and Hilo Sites (Neighbor Island Consultants, 1977; Goeggel, 1978; Chave and Miller, 1978). Table 3-6 lists concentration values. Youngberg (1973) noted that the cultivated soils on the island of Oahu were higher in concentrations of cadmium, chromium, copper, lead, manganese, nickel, and zinc than uncultivated soils, suggesting the influence of anthropogenic activities (e.g., domestic sewage disposal, irrigation, and construction materials which contain these metals).

TABLE 3-6
SEDIMENT TRACE METAL CONCENTRATIONS AT THE PROPOSED SITES

Proposed Site	Trace Metal							
	Cadmium		Mercury		Copper		Lead	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
South Oahu	4.0-6.3	5.2	0.50-0.90	0.7	17.6-45.5	31.0	38.1-59.0	48.6
Nawiliwili	3.9-4.8	4.4	0.27-0.50	0.39	13.8-28.7	21.2	16.9-32.2	24.6
Port Allen	4.9-5.0	5.0	0.27-0.50	0.39	13.8-28.7	21.1	16.9-32.2	24.6
Kahului	5.7-6.1	5.9	0.09-0.20	0.15	10.9-38.3	24.6	23.6-40.9	32.3
Hilo	---	3.4	0.10-0.59	0.35	33.9-38.1	36.0	19.5-29.0	24.3
Grand Mean	---	4.8	---	0.4	---	26.8	---	30.9

Units = ppm or mg/kg dry weight

Sources: Neighbor Island Consultants, 1977; Goeggel, 1978; Chave and Miller, 1978

BIOTA

Trace Metals

Trace metal concentrations in shrimp muscle tissues (Heterocarpus ensifer), collected by Chave and Miller (1977b) in Mamala Bay, are listed in Table 3-7. Copper and zinc were the only metals detected.

TABLE 3-7
TRACE METAL CONCENTRATIONS IN SHRIMP (Heterocarpus ensifer)
COLLECTED AT THE PROPOSED SOUTH OAHU SITE

Station	Date	Ag	Cd	Cr	Cu	Ni	Pb	Zn
S1 (dump site)	7/15/77	ND	ND	ND	12	ND	ND	12
S2 (control)	7/15/77	ND	ND	ND	19	ND	ND	12
S7 (dump site)	12/77	ND	ND	ND	8	ND	ND	7
S8 (control)	12/77	ND	ND	ND	8	ND	ND	8

Units = mg/kg wet weight

ND = not detectable

Source: Chave and Miller, 1977b

Results of trace metal analyses of preserved zooplankton samples are presented in Table 3-8 (Chave and Miller, 1978). Samples were either whole or split, with the exception of one select sample which consisted entirely of chaetognaths.

TABLE 3-8
TRACE METAL CONCENTRATIONS IN ZOOPLANKTON COLLECTED AT THE PROPOSED SOUTH OAHU SITE

Date	Tow No.	Whole/Split	Ag	Cd	Cr	Cu	Ni	Pb	Zn
7/21/76	1	(15/16 aliquot)	ND	ND	ND	19	ND	13	39
6/15/77	12	Chaetognaths	ND	ND	ND	2	ND	ND	13
6/15/77	13	(15/16 aliquot)	ND	ND	ND	1	ND	3	20
9/13/77	5	Whole	ND	ND	34	6	ND	157	118
12/8/77	10	Whole	ND	ND	3	89	ND	35	70

Units = ppm or mg/kg wet weight
ND = not detectable

Source: Chave and Miller, 1978

BIOLOGICAL CONDITIONS

Biota in the water and in benthic environments of the dredged material disposal sites are described below. Water column biota include phytoplankton, zooplankton, and nekton. Benthic biota include the foraminifera, polychaetes, mollusks, crustacea, and other invertebrates.

WATER COLUMN

Phytoplankton

Phytoplankton are small, free-floating algae which produce the organic matter upon which the rest of the marine food chain is built. Chlorophyll *a* concentrations are customarily used to indicate phytoplankton biomass. In February 1977, at the proposed South Oahu Site, chlorophyll *a* concentrations increased from 0.025 mg/m^3 at 15 m depth to 0.050 mg/m^3 at 30 m depth, then decreased with depth (Tetra Tech, 1977). In April 1977, the chlorophyll *a* concentrations in the upper water column were lower than the February values, and increased to maximal level at 150 m depth. Chlorophyll *a* concentrations in the lower water column (300 to 450 m depth) were similar for both samplings. Considerable temporal variability occurs in the upper portions of open-ocean Hawaiian waters (Cattel and Gordon, 1971). Since the compensation depth was approximately 112 m, the chlorophyll _a_ concentrations at 300 m and 450 m depths are probably degraded products of chlorophyll, and are not living biomass.

At other locations in the Hawaiian Islands, chlorophyll _a_ concentrations increase with depth (0.07 to 0.30 mg/m^3) to reach subsurface maxima at the compensation depths (Bathen, 1977; Gilmartin and Revelante, 1974). Chlorophyll _a_ concentration at compensation depth is usually double that of the overlying waters.

Primary productivity investigations in Hawaiian waters show that carbon fixation potential reached maximum at 1100 and 1400 hours, with a noontime depression. The minimum was between 2100 and 0300 hours, with a maximum-minimum ratio of 8.4:1 (Gilmartin and Revelante, 1974).

Zooplankton

Zooplankton are minute, weakly swimming animals, normally considered as the second trophic level of the oceanic food chain. The zooplankton found at the proposed South Oahu Site by Chave and Miller (1977a) were dominated by copepods (numerically, about 80% of the local zooplankton). Chave and Miller also reported that the zooplankton biomass of 3.3 mg dry weight/m^3 is slightly higher than the zooplankton biomass of 2.2 mg/m^3 reported by King and Hida (1954), as adapted from Wiebe et al. (1975). The conditions in other proposed sites approximate the proposed South Oahu Site values.

Nekton

Nekton (e.g., fish, cephalopods, and marine mammals) can swim strongly, either maintaining their position or moving against currents. Nekton are subdivided into three groups: micronekton, demersal nekton, and pelagic nekton. Micronekton are weakly swimming nekton (e.g., mesopelagic fish and squid). Demersal nekton are extremely motile members of the nekton which live on the bottom, and pelagic nekton inhabit the overlying waters. Many nektonic organisms are highly motile, migrate over long distances, and have unknown depth ranges; therefore, information on such organisms is limited and qualitative. Typical habitats and associated fish fauna for the Hawaiian open coast are depicted in Figure 3-1.

The proposed South Oahu Site has approximately half the micronekton biomass predicted by offshore studies. Fish exist in smaller proportions of total samples due to differences in water depths between offshore sample sites and the proposed site. Micronekton remain below 200 m depths during the day, thus they would be expected to be sparse at the proposed South Oahu, Kahului, and Hilo Sites. Micronekton populations at the deeper proposed sites (Nawiliwili and Port Allen) are similar to the offshore region inventories.

Trawling studies at the proposed Nawiliwili, South Oahu, Kahului, and Hilo Sites revealed the demersal fish, greeneye, to be the most abundant species (Neighbor Island Consultants, 1977). The studies confirmed that the general ichthyological communities at various depth ranges of the Hawaiian upper slope zone inhabit the proposed sites equally (Struhsaker, 1973). Rattails and flatfishes are abundant at all sites.

Pelagic nektonic predators include marine mammals, tuna, marlin, barracuda, and sharks. The majority of the fish are broadcast spawners, whose eggs are usually small and planktonic. The common Hawaiian nearshore and offshore marine mammals are listed in Table 3-9.

BENTHOS

Sediment type and water depth vary among the sites and are important factors in the analyses of benthic faunal compositions. The proposed Nawiliwili and Port Allen Sites are in deep water (840 to 1,610 m), while the other proposed sites are shallower (330 to 475 m). The proposed sites at Nawiliwili, Port Allen, and Kahului have similar sediments of silty sand.

Benthic fauna at the proposed sites (Table 3-10) are dominated in abundance and diversity by small infaunal and tube-dwelling polychaetes. Several other groups are present in much fewer numbers, or are locally abundant (e.g., Nematoda, Sipuncula, Crustacea, Mollusca, and Echinodermata).

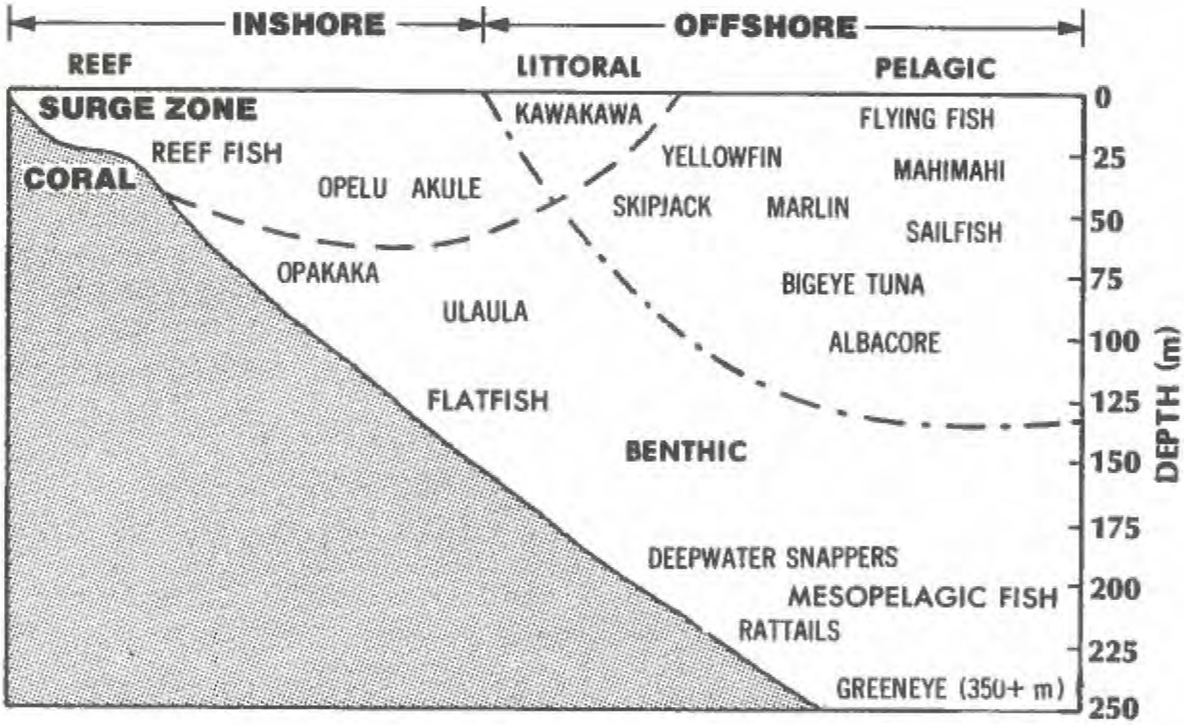


Figure 3-1. Typical Hawaiian Marine Open Coast Habitats and Associated Fish Fauna
Source: After Gosline and Brock, 1965

TABLE 3-9
COMMON HAWAIIAN MARINE MAMMALS

Scientific Name	Common Name
WHALES	
Globicephala macrorhynchus	Pilot Whale
Pseudorca crassidens	False Killer Whale
Feresa attenuata	Pygmy Killer Whale
Physeter catodon	Sperm Whale
Megaptera novaeangliae	Humpback Whale
DOLPHINS	
Steno bredanensis	Rough-toothed Dolphin
Stenella attenuata	Spotted Dolphin
S. longirostris	Spinner Dolphin
Tursiops gillii	Pacific Bottlenose Dolphin
Peponocephala electra	Hawaiian Dolphin

Source: Tetra Tech, 1976

TABLE 3-10
BENTHIC ORGANISMS COLLECTED AT THE PROPOSED SITES

Parameter	South Oahu	Nawiliwili	Port Allen	Kahului	Hilo
Percent Composition Epifauna	56*	87.5*	55*	89*	61*
Percent Composition Infauna	44*	12.5*	45*	11*	39*
No. Micromollusks/cm^3	11.3-13.0†	12.9-15.2†	1-31†		2.8-3.6†
No. Foraminifera/ml	262** 574† 3,116*	849† 909*	295† 992*	1,161† 1,971*	436† 818*
Ratio: Planktonic/ Benthic Foraminifera	0.8† 1.8*	5.1† 3.7*	4.2† 3.2*	1.3† 1.8*	3.2† 3.3*
No. Polychaetes/liter	19.9† 17.6*	20.4† 21.8*	17.0† 31.0*	47.7† 17.5*	7.2*
No. Cnidaria/liter	1.4*	3.6*	0.5*	1.0*	0.7*
No. Nematoda/liter	0.4*	< 0.1*	<0.1*	<0.1*	<0.1*
No. Sipuncula/liter	0.8* 0.7†	0.4* 1.4†	0.1* 0.3†	0.3* 1.7†	<0.1*
No. Cirripedia/liter	< 0.1*	<0.1*	<0.1*	<0.1*	<0.1*
No. Other Crustacea/liter	0.6* 0.4†	0.3*	0.1* 0.3†	0.2* 1.0†	0.1*
No. Aplacophora/liter	0.2*	< 0.1*	0.2* <0.1†	<0.1* 1.3†	<0.1*
No. Echinoidea/liter	< 0.1*	<0.1*	<0.1*	<0.1*	0.1*
No. Holothuroidea/liter	0.1*	0.1*	<0.1*	0.2*	0.2*
No. Ophiuroidea/liter	0.3*	0.5*	0.2* < 0.1†	0.1*	0.2*
No. Nemertea/liter	0.1*	0.2*	<0.1*	<0.1*	<0.1*

Sources: * Neighbor Island Consultants, 1977
† Goeggel, 1978
** Chave and Miller, 1977b

Most organisms collected from the sites are detritivores (detritus eaters) which feed on organic particulate materials attached to sand grains or in the water column, larger organic remains (e.g., dead organisms, rotting vegetable material), and feces from marine animals. Some detritivores are nonselective deposit feeders, and others are selective particle feeders. The water depths at all sites are well below the photic zone, thus producers and herbivores are absent. Filter or suspension feeders (e.g., sabellid or serpulid tube worms and some mollusks) sieve organic particles from the water column. Other feeding types include browsers (e.g., micromollusks and carnivores).

Foraminifera

Foraminifera are benthic and planktonic protozoans possessing calcium carbonate shells. Certain forams are common at all sites and are not depth-restricted. The deeper proposed sites (Nawiliwili and Port Allen) exhibit lower species diversities than the other sites. Porcelaneous species are uncommon and agglutinated species are abundant in deeper sites, while at the shallower proposed South Oahu, Kahului, and Hilo Sites the reverse is true.

The proposed Nawiliwili and Port Allen Sites have higher planktonic-to-benthic foraminifera ratios than the South Oahu and Kahului Sites. The numbers of planktonic tests are higher at the Nawiliwili and Port Allen Sites than at other sites, thus reflecting the important role of planktonic foraminifera as a source of sediment. The depths at the proposed Hilo Site are comparable to those at the proposed South Oahu and Kahului Sites, yet the ratios of planktonic-to-benthic foraminifera are higher, therefore more characteristic of deeper locations. This discrepancy appears to be caused by the bottom traits beyond Hilo, which permits a larger portion of planktonic foraminifera to exist closer to shore.

Polychaetes

The benthic fauna at the proposed sites are dominated in abundance and diversity by small infaunal and tube-dwelling polychaetes. The predominant feeding types are deposit feeders, with predacious carnivores the second most numerous. Suspension feeders represent a small percentage of total abundance. The numbers of families and species are few at the proposed Nawiliwili and Port Allen Sites, and more profuse at the other three proposed sites.

Mollusks

Mollusks are of two types: micromollusks and macromollusks. Micromollusks are less than 0.5 mm in greatest dimension, and act as indicators of different types of benthic communities (Kay, 1973). Micromollusks at the proposed sites have two components: shells of mollusks characteristic of depths of 20 to 150 m (shallow-water species), and those known only at depths greater than 150 m. The shallow-water micromollusks at all sites are dominated by representatives of two families. Their occurrence in sediments at the proposed sites is believed to be due to transport from shallower depths or to their occurrence as fossils in subtidal fossil reefs. Macromollusks were rare or absent in the samples taken from the proposed sites.

Crustaceans

Benthic crustaceans found at the proposed sites are dominated by the shrimps of the genus *Heterocarpus*. The mean numbers per trap, weights, and carapace lengths of the shrimp, *H. ensifer*, caught at the sites are given in Table 3-11. The shrimps, *H. ensifer* and *H. laevigatus*, were collected at all sites, and although the former is smaller and less commercially valuable than the latter, it is much more abundant. A survey of the deepwater shrimp resources in Hawaiian waters was conducted by the National Marine Fisheries Service between 1971 and 1973 (Struhsaker and Aasted, 1974). Analyses indicated a depth range for *H. ensifer* from 137 to 660 m, with peak abundances between 365 and 440 m. *H. laevigatus* is found at depths from 430 to 825 m, with maximal abundance between 440 and 655 m.

Other Invertebrates

The abundance of invertebrates other than polychaetes, mollusks, foraminifera, and shrimp in the sediments of the proposed sites is insignificant

TABLE 3-11
PARAMETERS FOR SHRIMP (Heterocarpus ensifer)
CAUGHT AT THE PROPOSED SITES

Parameter	South Oahu	Nawiliwili	Port Allen	Kahului	Hilo
Mean Number Per Trap	52* 283	81	104	141	35
Mean Weight (g)	3.8	8.5	8.3	9.7	8.7
Mean Carapace Length (cm)	1.8	2.7	2.7	2.7	2.6

Sources: Goeggel, 1978
*Chave and Miller, 1977b

(Table 3-10). All Bryozoa are erect foliose forms, a type of growth form that requires a hard, stable surface for attachment. All cnidarians (corals), chitons, and probably some of the bryozoans were dead when collected. These organisms may indicate immigrant materials (e.g., transport of skeletons by currents from shallow water, or residual materials from submerged reefs).

THREATENED AND ENDANGERED SPECIES

Threatened and endangered species of the Hawaiian Islands include the humpback whale (Megaptera novaeangliae), Hawaiian monk seal (Monachus schauinslandi), and the green sea turtle (Chelonia mydas). The humpback whale breeding grounds are in nearshore Hawaiian Island waters from November until May. Calving occurs mainly between January and March. Areas frequented by the humpback whale during these months are shown in Figure 3-2.

The monk seal is endemic to the extreme Northwestern Hawaiian Islands.

The green sea turtle is the only common offshore reptile in Hawaiian waters. Green turtle breeding (nesting) grounds are entirely in the Northwestern Hawaiian Islands, primarily at French Frigate Shoals.

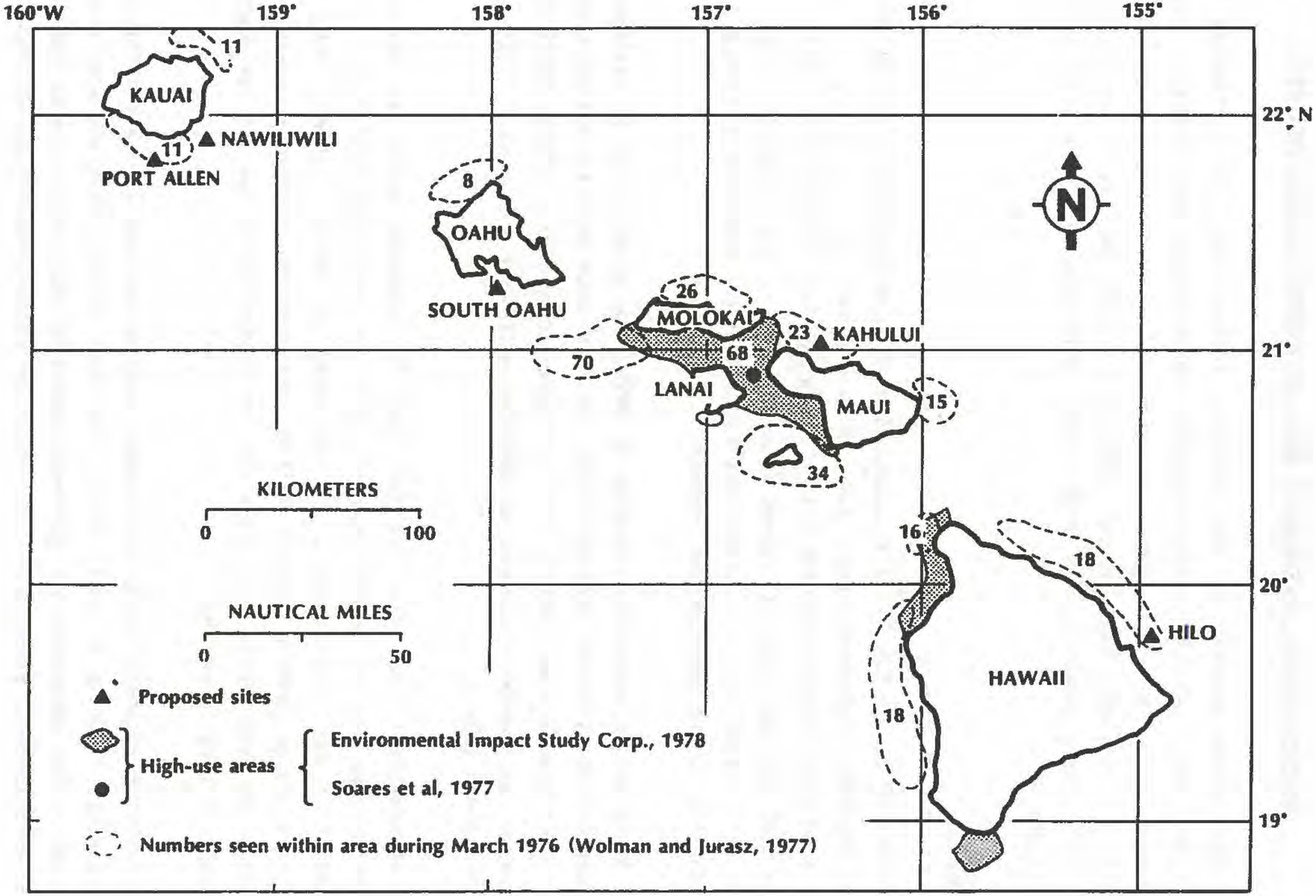


Figure 3-2. Humpback Whale (<u>Megaptera</u> <u>novaeangliae</u>) Distribution in Hawaii

RECREATIONAL, ECONOMIC, AND AESTHETIC CHARACTERISTICS

The unique setting of the Hawaiian Islands strongly influences their economics due to the State's popular recreational activities. Hawaii's economic lifeline relies upon a few major industries: tourism, defense, and Federal nonmilitary expenditures (Federal civilian jobs, etc.) account for 81% of the State's annual income (NOAA, 1978), with tourism as the State's largest employer.

TOURISM

Tourism is now the State's largest industry, and is directly influenced by the aesthetic and recreational value of the coastal waters. At least 7 of the 12 principal recreational activities conducted near the proposed sites involve the use of the coastal waters (Table 3-12). The offshore recreational activities available to tourists are numerous, thus enhancing the value of the coastal areas in the Hawaiian economy.

Since Hawaii achieved statehood in 1959, the growth rate of visitors has increased at an annual rate of 17.7%. In 1973, more than 3.6 million visitors to the islands spent nearly $900 million (Tetra Tech, 1976; NOAA, 1978). Tourism, as uppermost element in civilian employment, generates 19.5% of all the State's jobs.

Recreational facilities are far from the disposal sites and are mainly concentrated on the island of Oahu, where an estimated 70% of all visitor facilities are located in a 1.8 km^2 area in Waikiki (NOAA, 1978). A significant proportion (nearly 40%) of the resident population inhabits the Mamala Bay shoreline. Tourists and residents alike use the recreational coastal waters intensively.

At other proposed sites, the coastal waters are used extensively by island residents. Present economic use of the other islands is minor when compared to Oahu, but represents the greatest potential for future growth because of the exhaustion of prime sites for hotels and visitor facilities on Oahu.

TABLE 3-12
RANKING OF RECREATIONAL ACTIVITIES
NEAR THE PROPOSED SITES

Activity	South Oahu	Nawiliwili	Port Allen	Hilo	Kahului	Overall Rank
Swimming/Sunbathing	2	1	1	1	3	1
Diving	-	9	8	8	6	8
Surfing	4	6	6	6	7	6
Fishing	3	5	5	5	6	5
Boating	-	7	7	7	-	7
Canoeing	-	7	8	-	-	8
Walking/Jogging	1	4	3	2	2	2
Picnicking	5	2	3	4	5	4
Camping	6	8	6	8	-	7
Hiking	7	9	7	8	7	7
Bicycling	2	3	2	3	4	3
Attending Outdoor Events	4	6	4	3	1	4

Source: Aotani and Hartwell Associates, 1975

NATIONAL DEFENSE

The second most important State industry, which creates employment and income, is national defense. Hawaii was chosen as the key Pacific military base because of its central location between the Far East and the U.S. mainland. In 1975, the defense sector provided 19% of all civilian jobs and 24.9% of the export income (NOAA, 1978).

Most military activities in Hawaii are centered around Pearl Harbor and Mamala Bay. Mamala Bay encompasses many restricted zones due to the U.S. Navy operation of Pearl Harbor (Figure 3-3).

The Pearl Harbor Naval Defense Area, outside the mouth of Pearl Harbor, is closed to all unauthorized ship traffic. West of the Naval Defense area is a zone where normal surface traffic is allowed; however, no anchoring, dredging, dragging, seining, or other fishing activities are permitted which might foul underwater installations. The only other restricted area in Mamala Bay is the explosives anchorage area, which is reserved for nitrate-laden vessels.

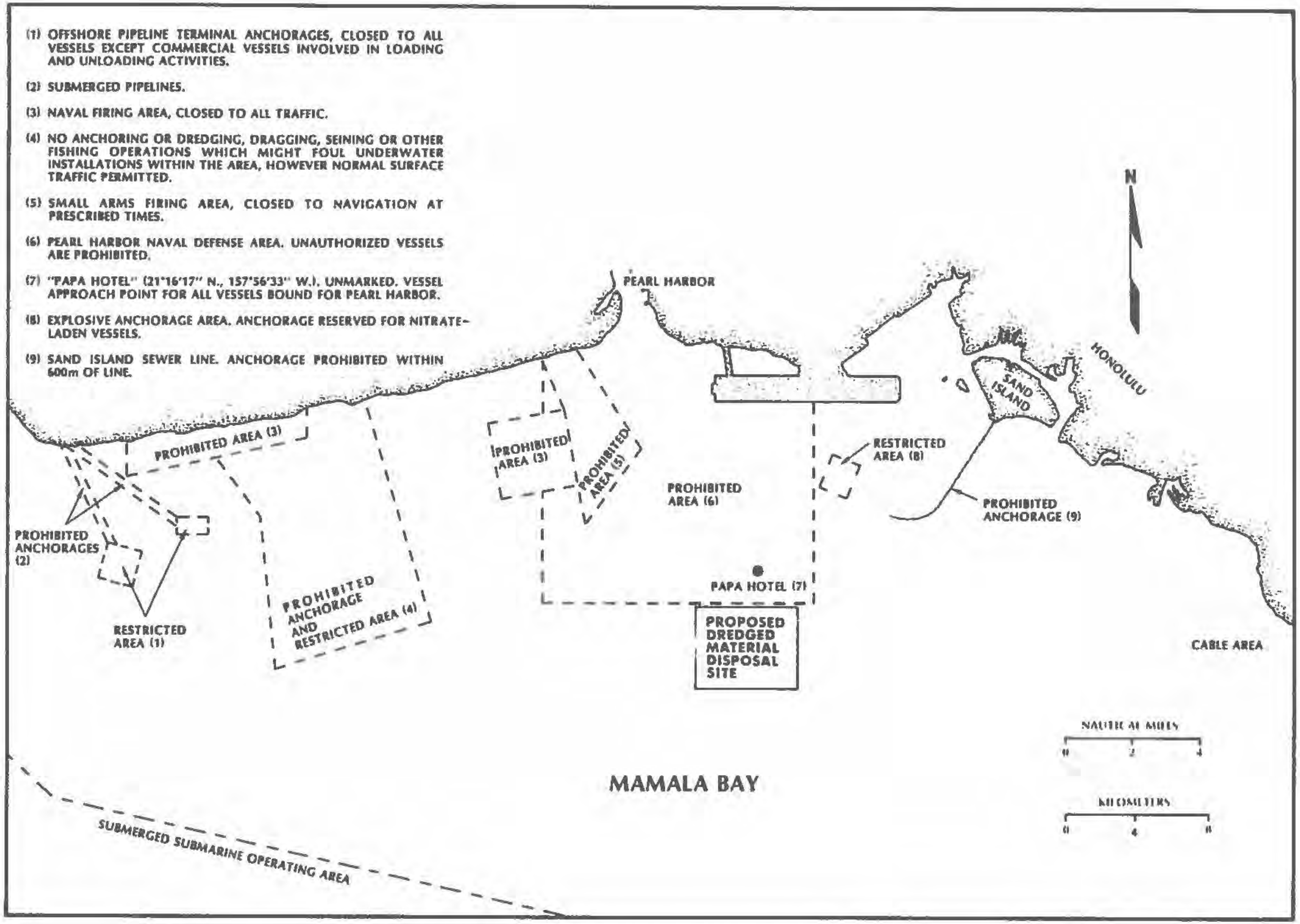


Figure 3-3. Restricted Zones in Mamala Bay
Source: U.S. Dept. of Commerce, 1978

FISHERIES

Commercial fishing is mainly confined to surface or pelagic offshore fishing. However, bottom fishing for demersal snappers and groupers occurs, although the catch is small compared to pelagic fisheries. Commercial fishing in 1975 contributed approximately $7.5 million to the State economy which exceeded $650 million. The dollar equivalent amount of fish caught in the fishery zones (where the proposed sites are located) was less than 12% of the State's total, with the majority caught near Hilo. The fishery zones are vast compared to the proposed sites (see Figure 3-4). A tabular presentation of the catch values and their percentages of the State's total and major catches appears in Table 3-13.

Many species of fishes and invertebrates form the commercial and recreational fisheries of the Hawaiian Islands. They may be classified by depth ranges into the following general ecological groups:

- Demersal inshore (0 to 65 m)
- Pelagic inshore (20 to 100 m)
- Demersal shelf-edge (65 to 225 m)
- Pelagic shelf-edge (100 to 200 m)
- Demersal upper slope (deeper than 225 m)
- Pelagic offshore (deeper than 200 m)

The regions of the proposed sites include the demersal upper slope and pelagic offshore. Three species of shrimp provide for small commercial fisheries in the demersal upper slope group: *Penaeus marginatus* (200 to 225 m), *Heterocarpus ensifer* (137 to 660 m), and *H. laevigatus* (430 to 825 m). However, demersal shrimp trawling in Hawaii is not presently a viable shellfishery and no commercial shrimp trawlers are working in Hawaiian waters. Thus, the resource presently exists without economic value in Hawaii's fishery, yet still remains a potential fishery (Maragos, 1979). The concentrations of shrimp at the sites are insufficient for commercial interest.

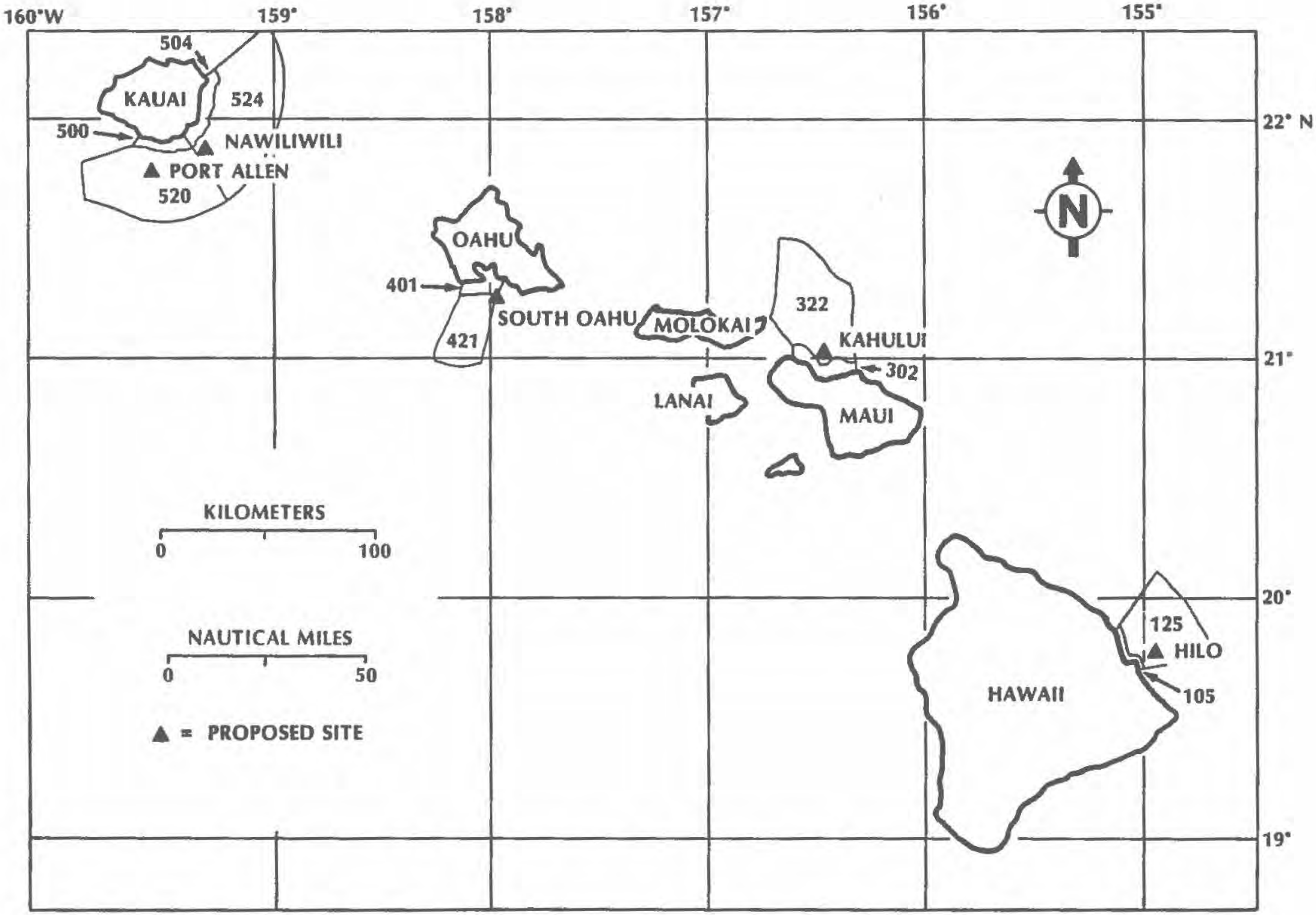


Figure 3-4. State Fish and Game Catch Areas in Vicinity of the Proposed Sites
(Numbers Indicate Specific Catch Areas)
Source: Neighbor Island Consultants, 1977

TABLE 3-13
FISHERY STATISTICS FOR 1975-76 IN THE VICINITY OF THE PROPOSED SITES

Proposed Site	Value (Thousands of Dollars)	Percent of Total Hawaiian Fisheries	Principal Catch (percentage of total site catch)								
			Aku (Skipjack Tuna)	Ahi (Yellowfin Tuna)	Bigeye Tuna	Alabacore Tuna	Akule (Bigeyed Scad)	Opelu (Mackerel Scad)	Ulua (Jack Crevally)	Uku (Gray Snapper)	Other
South Oahu	200	2.6	45				26			7	22
Kahului	39	0.5	8								92
Hilo	338	4.5	80								20
Nawiliwili	190	2.5		77							23
Port Allen	112	1.5		45			34				21
Total	879	11.6									

Source: Neighbor Island Consultants, 1977

Fisheries near Mamala Bay in 1975-76 were valued at approximately $200,000 (2.6% of the total Hawaiian fishery, Table 3-13). Fishing for akule (Trachurops crumenophthalmus), opelu (Decapterus pinnulatus), and ulua (Carangidae spp.) was 26% of the total fishery in 1975-1976 and the major part of the shallow water fishery. Uku (Aprion virescens) is also concentrated at Barbers Point in Mamala Bay near the proposed South Oahu Site. Fishing for aku (Katsuwonus pelamis) is the major portion of fishery near the dredged material disposal site; however, the majority of aku are taken well seaward of the site. In 1977, the total catch was valued at $237,000, with aku representing more than half the dollar amount. Data for the first half of 1978 indicated that the fisheries value increased to over $300,000.

The value of the 1975-1976 fishery surrounding the proposed Nawiliwili Site was reported to be $190,000 (2.5% of the total Hawaiian fishery). The major contributions to the fishery were aku, ahi (Neothunnus macropterus), bigeye tuna (Parathunnus sibi), and albacore (Germo alalunga), with tuna comprising 77% of the fishery. The inshore akule fishery was 8% of the total fishery, while assorted reef fishes and squid constituted the remainder. Fishery values in 1977 increased to $383,000, with bigeye tuna representing over 60% of the dollar value.

The value of the 1975-1976 fishery in the area surrounding the proposed Port Allen Site was $112,000 (1.5% of the total Hawaiian fishery). The total value in 1977 declined to $57,000. Aku, ahi, and bigeye tuna, combined, were 45%, striped marlin (Makira audax), 2%, and inshore akule, 34% of the total fishery. Miscellaneous reef and pelagic fishes and invertebrates constituted the remainder.

The value of the 1975-1976 fishery in the proposed Hilo area was about $338,000 (4.5% of the total Hawaiian fishery); the value in 1977 was only $217,000. The large tuna species, especially ahi, were the major fisheries during the summer and autumn, representing about 80% of the year-round catch from the area. The inshore akule fishery was 6.5% of the catch, while deepwater snappers comprised 2% of the catch.

The value of the fishery near the proposed Kahului Site was approximately \$39,000 (0.5% of the total Hawaiian fishery) in 1975-1976, and \$36,000 in 1977. Akule represented 8% of the area's catch. Most of the fishery consisted of invertebrates: opihi (Helcioniscus spp.), lobster, and octopus. Shallow-water reef fishes such as weke (Mulloidichthys spp.) were also caught in large numbers.

All sites are statistically insignificant and negligible in the areas where the foregoing data were obtained with respect to fisheries.

NAVIGATION

Ocean surface transportation is Hawaii's lifeline; dredging activities are indispensable for maintenance of harbor depths. Consumer goods and raw materials are imported to, and exported from Hawaii. Honolulu Harbor is the focal point of all shipping, annually handling over 8 million tons of incoming cargos, and 5 million tons of outgoing cargos. The majority of cargo ship traffic travel is trans-Pacific, not inter-island. Most traffic originates from California ports, the remainder from the east coast and other Western Pacific ports.

The 8 million short tons of cargos handled in 1970 by Honolulu Harbor were double the volume of 1961. Approximately half the cargos were foodstuffs and petroleum, the remainder consisting of building materials, chemicals, primary metal products, and farm products. In 1970, imports totalled nearly 5.5 million tons and exports totalled 2.6 million tons. The presence of a Foreign Trade Zone in Honolulu Harbor stimulates foreign trade, and encourages port usage by international businessmen.

Pearl Harbor, a strategic military base of the United States, contributes significantly to traffic through Mamala Bay. Cargo traffic in Pearl Harbor totalled nearly 4.5 million tons between 1964 and 1971, but steadily decreased from 530,000 in 1964 to 188,000 tons in 1971. The cargos handled in Pearl Harbor are all military cargos.

There are no established shipping lanes into or out of the Mamala Bay Harbors. Pilots board vessels bound for Honolulu approximately 2 miles south of Honolulu Channel. All vessels bound for Pearl Harbor must pass through the approach point "Papa Hotel" to enter the harbor. Neither approach points for Honolulu Harbor nor Pearl Harbor are marked with navigational aids.

INPUTS AT THE PROPOSED SITES OTHER THAN DREDGED MATERIAL

PREVIOUS DREDGING ACTIVITIES

The annual schedule for maintenance dredging the harbors, origin of harbor sediments, and volumes of disposed dredged material are listed in Table 3-14. Honolulu, Nawiliwili, and Port Allen Harbors are dredged approximately every 5 years, whereas Kahului and Hilo Harbors are dredged approximately every 10 years. Pearl Harbor is dredged as needed. Each harbor was dredged in 1977-1978. Of the total amount of dredged material in 1977-1978 (2,715,200 yd^3), 71% (1,918,300 yd^3) went to the Pearl Harbor Site, 17% (451,770 yd^3) to the Honolulu Site (for a total of 88% at the proposed South Oahu Site), and the remaining 12% (342,720 yd^3) to the other four disposal sites (Figure 3-5). The proposed Kahului Site received the smallest volume of material (23,500 yd^3) in the 1977-1978 maintenance dredging cycle.

OTHER WASTE INPUTS

The South Oahu Site is the only proposed site where waste inputs other than dredged material are significant. However, these inputs are derived from nearby shallow water areas and consisted, in 1973, of approximately 23 point sources which discharged 4.7 million yd^3 of waste per day, either directly into Mamala Bay, or indirectly into the Bay via Pearl and Honolulu Harbors. Of these 23 sources, 13 were municipal and military sewage sources which contributed 9% (0.42 million yd^3 per day) of the total, 6 were strictly thermal (cooling water) discharge sources from power-generating plants which contributed 91% (4.3 million yd^3 per day) of the total, 4 were miscellaneous industrial sources which represented less than 0.1% (0.004 million yd^3 per day). In 1979, the number of point-source outfalls increased to 44, causing a 12% increase (0.59 million yd^3 per day) over the 1973 discharge volumes. These contributions are summarized in Table 3-15.

TABLE 3-14
DREDGING OPERATION CHARACTERISTICS

Parameter	Honolulu Harbor, Oahu	Pearl Harbor, Oahu	Nawiliwili Harbor, Kauai	Port Allen Harbor, Maui	Kahului Harbor, Maui	Hilo Harbor, Hawaii
Dredging Frequency (yrs)*	5	As Needed†	5	5	10	10
Dredging Quantities (yds^3)						
1978		1,157,000				
1977**	456,500	761,300	120,300	142,600	23,500	54,000
1972	188,400		146,500	107,300		
1968*	132,100		242,000	179,200		
1962					40,500	85,000
1969-1976		315,200				
1968-1969††		3,100,000				
1959-1967		800,500				
Origin of Sediment*	Nuuanu Stream Kapalama Stream	Waikele Stream Waiawa Stream Waiau Stream Waimalu Stream Kalauao Stream Aiea Stream Halawa Stream Honouliuli Stream	Huleia Stream Niumalu Stream Nawiliwili Stream	Hanapepe River	No Streams; some ground water	Wailuku River Wailoa River seepage

Sources: * U.S. Army Corps Engineer District Honolulu, 1975
† U.S. Navy Headquarters, Pearl Harbor, 1980, personal communication
** Goeggel, 1978
†† Chave and Miller, 1977a

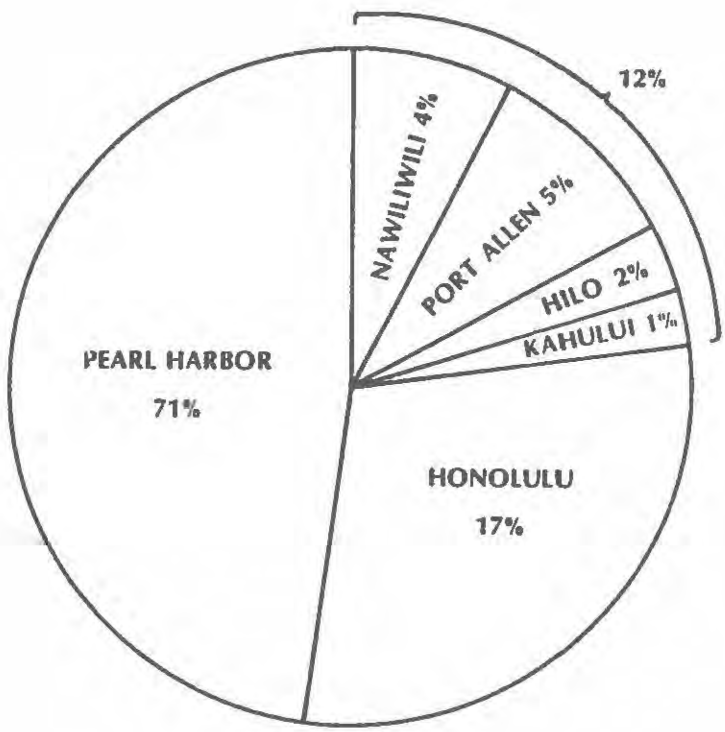


Figure 3-5. 1977-1978 Dredged Material Source Breakdown
Source: Goeggel, 1978

TABLE 3-15
POINT SOURCE SUMMARY FOR PEARL HARBOR AND MAMALA BAY

Source	Number of Permits	Total Volume (Thousands of Cubic Yards per Day)	Comparative Contributions* (Thousands of Cubic Yards Per Day)		
			Sewage	Industrial	
				Thermal	Other
Pearl Harbor					
1971-73†	15	3,100	92 (3%)	3,048 (97%)	0.4 (0.1%)
1979**	22	3,300	123 (4%)	3,125 (95%)	39 (1%)
Mamala Bay					
1971-73†	8	1,600	320 (20%)	1,278 (80%)	-
1979**	22	2,000	438 (22%)	1,588 (78%)	1.3 (0.1%)
Combined Total					
1971-73	23	4,700	412 (9%)	4,326 (91%)	0.4 (0.1%)
1979	44	5,300	561 (11%)	4,713 (89%)	41 (1%)

Sources: * Percent contribution noted in parentheses
† Tetra Tech, 1976
** S. Konno, State of Hawaii, Dept. of Health, 1979

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Implementation of the proposed action will not significantly degrade or endanger the marine environment or public health. There will be few unavoidable adverse effects on the marine environment or public health, and there will be no conflicts between the proposed action and other existing or alternative site uses. Appendix C contains supplemental data and text to support the discussions in this chapter on the environmental consequences of implementation of the proposed action.

The majority of all dredged material ocean disposal sites are located in shallow waters less than 30 m deep. Consequently, few detailed environmental evaluations of dredged material disposal in deep oceans exist. However, such is not the case in Hawaii where a number of deep ocean environmental studies have been conducted; thus, deep-ocean disposal is likely to be preferable to shallow-water disposal for several reasons. The deep ocean covers enormous areas and has great volumes of water for dilution. The biomass of the deep ocean is miniscule in contrast to that of the shallow inshore waters, and the majority of the inhabitants of the deep ocean are bottom scavengers with burrowing habits. The deep oceans around Hawaii, and throughout the world, are not used to any great extent for fisheries or food production. As a result, there is no direct food-chain link from these areas to man and this minimizes public health risks (Pequegnat et al., 1978). In support of the preference for deep-ocean disposal sites, the Ocean Dumping Regulations mandates that a dump site should be located, when feasible, beyond the continental shelf.

The proposed and alternative sites are all located in characteristically deep-ocean environments. The proposed sites are preferable to alternatives because of some environmental characteristics which minimize or reduce possible adverse impacts. Accordingly, this EIS is directed primarily towards evaluating the environmental consequences of implementing the proposed action, and the effects of such action on the proposed sites (in particular, the proposed South Oahu Site, as it will receive the largest volume of dredged material and is closest to the State's primary tourist and population center). The other proposed sites are in potential tourism growth areas. The characteristics and features of the alternative sites are described with reference to decisions for selection of the proposed sites.

This chapter forms the scientific and analytical basis for comparing and evaluating the alternatives discussed in Chapter 2, and contains the following sections:

- Effects on Recreational, Economic, and Aesthetic Values
- Other Environmental Effects
- Potential Conflicts with Other Ocean Uses
- Potential Conflicts with Federal and State Plans and Policies
- Unavoidable Adverse Environmental Effects and Mitigating Measures
- Relationship Between Short-term Use and Long-term Productivity
- Irreversible or Irretrievable Commitment of Resources

EFFECTS ON RECREATIONAL, ECONOMIC, AND AESTHETIC VALUES

This section interprets the effects of dredged material disposal on (1) economic values (tourism, fishing, and navigation), and (2) aesthetic values (e.g., the potential for recruitment of nuisance species and short-term presence of the discharge plume).

RECREATIONAL AND ECONOMIC VALUES

SITE WATER QUALITY

The discharge of dredged material at the proposed South Oahu Site will not lower the water qualities of the region. Six daily trips (or one every four hours) for disposal were made to the former Honolulu Site by the CE hopper dredge CHESTER HARDING in 1977. Considering the most conservative ocean currents at this proposed site (10 cm/sec), surface waters are replaced every seven hours. Thus, the brief occurrence (1.5 to 5 hours) of a surface plume after disposal (Chave and Miller, 1978; Swafford, 1979) will not degrade or reduce water quality at the proposed site.

Available data on dredged material characteristics do not indicate the presence of pathogens which could jeopardize public health, directly or indirectly through fisheries. Dredged materials must not contain any of the prohibited materials cited in Ocean Dumping Regulations; however, permissible quantities of the materials "prohibited except in trace amounts" have been reported in dredged materials (see Appendix B). Concentrations of such materials present no dangers to public health.

FISHING

Most fishing in Hawaii is either surface or midwater fishing; however, bottom fishing for demersal snappers and groupers does occur. Shrimp is the principal bottom fishing resource, but no commercial shrimp trawlers are presently working in Hawaiian waters. However, shrimp is still a potential fishery. Therefore, the National Marine Fisheries Service, U.S. Fish and Wildlife Service, and State of Hawaii Department of Fish and Game urged the CE to select sites outside the primary range of the shrimp, or beyond the 200-fathom (366 m) isobath. This general recommendation was in part a consequence of the lack of field information from the sites at that time. Now that detailed site-specific data are available for all sites, the need for a depth limit was reevaluated on a site-specific basis. The recommmended sites are all close to or exceed the 200-fathom contour while the proposed South Oahu Site is within the range of the potentially valuable shrimp. The proposed South Oahu Site is not favored for shrimp fishing because no commercial concentrations of shrimp exist. Migrating shrimp have been reported at the site after disposal operations (Goeggel, 1978, Tetra Tech, 1977; Chave and Miller, 1978) and may have been attracted to the disposal activity. During the Phase I predisposal site survey at the former Honolulu Site, live military ordnance was recovered by demersal trawling through the region (Neighbor Island Consultants, 1977). Thus, risks associated with trawling outweigh the potential economic gain.

The proposed Hilo Site (9) was selected in preference to alternative Site 9A because most commercial fishing in the area occurs along the western edge of Site 9A.

Two species of shrimp of commercial value, but not in commercial quantities, inhabit the region of the proposed and alternative Kahului Sites: Heterocarpus laevigatus, of greater value, found primarily at the alternative site, and H. ensifer, of lesser value, found in abundance over the entire north main terrace off Maui (Neighbor Island Consultants, 1977).

Recreational fishing from charter boats is widely practiced throughout the Hawaiian Islands, mainly for offshore sport fish (e.g., mahimahi and billfish). However, since such fish are taken by trolling (i.e., midwater fishing), and since disposal operations last for short periods, disposal will not adversely affect this activity (Maragos, 1979).

NAVIGATION

Infrequent dredging, and the short periods when dredge vessels operate at a disposal site, ensure that disposal activities will not affect commercial or recreational navigation at any of the proposed sites.

Adverse weather conditions which would affect dredged material releases are quite infrequent. Visibility in the Hawaiian Islands is consistently excellent, thereby reducing potential collisions at sea during disposal operations. Extreme winds and storms are infrequent. Hurricane records since 1950 list only seven known tropical depressions which affected Hawaii (Haraguchi, 1975).

Recreational boating is a major popular pastime in the Islands, and several harbors provide adequate docking. No adverse effects on recreational boating will result from dredged material disposal.

TOURISM

The use of the proposed sites for deep-ocean dredged material disposal will not jeopardize coastal water attractiveness to tourists for several reasons. All sites are far from tourist recreational areas. Dredging and disposal are infrequent, and volumes of dredged material for disposal are minor inputs to the waters when compared to inputs from other sources. Strong ocean currents prevent the material from washing towards Hawaiian beaches.

In addition, hopper dredge operations are unobtrusive to ship traffic and not likely to attract the attention of tourists. The direct benefit of dredged material disposal is that dredging of several harbors will enhance tourism by providing excellent navigational channels for large recreational and commercial vessels to enter Hawaiian harbors.

AESTHETIC VALUES

Dredged material disposal will not diminish the aesthetic quality of the recreational areas adjacent to the disposal sites. The only visible manifestation of the dredged material release is a short-term surface plume that is only visible to vessels and aircraft passing near the proposed sites. The plume's duration, although dependent upon currents at time of release and the characteristics of the dredged material being dumped, is generally from one to five hours (Swafford, 1979). The initial width of a plume after release was estimated by Tetra Tech (1977) to be 100 m, but plume details became more difficult to observe with time as currents dispersed the material. Two factors mitigate the effects of the disposal plume on aesthetic values. The distance of the disposal sites from shore ensures that the plume will not be visible from shore. Further, since the prevailing currents at the sites are offshore or alongshore, the plume will not reach areas of aesthetic value.

Pearl Harbor dredged material reportedly contained 11.9 g/kg of oil and grease (Youngberg, 1973). However, oil sheens were not reported at the former Pearl Harbor Site, and no sheens were visible during dumping operations (Maragos, 1979).

OTHER ENVIRONMENTAL EFFECTS

Key factors in the evaluation of impacts are the anticipated dispersion, dilution, and settling rate of the dredged material after release from a hopper dredge vessel. One method of prediction and description is mathematical modeling. In Hawaii, several attempts were made to model and predict the settling patterns of materials (Brandsma and Divoky, 1976; R.M. Towill Corp., 1972; Johnson and Holliday, 1977; Tetra Tech, 1977). Unfortunately, these models could not be verified during disposal operations. Subsequently, a simplistic box model was used to make a conservative estimate of the quantitative effects of disposal, as described below.

The fate of dredged material after release is affected by two forces: prevailing site conditions and the contents of dredged material. The proposed South Oahu Site is 450 m deep, has dimensions of 1.1 nmi (2.0 km) wide by 1.4 nm (2.6 km) long, and has a generally vertically uniform current of 10 cm/sec, which flows in an offshore direction. This prevailing current velocity will replace waters in the proposed site with upstream waters approximately every 7 hours. Disposal operations require approximately 4 hours to refill disposal vessels with dredged material between release periods.

Hawaiian dredged material characteristics vary, but two basic types have been reported: (1) 49% coral, 37% sand, and 14% granular shell material (Tetra Tech, 1977), and (2) a mean for all harbors of 60% silt and clay and 40% sand. Samples of both types were collected from the CE hopper dredge vessel CHESTER HARDING during the 1977-1978 operations. (See Appendix B.)

Heavier components of dredged materials (rocks, coral heads, and pebbles) will descend immediately, while fine sands (0.1 mm) descend much more slowly (at a rate of 1.8 cm/sec), requiring 7 hours to settle (Graf, 1971). Settling rates for silts and clays are even slower (0.3 cm/sec), requiring approximately 34 hours to reach bottom (Chave and Miller, 1977b). Material composed of 60% silt and 40% clay will thus take longer to settle. For example, 23% of the material (by weight) would fall within 6 hours, 44% in 2-1/2 days, with the remainder being transported out of the region (see Appendix C). Figure 4-1 illustrates the settling of dredged material after release, and depository patterns for dredged materials are shown in Figure 4-2 (Tetra Tech, 1977).

An expanded review of previous modeling efforts is presented in Appendix C with further descriptions of impact assessment calculations.

EFFECTS ON WATER COLUMN

TURBIDITY

Turbidity of the receiving waters is increased for a short period (2 to 5 hours) due to dredged material disposal. The highest concentration of suspended matter observed by Tetra Tech during the 1977-1978 disposal operations was approximately 30 mg/liter. Chave and Miller (1977b) reported surface concentrations of over 60 mg/liter 14 minutes after material release. It is concluded that the suspended loads are not sufficiently great to cause any short-term or long-term adverse effects (see Appendix C).

NUTRIENT RELEASES

Phytoplankton are at the base of the food chain and require nitrogen and phosphorus to photosynthesize and grow. Most oceanic waters are limited in nitrogen content. Concerns created by nutrient releases (particularly ammonia) from dredged material disposal activities stem from two opposing effects which releases might have (Pequegnat et al., 1978). Nutrient releases can stimulate biological activity, leading to rapid growth of undesirable organisms, or else the nutrients (particularly ammonia) act as toxins. The potential occurrence of either effect depends upon environmental factors such as oxygen levels, and mixing and dilution rates.

Windom (1972, 1975, 1976) reported ammonia to be the only constituent, monitored during initial disposal operations in North Carolina, South Carolina, and California, which was consistently released in great volumes. No data for ammonia concentrations are available for the dredged material; however, Youngberg (1973) reported total Kjeldahl nitrogen (TKN) values of

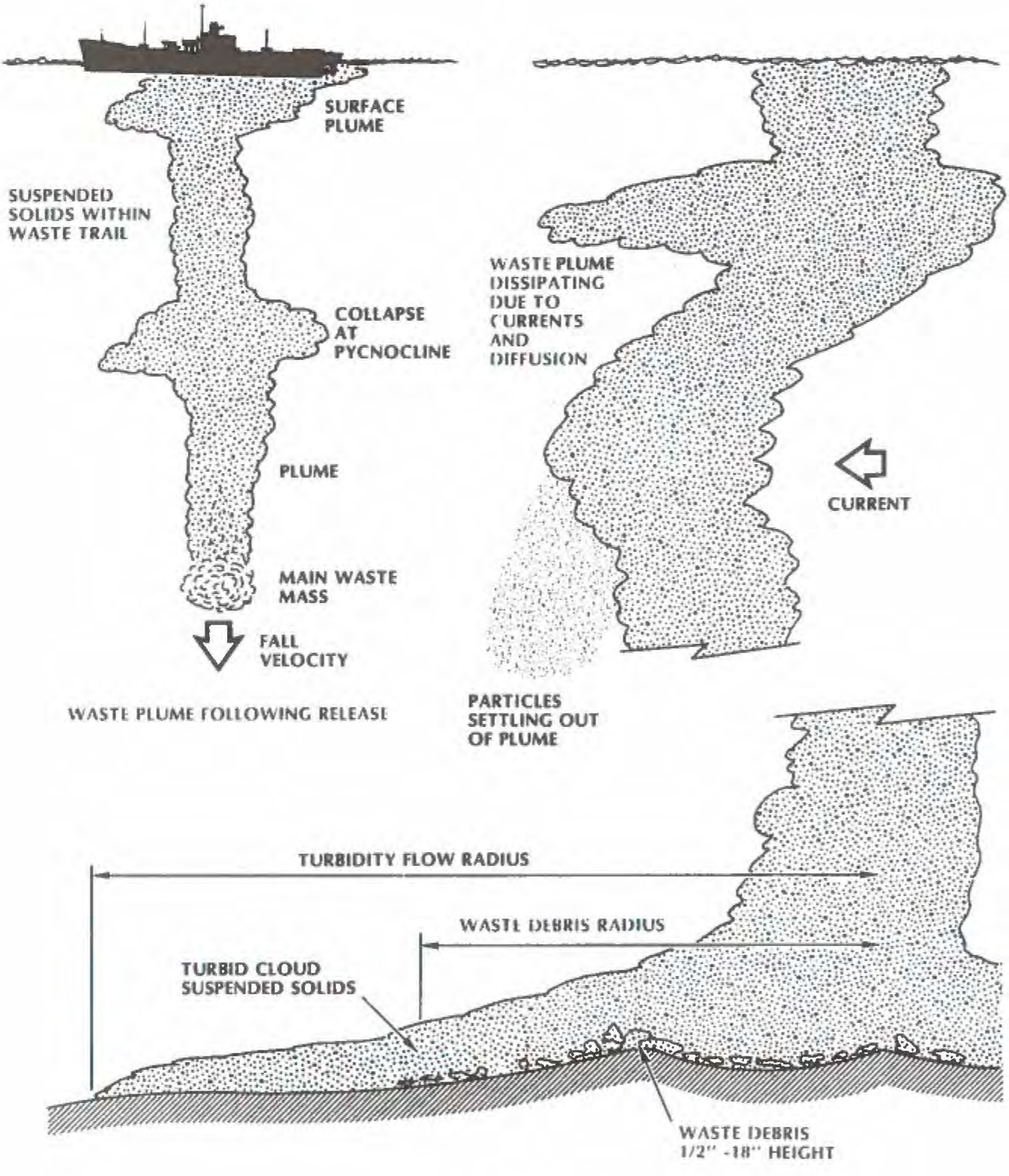


Figure 4-1. Dredged Material Release Scenario
Source: Goeggel, 1978

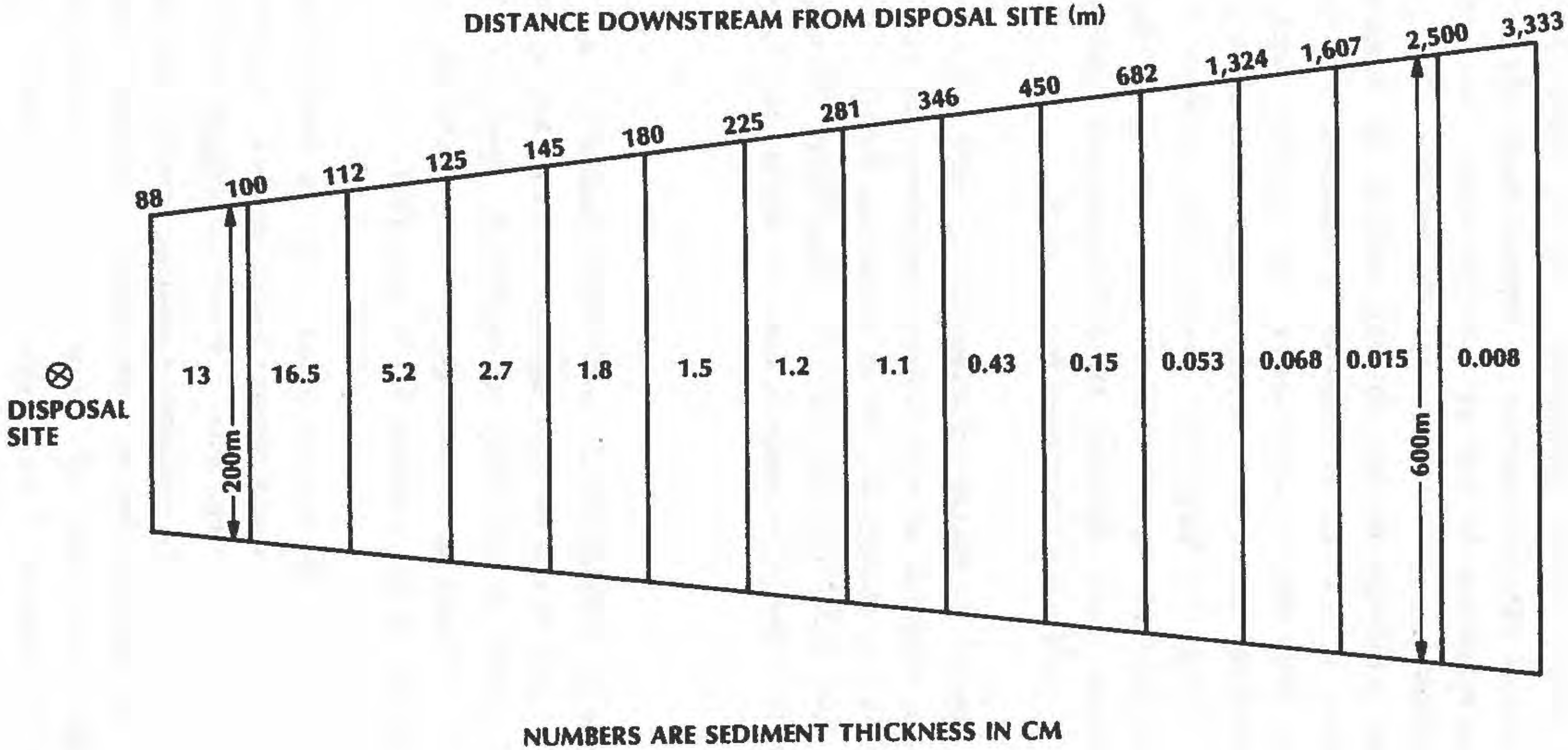


Figure 4-2. Depository Patterns of a Single Discharge (2,681 yd^3)

825 mg/kg in Pearl Harbor sediments. While there is no consistent relationship between TKN and ammonia in dredged materials, by assuming that the ammonia concentration is 75% of the TKN value, an order of magnitude estimate can be deduced as to the effects of ammonia release on productivity. Thus, with each discharge by the CHESTER HARDING of dredged material, an estimated maximum of 736 kg of ammonia is released into the water. If distributed throughout the water column at the proposed South Oahu Site, the ammonia concentration would be increased approximately 0.31 μg/liter to 4.7 μg/liter. Using the Eppley and Thomas (1969) conversion of ammonia to phytoplankton, a phytoplankton biomass increase of approximately 5% per dump may occur within the site. However, rapid dilution and transport would reduce the concentration before this increase could occur.

Toxicity of ammonia to marine organisms is not well known. However, lethal effects have been reported at much higher concentrations than those expected to occur at all sites (Natarajan, 1970; Brown and Currie, 1973; Wuhrman and Woker, 1948). Even under the most extreme conditions, there appears to be no potential for toxic effects of ammonia upon the biota (see Appendix C).

OXYGEN DEMAND

Release of dredged materials in water often causes a small initial oxygen sag which varies from 0.006 to 0.02 mg/liter/minute (Lee et al., 1975). The upper limit of these values, when extrapolated, reveal a dissolved oxygen demand, in the first hour after dumping, of 1.6 gm $O_2/m^3/hr$, or approximately 0.008% of the oxygen in the proposed South Oahu Site.

Complete oxidation of the organic matter found in dredged material disposed at the site with each dump would require approximately 6 percent of the oxygen within the proposed South Oahu Site. However, Goeggel (1978) reported that during disposal operations, surface dissolved oxygen concentrations were reduced for a few minutes before returning to ambient levels. In other instances, oxygen reductions of lesser magnitudes were observed. Such depressions are insignificant on a short-term basis and will not have any adverse effects on biota.

TRACE METAL AND ORGANOHALOGEN ACCUMULATION

The toxic levels of most metallic compounds for marine organisms have not been established, partially due to the extreme variabilities in the sensitivities exhibited by different organisms during different life-stages of the same organism. Trace metals present in dredged material may follow many pathways when introduced to the site environment. Three possibilities are: (1) the trace metals become part of the site sediment, (2) the trace metals may be released into the water column of the site while the dredged material is settling to the sea floor and after it has settled, (3) the trace metals may be ingested by both pelagic and benthic organisms.

Studies at the Hawaiian disposal sites (Chave and Miller, 1978; Goeggel, 1978) revealed that concentrations of several trace metals in the site sediments after dumping were elevated with respect to pre-disposal values (see Appendix A, Table A-6); this suggests the possibility of trace metal accumulation in the sediments due to dumping. However, definitive conclusions from these data are lacking because (1) post-disposal control site metal concentrations were also elevated with respect to pre-disposal values, and (2) the average pre-disposal and post-disposal metal concentrations were associated with such large standard deviations that the ranges of values overlapped.

Laboratory and field tests on dredged material (Lee et al., 1975; Chen et al., 1976) indicated that, under certain conditions (e.g., oxidizing or reducing environments), some trace metals were released from dredged material into sea water in concentrations above background levels. Lee et al. (1975) concluded that manganese was released in the greatest quantities under both oxidizing and reducing conditions. Under reducing conditions, substantial amounts of iron and possibly lead were also released. Zinc was taken up from the water under oxidizing and, perhaps, under reducing conditions, while copper, lead, and cadmium were neither released nor taken up under oxidizing conditions. The actual increases over background values which did occur were miniscule (parts per billion or less), so that considerable analytical difficulties were encountered. Furthermore, there is little evidence to indicate that such low levels would cause adverse effects on marine organisms during the extremely short time before the concentrations were diluted to the original background levels, or if the metals were precipitated (Pequegnat et al., 1978).

The possibilities of water column accumulation of trace metals at the Hawaiian disposal sites are extremely low, as illustrated by assuming an extreme case, where, after release of one dump, all of the metals contained in the load of dredged material were evenly distributed throughout the water volume of the proposed South Oahu Site, mercury concentrations would increase by 0.4 ng/liter, cadmium by 0.6 ng/liter, lead by 40 ng/liter, and copper by 50 ng/liter for the Pearl Harbor sediments. Considering these increases for a single dump, it would take nearly 8,333 dumps into the same volume of water to equal the permissible EPA (1976) Water Quality Criteria level for cadmium, and over 250 dumps for mercury, discounting the ambient concentrations of these metals at the site (see Table 4-1).

There are no bioassay data on pelagic or benthic organisms with respect to dredged material previously dumped at any of the sites. Heavy metal body burdens were found in shrimp in the proposed South Oahu Site vicinity and compared with biota at control stations (Chave and Miller, 1977b; 1978). These data showed no significant (t-test) differences in concentrations of trace metals. However, dredged material was also found at the control site, thus invalidating these data from consideration as control data. Thus, no hard empirical data exist for estimating the potential for bioaccumulation of trace metals from dredged material previously dumped. However, past dumping is believed to have presented no public health threat for several reasons: (1) fishing in Hawaii is conducted primarily at surface and midwater depths, (2) no shellfishing (including shrimp trawling) occurs near the sites, and (3) disposal occurs for only 45 hours extended over a few months every five or ten years at each site. In accordance with the Ocean Dumping Regulations, future materials intended for disposal at the sites will be tested for potential to bioaccumulate, and materials which cannot comply with the regulatory criteria will not be permitted for open-ocean dumping, and other disposal methods will be needed.

TABLE 4-1
TRACE METAL CONCENTRATION INCREASES AFTER ONE DUMP OF DREDGED MATERIAL*

Metal	Pearl Harbor Sediments Contribution (ng/liter)	Honolulu Harbor Sediments Contribution (ng/liter)	Water Quality Criteria (EPA, 1976)
Mercury	0.4	0.8	100 ng/liter
Cadmium	0.6	4.3	5,000 ng/liter
Lead	40	131	0.01 multiplied by 96-hour LC_{50} value†
Copper	50	94	0.1 multiplied by 96-hour LC_{50} value
Manganese	300	237	100,000 ng/liter

* Evenly mixed throughout the water column
† Criterion exists for freshwater organisms only

Dredged material, from Pearl Harbor only, has been reported to contain detectable quantities of organohalogens. (See Appendix B.) Such concentrations, extrapolated throughout the water column, are much less than EPA Water Quality Criteria limits.

WATER COLUMN TRAPPING

Marine life in the path of denser dredged material may be trapped, carried to the bottom, and smothered. Microscopic plants (phytoplankton) and animals (zooplankton) and small fish (micronekton) will be in the path of dumped material. Decay of dead organisms carried to the bottom will consume oxygen and may lead to a reduction of oxygen at the sediment-water interface.

Several investigators (Gunnerson and Emery, 1962; Olson et al., 1941; Welch, 1952) have suggested that high-density dredged material, during its fall to the bottom, may trap planktonic organisms, carrying them to the ocean floor. Available studies on biota trapping are minimal, but it can be expected that the ability of an organism to withstand being carried to the bottom is directly related to its ability to swim and the size of each plankton. Great pressures and temperature differentials must also be considered.

Potentially, a single dump of dredged material could trap and carry to the bottom 1% of the phytoplankton biomass, 0.3% of the zooplankton biomass, and 0.2% of the micronekton biomass in the proposed South Oahu Site. Most of these organisms move with the currents, and the water in the proposed South Oahu Site will be replenished between each dump, thus there will be no significant adverse impact on the local planktonic community due to trapping of organisms by the descending dredged materials. Other proposed and alternative sites are similar to the proposed South Oahu Site, therefore the same water column trapping effects would occur.

EFFECTS ON THREATENED AND ENDANGERED SPECIES

The Hawaiian Islands provide a critical habitat for three threatened and endangered marine organisms: the green sea turtle, Hawaiian monk seal, and humpback whale. Green sea turtle nesting grounds are confined entirely to the northwestern Hawaiian Islands. The distribution of the monk seal is centered primarily on the northwestern Hawaiian Islands. Dredged material disposal produces localized environmental effects which are not expected to affect these populations. However, the effects on the humpback whale and green sea turtle, of short-term turbidity resulting from dredged material disposal, are not known at this time.

During breeding season, humpback whales are sensitive to human presence and activities. Dredged material disposal, conducted at a time when whales are actually present within the site vicinity, would most likely induce avoidance behavior. Out of the breeding season, humpbacks have been reported to be undisturbed by boat and ship traffic which is not directed towards them (Norris and Reeves, 1978). Figure 3-2 in Chapter 3 shows that none of the proposed disposal sites are within areas frequently visited by the whales. However, dumping operations will be scheduled and conducted in a manner which minimizes the potential for disturbing humpbacks during breeding season (November to May).

In the future, Federal, State, or county "humpback parks" or critical humpback whale habitats may be established. Dredged material disposal activities must not conflict with these areas or the goal of protecting humpback whales in their wintering grounds.

EFFECTS ON BENTHOS

Principal effects of dredged material disposal are upon bottom life. Bottom impacts evaluated include organism trapping, benthic smothering (burial), alteration of sediment distribution size, associated benthic community change, and mounding. The intake potential of toxic materials by organisms was previously discussed for plumes and sediments.

BENTHOS SMOTHERING

As distance from shore and water depth increase, the benthic biomass dramatically decreases (Moiseev, 1971; Rowe and Menzel, 1971; Thiel, 1975). Pequegnat et al., (1978) reported that, on a worldwide basis, the average deep-ocean biomass is about 0.01% of life on the continental shelf. Nevertheless, while abundance is low, some organisms in the direct path of disposal will be buried.

The ability of organisms to survive burial is related to habitat and body or shell morphology. Organisms of similar lifestyle and morphology react similarly when covered with sediment (Hirsch et al., 1978). For example, all epifaunal organisms (animals living above the bottom) are usually killed when trapped under deposited dredged material, while infaunal organisms (those living in the sediments) migrate in varying degrees. Hirsch et al. (1978), report studies which determined that mud crabs and amphipods (which have morphological and physiological adaptations for crawling through sediments) were able to migrate vertically through deposits tens of centimeters thick. Similarly, Maurer et al. (1978) reported that the majority of animals tested were able to migrate vertically, with as much as 32 cm of dredged material piled on top of them.

More severe effects are anticipated when organisms are buried under exotic sediments (i.e., those in or on which the organisms do not normally live), compared to conditions when they are buried under sediments similar to those at the disposal site. For example, adverse effects are generally minimal when sand is placed on a sandy bottom, and are maximal when mud is deposited over a sand bottom. Smaller organisms and animals in poor physiological condition are usually more susceptible to the effects of burial than the larger organisms (Morton, 1976; Saila et al., 1971, 1972). Crustaceans react to oxygen deficiency by increasing ventilation, and if the weight of sediments interferes with this activity, they quickly die. Some bivalve mollusks can incur an oxygen deficit, and certain polychaetes can reduce their metabolic activity when oxygen levels are low, thus increasing the time available for escape.

Comparisons of grain-size distribution of dumped dredged material and sediments at the proposed disposal sites are presented in Table 4-2. It can be seen that sediments at the proposed South Oahu Site resemble the materials dredged from both Pearl and Honolulu Harbors. While sand usually predominates at the other proposed sites, primarily silt will be dumped; however, terrestrial silts do form a portion of the deep-ocean oozes around Hawaii. Thus, the materials introduced into the proposed sites are not entirely foreign to the environment and are not expected to have significant effects (Maragos, 1979).

Epifaunal organisms are more abundant at the sites than infaunal organisms. These benthic organisms live in a deep sea environment with low sedimentation rates, approximately 2.0×10^{-4} cm/year (R.M. Towill Corp., 1972). The epifauna are dominated by tube-dwelling polychaetes and micromollusks. In a worst-case estimate, these organisms succumb to burial by 5 cm of sediment. The infauna are dominated by detritivore and carnivore polychaetes having greater burrowing abilities than epifaunal organisms. Such organisms may succumb to burial by greater than 30 cm of sediment thickness. Infaunal organisms will be smothered within a 2,400 m^2 area, while epifaunal organisms will be smothered within a 5,000 m^2 area. These account for 0.05% of the infauna and 0.1% of the epifauna within the site which may be adversely affected by each dredged material discharge.

TABLE 4-2
GRAIN-SIZE DISTRIBUTION COMPARISONS OF SEDIMENTS
AT THE PROPOSED SITES AND DREDGED MATERIAL TO BE DUMPED

Proposed Site/Source	Composition (%)		
	Gravel	Sand	Silt/Clay
South Oahu Region			
Disposal Site	10-14 (a,b)	75-76 (a,b)	10-15 (a,b)
Dredged Material/			
Pearl Harbor	-	58 (c)	42 (c)
Honolulu Harbor		39 (d)	51 (d)
Port Allen			
Disposal Site	1 (a)	63 (a)	36 (a)
Dredged Material/			
Port Allen Harbor	-	9 (d)	91 (d)
Nawiliwili			
Disposal Site	6 (a)	92 (a)	2 (a)
Dredged Material/			
Nawiliwili Harbor	-	8 (d)	92 (d)
Kahului			
Disposal Site	11 (a)	80 (a)	9 (a)
Dredged Material/			
Kahului Harbor	-	22 (d)	78 (d)
Hilo			
Disposal Site	1 (a)	77 (a)	22 (a)
Dredged Material/			
Hilo Harbor	-	13 (d)	87 (d)

Sources: (a) Neighbor Island Consultants, 1977
(b) Chave and Miller, 1978
(c) Youngberg, 1973
(d) Goeggel, 1978

All alternative sites have either biologically richer and/or more diverse benthic communities than the proposed sites. In general, commercially valuable shrimp are more abundant at the alternative sites. Thus, dredged material disposal will likely have more of an adverse smothering effect on the alternative sites than on the proposed sites.

FAUNAL SHIFTS

Previous biological surveys at the proposed sites have produced considerable qualitative data. The biomass or species mapping, however, cannot be determined from available data. Generally, the organisms at the proposed sites have adapted to fairly stable oceanic conditions. The inshore or estuarine organisms are much more tolerant of changes in environmental conditions. Numerous studies have demonstrated grain size to be important in the distribution of benthic life (Sanders, 1958; Wieser, 1959; Rogers, 1976; Harman, 1972). A change in substrate may be expected to cause the species to shift. Accordingly, the Ocean Dumping Regulations specify that "...material proposed for dumping is substantially the same as the substrate..." at the disposal site. Materials which do not comply with this guideline must undergo further testing.

The materials to be dumped at the proposed South Oahu Site are typically characterized by a 40% to 50% silt/clay proportion which does not immediately settle and will not alter the substrate substantially. The bulk of dredged material proposed for dumping at the proposed South Oahu Site is composed of sand and gravel, and presents no great variation in disposal site substrate.

Stress upon the benthic biota and organism tolerance of stress is still comparatively unknown (Goeggel, 1978). Most dredged material studies have usually indicated that stress is minor and of short duration. Data collected during and after the 1977-1978 disposal operations in Hawaii are in agreement with these conclusions (Goeggel, 1978; Chave and Miller, 1978). The only variation in community shift was the increase at the proposed South Oahu Site of the shrimp *Heterocarpus ensifer* (Tetra Tech, 1977; Goeggel 1978).

MOUNDING

Dredged material will not cause mounding at any proposed site sufficient to cause adverse impacts, even though large volumes may be dumped. Comparisons of bathymetry at the proposed South Oahu Site (former Honolulu Disposal Site) before and after dumping of 456,500 yd^3 in 1977-1978 (Neighbor Island

Consultants, 1977; Goeggel, 1978) show no changes in depths. Changes which do appear are beyond the accuracy limits of the navigational and sonar equipment used in the surveys.

An approximation of the buildup at the proposed South Oahu Site is evaluated in several ways. First, if the entire amount of dredged material taken from Honolulu and Pearl Harbors during 1977-1978 (a total of 487 loads) were to be released by the CHESTER HARDING at the proposed site, the maximal sediment thickness of dumped dredged material would range from 80 m thick at a downstream distance of 100 m to about 4 cm thick 3.3 km downstream. Second, if 1 million m^3 (1.3 million yd^3) of dredged material were to be uniformly distributed over the proposed South Oahu Site area (5.2 million m^2), the result would be a uniform sediment thickness of 19 cm. Since the alternative sites are similar to the proposed sites, buildups would be similar.

IMPACTS ON OTHER OCEAN USES

SCIENTIFIC USES

The proposed sites are not near any reported ecologically unique area and have not been utilized for purely scientific studies. All oceanographic studies performed near the proposed sites have been for the purpose of dredged material disposal impact evaluation.

PRESERVATION AREAS

The CE (1975) reviewed the National and State of Hawaii Registers of Historic Sites and Places, then contacted the State Historic Preservation Officer and Archaeologist to report that no historical, geological, or archaeological sites of interest are near the proposed sites.

Pearl Harbor Naval Base is listed in the 1972 National Register of Historic Places (Federal Register, Feb. 1975), and Aloha Tower in Honolulu is an important historic site near the proposed South Oahu Site; however, although historic places and locations are near the harbors, they will not be affected by maintenance dredging or ocean disposal operations. There are no marine protection preserves in Mamala Bay, or near the other proposed sites, which could be influenced by dredged material disposal.

INDUSTRIAL USE AREAS

The only areas of industrial usage near the proposed sites are close to the South Oahu Site. Three areas of Mamala Bay have permanent industrial installations. The Sand Island Outfall extends 1,100 m from Sand Island and discharges sewage at a depth of 12 m; anchoring is prohibited within 600 m of this pipeline. Two offshore pipeline terminals for unloading oil from tankers are off Barbers Point, approximately 20 miles (37 km) west of the proposed South Oahu Site. The area is closed to all vessels except commercial vessels involved in loading or unloading activities. A cable area exists southwest of Diamond Head.

OCEAN THERMAL ENERGY CONVERSION (OTEC)

OTEC is a method for producing energy from the ocean by using the warm surface waters to vaporize a working fluid (e.g., ammonia), then using the cold, deep ocean waters to condense the vapor. The world's first OTEC plant, constructed by Lockheed Missiles and Space Company and others, is situated off Keahole Point, Hawaii. A second preoperational platform is presently under construction and will be tested off the Kona coast (Hawaii) in 1980 (Sands et al., 1978).

Candidates for OTEC siting require an annual average temperature gradient of at least 17°C between the surface and waters 700 to 1,000 m in depth. The possibility of siting a plant near any of the proposed sites is unlikely since OTEC plants require areas with the above depths. The two Kauai sites (Port Allen and Nawiliwili) are in water deep enough for an OTEC plant; however, the bottom is too steeply sloped for mooring a platform. The implantation of a transmission cable through the sites is a possible conflict which can be avoided by planning.

OCEAN INCINERATION

In 1978, a site 100 nmi (180 km) southwest of Honolulu was tentatively selected by EPA for ocean incineration of organochlorine wastes. Dredged material disposal will not interfere with this activity.

DEEP-OCEAN MINING

There is no planned mining of manganese nodules or other deep-ocean mineral resources near any proposed sites. Potential mining areas are generally much farther offshore.

SAND MINING

Studies have been conducted on the possibilities and economic future of sand mining in the inshore waters off Hawaii. There is no potential conflict with dredged material disposal operations, inasmuch as sand mining is restricted to water depths of less than 15 m (Maragos et al., 1977).

CORAL HARVESTING

Precious coral harvesting is a continuing industry in the Hawaiian Islands. The proposed sites are not near any of the resource areas (Grigg, 1979; Maragos, 1979).

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

Few unavoidable adverse environmental effects will be created by the ocean disposal of dredged material at the proposed sites. Unavoidable adverse effects can be categorized as short-term or long-term. Short-term effects are:

- Elevated concentration of suspended material in the water

- Short-term dissolved oxygen decrease and ammonia increase in the water

- Possible attraction to or avoidance of the area by fish

- Biota trapping

The first three of these adverse effects are mitigated naturally by rapid dilution of the discharge plume in the water. Some water column biota may be trapped as the dredged material falls to the ocean floor. Some benthic organisms will dig out and escape.

The longer-term unavoidable adverse effects are:

- Biota smothering

- Accumulation of material on the ocean floor

The biomass at the proposed sites is small, and the few organisms which cannot dig out represent an insignificant proportion of the inhabitants. The extent of biota smothering will be decreased by dumping at one specific area in a proposed site. The infrequency of disposal operations is also a mitigating factor for biota smothering.

Scientific knowledge of summer fish spawning and migration is minimal, thus summer ocean disposal should be eliminated until more information is obtained.

The Ocean Dumping Regulations require reviews of physical characteristics and chemical constituents of the dredged material. Materials which do not comply with MPRSA will not be ocean-dumped.

Representative samples will be collected periodically from the dredge vessel hoppers after they have been filled in the harbor and before release at a site, to obtain a better characterization of the materials. Profiles of physical and chemical characteristics will be obtained by measurements. These data can be compared to pre-dredging harbor sediment values to determine the nature of the materials being dumped at the proposed site. The data will also provide information on the temporal changes of trace metals in the dredged harbor materials.

To evaluate the effects of dredged material ocean disposal over a longer time period, an environmental monitoring program will be considered by the CE for each disposal cycle at the proposed South Oahu Site, since it receives the greatest volume of dredged material. If monitoring at South Oahu indicates evidence of adverse effects, the other disposal sites will be considered for monitoring, at the discretion of CE. The monitoring plan will concentrate on the benthos, to determine benthic community recovery rates, long-term effects on benthos, and dredged material distribution on the site floor.

Periodic water measurements made during the disposal operation will provide information on the direction and rate of settling of the various fractions dumped, and will refine data concerning the descent and dispersion of the dredged material after release.

RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The sites proposed for designation are used for occasional sportfishing, but there is little nearby commercial fishing. Sportfishing occurs only in surface waters, and is independent of the quality of the bottom conditions. Designation of these sites will not adversely affect commercial ship traffic, other existing or potential site uses, or ecologically sensitive areas.

The Mamala Bay region, (where the proposed South Oahu Site exists), receives several point-source discharges from industrial and municipal outfalls. Ocean disposal of dredged material will not affect the long-term productivity of this or the adjoining area.

The designation of the proposed sites for continued use for short-term ocean disposal will not jeopardize long-term productivity of the sites.

IRREVERSIBLE OR IRRETRIEVABLE RESOURCE COMMITMENT

Resources which would be irreversibly and irretrievably committed upon implementation of the proposed action include:

- Loss of energy in the form of fuel required for transport of dredging vessels to and from the proposed sites.

- Loss of constituents such as trace metals in the dredged material, because existing technology is not adequate to recover them efficiently.

- Loss of insignificantly few benthic organisms smothered by dredged material during disposal operations.

Chapter 5

COORDINATION

PREPARERS OF THE EIS

The preparation of this EIS was a joint effort employing members of the scientific and technical staff of Interstate Electronics Corporation and the Pacific Ocean Division of the Army Corps of Engineers. The preparers and the sections of the EIS for which they were responsible are presented in Table 5-1.

TABLE 5-1. LIST OF PREPARERS

Author	Summary	Chapter						Appendix				
		1	2	3	4	5	6	A	B	C	D	F
M.D. Sands	X	X	X	X	X	X					X	
J. Donat		X	X	X	X	X	X	X	X	X		X
M. Howard				X	X			X	X	X		
S. Sullivan				X	X			X		X		
J. Maragos		X	X	X	X	X	X	X	X	X	X	
M. Lee		X	X	X	X	X	X	X	X	X	X	

M. DALE SANDS

Mr. Sands, the principal author of this EIS, possesses a B.S. degree in chemistry and biological sciences and an M.S. degree in environmental health sciences (environmental chemistry). He prepared the Summary, Chapters 1, 2, 3, 4, and 5, and Appendix D of the EIS. As EIS coordinator, he directed writing efforts on other sections of the EIS, edited all chapters, and maintained liaison with EPA headquarters and the Pacific Ocean Division of the Army Corps of Engineers.

JOHN R. DONAT

Mr. Donat holds a B.S. degree in chemical oceanography. He assisted with the writing of Chapters 1, 2, 3, 4, 5, and 6 and Appendixes A, B, C, and F.

MATTHEW HOWARD

Mr. Howard holds a B.S. degree in physical oceanography. He assisted in the preparation of Chapters 3 and 4 and Appendixes A, B, and C.

STEPHEN M. SULLIVAN

Mr. Sullivan holds a B.S. degree in biological oceanography. He assisted in the preparation of Chapters 3 and 4 and Appendixes A and C.

MICHAEL LEE

Mr. Lee is an environmental biologist at the U.S. Army Corps of Engineers Environmental Resources Section, Pacific Ocean Division, Honolulu, Hawaii. He holds a B.S. degree in marine biology. Mr. Lee assisted in editing the entire EIS.

JAMES E. MARAGOS

Dr. Maragos is Chief of the Environmental Resources Section, Pacific Ocean Division, U.S. Army Corps of Engineers, Honolulu, Hawaii. He holds a B.A. degree in zoology and a Ph.D. in biological oceanography. Dr. Maragos assisted in editing the entire EIS.

COMMENTERS ON THE DRAFT EIS

The following persons submitted written comments:

Sidney R. Galler
Deputy Assistant Secretary for Environmental Affairs
U.S. Department of Commerce
Assistant Secretary for Science and Technology
Washington, D.C. 20230
(February 4, 1980; February 12, 1980)

George C. Steinman
Chief, Environmental Activities Group
Office of Shipbuilding Costs
U.S. Department of Commerce
Maritime Administration
Washington, D.C. 20230
(December 28, 1979)

James W. Rote
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Director, Office of Fisheries and Habitat Protection
Washington, D.C. 20235
(February 6, 1980)

Doyle E. Gates
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Region
Western Pacific Program Office
P.O. Box 3830
Honolulu, Hawaii 96812
(January 9, 1980)

Robert B. Rollins
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey
Rockville, Maryland 20852
(December 28, 1979)

R. Kifer
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Coastal Zone Management
Washington, D.C. 20235
(January 7, 1980)

Kisuk Cheung
Chief, Engineering Division
U.S. Department of the Army
Pacific Ocean Division, Corps of Engineers
Building 230
Fort Shafter, Hawaii 96858
(January 2, 1980)

R.D. Eber
CDR, CEC, USN
Facilities Engineer
Headquarters, Naval Base Pearl Harbor
Box 110
Pearl Harbor, Hawaii 96860
(January 11, 1980)

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services
U.S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
Atlanta, Georgia 30333
(January 9, 1980)

Patricia Sanderson Port
Regional Environmental Officer
U.S. Department of the Interior
Office of the Secretary
Pacific Southwest Region
Box 36098
450 Golden Gate Avenue
San Francisco, California 94102
(December 18, 1979)

Donald R. King
Director, Office of Environment and Health
Department of State
Bureau of Oceans and International Environmental and
Scientific Affairs
Washington, D.C. 20520
(February 5, 1980)

Adair F. Montgomery
Chairman, Committee on Environmental Matters
National Science Foundation
Washington, D.C. 20550
(January 14, 1980)

James S. Kumagai, Ph.D.
Deputy Director for Environmental Health
State of Hawaii
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801
(January 11, 1980)

Richard L. O'Connell
Director, Office of Environmental Quality Control
Office of the Governor
550 Halekauwila Street
Room 301
Honolulu, Hawaii 96813
(January 15, 1980)

Susumu Ono
Chairman, Board of Land and Natural Resources
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809
(December 19, 1979)

Ah Leong Kam
State Transportation Planner
State of Hawaii
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813
(January 8, 1980)

Wallace Miyahira
Director and Chief Engineer
Department of Public Works
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813
(December 28, 1979)

George S. Moriguchi
Chief Planning Officer
Department of General Planning
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813
(December 5, 1979)

Toshio Ishikawa
Planning Director
County of Maui
Planning Department
200 South High Street
Wailuku, Maui, Hawaii 96793
(December 7, 1979)

Sidney Fuke
Director, Planning Department
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720
(December 20, 1979)

Tyrone T. Kusao
Director of Land Utilization
Department of Land Utilization
City and County of Honolulu
650 South King Street
Honolulu, Hawaii 96813
(December 12, 1979)

Doak C. Cox
Director, Environmental Center
University of Hawaii at Manoa
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822
(January 15, 1980)

Kelley Dobbs
Greenpeace Foundation
P.O. Box 30547
Honolulu, Hawaii 96820
(January 14, 1980)

Kenneth S. Kamlet
Assistant Director, Pollution and Toxic Substances
National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036
(January 15, 1980)

Chapter 6

GLOSSARY, ABBREVIATIONS, AND REFERENCES

GLOSSARY

Aesthetics	Pertaining to the natural beauty or attractiveness of an object or location.
Ambient	Pertaining to the existing conditions of the surrounding environment.
Appropriate sensitive benthic marine organisms	At least one species each representing filter-feeding, deposit-feeding, and burrowing species chosen from among the most sensitive species accepted by EPA as being reliable test organisms to determine the anticipated impact on the site.
Appropriate sensitive marine organisms	At least one species each representative of phytoplankton or zooplankton, crustacean or mollusk, and fish species chosen from among the most sensitive species documented in the scientific literature, or accepted by EPA as being reliable test organisms, to determine the anticipated impact of the wastes on the ecosystem at the disposal site.
Assemblage	A group of organisms sharing a common habitat.
Atmosphere	A unit of pressure equal to the air pressure at mean sea level, comparable to 760 mm of mercury.
Background level	The naturally occurring level of a substance within an environment prior to the unnatural addition of that substance.
Basalt	An aphanitic crystalline rock of volcanic origin, composed largely of dark minerals such as pyroxene and olivine.
Baseline data	Data collected prior to the outset of actions which have potential of altering an existing environment.
Bathymetric gradient	The rate of change in depth of the bed of a body of water.
Bathypelagic zone	The biogeographic realm of the ocean lying between depths of 1,000 and 4,000 m.
Benthos	A category of marine organisms that live on, in, or near the bottom of the ocean.

Bioaccumulation	The uptake and assimilation of substances, such as heavy metals, leading to a concentration of these substances within an organism's tissue, blood, or body fluid.
Bioassay	Exposure of a test organism to samples of contaminant-laden water under controlled conditions to determine the contaminant concentration lethal to the organism over varying lengths of time.
Biochemical oxygen demand (BOD)	The amount of dissolved oxygen used up during the oxidation of oxygen-demanding material.
Biomagnification	The process by which the concentration of a substance can be greatly increased as organisms in the lower levels of a food chain are ingested by animals in the upper levels.
Biomass	The physical mass (weight) of living organisms considered in total. Used in expressing population density.
Biota	Pertaining to life and living organisms, collectively plants and animals.
Biotic groups	Organisms which are ecologically, structurally, or taxonomically grouped.
Calcareous	Consisting of or containing calcium carbonate.
Calcareous ooze	A fine-grained pelagic deposit which contains more than 30 percent calcium carbonate, derived from the skeletal material of various planktonic animals and plants.
Carbonates	Salts or esters of carbonic acid.
Carbon fixation	Process by which primary producers (phytoplankton) utilize inorganic carbon for the production of energy in photosynthesis.
Carcinogen	A substance or agent producing or inciting cancer.
Carnivorous	Eating or feeding on animal tissues.
Chaetognaths	Small, elongate, transparent, wormlike animals pelagic in all seas from the surface to great depths. They are abundant and may multiply into vast swarms.
Chlorophyll *a*	A specific green pigment used in photosynthesis which serves as a convenient measure of phytoplankton biomass.
Chronic effect	A toxic effect which does not directly result in the death of an organism but in some way reduces the survivorship of that organism over a long period.

Circulation pattern	The general geometric configuration of oceanic currents usually applied in synoptic oceanography.
Coelenterates	A large, diverse group of simple animals possessing two cell layers and a digestive cavity with only one opening. This opening is surrounded by tentacles containing stinging cells.
Compensation depth	The depth in the ocean at which oxygen production by photosynthesis equals that consumed by plant respiration during a 24-hour period.
Continental shelf	The continental margin extending seaward from the coast to a depth of about 200 m.
Continental slope	The steeply descending slope lying between the continental shelf and the deep ocean floor (abyssal plain).
Copepods	Minute, shrimplike crustaceans, most species of which range between about 0.5 and 10 mm in length.
Crustaceans	Animals with jointed appendages and a segmented external skeleton composed of a hard shell or crust. The group includes barnacles, crabs, shrimps, and lobsters.
Current drogue	Device placed somewhere in the water column which moves along with the current for a cumulative distance over a specified time period, thus displaying average current velocity, by observation and calculations.
Current meter	Any device for measuring and indicating speed or direction (often both) of flowing water.
Cyclonic eddies	Mesoscale (50 to 100 km) features of oceanic circulation in which water flows in a circular pattern around cold core waters.
Demersal	Living on or near the bottom of the sea.
Density	The mass per unit volume of a substance.
Detritivore	An organism which ingests detritus.
Detritus	Loose material (organic or inorganic) that results directly from disintegration.
Diatom	A microscopic, planktonic plant with an external skeleton of silica; abundant worldwide.
Diffusion	Transfer of material by eddies or molecular movement. Results in dissemination of matter under the influence of a concentration gradient, with movement from the stronger to the weaker solution.

Dilution	A reduction in concentration through the addition of ambient waters.
Discharge plume	The region of fluid derived from the discharge pipe which is distinguishable from the surrounding water.
Dispersion	The dissemination of discharged matter over large areas by the natural processes of turbulence currents.
Dissolved oxygen	The quantity of oxygen dissolved in a unit volume of water; usually expressed in ml/liter.
Dissolved solids	The dissipation of solid matter in solution, such as salt dissolved in water.
Diversity	A measure of the variety of species in a community that takes into account the relative abundance of each species.
Dominance	A species or group of species which largely control the energy flow and strongly affect the environment within a community.
Dry weight	The weight of a sample of organisms after all water has been removed; a measure of biomass.
Ecosystem	A functional system which includes the organisms of a natural community or assemblage together with their physical environment.
Echinoderms	Principally benthic marine animals having either calcareous plates with projecting spines forming a rigid or articulated skeleton, or plates and spines embedded in the skin. They have radially symmetrical, usually five-rayed bodies. They include the starfish, sea urchins, crinoids, and sea cucumbers.
Eddy	A water current moving contrary to the direction of the main current, especially in a circular motion.
Endemic	Restricted or peculiar to a locality or region.
Epifauna	Animals which live on or near the bottom of the sea.
Epipelagic	Ocean zone ranging from the surface to 200 m in depth.
Erosion	The group of natural processes (including weathering, dissolution, abrasion, and corrosion) by which the surface is removed from a material.
Estuary	A semienclosed, tidal, coastal body of fresh and saline water with free connection to the sea, commonly the lower end of a river.

Fauna	The animal population of a particular location, region, or period.
Flocculate	The process of aggregation into small lumps, especially with regard to solids and colloids.
Flora	The plant population of a particular location, region, or period.
Foraminifera	Single-celled, planktonic or benthic protozoans possessing shells, usually of calcium carbonate.
Heavy metals or elements	Elements which possess a specific gravity of 5.0 or greater.
Herbivorous	Eating or feeding on plants.
Holothurian	A worm-like animal, commonly called a sea cucumber, which is related to starfish, sea urchins, and sand dollars.
Hopper dredge	A self-propelled vessel which has the capabilities to dredge, store, transport, and dispose of dredged material.
Indigenous	Having originated in and being produced, growing, or living naturally in a particular region or environment.
Infauna	Animals which live buried in soft substrata.
Initial mixing	That dispersion or diffusion of liquid, suspended particulate, and solid phases of a material which occurs within 4 hours after dumping.
In situ	In the original or natural setting (Latin).
In toto	In full, to the fullest extent (Latin).
Insular shelf	The zone surrounding an island extending from the line of permanent immersion to the depth (usually 200 meters) where there is a marked or rather steep descent toward great depths.
Invertebrates	Animals without backbones.
Island mass effect	A phenomenon in which the abundance or biomass of organisms in the immediate vicinity of an island is markedly higher than the surrounding oceanic area.
Isopods	The second largest order of crustaceans. These flattened organisms are generally scavengers.

K_s	The dissociation constant of the enzyme-substrate complex in an enzyme-activated reaction. Used in biochemistry, especially metabolic studies and photosynthesis, to study the effects of changes in concentration of reactants and products on organisms. It is measured as: $$K_s = \frac{[E][S]}{[ES]}$$ Where [E] = concentration of enzyme [S] = concentration of substrate [ES] = concentration of enzyme-substrate complex.
Kona	Southerly winds in Hawaii.
LC_{50} (Lethal concentration 50)	In bioassay studies, the concentration of a contaminant which causes 50% mortality in the population of the test organisms during a unit time.
LC_{10}	A bioassay or toxicity study in which the concentration of pollutant which causes 10% mortality in the population of test organisms during a unit time is determined.
Limiting permissible concentration (LPC)	A concentration of a constituent that, after initial mixing, does not exceed marine water criteria or cause unreasonable acute or chronic toxicity or other sublethal adverse effects.
Lipophillic	Having an affinity for lipids (in the form of fats).
Lithogenic	Of or derived from rock.
Marine	Pertaining to the sea.
Mesopelagic	Relating to the oceanic depths between 200 m and 1,000 m.
Microgram-atom (μg-at)	Mass of an element numerically equal to its atomic weight in grams divided by 10^6.
Micromollusks	Tiny mollusks generally less than 0.5 mm in size.
Micronekton	Organisms commonly collected in a Isaac-Kidd Midwater Trawl. This group consists of weakly swimming nekton such as mesopelagic fish, small squid, gelatinous organisms, and fish larvae.
Micronutrients	Substances which an organism must obtain from its environment to maintain health, though necessary only in minute amounts.

Micro-organisms	Organisms which cannot be detected without the aid of magnifying equipment.
Microzooplankton	Planktonic animals with lengths between 20 and 200 microns, composed mainly of protozoans and juvenile copepods.
Mixed layer	The upper layer of the ocean which is well mixed by wind and wave activity.
Monitoring	As considered here, the observation of environmental effects of disposal operations through biological and chemical data collection and analyses.
Motile	Exhibiting or capable of spontaneous movement.
Mutagen	A substance that tends to increase the frequency or extent of mutation.
Nannoplankton	Minute planktonic plants and animals which are 50 microns or less in size. Individuals of this size will pass through most plankton nets and are therefore usually collected by centrifuging water samples.
Nekton	Free-swimming aquatic animals which move independently of water currents.
Nematoda	Free-living and parasitic unsegmented worms.
Nephelometry	The determination of the concentration or particle size of suspensions by means of transmitted or reflected light.
Neritic waters	Shallow waters in the marine environment.
Nuisance species	Species of organisms which have no commercial value yet out-compete commercially important species due to an induced shift in environmental conditions.
Nutrient	Any substance which promotes growth or provides energy for biological processes.
Nutrient-light regime	The overall condition of the nutrients and light in the environment as they relate to photosynthesis.
Octocorals	Animals possessing soft coralline exoskeletons having eight, or multiples of eight tentacles, such as sea fans.
Omnivorous	Eating animal, vegetable, and mineral substances.
Organohalogen pesticides	Pesticides whose chemical constitution includes the elements carbon and hydrogen plus one element of the halogen family: fluorine, chlorine, bromine, iodine.

Organophosphorus pesticides	A phosphorus-containing organic pesticide, such as parathion or malathion.
Ortho-phosphate	One of the possible salts of orthophosphoric acid; also, one of the components in seawater that is of fundamental importance to the growth of marine phytoplankton.
Oxidation	The process in which a substance gives up oxygen, removes hydrogen from another substance, or attracts negative electrons. Examples of oxidation are the rusting of iron, the burning of wood in air, the change from cider to vinegar, and the decay of animal and plant material.
Oxygen minimum layer	The portion of the water column in which the lowest concentration of dissolved oxygen exists.
Parameters	Any of a set of physical properties whose values determine the characteristics or behavior of something such as temperature, pressure and density; a characteristic element.
Parts per thousand (ppt; $^{o}/oo$)	A unit of concentration of a mixture denoting the number of parts of a constituent contained per thousand parts of the entire mixture. Salinity in seawater, which is expressed as grams per kilogram, or ppt (by weight).
Pathogen	An organism producing or capable of producing disease.
Pelagic	Pertaining to water of the open ocean beyond the continental shelf.
pH	The acidity or alkalinity of a solution as determined by the negative logarithm of the hydrogen ion concentration.
Phi units (ϕ)	Logarithmic mean particle diameter obtained by using the negative logarithm of the sediment size class midpoints taken to the base 2: $\phi = -\log_2$ (particle size in mm)
Photic zone	The layer of ocean from the surface to the depth where light is reduced to 1% of its surface value.
Photosynthesis	Synthesis of chemical compounds in light, especially the manufacture of organic compounds from carbon dioxide and a hydrogen source, with simultaneous liberation of oxygen by chlorophyll-containing plant cells.

Phytoplankton	Minute passively floating plant life of a body of water; the base of the food chain in the sea.
Plankton	The passively floating or weakly swimming, usually minute, animal and plant life of a body of water.
Polychaetes	Segmented marine worms, some of which are tubeworms, others are free-swimming.
Porcelaneous	Having calcareous, white, shiny, and commonly imperforate walls resembling porcelain in surface appearance, e.g., abalones.
Primary production	The amount of organic matter synthesized by organisms from inorganic substances in unit time, in a unit volume of water, or in a column of water of unit area extending from the surface to the bottom.
Radionuclides	Species of atoms that exhibit radioactivity.
Recruitment	Addition to a population of organisms by reproduction or immigration of new individuals.
Reference water column	The volume of water which may potentially be affected by dredged material disposal, e.g., the volume of the proposed South Oahu Site, which is a region 450 m deep, 2,000 m wide, and 2,600 m long.
Release zone	The area swept out by the loci of points constantly 100 m from the perimeter of the conveyance engaged in dumping activities, beginning at the first moment at which dumping is scheduled to occur and ending at the last moment at which dumping is scheduled to occur.
Salinity	The amount of dissolved salts in seawater measured in grams per kilogram or parts per thousand.
Sigma-t (σ_t)	A conveinently abbreviated value of density of a sea water sample of temperature, t, and salinity, s: $\sigma_t = [\rho(s,t) - 1] \times 10^3$ where $\rho(s,t)$ is the density of the sea water at standard atmospheric pressure.
Significant wave height	The average height of the one-third highest waves of a given wave group.
Species	(1) A group of organisms having similar characteristics and capable of interbreeding and producing viable offspring, (2) taxa forming a basic taxonomic group which closely resemble each other structurally and physiologically and in nature, interbreed, producing fertile offspring.

Specific gravity	The ratio of the density of substance relative to the density of pure water at 4°C.
Standing stock	The biomass or abundance of living material per unit volume or area of water.
Stressed	A state resulting from factors that tend to alter an existent equilibrium.
Surveillance	Systematic observation of an area by visual, electronic, photographic, or other means for the purpose of ensuring compliance with applicable laws, regulations and permits.
Suspended solids	Finely divided particles of solids temporarily suspended in a liquid (e.g., soil particles in water), expressed as a weight per volume.
Taxon	A group or entity sufficiently distinct to be distinguished by name and to be ranked in a definite category (adj. taxonomic).
Teratogen	A chemical agent which causes developmental malformations and monstrosities.
Terrigenous	Being or relating to oceanic sediment derived directly from the destruction of rocks on the Earth's surface.
Thermocline	A sharp temperature change which usually delineates a warmer surface water layer from a cooler subsurface layer. This phenomenon is most pronounced during summer months.
Trace metal or element	An element found in the environment in extremely small quantities.
Trade winds	The wind system, occupying most of the tropics which blows from the subtropical highs towards the equatorial trough; the winds are northeasterly in the Northern Hemisphere and southeasterly in the Southern Hemisphere.
Trophic level	Discrete steps along a food chain in which energy in the form of nutrition is transferred from the primary producers (plant) to herbivores and finally to carnivores.
t-Test	A statistical procedure for estimating and testing hypotheses by comparing population means and variances.
Turbidity	A reduction in transparency, as in the case of seawater, by suspended sediments or plankton growth.

Upwelling	The rising of water toward the surface from subsurface layers of a body of water. Upwelling is most prominent where persistent wind blows parallel to a coastline so that the resultant wind current sets away from the coast. The upwelled water, besides being cooler, is rich in nutrients, so that regions of upwelling are generally areas of rich fisheries.
Vertical distribution	The frequency of occurrence over an area in the vertical plane.
Water mass	A body of water usually identified by its temperature, salinity and chemical content, and containing a mixture of water types.
Wet weight	The weight of a sample of biomass determined before water is removed.
Zooplankton	Weakly swimming animals which are unable to resist water current movements.

ABBREVIATIONS

ANOVA	Analysis of Variance
APHA	American Public Health Association
BOD	biochemical oxygen demand
CE	U.S. Army Corps of Engineers
cf.	(Latin abbr.) conferre = refer to (figure, table, or map, etc.)
CFR	Code of Federal Regulations
cm	centimeter(s)
cm/sec	centimeters per second
COD	chemical oxygen demand
°C	degrees Celsius
DMRP	Dredged Material Research Program
e.g.	(Latin abbr.) exempli gratia = for example
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
$gm\text{-}O_2/m^3/hr$	grams oxygen per cubic meter per hour
i.e.	(Latin abbr.) id est = that is (to say)
kg	kilogram(s)
kgdw	kilograms dry weight
kgww	kilograms wet weight
kg/day	kilograms per day
kg/hr	kilograms per hour
km	kilometer(s)
kph	kilometers per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
m/sec	meters per second
µg/kg	micrograms per kilogram, or millionth gram per kilogram
µg/liter	micrograms per liter, or millionth gram per liter
µg-atom N/liter	microgram atom of nitrogen per liter
mi	mile(s)
mg	milligram(s), or thousandth gram

mg-C/m^3	milligrams carbon per cubic meter
mg-C/m^2/day	milligrams carbon per square meter per day
mg-O_2/l/min	milligrams oxygen per liter per minute
mg/kg	milligrams per kilogram
mg/kgdw	milligrams per kilogram dry weight
ml	milliliter(s), or thousandth liter
mm	millimeter(s), or thousandth meter
ng	nanogram, or billionth gram
ng/liter	nanograms per liter, billionth gram per kilogram
nmi	nautical mile(s)
nmi^2	square nautical miles
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity units
ppm	parts per million
ppt	parts per thousand
sec	second(s)
sq	square
SS	suspended solids
S-T-D	salinity-temperature-depth
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TSS	total suspended solids
USCG	U.S. Coast Guard
U.S. AED	U.S. Army Engineer District
viz.	(Latin abbr.), videlicet = namely
XBT	expendable bathythermograph
yd	yard
yd^3	cubic yard(s)

REFERENCES

American Public Health Association (APHA). 1975. Standard methods for the examination of water and wastewater. Fourteenth edition. 1,193 pp.

Aotani and Hartwell Associates, Inc. 1975. State comprehensive outdoor recreation plan - 1975. Prepared for Department of Planning and Economic Development, State of Hawaii. 301 pp.

Ballinger, D.G., and G.D. McKee. 1971. Chemical characterization of bottom sediments. J. Water Pollution Control Federation. 43:216-227.

Bathen, K.H. 1974. Results of circulation measurements taken during August 1972 to May 1973 in the area between Barbers Point and the entrance to Pearl Harbor, Oahu, Hawaii. Look Laboratory Report No. 34.

Bathen, K.H. 1975. An evaluation of oceanographic and socioeconomic aspects of a nearshore ocean thermal energy conversion pilot plant in subtropical Hawaiian waters. Department of Ocean Engineering, University of Hawaii, Honolulu. 925 pp.

Bathen, K.H. 1977. The behavior of nearshore ocean currents, plankton biology, benthic currents and ocean temperatures to depths of 2,200 feet at a potential OTEC site off Keahole Point, Hawaii. College of Engineering. University of Hawaii, Honolulu. 92 pp.

Biggs, R.B. 1968. Environmental effects of overboard spoil disposal. J. Sanitary Engineer Division ASCE. 94(SA3):477-487.

Brandsma, M.B., and D.J. Divoky. 1976. Development of models for prediction of short-term fate of dredged material in the estuarine environment. Contract Report D-76-5, May 1976, prepared by Tetra Tech, Inc., for the Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Work Unit 1B02. NTIS No. AD A027131.

Brown, A.C., and A.B. Currie. 1973. Tolerance of Bulla digitalis (Prosobranchiata) to solutions of ammonium nitrate in natural seawater. S. Afr. J. Sci. 69:219-220.

Cairns, J., Jr. 1968. Suspended solids standards for the protection of aquatic organisms. Twenty-second Purdue Ind. Waste Conference, Purdue University Eng. Bulletin 129:16-27.

Cattel, S.A., and D.C. Gordon. 1971. An observation of temporal variations of primary productivity in the Central Subtropical North Pacific. Unpub. ms., 13 pp.

Chave, K.E., and J.N. Miller. 1977a. Baseline studies and evaluation of the physical, chemical, and biological characteristics of nearshore dredge spoil disposal, Pearl Harbor, Hawaii. Part A: Baseline studies, investigation and selection of a suitable dredge spoil site. Final report. Prepared for Pacific Division Naval Facilities Engineering Command, Honolulu, Hawaii. Environmental Center, University of Hawaii. 184 pp.

Chave, K.E., and J.N. Miller. 1977b. Baseline studies and evaluation of the physical, chemical, and biological characteristics of nearshore dredge spoil disposal, Pearl Harbor, Hawaii. Part B: Immediate effects of dumping: monitoring studies. Final Report. Prepared for Pacific Division Naval Facilities Engineering Command, Honolulu, Hawaii. Environmental Center, University of Hawaii.

Chave, K.E., and J.N. Miller. 1978. Baseline studies and evaluation of the physical, chemical, and biological characteristics of nearshore dredge spoil disposal, Pearl Harbor, Hawaii. Part C: Long-term effects of dumping. Final Report. Prepared for Pacific Division Naval Facilities Engineering Command, Honolulu, Hawaii. Environmental Center, University of Hawaii.

Chen, K.Y., S.K. Gupta, A.F. Sycip, J.C.S. Lu, M. Krezevic, and W.W. Choi. 1976. Research study on the effect of dispersion settling, and resedimentation on migration of chemical consituents during open-water disposal of dredged materials. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Contract Rep. D-76-1: 243 pp.

City and County of Honolulu. 1972. Final report: water quality program for Oahu with special emphasis on waste disposal. Department of Public Works.

Cox, D.C. and L.C. Gordon. 1970. Estuarine pollution in the State of Hawaii. University of Hawaii, Water Resources Research Center. TR No. 31. 151 pp.

Davis, H.C. 1960. Effects of turbidity-producing materials in seawater on eggs and larvae of the clam *Venus mercenaria*. Biol. Bull. 118:48-54.

Davis, H.C., and H. Hidu. 1969. Effects of turbidity-producing substances in seawater on eggs and larvae of three genera of bivalve mollusks. The Veliger. 11(4):316-323.

Environmental Impact Study Corporation. 1978. Inventory of restricted and sensitive marine areas within the State of Hawaii for the mooring study - Honolulu, Hawaii. Prepared for the Department of Army Corps of Engineers, Pacific Ocean Division.

EPA - See U.S. Environmental Protection Agency

Eppley, R.W., A.F. Carlucci, O. Holm-Hansen, D. Kiefer, J.J. McCarthy, and P.M. Williams. 1972. Evidence for eutrophication in the sea near Southern California coastal sewage outfalls, July 1970. CALCOFI Report.

Eppley, R.W., J.N. Rogers, and J.J. McCarthy. 1969. Half-saturation constants for uptake of nitrate and ammonium by marine phytoplankton. Limnol. Oceanogr. 14:912-920.

Eppley, R.W., and W.H. Thomas. 1969. Comparison of half-saturation constants for growth and nitrate uptake of marine phytoplankton. J. Phycol. 5:375-379.

Evans, E.C. III (ed.). 1974. Pearl Harbor biological survey - final report. Part III. Naval Undersea Center, San Diego, California. NUC TN 1128.

Federal Register. 1977. Ocean dumping: final revision of regulations and criteria. Title 40, Parts 220-228. 42 (7).

Federal Register, 1980. Criteria for the management of disposal sites for ocean dumping; extension of interim designations. (Amendments to 40 CFR Section 228.12.) Vol. 45 No. 11 pp. 3053-3055.

Gilmartin, M., and N. Revelante. 1974. The "island mass" effect on the phytoplankton and primary production of the Hawaiian Islands. J. Exp. Mar. Biol. Ecol., 16:181-204.

Goeggel, G.B. 1978. Phase III Environmental surveys of deep ocean dredged spoil disposal sites in Hawaii. Prepared for U.S. Army Corps of Engineers, Honolulu, Hawaii. Hawaii Planning Design and Research, Honolulu, Hawaii.

Gosline, W.A., and V.E. Brock. 1965. Handbook of Hawaiian fishes. University of Hawaii Press. 372 pp.

Graf, W.H. 1971. Hydraulics of sediment transport. McGraw-Hill Book Company. 531 pp.

Grigg, R. 1979. Personal communication. University of Hawaii, Honolulu.

Gross, M.G. 1972. Oceanography: view of the earth. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 580 pp.

Gundersen, K.R., C.W. Mountain, D. Taylor, R. Ohye, and J. Shen. 1972. Some chemical and microbiological observations in the Pacific Ocean off the Hawaiian Islands. Limnology and Oceanography. 17(4):524-531.

Gunnerson, C.G., and K.O. Emery. 1962. Suspended sediment and plankton over San Pedro Basin, California. Limnology and Oceanography 7:14-20.

Haraguchi, P. 1975. Forecasting hurricanes in the Central Pacific. U.S. Dept. of Commerce. NOAA Technical Memorandum NWSTM PR-13. 14 pp.

Harman, W.N. 1972. Benthic substrates: their effects on freshwater mollusca. Ecology. 53(2):271-277.

Hirota, J. 1978. Personal communication. University of Hawaii.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of dredging and disposal on aquatic organisms. Dredged Material Research Program. Technical Report DS-78-5. 41 pp.

Horne, R.A. 1969. Marine chemistry. Wiley Interscience, New York. 568 pp.

Johnson, B.H., and B.W. Holliday. 1977. Numerical model results of dredged material disposal at ten proposed ocean disposal sites in the Hawaiian Islands. Miscellaneous paper H-77-6. Hydraulics Laboratory. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi 39180. D-691.

Johnson, J.K. 1971. Effect of turbidity on the rate of filtration and growth of the slipper limpet, Crepidula fornicata, Lamarch, 1799. The Veliger. 14(3):315-320.

Kay, E.A. 1973. Micromolluscs. In: L.S. Lau. (ed.) The quality of coastal waters: second annual progress report. Technical Report No. 77. UMIHI-SEAGRANT-CR-74-05.

King, J.E., and T.S. Hida. 1954. Variations in zooplankton abundance in Hawaiian waters, 1950-1952. U.S. Dept. of Interior, Fish and Wildlife Serv., Spec. Scient. Rpt., Fisheries No. 118. 66 pp.

Koh, C.Y., and Y.C. Chang. 1973. Mathematical model for barged ocean disposal of wastes. EPA Report EPA-660/2-73-029.

Konno, S. 1979. Personal communication. State of Hawaii, Department of Health.

Lee, G.F., M.D. Piwoni, J.M. Lopez, G.M. Mariani, J.S. Richardson, D.H. Homer, and F. Saleh. 1975. Research study for the development of dredged material disposal criteria. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 381 pp.

Lunz, G.R., Jr. 1938. Part I: Oyster culture with reference to dredging operations in South Carolina. Part II: The effects of flooding on the Santee River in April 1936 on oysters in the Cape Romain area of South Carolina. Report to U.S. Army Engineer District, Charleston, South Carolina.

MacIsaac, J.J., and R.C. Dugdale. 1969. The kinetics of nitrate and ammonia uptake by natural populations of marine phytoplankton. Deep-sea Research. 16:415-422.

Maragos, J.E. 1979. Personal communication. Pacific Ocean Division, U.S. Army Corps of Engineers, Honolulu, Hawaii.

Maragos, J.E., J. Roach, R.L. Bowers, D.E. Hemmes, R.F.L. Self, J.D. Macneil, K. Ells, P. Omeara, J. Vansant, A. Sato, J.P. Jones, D.T.O. Kam. 1977. Environmental surveys before, during, and after offshore marine sand-mining operations at Keauhou Bay, Hawaii. Working Paper No. 28. Sea Grant College Program, University of Hawaii, Honolulu.

Maurer, D.L., R.T. Keck, J.C. Tinsman, W.A. Leatherm, C.A. Wethe, M. Huntzinger, C. Lord, and T.M. Church. 1978. Vertical migration of benthos in simulated dredged material overburdens. Vol. I: Marine benthos. Dredged Material Research Program. Technical Rept. D-78-35. 108 pp.

Moiseev, P.A. 1971. The living resources of the world ocean. Israel Prog. for Sci. Trans., Jerusalem. Nat. Sci. Found., Washington, D.C. 334 pp.

Morton, J.W. 1976. Ecological impacts of dredging and dredge spoil disposal: a literature review. M.S. thesis, Cornell University.

Natarajan, K.V. 1970. Toxicity of ammonia to marine diatoms. J. Wat. Poll. Cont. Fed. 42(5):R184-R190.

Neighbor Island Consultants. 1977. Final report. Environmental surveys of deep ocean dredged spoil disposal sites in Hawaii. Prepared for U.S. Army Corps of Engineers, Honolulu, Hawaii. Volumes I and II.

NOAA. 1978. State of Hawaii coastal management program and draft environmental impact statement. U.S. Department of Commerce, NOAA, Office of Coastal Zone Management. 402 pp.

Norris, K.S. and R.R. Reeves (eds.). 1978. Report of a workshop on problems related to humpback whales (Megaptera novaeangliae) in Hawaii. Oct. 1977. Final Report to U.S. Marine Mammal Commission, Contract MMFAC018.

Olson, R.A., H.F. Brust, and W.L. Tressler. 1941. Studies of the effects of industrial pollution in the lower Patapsco River Area; I. Curtis Bay Region. Pub. No. 43. Chesapeake Biological Laboratory. Solomons Island, Maryland.

Paffenhofer, G.A. 1972. The effects of suspended "red mud" on mortality, body weight, and growth of the marine planktonic copepod, Calanus helgolandicus. Water, Air and Soil Poll. 1:314-321.

Parsons, T.R., and M. Takahashi. 1973. Biological oceanographic processes. Pergamon Press, New York. 186 pp.

Peddicord, R.K., V.A. McFarland, D.P. Belfiori, and T.E. Byrd, 1975. Dredge disposal study, San Francisco Bay Estuary. Appendix G: Physical impact, effects of suspended solids on San Francisco Bay organisms. U.S. Army Engineer District, San Francisco, California.

Pequegnat, W.E., in collaboration with David D. Smith, et al. 1978. An assessment of the potential impact of dredged material disposal in the open ocean. Technical Report D-78-2, January 1978, prepared by TerEco Corporation, for the Environmental Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. NTIS No. AD A050 914.

Redfield, A.C., B.H. Ketchum, and F.S. Richards. 1963. The influence of organisms on the composition of seawater. Pages 26-77 in M.N. Hill, ed. The sea. Vol. 2. Interscience.

Reeve, M.R. 1963. The filter-feeding of Artemia; II, in suspensions of various particles. J. Exp. Biol. 40:207-214.

Rogers, B.A. 1969. Tolerance levels of four species of estuarine fishes to suspended mineral solids. M.S. Thesis, University of Rhode Island.

Rogers, R.M. 1976. Distribution of meiobenthic organisms in San Antonio Bay in relation to season and habitat disturbance. In: A.H. Bouna, ed. Shell dredging and its influence on Gulf Coast environments. Gulf Publ. Co., Houston, Texas.

Rowe, G.T. and D.W. Menzel. 1971. Quantitative benthic samples from the deep Gulf of Mexico with some comments on the measurement of deep-sea biomass. Bull. Mar. Sci. 21(2):556-566.

Saila, S.B., S.D. Pratt, and T.T. Polgar. 1971. Providence Harbor improvement spoil disposal site evaluation study - phase II. Report to Bureau of Sport Fish. and Wildlife, Mar. Exper. Sta., Univ. of Rhode Island, Kingston, Rhode Island.

Saila, S.B., S.D. Pratt, and T.T. Polgar. 1972. Dredged spoil disposal in Rhode Island Sound. Tech. Rep. No. 2, Univ. of Rhode Island. 48 pp.

Sanders, H.L. 1958. Benthic studies in Buzzards Bay. I. Animal-sediment relationships. Limnol. and Oceanogr. 3(3):245-258.

Sands, M.D., M. Andrews, M.K. Howard, M. Smookler, S.M. Sullivan. 1978. Draft environmental impact assessment - Ocean Thermal Energy Conversion (OTEC) Preoperational Ocean Test Platform. Prepared for the U.S. Department of Energy, Division of Solar Energy.

Sherk, J.A., Jr., J.M. O'Conner, and D.A. Neumann. 1976. Effects of suspended solids on selected estuarine plankton, Misc. Report No. 76-1, U.S. Army Coastal Engineering Research Center, CE, Fort Belvoir, Virginia.

Sinay-Friedman, L. 1979. Supplement to the draft environmental impact assessment, ocean thermal energy conversion (OTEC) preoperational ocean test platform. Prepared for the United States Department of Energy.

Smith, G. 1979. Personal communication. Tetra Tech, Inc., Pasadena, California.

Soares, M., E. Shallenberger, and R. Antinoja. 1977. Abstract submitted for second conference on biology of marine mammals - December 1977.

State of Hawaii. 1974. The State of Hawaii Data Book. Department of Planning and Economic Development.

Steele, J.H. 1964. A study of production in the Gulf of Mexico. Journal Marine Research. 22(3):211-222.

Stern, E.M. and W.B. Stickle. 1978. Effects of turbidity and suspended material in aquatic environments: literature review. Technical Report D-78-21, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

Struhsaker, P. 1973. A contribution to the systematics and ecology of Hawaiian bathyal fishes. Ph.D. Thesis. University of Hawaii, Honolulu. 482 pp.

Struhsaker, P., and D.C. Aasted. 1974. Deepwater shrimp trapping in the Hawaiian Islands. Mar. Fish. Rve. 36(10):24-30.

Swafford, B. 1979. Personal communication. Portland CE District, Portland, OR.

Sverdrup, H.U., M.W. Johnson, and R.H. Fleming. 1942. The oceans: their physics, chemistry, and general biology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 1060 pp.

Tetra Tech, Inc. 1976. Environmental impact assessment: water quality analysis - Hawaii. Prepared for National Commission on Water Quality, Washington, D.C.

Tetra Tech, Inc. 1977. Ocean disposal of harbor dredged materials in Hawaii. Final Report. Prepared for U.S. Army Corps of Engineers, Ft. Shafter, Hawaii. Tetra Tech Report TC 852. 154 pp.

Thiel, H. 1975. The size structure of the deep-sea benthos. Int. Revues Hydrobiol. 60:576-606.

R.M. Towill Corporation. 1972. Environmental assessment of maintenance dredging operations for Port Allen Harbor, Kauai, Hawaii. 1600 Kapiolani Blvd., Honolulu, Hawaii.

U.S. Army Corps Engineer District. 1975. Final environmental statement. Harbor maintenance dredging in the state of Hawaii. U.S. Army Engineer District, Honolulu, Hawaii.

U.S. Army Corps of Engineers. 1977. Dredged Material Research Program: fourth annual report. Environmental Effects Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. 165 pp.

U.S. Dept. of Commerce. 1978. United States Coast Pilot #7. Pacific coast: California, Oregon, Washington, and Hawaii. Fourteenth edition. National Oceanic and Atmospheric Administration. 404 pp.

U.S. Environmental Protection Agency and Corps of Engineers. 1977. Ecological evaluation of proposed discharge of dredged material into ocean waters. Implementation manual for Section 103 of Public Law 92-532 (Marine Protection, Research, and Sanctuaries Act of 1972). Environmental Effects Laboratory,. U.S. Army Waterways Experiment Station, Vicksburg, Mississippi. 121 pp.

U.S. Environmental Protection Agency. 1976. Quality criteria for water. U.S. Government Printing Office, Washington, D.C.

U.S. Navy Weather Service Command. 1971. Synoptic summaries of meteorological observations. Volume I. Areas 1-4: Hawaiian and selected North Pacific island coastal areas. 632 pp.

U.S. Navy Headquarters, Naval Base Pearl Harbor. 1980. Personal communication, Dick Leong.

Welch, P.S. 1952. Limnology. 2nd edition. McGraw-Hill, N.Y. 176 pp.

Wiebe, P.H., S. Boyd, and J.L. Cox. 1975. Relationships between zooplankton displacement volume, wet weight, dry weight, and carbon. Fishery Bulletin. 23(4):777-786.

Wieser, W. 1959. The effects of grain size on the distribution of small invertebrates inhabiting the beaches of Puget Sound. Limnol. and Oceanogr. 4(2):181-194.

Windom, H.L. 1972. Environmental aspects of dredging in estuaries. J. Waterways, Harbors and Coastal Engineering Div., ASCE, New York. 98:475-487.

Windom, H.L. 1975. Water-quality aspects of dredging and dredge-spoil disposal in estuarine environments. Pages 559-571 in L.E. Cronin, ed. Estuarine Research, Vol. 2. Academic Press, New York.

Windom, H.L. 1976. Environmental aspects of dredging in the coastal zone. CRC Critical Rev. in Environ. Control. 6(2):91-109.

Wolman, A.A., and C.M. Jurasz. 1977. Humpback whale distribution in Hawaii. Nat. Mar. Fish. Serv., Mar. Fish. Rev. Paper 1254. 39(7).

Wuhrmann, K., and H. Woker. 1948. Toxicity of fish. II. Experimental investigations on the toxicity of ammonia and cyanide. Schweiz. Zeitschr. Hydrol. 11:210-244.

Youngberg, A.D. 1973. A study of sediments and soil samples from Pearl Harbor area. Naval Civil Engineering Laboratory. Port Hueneme, California 185 pp.

APPENDICES

Appendix A

GENERIC SITE CHARACTERISTICS

CONTENTS

FIGURES

TABLES

Appendix A

GENERIC SITE CHARACTERISTICS

The physical and geological characteristics of the proposed Hawaii Sites discussed in this appendix are supplementary to the data in Chapter 3, "Affected Environment."

PHYSICAL CHARACTERISTICS

CURRENTS

Current measurements in the proposed sites are few in number. Three studies were conducted near the sites: (1) Neighbor Island Consultants (1977) deployed a moored array of current meters and surface current drogues at the proposed sites; however, the current meters were deployed for only 12 to 24 hours, (2) Chave and Miller (1977b) recorded 35 days of continuous current measurements at several depths near the proposed South Oahu Site, and (3) Bathen (1974) studied the circulation of the nearshore region between Pearl Harbor and Barbers Point. Specific information relevant to the individual proposed sites is described below.

South Oahu Site

Bathen (1974) studied the inshore (shoreward of the 180-meter contour) circulation between Pearl Harbor and Barbers Point. One station just south of Pearl Harbor was north of the proposed South Oahu Site. Three current meters were deployed for two 30-to-40-day periods August to September, and December to January. The current meters were moored near the surface, at mid-depth, and near the bottom. Measurements showed wide variations of directional orientation in near-surface and near-bottom currents. At the mid-depth level, a strong east-west directional predominance (corresponding to the tides) was observed. Daily net transport at the surface and mid-depth was north-northwest, towards the harbor entrance. Near-bottom net transport was slower and generally westward. Current velocities near the bottom rarely exceeded

10 cm/sec. During flood tides the flow favored a westerly direction, but during ebb tides, currents were generally eastward. Often, an onshore-offshore component in the flow was observed, evidently due to the daily flooding and ebbing of Pearl Harbor. An 11-to-14-day periodicity was observed in the current records from this station. For 8 to 10 days, the flow was strong, unidirectional, and generally towards the southwest. During the following 3 to 4 days the transport rate decreased somewhat, and the directional flow either decreased or reversed. The cycle was then repeated with strong directional flows.

The direction of the net transport is apparently variable. Measurements made in 1970 show the net transport to be slightly southwesterly in direction. Two years later, data (possibly Bathen's) showed a net north-northwest transport (Tetra Tech, 1976). This net shift has been explained as a consequence of the relationship between freshwater flows into Pearl Harbor and the excess evaporation from the Harbor surface. During Kona (southerly) winds, an increase in the onshore component of the surface flow occurs.

Chave and Miller (1977b) measured the currents near the proposed South Oahu Site during May 1977. Current meters were deployed at three depths: 50 m, 172 m, and 356 m. Instrument malfunctions were blamed for an approximate 40% data loss; the upper meter returned only 8 days of data from a 30-day deployment, and the mid-depth meter returned only velocity measurements. Mean velocity from the 8-day record was 5 cm/sec towards the southeast. Mean velocity from the bottom current meter (full 30 days of record) was about 9 cm/sec towards the west. Maximal speeds of 40 and 50 cm/sec were reported for the surface and bottom meters, respectively.

Neighbor Island Consultants (1977) performed a survey near the proposed South Oahu Site. They used moored current meters and surface current drogues. Two separate current meter deployments were made. One was deployed for 25 hours and the other for 35 days. Drogues were followed during the daylight hours for two consecutive days. Difficulties were encountered in data reduction and in the meters' performances; hence, only generalities can be obtained from the results. Surface drift during the first and second drogue deployments was consistently to the north and west. Speeds on the first day were estimated to be 5 to 10 cm/sec. On the second day speeds increased to an estimated 67 cm/sec. Results from the 25-hour survey suggest that at 46 and 183 m depth the direction is generally to the southwest. Records from the deeper current meters suggest that the general direction of the flow is somewhat northerly, and speeds generally decrease with increasing depth. The shallow current meter (23 m depth) returned 15 days of data before failing. In general, the majority of the speeds were between 8 and 15 cm/sec. Maximal speed recorded was 40 cm/sec. Currents tended towards every direction except southward. Tidal effects were always apparent. At 183 m depth, a full 35 days of data were recovered. About 75% of the current speeds were between 13 and 23 cm/sec. The flow directions were generally west-northwest and east-southeast, apparently reversing tidally along the bottom. At 366 m depth, flow was strong to the west; however, the current speeds from this record were clearly anomalous. The deepest meter (451 m depth) indicated that about 60% of the current velocities were between 8 and 20 cm/sec. However, no particular direction was dominant.

Nawiliwili Site

Neighbor Island Consultants (1977) estimated the surface currents (0 to 50 m depth) to be between 20 and 30 cm/sec in a southerly direction, based upon current drogue trajectories. Current meters were deployed at 50 m, 180 m, and 370 m depths. Maximal current velocity was approximately 66 cm/sec. The records showed strong tidal influences and mean current speeds were found to range from 15 to 40 cm/sec for the 370- and 50-meter records, respectively.

Port Allen Site

Estimates of the surface currents at this proposed Site were based on the trajectories of surface current drogues (Neighbor Island Consultants, 1977). Estimated current velocities at 3 and 18 m depth were north-northwest at speeds of 5 to 46 cm/sec. Drogues deployed at 30 and 46 m depths showed a mean flow towards the east. Current meters were deployed at two depths, 366 and 1,579 m. The upper meter recorded northward currents at speeds of 10 to 26 cm/sec. The extremely high values recorded by the lower meter were believed to be in error.

Kahului Site

Surface currents, estimated by current drogues, were very strong to the west at speeds of 51 to 113 cm/sec. Current meter data indicated a consistent flow towards the west between the surface and 45 m depth. The direction was towards the northwest at 183 m and 360 m depth. Mean speeds decreased with depth and were 45, 25, 17, and 15 cm/sec for depths of 15, 45, 183 and 360 m, respectively (Neighbor Island Consultants, 1977).

Hilo Site

Surface currents were estimated, from drogue movements, to be towards the northwest at speeds ranging from 15 to 36 cm/sec. Current meter measurements showed that current speeds decreased with depth, and simultaneously became more consistent in direction. Mean speeds were 29, 19, 16, and 11 cm/sec for current meters at depths of 15, 45, 183 and 341 m, respectively. Flow directions at the deeper meters were generally towards the north (Neighbor Island Consultants, 1977).

TEMPERATURE PROFILE

Temperature measurements were made near the proposed South Oahu Site by Chave and Miller (1977b), by means of expendable bathythermograph (XBT) drops on August 3, 1976. The surface mixed layer (the isothermal surface layer) extended from the surface to about 50 m depth. In October the surface mixed layer had deepened to about 75 m depth. During the second survey (in October) temperatures in the mixed layer were about 1°C higher (about 26°C). Table A-1 shows the values obtained during each survey. Observed temperatures ranged from 10.5°C to 26.3°C .

Neighbor Island Consultants (1977) performed salinity-temperature-depth (S-T-D) casts at each of the proposed sites; however, equipment malfunctions prevented data (from depths shallower than about 40 m) from being recorded. Equipment problems were blamed for the complete loss of data from the proposed Port Allen Site. Digitized data are shown in Tables A-2 to A-5. In general, the temperature profiles for these stations are quite similar, gradually decreasing with increasing depths.

TABLE A-1
TEMPERATURE, SALINITY, DISSOLVED OXYGEN, AND pH NEAR THE PROPOSED SOUTH OAHU SITE

Station	Depth (m)	Temperature (°C)		Salinity (g/kg)	Dissolved Oxygen (ml/l)	pH
		8/3/76	9/9/76			
1	0	25.4	26.3	34.8	5.7	8.1
	25	25.1	26.2	34.1	5.5	8.2
	50	24.9	26.2	34.3	5.5	8.2
	100	22.3	.23.2	34.5	5.3	8.2
	200	14.9	17.8	34.5	5.1	8.1
2	0	25.3	26.3	34.5	5.5	8.1
	25	25.2	26.2	34.5	5.6	8.2
	50	25.0	26.0	34.8	5.6	8.2
	150	19.5	20.3	33.7	5.4	8.1
	250	13.2	16.2	34.9	5.1	8.1
3	0	25.2	26.2	34.5	5.5	8.2
	25	25.1	26.1	35.0	5.6	8.2
	50	24.8	25.5	34.0	5.5	8.2
	100	21.3	23.2	35.6	5.2	8.0
	200	16.5	18.0	35.0	5.0	8.0
	300	10.5	12.5	34.5	4.8	7.9
4	0	--	26.2	34.8	5.4	8.1
	25	--	26.1	34.3	5.6	8.1
	50	--	26.1	33.8	5.6	8.2
	100	--	22.0	36.0	5.7	8.2
	200	--	19.2	34.0	5.4	8.1
	400	--	12.6	34.3	5.2	7.9

Source: Chave and Miller, 1977b

TABLE A-2
DIGITIZED S-T-D DATA - HONOLULU

STATION: Honolulu #3 ZERO ERROR, CONDO: +0.40 ZERO ERROR, TEMP: +0.39	LAT 21°15'00"N LONG 157°56'00"W	DEPTH INCREMENT: 20 m DEPTH ERROR: + 2 m DATE, TIME: 7/23/76, 18:12

Increment	Depth (m)	Conductivity (MMHOS/CM)	Temperature (°C)	Salinity g/kg	Sigma T
1	45	53.14	24.18	35.68	24.13
2	67	52.05	23.04	35.76	24.54
3	87	51.24	22.28	35.74	24.74
4	107	50.79	21.70	35.86	24.99
5	127	50.09	21.02	35.86	25.18
6	147	49.56	20.44	35.92	25.38
7	168	48.94	19.99	35.82	25.40
8	187	48.06	19.24	35.69	25.52
9	207	47.61	18.86	35.63	25.57
10	227	46.33	17.71	35.53	25.79
11	247	44.39	16.16	35.19	25.89
12	267	42.28	13.79	35.40	26.57
13	287	40.19	12.24	34.83	26.45
14	307	39.20	11.25	34.78	26.60
15	327	38.67	10.63	34.83	26.75
16	347	37.73	9.74	34.72	26.81
17	367	37.28	9.30	34.67	26.85
18	387	36.60	8.59	34.67	26.94
19	407	36.63	8.17	35.07	27.35
20	427	35.76	7.66	34.64	27.08
21	447	35.57	7.41	34.67	27.14
22 END	455	35.06	7.08	34.44	27.16

Source: Neighbor Island Consultants, 1977

TABLE A-3
DIGITIZED S-T-D DATA - NAWILIWILI

STATION: Nawiliwili #1 ZERO ERROR, CONDO: 0.021 ZERO ERROR, TEMP: 0.03	LAT 21°55'00"N LONG 159°17'00"W	DEPTH INCREMENT: 20 m DEPTH ERROR: 78 m DATE, TIME: 8/05/76, 11:45

Increment	Depth (m)	Conductivity (MMHOS/CM)	Temperature (°C)	Salinity (g/kg)	Sigma T
1	76	53.75	24.61	35.78	24.07
2	97	52.89	23.56	35.97	24.53
3	117	52.44	22.53	36.47	25.21
4	137	51.25	21.52	36.37	25.41
5	157	50.69	21.05	36.31	25.50
6	177	49.40	19.93	36.21	25.72
7	197	48.28	18.64	36.39	26.20
8	217	47.10	18.06	35.89	25.96
9	237	45.65	16.81	35.73	26.14
10	257	44.74	16.16	35.50	26.12
11	277	42.52	13.72	35.68	26.79
12	297	41.49	12.87	35.49	26.82
13	317	40.89	11.79	35.93	27.37
14	337	39.56	10.69	35.66	27.37
15	357	38.72	9.84	35.63	27.49
16	378	37.74	9.20	35.24	27.30
17	396	37.04	8.34	35.35	27.52
18	417	36.74	7.98	35.38	27.60
19	437	36.20	7.49	35.29	27.60
20	457	35.97	7.06	35.46	27.80
21	477	35.50	6.51	35.49	27.90
22	497	35.00	6.26	35.18	27.68
23	517	34.87	5.92	35.38	27.89
24	537	34.66	5.66	35.40	27.94
25	568	34.52	5.50	35.40	27.96
26	577	34.38	5.30	35.44	28.01
27	597	34.27	5.30	35.30	27.90
28	617	34.26	5.26	35.32	27.92
29	637	34.26	5.20	35.38	27.98
30	657	34.26	5.13	35.44	28.03
31	677	34.17	4.99	35.47	28.07
32	697	34.09	4.91	35.46	28.07
33	717	34.01	4.80	35.47	28.10
34	737	33.89	4.75	35.37	28.02
35	757	33.88	4.75	35.35	28.01
36	777	33.81	4.62	35.40	28.06
37	797	33.73	4.55	35.37	28.04
38	817	33.72	4.50	35.40	28.07
39	837	33.64	4.41	35.39	28.08
40	857	33.46	4.29	35.30	28.02
41	877	33.18	4.17	35.08	27.86
42	897	33.07	4.15	34.96	27.76
43	917	33.03	4.10	34.96	27.77

Source: Neighbor Island Consultants, 1977

TABLE A-4
DIGITIZED S-T-D DATA - KAHULUI

STATION: Kahului #7A ZERO ERROR, CONDO: 0.00 ZERO ERROR, TEMP: 0.01	LAT 21°04'42"N LONG 156°28'48"W	DEPTH INCREMENT: 20 m DEPTH ERROR: 79 m; 9 m DATE, TIME: 7/25/76, 11:34

Increment	Depth (m)	Conductivity (MMHOS/CM)	Temperature (°C)	Salinity g/kg	Sigma T
1	77	53.05	24.85	35.07	23.46
2	86	52.61	23.92	35.47	24.04
3	106	52.44	23.35	35.79	24.45
4	126	52.15	22.86	35.96	24.72
5	146	51.21	22.49	35.53	24.50
6	166	50.88	21.69	35.92	25.03
7	186	49.97	21.35	35.47	24.78
8	206	48.85	21.32	34.60	24.13
9	226	46.39	18.42	34.97	25.17
10	246	44.32	16.40	34.92	25.62
11	266	42.66	14.78	34.85	25.93
12	286	41.99	14.05	34.88	26.11
13	306	41.30	13.56	34.67	26.05
14	326	40.58	12.76	34.71	26.24
15	346	40.17	12.28	34.75	26.36

Source: Neighbor Island Consultants, 1977

TABLE A-5
DIGITIZED S-T-D DATA - HILO

STATION: Hilo #9 ZERO ERROR, CONDO: 0.035 ZERO ERROR, TEMP: 0.021	LAT 19°48'30"N LONG 154°58'30"W	DEPTH INCREMENT: 20 m DEPTH ERROR: 61 m DATE, TIME: 7/27/76, 15:43

Increment	Depth (m)	Conductivity (MMHOS/CM)	Temperature (°C)	Salinity g/kg	Sigma T
1	61	50.53	21.91	35.50	24.65
2	81	50.53	21.26	36.03	25.23
3	101	50.83	21.65	35.94	25.05
4	121	50.12	21.25	35.70	24.98
5	141	48.80	20.00	35.67	25.29
6	161	46.54	18.11	35.39	25.56
7	181	44.38	16.05	35.31	26.00
8	201	42.99	15.00	34.98	25.98
9	221	42.00	13.73	35.21	26.43
10	241	39.40	11.54	34.73	26.49
11	261	38.65	10.31	35.14	27.03
12	281	38.15	9.45	35.46	27.43
13	301	37.25	8.88	35.08	27.22
14	321	36.82	8.72	34.77	27.01

Source: Neighbor Island Consultants, 1977

SALINITY PROFILE

Wide horizontal variations in salinity were observed at three stations (1, 2, 3; Table A-1) north of the proposed South Oahu Site, and at a fourth station inside the site during the survey performed by the Environmental Center at the University of Hawaii (Chave and Miller, 1977b). The variations were noted especially in waters shallower than 100 m. Below this layer, a salinity maximum was observed, and below this maximum, salinities decreased in value towards the bottom. Salinity values were reported only to the first decimal place and, therefore, were not readily usable for density calculations. Values ranged from 36.0 to 33.7 g/kg.

Neighbor Island Consultants (1977) provided salinity profiles for the proposed sites, with the exception of the proposed Port Allen Site, where the data were lost due to equipment failure. Analogous to temperature profiles, salinity profiles are quite similar at all stations (Tables A-2 to A-5). The salinity maximum occurs at about 100 to 120 m depth; below this depth, salinity slowly decreases to a depth of 380 m, and remains the same to the bottom.

GEOLOGICAL CHARACTERISTICS

SEDIMENTS

Table A-6 lists the characteristics of sediment samples taken from the proposed sites, before and after dredging of the respective harbors in 1977. Grain-size distributions show that the proposed disposal site bottoms are composed mainly of sand, and analyses show the sediment to be chiefly calcium carbonate at the proposed South Oahu, Port Allen, and Kahului Sites. Sediments at the proposed Hilo Site are mainly silt and clay. The percentage of calcium carbonate decreased in postdisposal values for all the sites except the proposed South Oahu Site. The percentage of basalt decreased after disposal for the proposed South Oahu, Port Allen, Kahului, and Hilo Sites, but increased at the proposed Nawiliwili Site. Percentages of carbon in the disposal site sediments decreased after disposal at the proposed South Oahu and Port Allen Sites, but remained unchanged at the proposed Nawiliwili Site, and increased at the proposed Kahului and Hilo Sites.

Grain-Size Distribution

Goeggel (1978) has determined the grain-size distribution of post-disposal sediments for each proposed Site (Figures A-1 to A-5). Grain-size distributions from the Neighbor Island Consultants (1977) pre-disposal study are plotted for comparison. Sediment distributions of the proposed Port Allen and South Oahu Sites show great similarity between pre-disposal and post-disposal samples. Sediments collected from Nawiliwili, however, are much finer in the post-disposal samples when compared to the pre-disposal samples. An analysis of the dredged material discharged at the proposed Nawiliwili Site did show a greater percentage of finer sediments.

Analyses of the post-disposal sediments from the proposed Hilo Site showed varied results. Some samples were similar to pre-disposal findings, while other samples were much finer. The analysis of the dredged material dumped at this site showed the waste to have characteristically finer grain size than that of the proposed Hilo Site pre-disposal sediment characteristics. No other evidence (e.g., discoloration, layering, microscopic analysis) was observed which would indicate that dredged material had been deposited in the area.

Trace Metals

Pre-disposal and post-disposal concentrations of cadmium in sediments at the proposed sites are each greater than in corresponding harbor sediments for the proposed South Oahu, Nawiliwili, Port Allen, and Kahului Sites, although the concentration of cadmium in sediments at the proposed Hilo Site is approximately equal to the concentration of cadmium in Hilo Harbor. Post-disposal concentrations of cadmium in sediments are lower than pre-disposal concentrations for all disposal sites except the proposed South Oahu Site. Sediments at the proposed South Oahu Site show a post-disposal decrease in cadmium concentration. The pre-disposal and post-disposal values for cadmium in sediments at all harbors are each greater than the cadmium content of basalt, and all values are below the Federal ocean disposal criteria for cadmium (40 CFR Section 227.6).

The pre-disposal and post-disposal concentrations of chromium in sediments at the proposed South Oahu Site are less than the concentrations of chromium in the sediments of Pearl and Honolulu Harbors. The post-disposal concentrations of chromium in sediments are higher than the pre-disposal values for all proposed sites. All concentrations of chromium in sediments are less than the concentration of chromium in basalt.

The pre-disposal and post-disposal concentrations of copper in sediments at the proposed South Oahu Site are less than the concentrations of copper in sediments from Pearl and Honolulu Harbors. The post-disposal concentrations of copper in sediments are higher than the pre-disposal values for all proposed sites. All pre-disposal copper values are less than the concentration of copper in basalt. Post-disposal concentrations of copper in sediments are lower than the copper content of basalt for all proposed sites except Port Allen, which shows a higher copper concentration.

All pre-disposal concentrations of lead in sediments at the proposed sites are lower than the concentrations of lead in the corresponding harbor sediments. Post-disposal concentrations of lead in sediments are higher than the concentrations of lead in sediments at the corresponding harbors for the proposed Port Allen and Kahului Sites. The concentrations of lead in sediments at the proposed South Oahu, Nawiliwili, and Hilo Sites are lower than those in their respective harbors. The post-disposal concentrations of lead in sediments increased above the pre-disposal values at all disposal sites, and all values for lead concentration in sediments are greater than the lead content in basalt.

The pre-disposal and post-disposal concentrations of manganese in sediments at the proposed South Oahu Site are lower than the concentrations of manganese in sediments at Pearl and Honolulu Harbors. The post-disposal manganese concentrations in sediments are higher than the pre-disposal

TABLE A-6
PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE PROPOSED SITES

Grain-Size Parameter (%)		South Oahu	Nawiliwili	Port Allen	Kahului	Hilo
Gravel		12 (a,b)	6 (a)	1 (a)	11 (a)	1 (a)
Sand		75 (a,b)	92 (a)	63 (a)	80 (a)	77 (a)
Silt & Clay		13 (a,b)	2 (a)	36 (a)	9 (a)	22 (a)
Cadmium (ppm)	(a)	5.4 ± 1.4	4.8 ± 1.8	5.02 ± 2.5	6.1 ± 0.5	3.4 ± 2.2
	(c)	5.2 ± 1.8 (b,c)	3.9 ± 1.7	4.93 ± 1.1	5.7 ± 0.5	3.4 ± 0.6
Chromium (ppm)	(a)	18.7 ± 19.7	37.6 ± 40.6	186.3 ± 116	54.5 ± 11.4	147.7 ± 9.7
	(c)	67.1 ± 26.9 (b,c)	116 ± 27	210.5 ± 56	86.7 ± 20.5	115.3 ± 30
Copper (ppm)	(a)	17.6 ± 4.7	13.8 ± 15	28.7 ± 15.3	10.9 ± 1.6	33.9 ± 4.0
	(c)	37.8 ± 32 (b,c)	28.7 ± 12	56.5 ± 12.1	38.3 ± 15	38.1 ± 9.6
Lead (ppm)	(a)	38.1 ± 3.6	16.9 ± 3	19.5 ± 13.2	23.6 ± 1.7	19.5 ± 2.9
	(c)	58.7 ± 23.2 (b,c)	32.2 ± 21	39.5 ± 2.7	40.9 ± 4.4	29.0 ± 4.3
Manganese (ppm)	(a)	191.4 ± 32.8	90.1 ± 69	118 ± 64	192.7 ± 49	382.1 ± 45
	(c)	161 ± 35	526.6 ± 369	461.2 ± 305	224.6 ± 53	475.1 ± 187
Mercury (ppm)	(a)	0.52 ± 0.32	0.27 ± 0.2	0.1 ± 0	0.2 ± 0.1	0.1 ± 0
	(c)	0.85 ± 1.7	0.50 ± 0.92	0.12 ± 0.09	0.09 ± 0.07	0.59 ± 1.5
Nickel (ppm)	(a)	35.4 ± 5.1	52.3 ± 23	57.8 ± 41.3	49.7 ± 2.4	187.1 ± 17
	(b)	142.3 ± 32.6	172 ± 114	132.6 ± 21.5	56.9 ± 8.7	125.6 ± 76
Zinc (ppm)	(a)	32.0 ± 5.6	36.1 ± 25	49.9 ± 18	42.5 ± 5.8	72.4 ± 8.2
	(b)	271.8 ± 313.3	82.0 ± 23	72.9 ± 17	47.6 ± 5.7	73.4 ± 8.6
% $CaCO_3$	(a)	88 ± 5	73.7 ± 10.6	59.5 ± 7.7	76.3 ± 2.1	18 ± 1.7
	(c)	85 ± 12	29.6 ± 29.5	42.8 ± 13.5	55.5 ± 8.7	16.5 ± 4.4
% Basalt	(a)	4.13 ± 4.22	11.5 ± 5	10.4 ± 4.0	14.6 ± 2.2	49.4 ± 26
	(c)	4 ± 1.8	46 ± 23	5.5 ± 2.3	12.2 ± 4.1	41.7 ± 10
% Carbon	(a)	3.67 ± 0.33	1.4 ± 0.4	2.16 ± 0.2	1.56 ± 0.4	0.65 ± 0
	(c)	0.81 ± 0.86	1.43 ± 1.30	1.67 ± 0.7	1.89 ± 0.8	1.14 ± 0.5
% Nitrogen	(a)	0.40 ± 0.04	0.43 ± 0.04	0.12 ± 0.02	0.11 ± 0.02	0
	(c)	1.7 ± 0.8	0.13 ± 0.06	0.23 ± 0.09	0.44 ± 0.31	0.19 ± 0.1

(a) Neighbor Island Consultants, 1977 (pre-dump)
(b) Chave and Miller, 1978 (post-dump)
(c) Goeggel, 1978 (post-dump)

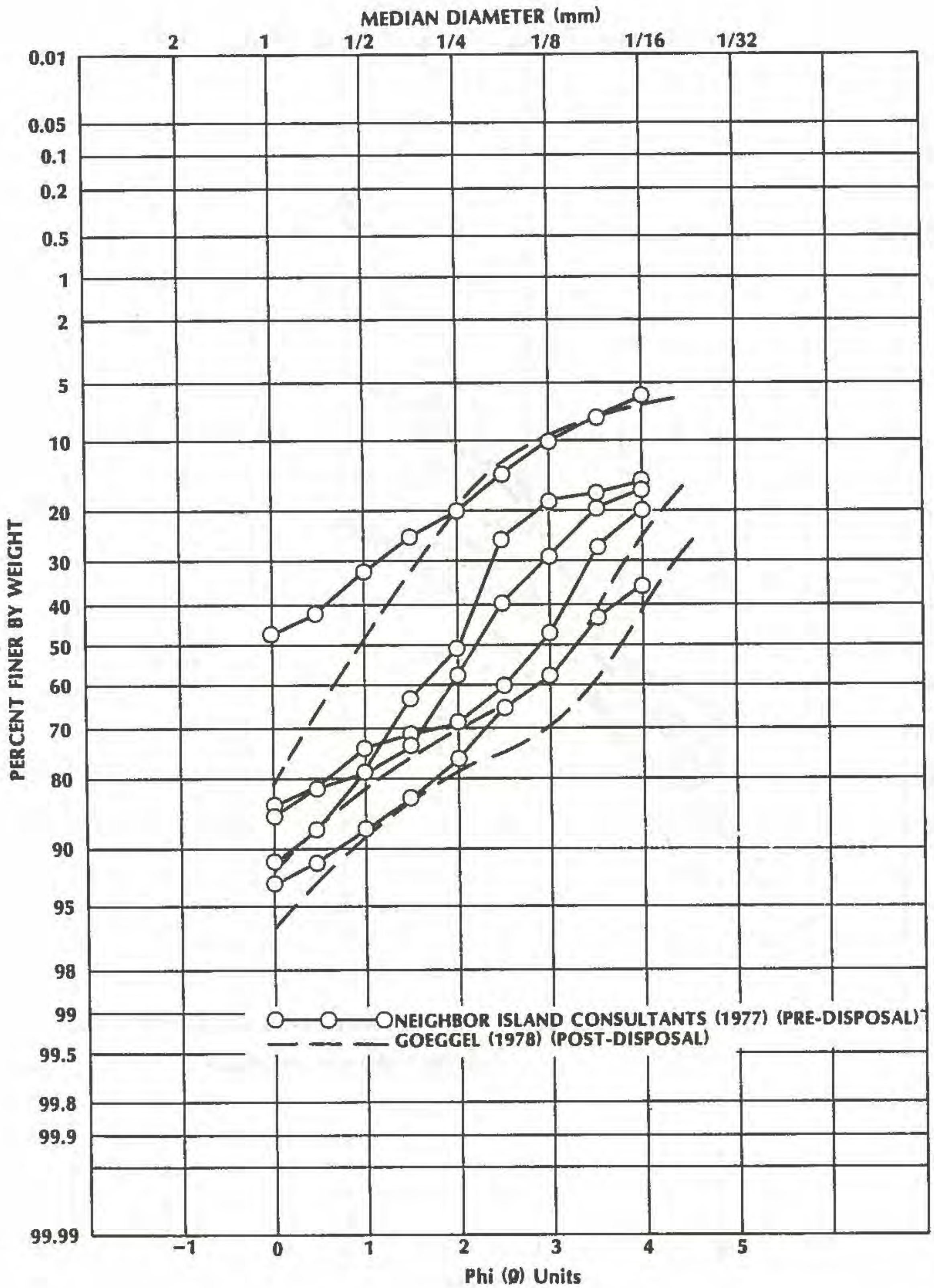


Figure A-1. Grain-Size Distribution for the Proposed South Oahu Site

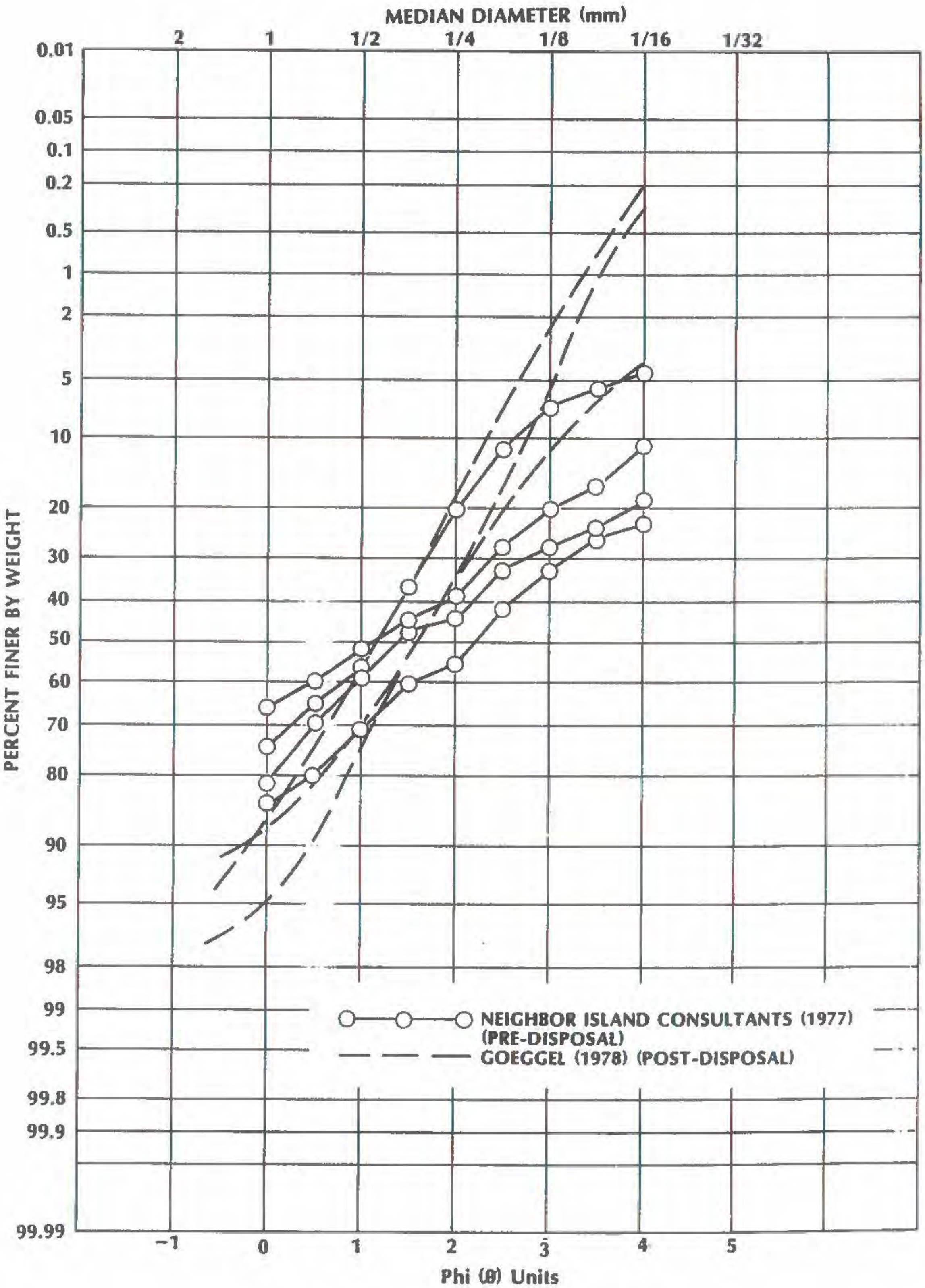


Figure A-2. Grain-Size Distribution for the Proposed Nawiliwili Site

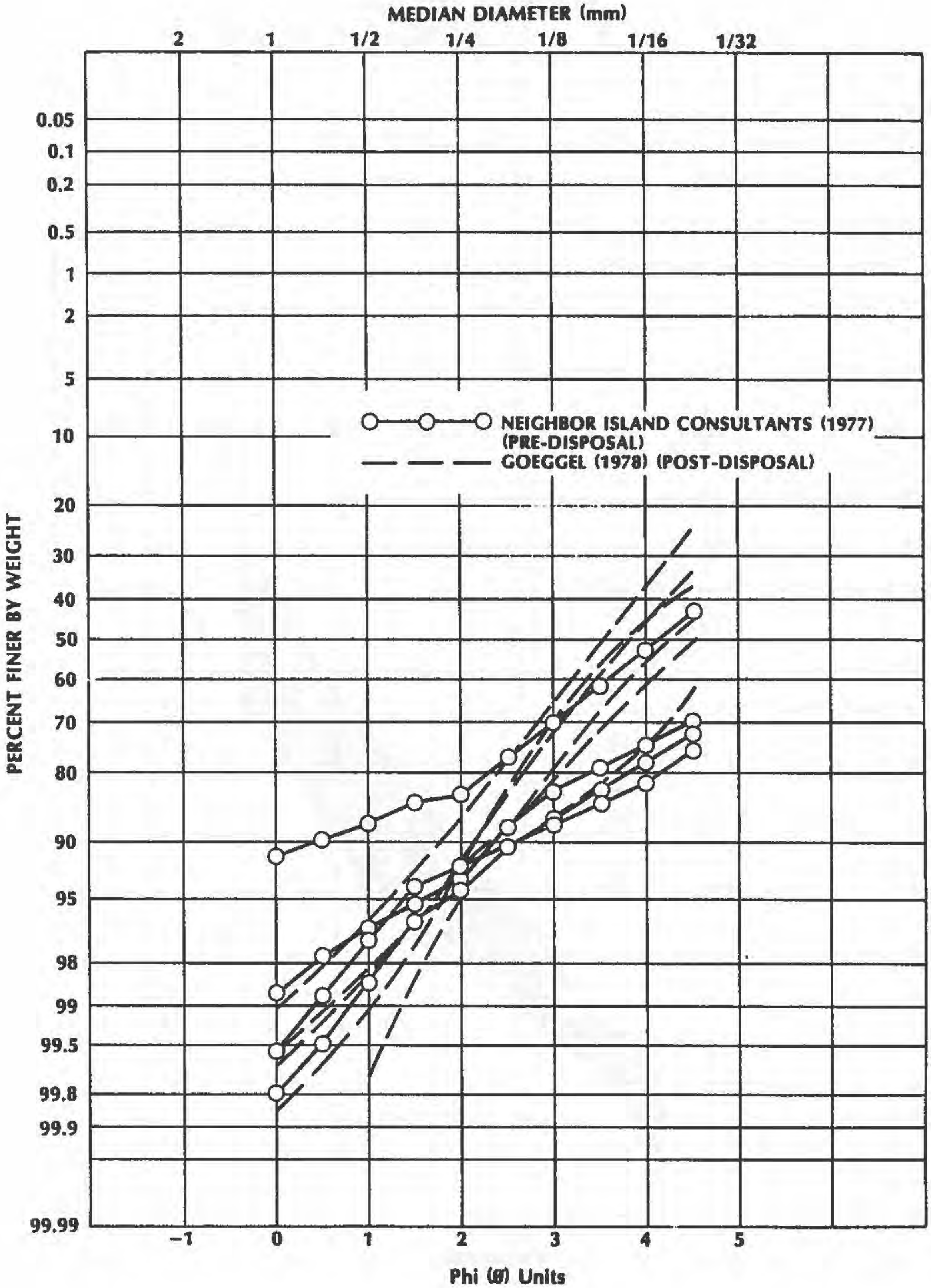


Figure A-3. Grain-Size Distribution for the Proposed Port Allen Site

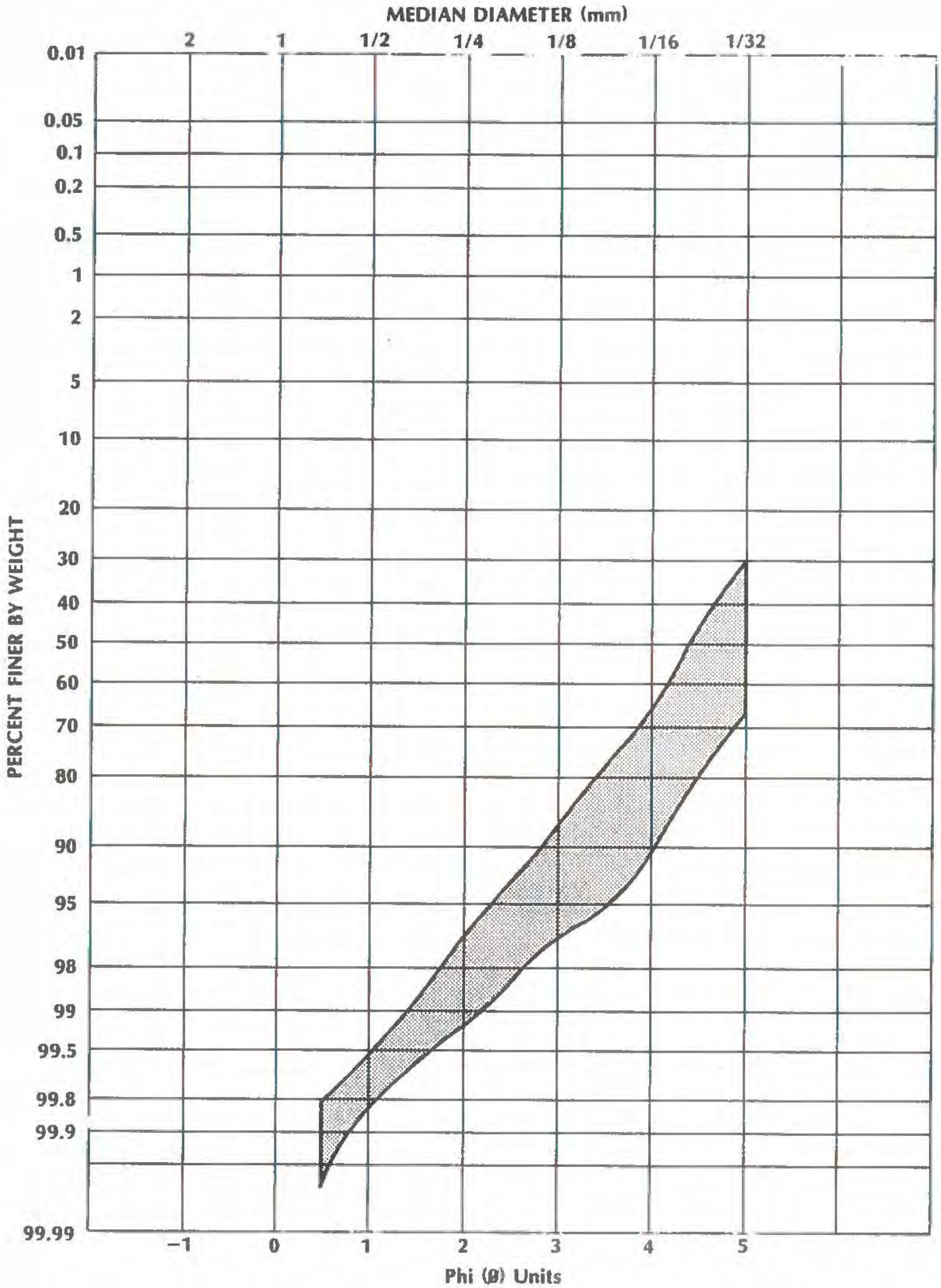


Figure A-4. Grain-Size Distribution for the Proposed Kahului Site
Source: Goeggel, 1978

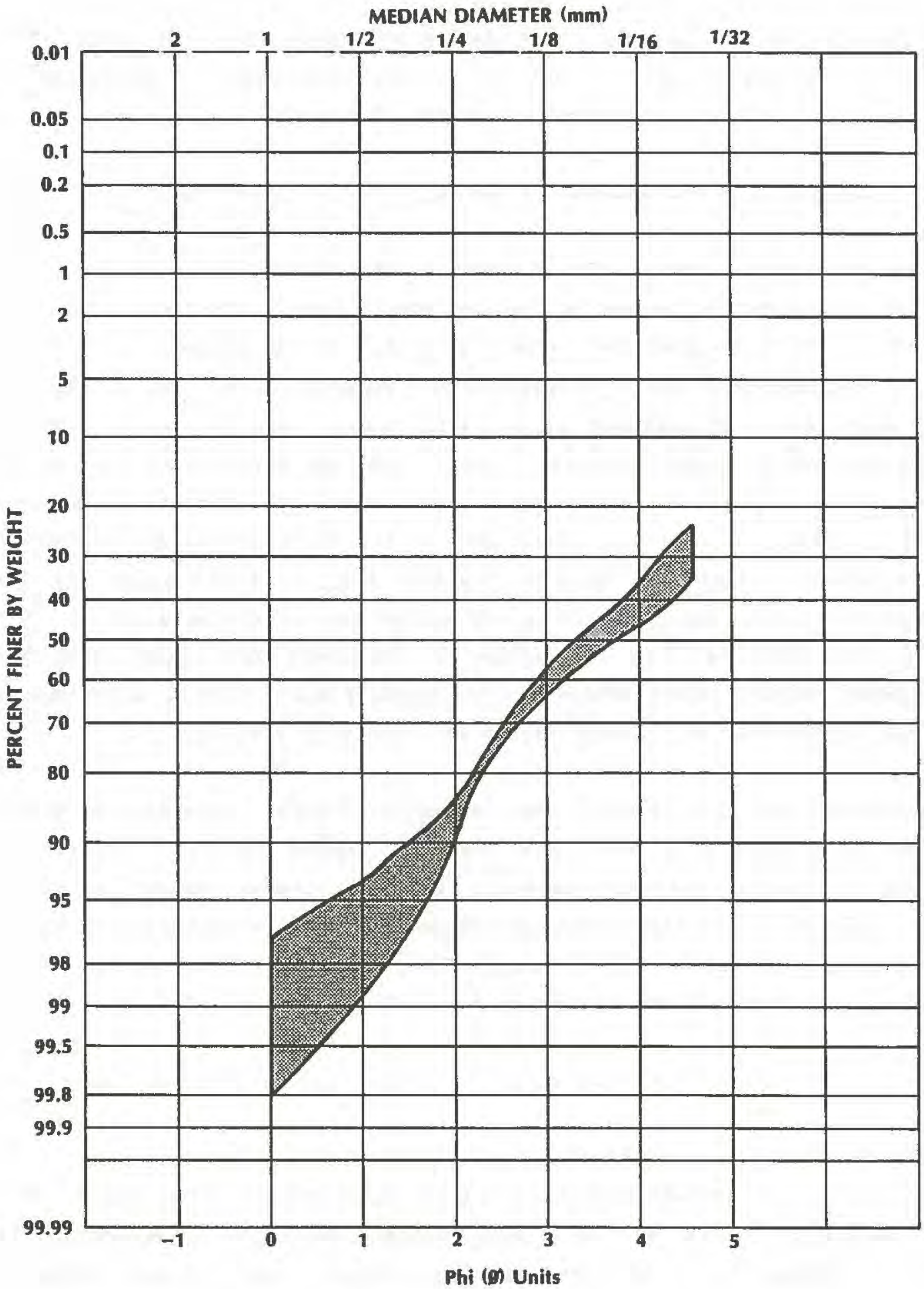


Figure A-5. Grain-Size Distribution for the Proposed Hilo Site
Source: Goeggel, 1978

concentrations for all proposed sites except the South Oahu Site, which shows a lower postdisposal value. All values for manganese concentration in sediments are less than the manganese content of basalt.

Pre-disposal concentrations of mercury in sediments are lower than concentrations of mercury in sediments at the corresponding harbors for the proposed South Oahu, Kahului, and Hilo Sites. Pre-disposal values were higher than the corresponding harbor values for the proposed Nawiliwili and Port Allen Sites. Post-disposal concentrations of mercury in sediments were lower than the corresponding harbor values for the proposed South Oahu and Kahului Sites, while the post-disposal values were higher than the harbor concentrations for the proposed Nawiliwili, Port Allen, and Hilo Sites. All values for mercury in sediments at the proposed sites were higher than the content of mercury in basalt, and the concentrations at all sites are below the Federal ocean disposal criteria for mercury (40 CFR Section 227.6) except at the proposed Hilo Site, where post-disposal values are at criteria level. All post-disposal concentrations of mercury in sediments are higher than the pre-disposal values, except those for the proposed Kahului Site, which show a decrease in post-disposal concentrations of mercury in sediments.

Pre-disposal and post-disposal concentrations of nickel in sediments at the proposed South Oahu Site are lower than the concentrations of nickel in sediments at Honolulu and Pearl Harbors. The post-disposal concentrations of nickel in sediments are higher than pre-disposal values for the proposed South Oahu, Nawiliwili, Port Allen, and Kahului Sites. Values for the proposed Hilo Site show a decrease in post-disposal concentration of nickel in sediments. Post-disposal nickel concentrations in sediments at the proposed South Oahu, Nawiliwili, Port Allen, and Hilo Sites are higher than the nickel content in basalt.

The pre-disposal concentrations of zinc in sediments at the proposed South Oahu, Nawiliwili, Port Allen, and Hilo Sites are lower than the concentrations of zinc in sediments from the corresponding harbors. Post-disposal sediment zinc concentrations in sediments at the proposed South Oahu and Nawiliwili Sites are higher than the zinc values in the corresponding harbors. Post-disposal zinc concentrations for the other sites are lower than the corresponding harbor concentrations. Both the pre-disposal and post-disposal concentrations of zinc in sediments at the proposed Kahului Site approximate the zinc content in sediments at Kahului Harbor. The post-disposal zinc concentration values for the proposed Nawiliwili and Port Allen Sites are higher than the pre-disposal values for these sites, while pre-disposal and post-disposal zinc concentrations are approximately equal for the proposed Kahului and Hilo Disposal Sites. Zinc concentrations at all proposed disposal sites are lower than the zinc content of basalt, except for the South Oahu Site, whose zinc content is greater than that of zinc in basalt.

Appendix B

DREDGED MATERIAL CHARACTERIZATION

CONTENTS

TABLES

Appendix B

DREDGED MATERIAL CHARACTERIZATION

The Federal government's harbor dredging program is part of a continuing plan to maintain adequate harbor channel and basin depths to ensure safe navigation. The deep-draft harbors considered in this EIS are dredged in approximate 5- to 10-year maintenance cycles or on an "as-needed" basis. Honolulu, Nawiliwili, Port Allen, Kahului, and Hilo Harbors are maintained under the administration of the U.S. Army Corps of Engineers. Pearl Harbor is maintained under the administration of the Department of the Navy.

Harbor dredging is performed on an "as needed" basis. High runoff during the interim periods may necessitate changes in dredging frequency. Kahului and Hilo Harbors are dredged on an approximate 10-year cycle (CE, 1975). Honolulu Harbor was dredged in 1979 as part of a Public Works operation; an estimated volume of 720,000 yd^3 of material was dumped at the proposed South Oahu (former Honolulu) Site (Maragos, 1979).

Characterization of the dredged material dumped at the disposal sites has been difficult. The major problem lies in determining what portion of the material drawn up the suction pipe of the dredging vessel is actually retained in the hoppers because the material drawn up the pipe is mainly water. Troughs at the tops of the hoppers provide a drain for excess water which is heavily laden with suspended silt and clay. The larger particles settle to the bottoms of the hoppers. Shipboard observations indicate that while large amounts of silt and clay are lost overboard with the overflow during dredging (Smith, 1979), a significant amount of fine material is retained in the hoppers and dumped at the disposal sites (Swafford, 1979). The amount of the fine-grain fraction which is lost or retained has not been determined. A true representative sample of what is being dumped rather than what is being dredged might be obtained by sampling directly from the hoppers after completion of dredging operations and before opening the hopper doors. Due to the difficulty in characterizing dredged material dumped at the sites, data from the harbors and the dredge vessel are presented.

CHARACTERISTICS OF HARBOR SEDIMENTS

The physical and chemical characteristics of the sediments in the harbors from which dredged materials are taken are listed in Table B-1. Sediments from Honolulu and Pearl Harbors are predominantly sand and silt while those at the other four harbors are mainly silt and clay. With the elutriate test, suspended solid contents in the harbor waters were determined to range from 686 mg/kg at Port Allen Harbor to 1,793 mg/kg at Kahului Harbor. Honolulu Harbor has an average total suspended solids concentration of approximately 832 mg/kg. No suspended solids data are available for Pearl Harbor.

Metal concentrations in harbor sediments are compared to their respective concentrations in basalt to illustrate the contribution of these metals to the harbors by the natural weathering of the Hawaiian Islands, which are composed mainly of basalt.

Heavy metal concentrations in sediments are consistently higher (cadmium excepted) at Honolulu and Pearl Harbors than at the other four Hawaiian harbors. Cadmium concentrations in harbor sediments range from less than 2 mg/kg at Pearl Harbor to 4.6 mg/kg at Honolulu Harbor. All Hawaiian harbors have slightly higher cadmium concentrations than the average cadmium concentration in basalt (0.11 mg/kg). However, all harbor sediment cadmium concentrations were below the interim EPA guidelines (then in effect), obtained by multiplying 1.5 by the ambient concentrations in the sediments of the respective disposal sites (40 CFR 227.6[e][2]). Youngberg (1973) noted that cadmium concentrations in cultivated soils, stream sediments, and sediments of Pearl Harbor are higher than in uncultivated soils, suggesting the addition of cadmium by man-made activities (cadmium is usually associated with phosphate found in fertilizers and detergents). Youngberg also suggested that water movement in irrigation and stream beds might concentrate the metal from natural materials.

Chromium concentrations in sediments are available only for Pearl and Honolulu Harbors; Pearl Harbor has the higher concentration. Both harbors are well under the average basaltic rock chromium concentration of 244 mg/kg.

TABLE B-1
PHYSICAL AND CHEMICAL CHARACTERISTICS OF HARBOR SEDIMENTS*

Parameter	Honolulu Harbor	Pearl Harbor	Nawiliwili Harbor	Port Allen Harbor	Kahului Harbor	Hilo Harbor	Basalt (a)
Grain-Size Distribution (%) (b)							
Sand	39	58	8	9	22	13	
Silt	43	27 (c)	45	54	53	65	
Clay	18	15	47	37	25	22	
Total Suspended Solids (mg/kg) (d)	832	NA	918	686	1,793	1,092	
Cadmium (mg/kg)	4.6 ± 0.2 (d)	1.45 ± 2.6 (d) 0.88 ± 1.8 (e) 1.8 ± 3.1 (c)	3.8 ± 0.3 (d)	3.1 ± 0.2 (d)	2.8 ± 0.1 (d)	3.7 ± 0.3 (d)	0.11 ± 0.01
Interim EPA Guideline-Cadmium (mg/kg) (†)	6.9	6.9	6.1	8.4	9.1	4.6	
Chromium (mg/kg)	63.8 ± 35 (d) 94.8 ± 56 (c)	100 ± 59 (e)	NA	NA	NA	NA	244 ± 206
Copper (mg/kg)	100 ± 47 (f)	40 ± 17 (g) 160 ± 190 (e) 131 ± 175 (c)	NA	NA	NA	NA	46 ± 21
Lead (mg/kg)	140 ± 80 (d)	105 ± 212 (c) 94.1 ± 193 (d) 45.5 ± 6.4 (g) 110 ± 210 (e)	43.5 ± 6 (d)	34.4 ± 4.5 (d)	34.2 ± 10 (d)	44.9 ± 3.3 (d)	15 ± 2.8
Manganese (mg/kg)	254 ± 81 (f)	570 ± 580 (e) 668 ± 742 (c)	NA	NA	NA	NA	1,336 ± 222
Mercury (mg/kg)	0.68 ± 0.38 (d) 1.1 ± 0.32 (f)	1.03 ± 1.3 (c) 1.0 ± 0.38 (d) 0.8 ± 0.1 (g)	0.12 ± 0.1 (d)	0.06 ± 0.02 (d)	0.29 ± 0.4 (d)	0.28 ± 0.2 (d)	0.015 ± 0.0047
Interim EPA Guideline-Mercury (mg/kg) (†)	0.02	0.02	0.15	0.26	0.3	0.15	
Nickel (mg/kg)	175 ± 99 (f)	120 ± 30 (e) 121 ± 140 (c)	NA	NA	NA	NA	121 ± 112
Zinc (mg/kg)	187 ± 67 (d)	210 ± 269 (d) 78 ± 36 (g) 250 ± 290 (e)	53.4 ± 29.5 (d)	86.3 ± 4.6 (d)	49.4 ± 4.0 (d)	87.4 ± 11 (d)	118 ± 32
BOD_5 (mg/kg) (d)	9.3	2.8 (h)	3.7	9.2	4.53	8.0	
Organohalogens (mg/kg) (d)	0.01	NA	0.01	0.01	0.01	0.01	
Phosphorus (mg/kg) (d)	0.1	NA	0.07	0.06	0.17	0.07	
Total Kjeldahl Nitrogen (mg/kg) (d)	1.12	690 (f)	0.537	2.16	1.57	2.12	
Nitrate (mg/kg) (d)	0.007	NA	0.011	0.008	0.016	0.006	
Oil and Grease (g/kg) (d)	0.01	11.96 (c)	0.002	0.002	0.006	0.005	

* All values dry weight
† These values represent a 1.5 multiplication of the concentrations in disposal site sediments
NA = Not available

Sources: (a) Sinay-Friedman, 1979
(b) Goeggel, 1978
(c) Youngberg, 1973
(d) U.S. Army Corps of Engineers, 1975
(e) Evans, 1974
(f) R.M. Towill Corp., 1972
(g) Tetra Tech, 1977
(h) Cox and Gordon, 1970

Sediments from streams flowing into Pearl Harbor and the sediments of Pearl Harbor itself show higher concentrations of chromium than in the uncultivated soils of Oahu, indicating man-made (anthropogenic) sources of chromium (Youngberg, 1973). Some anthropogenic sources may be domestic sewage, irrigation runoff, power plant effluent, paints, pigments, copper piping, and electroplating.

Copper concentrations in sediments are available only for Pearl and Honolulu Harbors. Pearl Harbor sediments have slightly higher copper concentrations than those of Honolulu Harbor, and concentrations at both harbors are significantly higher than a value of 46 mg/kg for basaltic copper concentration (Sinay-Friedman, 1979). Youngberg (1973) found a significantly greater copper content in the cultivated soils of Oahu and Pearl Harbor sediments compared to the uncultivated soils of Oahu. He suggests that the copper in cultivated soils may be added by fertilizers or by leaching, whereas copper in Pearl Harbor sediments may arise from anthropogenic sources (e.g., paints, pigments, copper piping, electroplating, and domestic wastes).

The highest lead concentrations in sediments are found in Pearl and Honolulu Harbors, with Honolulu having the maximum of 140 mg/kg. Sediments at the other four harbors have lead concentrations which are comparable among themselves, yet much lower than either Pearl or Honolulu Harbors. All harbors, however, have lead concentrations in sediments which are much higher than the basaltic concentration of 15 mg/kg. The cultivated soils and stream sediments of Oahu and sediments from Pearl Harbor are higher in lead concentrations than the uncultivated soils of Oahu, indicating enrichment by human activity (Youngberg, 1973). Some man-made sources of lead are zinc products, paints, pigments, metal finishing, plumbing systems, and domestic wastes.

Manganese concentrations in sediments are available only for Pearl and Honolulu Harbors, with Pearl Harbor having the higher concentration. Both harbors, however, contain manganese concentrations in sediments much less than that found in basalt (1,336 mg/kg). Youngberg (1973) noted a definitely higher manganese content in cultivated soils compared to uncultivated soils of Oahu. He suggested that the higher manganese in the cultivated soils may be due to leaching processes in the soils caused by rainfall and irrigation. Youngberg also observed a decrease in manganese content as the metal moves from the soil to stream sediments, and finally into Pearl Harbor, which he attributed to increasing dissolution of manganese.

Among the six Hawaiian harbors, Pearl and Honolulu Harbors have the highest mercury concentrations in sediments, near 1.0 mg/kg. Sediments at the remaining four harbors have mercury concentrations of less than 0.3 mg/kg. All harbors have sediment concentrations of mercury which are much greater than the mercury concentration in basalt (0.015 mg/kg). However, all harbor sediment mercury concentrations are below interim EPA guidelines, obtained by multiplying 1.5 by the ambient sediment mercury concentrations at the respective disposal sites (40 CFR 227.6[e][2]). Youngberg (1973) found little difference in the mercury content among the uncultivated soils, cultivated soils, and stream sediments of Oahu. He stated that mercury was previously used by the sugar industry in the form of organomercuric fungicides.

Values for nickel concentrations in sediments are available only for Pearl and Honolulu Harbors. Concentrations of nickel in Honolulu Harbor sediments are slightly higher than those in Pearl Harbor, and the concentrations of nickel in the sediments of both harbors are slightly greater than or equal to the nickel concentration in basalt. Nickel concentrations in the cultivated soils and stream sediments of Oahu, and in Pearl Harbor sediments, are higher than the nickel content of Oahu uncultivated soils, indicating the probability of anthropogenic sources; the greater nickel content in cultivated soils may be due to the addition of nickel by fertilizers, leaching from the soils by rainfall, or irrigation (Youngberg, 1973). Youngberg mentioned that the higher nickel content in streams could be due to the addition of nickel from cultivated soils, and that water movement in stream beds may concentrate the metal.

Concentrations of zinc in harbor sediments range from 49 mg/kg at Kahului Harbor to 250 mg/kg at Pearl Harbor. Both Pearl and Honolulu Harbors have zinc concentrations greater than that found in basalt, while the remaining four harbors have zinc concentrations less than that of basalt. Youngberg (1973) observed higher zinc concentrations in cultivated soils and stream sediments of Oahu and the sediments of Pearl Harbor than those in uncultivated soils. He suggested that zinc is possibly being added to soils by fertilizers, and that cultivation and irrigation practices may be concentrating zinc.

Organohalogen concentration data are available for all harbors except Pearl Harbor. In all harbor sediments, the organohalogen concentrations are less than 0.01 µg/kg. No bioassay data, as specified by the ocean disposal criteria (40 CFR 227.6[e][3]), are available for the Hawaiian harbors, with respect to organohalogens. Due to their low concentration, bioassays may not be warranted for this purpose.

Oil and grease concentrations in the Hawaiian harbors range from 2 mg/kg at Port Allen and Nawiliwili to 11.96 g/kg in Pearl Harbor. No surface sheen data, as specified in the ocean disposal criteria (40 CFR 227.6[e][4]), are available for oil and grease concentrations in the Hawaiian harbors. However, oil sheens were not observed during the disposal of Pearl Harbor dredged material, the only harbor where oil and grease content is elevated.

Concentrations of total Kjeldahl nitrogen (TKN) in harbor sediments range from 0.54 mg/kg at Nawiliwili Harbor to 690 mg/kg at Pearl Harbor. The biochemical oxygen demand (BOD) of the sediments in the Hawaiian harbors ranges from 2.8 mg/kg at Pearl Harbor to 9.3 mg/kg at Honolulu Harbor.

CHARACTERISTICS OF MATERIALS FOUND IN DREDGE VESSEL HOPPERS

Only one record was found of a sample of dredged material, taken directly from the hopper aboard the CE hopper dredge CHESTER HARDING, for which grain-size analysis was available (Tetra Tech, 1977). The grain-size analysis (Table B-2) indicates that 49.7% of the material was coral pebbles with particle diameters between 4 and 11.2 mm. Granular shell and coral debris with particle diameters between 2 and 2.83 mm constituted 13.8% of the material. The remainder of the sample was composed of calcareous sands with particle diameters between 0.18 and 1.41 mm.

Samples of dredged material were taken by personnel aboard the CHESTER HARDING during the 1977 dredging operations at each of the five deep-draft harbors maintained by the CE and at Pearl Harbor. Samples were collected by passing a container through the flow of sediment-water slurry as it left the dredge pipe just before entering the hopper bins.

TABLE B-2
GRAIN-SIZE DISTRIBUTION OF DREDGED MATERIAL SAMPLED FROM HOPPER

Description	Size Class (ϕ)	Median Diameter (mm)	Weight (%)
Coral Pebbles (49.3%)	-3.5	11.20	30.4
	-3.0	8.00	8.4
	-2.5	5.66	4.9
	-2.0	4.00	6.0
Granular Shell and Coral Debris (13.8%)	-1.5	2.83	6.8
	-1.0	2.00	7.0
Calcareous Sand (36.9%)	-0.5	1.41	7.8
	0	1.00	7.6
	0.5	0.71	3.0
	1.0	0.51	6.0
	1.5	0.31	5.4
	2.0	0.25	2.4
	2.5	0.18	4.3
Total:			100.0

Source: Tetra Tech, 1977

The composition of the dredged material was found to vary greatly from harbor to harbor, and in one case (Honolulu Harbor) intraharbor samples were highly variable, ranging from mostly sand to mostly silt and clay. Pearl Harbor sediments were chiefly silt and clay. Port Allen had nearly as much silt as Pearl Harbor, but less clay. The average of the Honolulu Harbor samples showed the sediments to be 50% sand and gravel and 50% silt and clay. Nawiliwili Harbor sediments were largely silt and clay. Sediments at Kahului Harbor were mostly sand and gravel, with minor silt and clay contents.

The percentages of material in each size class for each sample from all harbors were summed, and average grain-size distributions were tabulated. Distributions represent an unweighted average composition of the type of material dredged in Hawaii (Table B-3). Silt and clay constitute about 60% of the typical samples, and the remaining 40% is sand and gravel-sized material.

TABLE B-3
COMPOSITE AVERAGE HAWAIIAN DREDGED MATERIAL
GRAIN-SIZE DISTRIBUTION

Particle diameter (mm)	Composition (%)	Cumulative (%)
25.0	0.1	
19.1	0.3	
12.7	0.9	
9.50	1.5	
4.75	0.6	
2.00	1.5	4.9
0.953	2.9	
0.850	0.2	
0.478	3.2	
0.425	0.5	
0.254	4.7	
0.250	0.1	
0.200	6.9	23.4
0.075	16.4	
0.074	1.0	
0.050	3.4	
0.037	5.5	
0.027	4.8	
0.022	2.5	
0.020	1.3	
0.019	1.6	
0.015	6.0	
0.011	5.3	
0.010	1.4	72.6
0.008	4.2	
0.0058	5.4	
0.0050	2.2	
0.0042	2.0	
0.0030	2.7	
0.0020	1.9	91.0
0.0014	1.7	
0.0013	2.0	
0.0012	5.0	
0.0011	0.3	
	100.0	100.0

Source: Modified from U.S. Army Corps of Engineers, 1975

Heavy metal and pesticide characteristics of dredged material samples, taken from Pearl Harbor by the CE hopper dredge CHESTER HARDING (Chave and Miller, 1977a), are listed in Table B-4. Concentrations of cadmium and chromium in the hopper samples are higher than the concentrations of these two metals in the Pearl Harbor sediments, while the concentrations of copper, lead, and zinc are lower in the hopper samples. Hopper samples showed concentrations of nickel similar to those in the sediments of Pearl Harbor. These differences can be explained in that the sediment data (Youngberg, 1973) were collected at points in time different from the hopper samples (Chave and Miller, 1977a). Dredging and sampling techniques and analysis procedures are also influential variables. Natural variability of metal content in the sediments of Pearl Harbor, as shown in Table B-1, is a prime consideration for these concentration differences. Pearl Harbor has four embayments, or lochs, each receiving unique flows of runoff and wastewater; thus, value variability is greatly dependent upon sampling locations. Metal concentrations may also vary with time, when runoff volumes, wastewater volumes, and ship traffic fluctuate.

TABLE B-4
CHARACTERIZATION OF DREDGED MATERIAL FROM THE DREDGE VESSEL
CHESTER HARDING FOR EXTRACTABLE METALS AND PESTICIDE RESIDUES (PEARL HARBOR)

Metal/Pesticide	Content (mg/kg)
Cadmium	3.0 ± 1.0
Chromium	203 ± 49
Copper	67 ± 2
Nickel	106 ± 26
Lead	40 ± 13
Zinc	119 ± 36
Dieldrin	0.4 ± 0.2
Lindane	28 ± 19
Chlordane	1.2 ± 1.2
DDD	1.6 ± 0.8
DDT	ND

Source: Adapted from Chave and Miller, 1977b

Appendix C

IMPACT EVALUATION

CONTENTS

TABLES

Appendix C

IMPACT EVALUATION

The proposed and alternative sites considered in this EIS differ from typical CE dredged material sites, in that these sites are in subtropical deep water, with depths ranging from 330 m at Hilo (Hawaii) to 1610 m at Port Allen (Kauai).

Several surveys have been conducted near the proposed South Oahu Site over the past decade, with two studies performed at each of the other proposed sites. Sediment sample collections at these sites were not too successful and the data are not as complete as anticipated. However, the approach taken here will be to consider potential environmental impacts for the oceanic environment.

Potential environmental impacts, caused by dredged material disposal at the proposed and alternative sites, may be divided into general site impacts, water column effects, and benthic effects (Pequegnat et al., 1978). (See Table C-1.)

Major elements in impact evaluation are the expected dispersion, dilution, and settling rates of dumped materials. An expanded view of previous mathematical modeling attempts is presented, with a discussion of the basic model used for impact evaluation.

PREVIOUS MATHEMATICAL STUDIES

Spatial and temporal distribution parameters of dredged material after release from a disposal vessel are bases for attempts to describe environmental impacts of ocean disposal. One method of prediction/description is by use of mathematical modeling. To date, modeling of dredged material deposition, particularly in deep-ocean environments, has had limited success.

TABLE C-1
POTENTIAL IMPACT SUMMARY

Potential Impact	Sphere							
	Phytoplankton	Zooplankton	Nekton	Benthos	Commerce	Military	Aesthetics	Man
General Site Use								
Navigation					X	X		
Fisheries					X		X	X
Other Waste Inputs	X	X	X	X			X	X
Military						X		
Industrial	X	X	X	X				
Scientific Study Areas	X	X	X	X				
Recreation						X	X	X
Preservation Regions	X	X	X	X		X	X	X
Water Column								
Plume Effects	X	X	X		X			X
Biota Trapping	X	X	X		X			X
Toxin Uptake/ Accumulation	X	X	X		X			X
Benthos								
Organism Smothering			X	X	X			
Toxin Uptake/ Accumulation			X	X	X			
Community Structure Shift			X	X	X			
Mounding				X				
Oxygen Demand for Degradation			X	X				

Source: Pequegnat et al., 1978.

The basis for the CE Dredged Material Research Program (DMRP) modeling attempts is the model created by Koh and Chang (1973). In the Koh-Chang model (originally designed for the Great Lakes), dredged material has two components - a solid portion and a liquid portion. The solid portion is assumed to separate into discrete particles which fall through the water column at known, empirically determined rates. The fluid portion is miscible with ambient fluid. Currents are assumed to be horizontally and temporally invariant, but current velocities and directions may vary vertically. Density structure can be arbitrary in the vertical, homogeneous in the horizontal, and stationary in both directions. The model does not explicitly consider effects of flocculation and hindered settling of dredged materials, although some modifications in settling velocities are permitted.

Further refinements of the Koh-Chang model were made by Brandsma and Divoky (1976) for the DMRP, and in contract with Tetra Tech Inc. (1977). The Koh-Chang model was used as a basis for development of two models more applicable to disposal of dredged material in a dynamic estuarine setting.

The Brandsma and Divoky model was applied to dredged material disposal operations in Hawaii by two groups - Johnson and Holliday (1977) and Tetra Tech (1977). R.M. Towill Corporation (1972) developed a different model and applied it to dredged material disposal operations at Port Allen.

The models were not successful in describing the short-term destinations of dredged material after disposal. The Brandsma and Divoky model (applied by Johnson and Holliday, and Tetra Tech) failed, chiefly due to inadequate or incorrect descriptions of dumped materials. The R.M. Towill Corporation (1972) model is also inadequate. Brief reviews of their findings are given below.

Johnson and Holliday (1977) applied the Tetra Tech model (Brandsma and Divoky, 1976) to ten proposed and alternative dredged material disposal sites in Hawaii. The conclusion was that most material leaves the site boundaries as suspended sediment. This was in conflict with the findings of researchers who monitored disposal at the proposed South Oahu (former Honolulu) Site, where the majority of the dredged material fell to the bottom within 20 to 30 minutes. The chief reason that the model did not accurately predict actual occurrences is due to complexities of describing physical properties of the dredged material.

Johnson and Holliday underestimated the grain sizes of the dredged material. They used a sediment composition based upon typical river sediments which enter the Gulf of Mexico, and not upon actual waste sediment sizes characteristic of regions with coral reef fringes. Field observations indicated that substantial portions of the material are gravel and rock. Cohesive material settled to the bottom of the dredge vessel hoppers, so that the materials had lower moisture contents and higher bulk values than anticipated. It was believed that the material fell in masses rather than in finely divided clouds. The inappropriate sediment composition data caused the inaccuracies, as noted above.

Tetra Tech (1977) used the model of Brandsma and Divoky (1976) to estimate deposition patterns at the proposed South Oahu (former Honolulu) Site. The ambient current structure, measured by Neighbor Island Consultants (1977), was applied, as well as the grain-size analysis of a sample taken from the CHESTER HARDING. Two release volumes were analyzed - 220 yd^3 and 1,766 yd^3. The model predicted that a discharge of 220 yd^3 would eventually cover an area of 0.7 to 2.4 nmi^2 (2.4 to 8.2 km^2), while the larger discharge would cover an area of about 0.8 to 1.5 nmi^2 (2.7 to 5.1 km^2). The smaller area of coverage from the larger volume is due to greater initial release momentum. According to the model, the sediment thickness should be 0.16 mm or less, even under the release point. Tetra Tech (1977) warns that these results may be misleading, because observers aboard the dredge vessel reported seeing coral fragments, in the hopper, of a size considerably larger than those measured in the hopper sediment sample.

The R.M. Towill Corporation (1972) model was developed on the basic assumption that the dredged material separates into individual particles and descends through the water column at laboratory-determined particle settling velocities. The particles were predicted to be under the influence of a uniform horizontal current until they reached the ocean floor. The model's limitations are that flocculation, diffusion, stratification, plume formation, and variable currents were not included. A maximal deposition of 4.25 mg/cm^2 was predicted 11 nmi (20.4 km) downcurrent at a 1,500 m water depth, from release of 246,000 yd^3 of dredged material. Noncohesive sand particles were used for this prediction, in contrast to the cohesive silt-clays characteristic of Hawaiian dredged material. The effect of such a difference would result in less dispersion of the Hawaiian dredged material (Neighbor Island Consultants, 1977).

Neighbor Island Consultants (1977) referred to studies by the San Francisco District Corps of Engineers. Despite disposal operations being conducted in shallow water, the studies could apply to Hawaii, because the dredge vessel CHESTER HARDING was used in San Francisco to dispose of dredged material similar to the Hawaiian material. The principal point of the San Francisco studies was that only dredged material with low moisture content was discharged by the hopper dredge. The material was dumped in 100 m of water, rapidly sank to the bottom, and mounded in large clumps. No significant plume remained visible in the water.

DISPOSAL OPERATIONS

The proposed South Oahu Site will be the most heavily used of all proposed sites. The next disposal cycle is scheduled for 1982, when an estimated 2.6 million yd^3 will be dumped. The volumes are expected to be temporally constant. About 28 weeks would be required to dispose of 2.6 million yd^3 of dredged material. In the 1977-1978 dredging cycle, there was a 2-day period allotted every 14 days for barge maintenance. All material is dredged and dumped by a hopper dredge; the CHESTER HARDING (capacity 2,681 yd^3) was used during the 1977-1978 cycle. The time required for disposal is 2 to 3 minutes, with the barge decelerating to a speed of 0 to 2 knots before release of material.

Barge contents have only been sampled a few times (Chave and Miller, 1977b; Tetra Tech, 1977) for dredged material from Honolulu Harbor, which was 49% coral pebbles, 37% sand, and the remainder granular shell and coral debris. Average settling velocities for sand and coral particles are listed in Table C-2.

TABLE C-2
SETTLING VELOCITIES FOR SAND AND CORAL PARTICLES

Particle Diameter (mm)	Time to Settle at 450 m depth	
	(Seconds)	(Hours)
11.2	1,000	0.28
8.0	1,125	0.31
5.66	1,250	0.35
4.00	1,452	0.40
2.83	1,800	0.50
2.00	2,250	0.63
1.41	2,813	0.78
1.00	3,462	0.96
0.71	4,500	1.25
0.51	6,818	1.89
0.31	13,235	3.68
0.25	16,071	4.46
0.18	25,000	6.94

Sources: Chave and Miller, 1977b; Tetra Tech, 1977

When dredged material falls through the water column, natural ocean turbulence and momentum-induced turbulence interact to dilute and disperse the material, and the material spreads horizontally as it approaches the sea floor. Immediately upon release of a load of dredged material at the proposed South Oahu (former Honolulu) Site, a surface plume about 100 m in width, with sharply defined outlines, was visible for less than an hour (Smith, 1979).

Heavier and larger components (rocks, coral heads, and pebbles) will reach bottom in 4 to 5 minutes after discharge. Fine sands (less than 3 ϕ, or 1/8 mm) have a much slower rate of descent (1.8 cm/sec), and are expected to scatter on the bottom over a 7-hour period at the proposed South Oahu Site. The last few fine sand particles to land will fall on the site fringe. Coarse silts are estimated to settle at the rate of 0.3 cm/sec, and would take 34 hours to reach bottom at the proposed South Oahu Site (Chave and Miller, 1977b).

With the exception of silts, the material will be dispersed approximately 2,500 m from the release point. All dredged material from a single dump, with a grain size greater than 0.18 mm, will be deposited over an area between 200 and 600 meters wide and 2,500 meters long, with a thickness of 1 cm. The remaining sediment will be distributed outside the site boundaries over a vast area.

The amount of horizontal spread occurring below the surface was decided somewhat arbitrarily. Based upon the single-dump depositional pattern observed by Chave and Miller (1977b), the values of 200 m and 600 m were decided to be the width of the deposition pattern at the closest and farthest points, respectively, from the release point. The amount of horizontal spreading was determined to be linear between the two downstream distances.

WATER COLUMN IMPACTS

The effects on the water column from the disposal of dredged material may be subdivided into four categories: plume effects, biota trapping, intake and biomagnification of toxic constituents, and substrate resuspension.

Plume effects are influenced by transport conditions at the sites, which determine the concentration and duration of increased suspended loads at each site. Nutrient release into the water column occurs immediately after dumping. The magnitude of ensuing phenomena is influenced by the effect of the dredged material on the photic zone, site mixing, dilution, and the dissolved oxygen available. During disposal operations, an immediate oxygen demand is expected (Pequegnat et al., 1978).

Biota in the path of the dense dredged material may be trapped, carried to the bottom, and smothered en route or on the sea floor. Phytoplankton, zooplankton, and nekton are exposed to this jeopardy. On the bottom, organism decay consumes oxygen and may cause chronic reduction of oxygen at the sediment-water interface.

Toxic constituents, trace metals, and chlorinated hydrocarbons from the plume may be ingested by the biota. Most trace metals and hydrocarbons make filter-feeding organisms particularly susceptible to accumulation. Chlorinated hydrocarbons are not highly soluble in water, but have been reported to be caused by oil and grease, due to their lipophillic character.

Plume effects after dumping are short-term phenomena. Various estimates have been made for plume width and length with time. There are four main elements of plume behavior: plume transport, increased turbidity effects, consequences of nutrient release, and the oxygen demand during disposal operations.

TRANSPORT MECHANISMS

The fate of dredged material at the deep ocean sites has been investigated by means of a simplistic model. The model yields sediment thickness estimates after release of 2,681 yd^3 (one barge load) of material dredged from Honolulu Harbor. Dredged material, sampled from a hopper in the dredge vessel CHESTER HARDING, was analyzed by Tetra Tech (1977).

The model assumes that the dredged material will fall through the water column at discrete particle settling velocities. These velocities were obtained from Graf (1971) and are shown in Table C-3. Due to the inherent complexities and lack of information on the effects of flocculation, hindered settling, clumping, drag, and initial jet descent, they were not considered. Most omissions were based on the knowledge that the dumped dredged material lacked any silt or clay fractions. The mean water depth at the proposed South Oahu Site is 450 m, and the sea floor was assumed to be flat and smooth. The other sites, excluding Kahului, are deeper than 450 m.

In order to model a worst-case condition, currents were assumed to be stationary and vertically uniform. A horizontal current velocity of 10 cm/sec was used in all calculations. While the effects of turbulent entrainment were assumed, the magnitude of the horizontal spreading of the dredged material cloud was not determined explicitly. The width of the depository pattern was estimated on the basis of field studies by Chave and Miller (1977b). The depth at the site studied was shallower than the proposed South Oahu Site, but current velocities were greater than those used in the calculations. The depository pattern is about 200 m wide 100 m downstream, and estimated to be 600 m wide 2.5 km downstream.

TABLE C-3
GRAIN-SIZE DISTRIBUTION OF DREDGED MATERIAL

Description	Median Diameter		Weight (%)	Settling Velocity (cm/sec)
	ø	mm		
Coral Pebbles (49.3%)	-3.5	11.20	30.4	45
	-3.0	8.00	8.4	40
	-2.5	5.66	4.9	36
	-2.0	4.00	6.0	31
Granular Shell and Coral Debris (13.8%)	-1.5	2.83	6.8	25
	-1.0	2.00	7.0	20
Calcareous Sand (36.9%)	-0.5	1.41	7.6	16
	0	1.00	7.6	13
	0.5	0.71	3.2	10
	1.0	0.51	6.0	6.6
	1.5	0.31	5.4	3.4
	2.0	0.25	2.4	2.8
	2.5	0.18	4.3	1.8

Sources: Tetra Tech, 1977; Graf, 1971

The model calculations were as follows: the time for each particle size (Table C-4) to fall 450 m at the calculated settling velocity was determined. This time was translated into a horizontal distance traveled by a particle carried by a unidirectional current at 10 cm/sec. By this means, particles which are 11 mm in diameter settle at a speed of 45 cm/sec, requiring 1,000 sec to fall 450 m, and travel a horizontal distance of 100 m from the disposal point. Grains having a diameter of 0.18 mm require 25,000 sec to fall 450 m, and travel about 2.5 km downstream before reaching bottom. In order to smooth the depository pattern into uniform distributions, rather than single point accumulations, it was assumed for a given grain-size value (e.g., 2.00 mm), that the actual composition of the size fraction was uniformly distributed between adjacent size categories (e.g., 1.41 mm and 2.83 mm). The smoothing calculations assumed that the volume of material reported for a discrete grain size would be deposited uniformly between the horizontal distance traveled by the adjacent grain sizes. For the largest and smallest grain sizes, uniform deposition over a length equal to twice the distance to the adjacent grain size was assumed.

TABLE C-4
DREDGED MATERIAL THICKNESS DEPOSITED BY 2,680 YD^3 DUMP

Downstream Distance from the Release Point (m)	Sediment Thickness Between Distances (cm)
80 - 100	13.0
100 - 112	16.5
112 - 125	5.2
125 - 145	2.7
145 - 180	1.8
180 - 225	1.5
225 - 281	1.2
281 - 346	1.1
346 - 450	0.43
450 - 682	0.15
682 - 1,324	0.053
1,324 - 1,607	0.068
1,607 - 2,500	0.015
2,500 - 3,333	0.008

Sources: Graf, 1971; Cnave and Miller, 1977b

Thicknesses of sediments from a single discharge of 2,680 yd^3, as a function of downstream distance from the initial release point, are listed in Table C-4. Sediment thicknesses range from 17 cm at a point 100 m downstream to 0.008 cm at a distance of 3.3 km from the point of discharge. No deposition is predicted for downstream distances less than about 80 m. The reason for this is that the Tetra Tech sampling procedure did not recover the coarse material consisting mainly of coral and other large debris; however, this material was observed among the hopper contents (Tetra Tech, 1977). It is probable that these pieces of material settled to the bottom of the hopper during dredging and thus may have escaped the sampling device. Bottom photographs taken by Tetra Tech (1977) show coarse material and coral pieces directly beneath the initial release point. Acoustic tracking of the dredged material following its release indicates that the coarse fraction falls to the bottom in less than 4 minutes (Tetra Tech, 1977). The model predicts that the coarse fraction of the dredged material will fall to the sea floor within the first few minutes following release, but the finer fractions may take up to 7 hours to reach bottom. Silt and clay fractions would take much longer to reach bottom, perhaps a few days. It is not probable that any of the material could be trapped by the density of the water column.

In contrast, there is evidence that the dredged material may consist of considerable fractions of silt and clay. Barge samples from the harbors contained silt and clay fractions of about 60%, with the remainder (40%) being sand and gravel-sized material.

TURBIDITY

Ocean disposal of dredged material causes a short-term increase of turbidity in the receiving waters. One barge load (2,680 yd^3), evenly distributed throughout the proposed South Oahu Site, would be approximately 1 part per million (by volume).

The relationship between increased turbidity and primary production is one of the least understood aspects of dredged material disposal. Little is known about durations of turbidity after dumping. Most investigators analyzing effects of disposal concluded that the reduced water transparency was of short duration, beneficial nutrients were released, and no gross adverse effects were observed.

Stern and Stickle (1978) reviewed numerous analyses of turbidity and suspended material impacts upon development of phytoplankton populations. It was found that the most frequently cited negative aspect of turbidity is reduced photosynthetic activity due to decreased light penetration.

Several studies (Reeve, 1963; Sherk et al., 1976) found that planktonic crustaceans could not select between nutritive and non-nutritive particles, and the maximal filtration rate was independent of the nature of the particles. Paffenhofer (1972) studied the effects of suspended solids on growth, body weight, and mortality of the copepod, Calanus helgolandicus, and reported that the molting ability was substantially reduced, growth and movement were hindered, and ovarian development was absent when 10 mg/liter suspended solids were present. However, since the surface plume is visible for less than 1 hour at the proposed South Oahu Site, the increased turbidity is estimated to be present less than 4 hours, and no adverse effects are anticipated.

Most studies of turbidity effects upon benthic organisms were concerned with coelenterates (corals), crustaceans, and mollusks. Most corals exist in waters shallower than the sites. However, precious pink and gold corals were reported to exist at depths to 550 m, but have not been reported near the proposed sites.

The phylum Mollusca includes slugs and snails (class Gastropoda), squids and octopi (class Cephalopoda); and clams, oysters, and mussels (class Pelecypoda). Many mollusks, particularly members of the class Pelecypoda, are filter feeders, thus susceptible to mechanical or abrasive action of suspended sediments, e.g., clogging of gills and irritation of tissues (Cairns, 1968). Bivalves are more or less stationary, so they frequently respond to increased levels of turbidity and suspended sediment by tightly sealing their valves. Thus, they may survive adverse conditions for several days by avoiding direct contact with the surrounding water. Bivalve mortalities are only observed after at least 5 days of constant exposure to extremely high (100 g/liter) suspended sediment concentrations (Peddicord et al., 1975).

Bivalve larvae and eggs settle and develop normally under most dredging and dredged material disposal conditions (Lunz, 1938), and grow even faster in low concentrations of turbidity-producing substances (Davis and Hidu, 1969). However, Davis (1960) and Davis and Hidu (1969) reported that the percentage of normally developing eggs and larvae decreased as the concentration of suspended materials increased.

The effects of turbidity and suspended material on gastropods have not been extensively studied. Johnson (1971) investigated turbidity effects on the rate of filtration and growth of the slipper limpet, *Crepidula fornicata*. The shell growth rate decreased as turbidity increased, perhaps because of inadequate food intake, due to clogging of the filtering mechanism by suspended materials. Filtration rates decreased when turbidity levels increased, with a pronounced reduction as the concentration increased from 0.2 to 0.6 g/liter.

Studies of effects of suspended solids have been performed on benthic crustaceans (shrimps, crabs, amphipods, and isopods), and the results indicate that these organisms are not greatly affected by high suspended solid concentrations. Peddicord et al. (1975) found that the amphipod *Anisogammarus conferricolus* was the most sensitive crustacean tested, with a 200-hour LC_{50} of 35 g/liter. The crab *Cancer magister*, was similarly tested and had a 200-hour LC_{50} value of 329 g/liter.

Turbidity and suspended material may affect fishes directly or indirectly. Direct effects include lethal agents and factors which influence physiological activities (reproduction, growth, development) or produce abrasive wear on tissues. Indirect effects include modifications to habitats and food chain organisms.

Rogers (1969) exposed several species of marine fish to a variety of suspended particles, and concluded that the suspended solids affected fish either by coating and clogging gills, or by abrasion of the branchial epithelium.

The highest suspended solid concentration reported for the dredged material disposal plume at the proposed South Oahu Site was about 30 mg/liter (Tetra Tech, 1977), therefore no effect is expected from increased turbidity during disposal.

NUTRIENT RELEASE

Phytoplankton require certain nutrients to photosynthesize and grow. The most important nutrients are nitrogen and phosphorus, which can be completely depleted in surface water during intense biological activity, thus limiting the growth of phytoplankton.

The release of nutrients from sediments which have been mechanically disturbed, as in dredging, has not been intensely studied; however, several scientists have investigated the problem in recent years due to its obvious relationship to water quality and biological activity. Biggs (1968), for example, reported nitrogen and phosphorus levels 50 to 100 times above ambient in the immediate vicinity of dredged material disposal sites. Windom (1975, 1976) reported vast increases in ammonia at disposal sites, but little change in nitrate and phosphate. In another study, Windom (1972) found ammonia to be the only constituent of the many monitored elements which was consistently released in large quantities during initial dispersion of dredged sediments into water. In some cases, phosphate was released, but in others it was not, behavior which Windom (1972, 1975) could not explain. Recent work with the EPA-CE elutriate test, especially by Lee et al. (1975), has done much to clarify the behavior of phosphate and other constituents of dredged material during disposal, and has shown the predominant importance of oxygen concentration as a controlling factor.

Phytoplankton generally show a preferential usage of ammonia for obtaining nitrogen, since ammonia can be used directly for amino acid synthesis by transamination, while nitrate and nitrite must be reduced before being used by a cell (Parsons and Takahashi, 1973). If surface phytoplankton productivity is greatly stimulated as a result of ammonia and other nutrient releases during disposal, the possible consequences of these activities must be considered. Even though it seems unlikely that adverse effects would result from increased productivity in the open ocean, the fact remains that oxygen depletion will ensue when surface organisms die and sink. If poor renewal of deeper water occurs, oxygen depletion could follow. Furthermore, increased surface productivity could possibly add to organic carbon loading on the sea floor, which will occur as dredged material settles.

Eppley and Thomas (1969) found the phytoplankton growth rate relative to nutrient depreciation and concentration to be estimated by the equation:

$$M = M_{max} \frac{S}{K_s + S^1}$$

where M and M_{max} are the growth rate and maximal growth rate, respectively, K_s is the half-saturation constant, and S^1 and S are the initial and final nutrient concentrations, respectively. Eppley et al. (1972) estimated M to be approximately 1.5 doublings/day in oligotrophic waters. MacIsaac and Dugdale (1969) report a K_s range of 0.1 to 0.6 mg-at NH_4/liter for the oligotrophic tropical Pacific, while Eppley et al. (1969) found the K_s values for oceanic phytoplankton to range between 0.1 and 0.4 mg-at NH_4/liter. Using a K_s value of 0.4 mg-at NH_4/liter, the growth rate of the phytoplankton in the ammonia-enriched site would be approximately 0.3 doublings/day. Since phytoplankton moving through the site have an exposure time of 4 hours, a biomass increase of about 5% could possibly occur within the site. A potential growth rate of 0.3 doublings/day is quite slow, and comparable to the measured growth rates in the Sargasso Sea and other nutrient-depleted waters. Therefore, eutrophication caused by nutrient release from the disposal of dredged material will not occur.

Toxicity of ammonia to marine organisms is not well known. Natarajan (1970) reported ammonia-inhibited photosynthesis by marine diatoms at 55 to 71.1 mg/liter. Brown and Currie (1973) found that concentrations of 50 to 100 mg/liter affected behavior and 300 mg/liter caused disability in a prosobranch gastropod (Bulla digitalis). Ammonia was lethal to dogfish (Squalus cephalis) after three hours at concentrations of 1.2 mg/liter (Wuhrmann and Woker, 1948).

If all the ammonia from a single discharge is released as the dredged material falls to the bottom, the ammonia will be distributed vertically over 450 m and laterally over 200 m, while the 10-cm/sec current will move the material a distance of 240 m horizontally in 40 minutes. If 736 kg of ammonia is released with each discharge, the maximal concentration of the ammonia is 3.4 mg/liter. This concentration will decrease rapidly and is less than concentrations found to affect the biota, therefore no effect from ammonia toxicity is anticipated.

OXYGEN DEMAND

Dredged material contains substances which are susceptible to oxidation by dissolved oxygen. The release of dredged material often causes an initial oxygen decrease (Lee et al., 1975). The dredged material dumped is predominantly sand with a coarse silt-clay fraction, from which most fine clays have been winnowed by the dredging activities. No barge samples have been analyzed for organic content; however, as a worst-case estimate, the organic content sampled in the harbor sediments will be considered equivalent to the concentration being dumped. It is expected that most of the finest sediments (high in total organic carbon) are washed overboard during the dredging operation. The available organic carbon values for Pearl Harbor sediments were determined by the Chemical Oxygen Demand (COD) method. In this method, a small quantity of sediment is digested with a potassium dichromate solution in boiling sulfuric acid. The positive interference of chlorides with this method is well known, and compensated by the addition of mercuric sulfate (APHA, 1975). The method is almost identical to the procedure outlined by Ballinger and McKee (1971) with respect to the chemical characterization of bottom sediments for organic carbon. The COD values reported are within the accepted range for sewage sludge (Ballinger and McKee, 1971). These values will be used in an order-of-magnitude estimate to assess the quantity of dissolved oxygen required to degrade the organic material.

Total organic content of the organic carbon concentration, based upon COD volumes, are 80,000 mg/kg in Honolulu Harbor (R.M. Towill Corp., 1972) and 90,000 mg/kg in Pearl Harbor (Youngberg, 1973). The barge vessel CHESTER HARDING holds approximately 4.5×10^6 kg (2,680 yd^3) of dredged material; therefore, approximately 400,000 kg of organic carbon could be released each dump. Using the Redfield et al. (1963) ratio (2.45 ml of oxygen to degrade 1 mg of carbon), approximately 9×10^{11} ml of oxygen are required to degrade totally the organic carbon from a single discharge. Therefore, the oxygen required to degrade the organic carbon from a single dump is approximately 6% of the oxygen within in the site, assuming the average dissolved oxygen concentration in the water column to be 5.3 ml/liter (Chave and Miller, 1977a). This estimation is based upon complete oxidation. The initial sag associated with disposal varies from 0.006 to 0.02 mg/liter per minute. The upper limit of these values can be extrapolated to an initial oxygen demand in the first hour of 1.6×10^2 gm-O_2/m^3/hr (Lee et al., 1975).

BIOTA TRAPPING

Phytoplankton are expected to be more affected by trapping than zooplankton. However, there are no studies which distinguish the effects of various sediment grain sizes on the plankton, thus it will be arbitrarily assumed that sediment particles of sizes greater than approximately 0.2 mm can trap phytoplankton, while particles larger than 2 mm can trap zooplankton. Phytoplankton and zooplankton range in size between approximately 0.01 to 10 mm and 0.1 to 30 mm, respectively. As a worst-case estimate it will be assumed that micronekton can be trapped and carried to the bottom by falling sediments of sizes greater than 10 mm. Approximately 95%, 60%, and 30% of the dredged material is greater than 0.2 mm, 2 mm, and 10 mm, respectively.

Phytoplankton contribute to primary productivity above the light compensation depth of 100 m; hence, only the upper 100 m of the water column will be considered. The greatest water volume above 100 m depth affected by the descending sediment of size 0.02 mm or larger is approximately $6 \times 10^6\ m^3$. The average phytoplankton chlorophyll a concentration in the water column is approximately $0.2\ mg/m^3$ (Hirota, 1978), which can be converted to $20\ mg\ C/m^3$ (Steele, 1964; Wiebe et al., 1975); therefore the phytoplankton biomass trapped by the falling sediment and carried to the bottom is estimated to be 1.2×10^8 mg C. This biomass can be compared to the estimated phytoplankton biomass in the site, approximately 10×10^9 mg C. Therefore, the phytoplankton biomass trapped by the falling sediment of a single discharge is approximately 1% of the phytoplankton biomass at the proposed South Oahu Site.

Another means of comparison is to relate the amount of phytoplankton trapped and carried to the bottom to the productivity in the surrounding waters. Productivity around the Hawaiian Islands is approximately 100 mg C/m^2/day (Sands et al., 1978), with an average productivity estimated at 1.0 mg C/m^3/day. Since the volume of water above 100 m in the site is 520×10^6 cubic meters, the expected productivity in the proposed South Oahu Site is 520×10^6 mg C/day. Therefore, the estimated loss of phytoplankton biomass due to trapping is comparable to the biomass produced in an average 5.5-hour period.

Chave and Miller (1977a) reported an average zooplankton biomass of approximately 1.1 $mgdw/m^3$. The volume of water affected by the falling sediment (of size 2 mm) is approximately $10 \times 10^6\ m^3$. Therefore, the zooplankton biomass estimated to be carried to the bottom is 11 kgdw. Since the zooplankton biomass estimated for the proposed South Oahu Site is 2,600 kg, the zooplankton biomass carried to the bottom is only 0.4% of the zooplankton biomass within the site.

Chave and Miller (1977a) estimated the micronekton biomass to average 1.3 mg wet wt/m^3. The expected extent of effect of sediment larger than 10 mm is approximately 5×10^6 m^3; thus, an estimated 6.5 kgww of micronekton will be carried to the bottom with each dump. This is only 0.2% of the micronekton biomass within the site.

RESUSPENDED SEDIMENTS

The available data will not support a profound assessment on the possibilities of dredged material resuspension and transport. However, some observations are relevant. Chave and Miller (1977a) and Neighbor Island Consultants (1977) performed grain-size analysis of bottom sediments before disposal of dredged material, then reported sparse silt and no clay-sized fractions. The silt and clay fractions were probably winnowed away by the bottom currents. Post-disposal samples showed that minor silt or clay fractions were deposited on the bottom sediments. Therefore, the silt and clay dumped at the site are most likely transported away from the site before reaching the bottom. Bottom currents in the dump sites are usually energetic enough to disperse these particles offshore with the net current drift.

BENTHIC IMPACTS

The principal effect of dredged material disposal will be upon the benthos. Evaluated benthic impacts include: organism smothering, toxic constituent accumulation (trace metals and chlorinated hydrocarbons), faunal shift, and mounding.

The benthic biomass at the proposed sites is not known; however, an estimate of the impact of disposal on the benthic community can be made. The proposed sites generally have flat bottoms with monotonous features, and the benthic biomass is distributed evenly. The impact of disposal becomes a function of bottom area impacted. Previous calculations (above) described the expected bottom deposits from a single discharge.

TRACE METAL ACCUMULATION

Youngberg (1973) reported that the average trace metal concentrations in Pearl Harbor sediments were 1.1 mg/kg mercury, 620 mg/kg manganese, 88.7 mg/kg lead, 1.4 mg/kg cadmium, and 110 mg/kg copper. These dredged materials may be deposited on sediments at the proposed South Oahu Site which have average trace metal concentrations of 0.7 mg/kg mercury, 176.2 mg/kg manganese, 48.6 mg/kg lead, 5.85 mg/kg cadmium, and 23.8 mg/kg copper. The Ocean Dumping Regulations (CFR 40 Section 227.6) permit the disposal of sediments with mercury and cadmium concentrations 1.5 times the concentrations in the receiving sediments. Since the permissible concentrations of all other trace metals are based on bioassay determinations, and no bioassays have been performed for dredged materials, it is not possible to predict the effect of the accumulation of trace metals. Furthermore, bioassays of endemic deepwater organisms for predicting trace metal accumulation are unfeasible due to difficulty in collection and culture of test organisms. However, the copper concentration in the sediments being dredged is markedly higher than the concentration in the sediments at the proposed South Oahu Site.

Comparative analyses of variance (ANOVA) of four trace metals (cadmium, copper, lead, and mercury) concentrations in the sediments of the proposed disposal sites were performed to determine: (1) whether significant differences exist among the sites, and (2) whether significant differences exist in the metal concentrations before disposal and after disposal. The analyses indicated no significant differences among the sites at the 95% confidence level (see Table C-5). However, a significant statistical difference does exist between pre-disposal and post-disposal metal concentrations, the post-disposal values being higher.

MOUNDING

Dredged material mounding on the sea floor is dependent upon several factors: the quantity and physical nature of dredged material dumped, methods of disposal, the water column depth of the site, and the speed and direction of the currents at the site. The condition which favors mounding would be a large amount of cohesive or dense material released instantaneously from a stationary source into calm shallow water.

TABLE C-5
AVERAGE Z SCORES OF FOUR SEDIMENT TRACE METALS (Cd, Cu, Pb, Hg) AT THE HAWAIIAN DREDGED MATERIAL DISPOSAL SITES BY SITE, TIME, AND BY SITE AND TIME*

Time \ Proposed Site	Nawiliwili	Port Allen	South Oahu	Kahului	Hilo	Average Z Scores by Time
Pre-Disposal	-0.44 (11)	-0.31 (20)	-0.03 (12)	-0.15 (21)	-0.37 (9)	-0.24 (73)
Post-Disposal	-0.19 (20)	0.14 (32)	0.24 (89)	0.06 (56)	-0.19 (40)	0.08 (237)
Average Z Scores By Site	-0.28 (31)	-0.03 (52)	0.21 (101)	0.01 (77)	-0.23 (49)	

ANALYSIS OF VARIANCE: Z SCORES BY TIME AND SITE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Signif. of F
Main effects	13.447	5	2.689	2.763	0.019
Time	4.097	1	4.097	4.209	0.041
Sites	7.753	4	1.938	1.991	0.096
2-Way interactions	0.508	4	0.127	0.130	0.971
Time and sites	0.508	4	0.127	0.130	0.971
Explained	13.956	9	1.551	1.593	0.117
Residual	292.037	300	0.973		
Total	305.992	309	0.990		

310 cases were processed.
0 cases (0.0 pct) were missing.

MULTIPLE CLASSIFICATION ANALYSIS BY TIME AND SITE
Grand Mean = -0.00

Variable + Category	Sample Size	Unadjusted Dev'n	Unadjusted ETA	Adjusted for Independents Dev'n	Adjusted for Independents BETA
Time					
1 Pre-dumping	73	-0.24		-0.21	
2 Post-dumping	237	0.08		0.07	
			0.14		0.12
Site					
1 Nawiliwili	31	-0.28		-0.25	
2 Port Allen	52	-0.03		0.01	
3 Honolulu & Pearl Harbor	101	0.21		0.18	
4 Kahului	77	0.01		0.02	
5 Hilo	49	-0.23		-0.24	
			0.17		0.16
Multiple R squared					0.044
Multiple R					0.210

* Sample sizes appear in parentheses.
Sources: Neighbor Island Consultants, 1977; Chave and Miller, 1977a; 1978; Goeggel, 1978

Appendix D

SUGGESTED ENVIRONMENTAL STUDIES

CONTENTS

Appendix D
SUGGESTED ENVIRONMENTAL STUDIES

The Ocean Dumping Regulations established that the impact of disposal on the disposal site and surrounding marine environment be evaluated periodically. The information used in evaluating disposal impact may include monitoring survey data; thus, "if deemed necessary" by CE or EPA, the District Engineer (DE) may establish a monitoring program to supplement historical site data and dumping history (40 CFR 228.9). The DE provides the basis of the monitoring plan by determining the appropriate monitoring parameters: the frequency and the areal sampling extent. The factors considered in this determination are the frequency and volumes of dredged material disposal, the physical and chemical nature of the dredged material, the dynamics of the site's physical processes, and the life histories of the species monitored.

Benthic and short-term water column effects are inevitable within the confines of any dredged material disposal site. The primary purpose of the monitoring program is to determine whether disposal at the site is significantly affecting areas outside the site. Consequently, the monitoring study must survey the site and surrounding areas, including control sites and areas which are likely to be affected (as indicated by environmental factors, e.g., prevailing currents and sediment transport). The results of an adequate survey will provide early indication of potential adverse effects radiating from the site. Knowledge of the gradients facilitates predictions of future impacts on areas surrounding the disposal site and provides direction for management of future disposal activities.

In the preparation of this EIS, some information was not available to permit more complete descriptions of disposal effects at the proposed sites. Studies which would provide these data include: (1) dredged material characterization as determined by sampling material from the dredge vessel hopper before release at the site, and (2) dispersion studies to identify where less-dense materials will settle. In addition, more information on the benthic biology recolonization and recovery rates beyond that already provided by past studies at the sites would be useful. Furthermore, the proposed dredged material characterization studies need not be duplicated if performed as a result of other requirements to test the suitability of dredged materials.

It is not necessary to perform these studies immediately, since there have been no significant adverse impacts reported or presently expected because of dredged material disposal at the proposed sites, assuming disposal of comparable types of materials as previously studied. These studies should not be performed at all sites during each disposal cycle. Rather, they will be performed at the discretion of the CE official and the EPA Regional Administrator who will determine optimal conditions for success.

Fundamental considerations for each of these three studies are presented below.

DREDGED MATERIAL CHARACTERIZATION

The relationship between measured harbor sediments and sediments in the dredge vessel hoppers before release has not been established. Results of analyses of samples collected from the dredge vessel are not consistent, but this may be due to the paucity in sample numbers and spatial harbor variability. Measurements of all parameters in harbor sediments provide only a gross estimate of the possible constituents present. During the actual dredging process, some of the finer silts and clays remain at the dredging site because they are decanted off before they have a chance to settle in the hopper bins.

During the disposal cycle, representative samples will be collected from the dredge vessel hoppers before dumping. Suggested parameters to be measured include trace metals (cadmium, mercury, lead, copper), organohalogens, ammonia, total Kjeldahl nitrogen, total organic carbon, and grain-size distribution.

These data will provide information on the spatial variability of constituents within the dredging site and, if continued over several cycles, the temporal variations of dredged materials. It may be more appropriate, as stated previously, to consider these studies as part of evaluations to determine suitability of materials for dumping.

DISPERSION STUDIES

Descent of sediment particles through the water to the ocean floor is dependent upon particle sizes and weights. Dense pieces of dredged material will settle quickly to the bottom, and remain within the designated site boundaries. Less dense particles in the dredged material require several minutes to hours to settle, and may be transported out of the site by ocean currents.

Dredged material characterization will provide more accurate data on the relative compositions of dredged material fractions. Field observations during disposal will help to refine the predicted locations of settling.

It is suggested that the parameters (including turbidity and/or in situ nephelometry profiles) are to be measured in the water at the disposal site, and will be designed to determine vertical and horizontal distributions of the dredged material released at the site. Samples of total suspended solids should be collected periodically to compare nephelometric profile data to actual weight (of suspended matter) per volume measurements. However, previous studies of this type were of limited success due to the rapid transit through the water column of the dredged material, thus turbidity-suspended solid profiles were not particularly valuable. Hence, additional studies must be carefully designed and alternate approaches carefully considered.

BENTHIC STUDIES

The low biomass at the sites ensures that minimal organism trapping and smothering will occur. Furthermore, benthic organisms appear to recolonize the site quickly after disposal. However, because of the low frequency of disposal operations (every five or ten years), it would be valuable to measure the biomass of the macroinfaunal organisms before the next disposal cycle.

These measurements will be compared to data obtained in the 1977-1978 studies to determine the biotic recovery rates at the sites. Sediment samples for geological or chemical analyses should be collected at fairly low cost during the same operation.

Appendix E

federal register

TUESDAY, JANUARY 11, 1977

PART VI

ENVIRONMENTAL PROTECTION AGENCY

OCEAN DUMPING

Final Revision of Regulations and Criteria

Those Regulations not pertinent to the ocean disposal of dredged material have been screened out

[redacted]

PART 225—CORPS OF ENGINEERS DREDGED MATERIAL PERMITS

AUTHORITY: 33 U.S.C. 1412 and 1418.

§ 225.1 General.

Applications and authorizations for Dredged Material Permits under section 103 of the Act for the transportation of dredged material for the purpose of dumping it in ocean waters will be evaluated by the U.S. Army Corps of Engineers in accordance with the criteria set forth in Part 227 and processed in accordance with 33 CFR 209.120 with special attention to § 209.120(g) (17) and 33 CFR 209.145.

§ 225.2 Review of Dredged Material Permits.

(a) The District Engineer shall send a copy of the public notice to the appropriate Regional Administrator, and set forth in writing all of the following information:

(1) The location of the proposed disposal site and its physical boundaries;

(2) A statement as to whether the site has been designated for use by the Administrator pursuant to section 102 (c) of the Act;

(3) If the proposed disposal site has not been designated by the Administrator, a statement of the basis for the proposed determination why no previously designated site is feasible and a description of the characteristics of the proposed disposal site necessary for its designation pursuant to Part 228 of this Subchapter H;

(4) The known historical uses of the proposed disposal site;

(5) Existence and documented effects of other authorized dumpings that have been made in the dumping area (e.g., heavy metal background reading and organic carbon content);

(6) An estimate of the length of time during which disposal will continue at the proposed site;

(7) Characteristics and composition of the dredged material; and

(8) A statement concerning a preliminary determination of the need for and/or availability of an environmental impact statement.

(b) The Regional Administrator will within 15 days of the date the public notice and other information required to be submitted by paragraph (a) of § 225.2 are received by him, review the information submitted and request from the District Engineer any additional information he deems necessary or appropriate to evaluate the proposed dumping.

(c) Using the information submitted by the District Engineer, and any other information available to him, the Regional Administrator will within 15 days after receipt of all requested information, make an independent evaluation of the proposed dumping in accordance with the criteria and respond to the District Engineer pursuant to paragraphs (d) or (e) of this section. The Regional Administrator may request an extension of this 15 day period to 30 days from the District Engineer.

(d) When the Regional Administrator determines that the proposed dumping will comply with the criteria, he will so inform the District Engineer in writing.

(e) When the Regional Administrator determines that the proposed dumping will not comply with the criteria he shall so inform the District Engineer in writing. In such cases, no Dredged Material Permit for such dumping shall be issued unless and until the provisions of § 225.3 are followed and the Administrator grants a waiver of the criteria pursuant to § 225.4.

§ 225.3 Procedure for invoking economic impact.

(a) When a District Engineer's determination to issue a Dredged Material Permit for the dumping of dredged material into ocean waters has been rejected by a Regional Administrator upon application of the Criteria, the District Engineer may determine whether, under § 103 (d) of the Act, there is an economically feasible alternative method or site available other than the proposed dumping in ocean waters. If the District Engineer makes any such preliminary determination that there is no economically feasible alternative method or site available, he shall so advise the Regional Administrator setting forth his reasons for such determination and shall submit a report of such determination to the Chief of Engineers in accordance with 33 CFR §§ 209.120 and 209.145.

(b) If the decision of the Chief of Engineers is that ocean dumping at the designated site is required because of the unavailability of feasible alternatives, he shall so certify and request that the Secretary of the Army seek a waiver from the Administrator of the Criteria or of the critical site designation in accordance with § 225.4.

§ 225.4 Waiver by Administrator.

The Administrator shall grant the requested waiver unless within 30 days of his receipt of the notice, certificate and request in accordance with paragraph (b) of § 225.3 he determines in accordance with this section that the proposed dumping will have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife, or recreational areas. Notice of the Administrator's final determination under this section shall be given to the Secretary of the Army.

[redacted]

[redacted]

PART 227—CRITERIA FOR THE EVALUATION OF PERMIT APPLICATIONS FOR OCEAN DUMPING OF MATERIALS

Subpart A—General

[redacted]

Subpart A—General

§ 227.1 Applicability.

[redacted]

(b) With respect to the criteria to be used in evaluating disposal of dredged materials, this section and Subparts C, D, E, and G apply in their entirety. [redacted] An applicant for a permit to dump dredged material must comply with all of Subparts C, D, E, G and applicable sections of B, to be deemed to have met the EPA criteria for dredged material dumping promulgated pursuant to section 102(a) of the Act. If, in any case, the Chief of Engineers finds that, in the disposition of dredged material, there is no economically feasible method or site available other than a dumping site, the utilization of which would result in noncompliance with the criteria established pursuant to Subpart B relating to the effects of dumping or with the restrictions established pursuant to section 102(c) of the Act relating to critical areas, he shall so certify and request that the Secretary of the Army seek a waiver from the Administrator pursuant to Part 225.

[redacted]

Subpart E of this Part 227 when he determines that:

(a) The material proposed for dumping does not contain any of the materials listed in Section 227.6 except as trace contaminants, or any of the materials listed in § 227.5;

(b) In accordance with Subpart C there is a need to ocean dump the material; and

(c) Any one of the following factors is of greater significance to the public interest than the potential for adverse impact on the marine environment, as determined in accordance with Subpart B:

(1) The need for the dumping, as determined in accordance with Subpart C; or

(2) The adverse effects of denial of the permit on recreational or economic values as determined in accordance with Subpart D; or

(3) The adverse effects of denial of the permit on other uses of the ocean, as determined in accordance with Subpart E.

Subpart B—Environmental Impact

§ 227.4 Criteria for evaluating environmental impact.

This Subpart B sets specific environmental impact prohibitions, limits, and conditions for the dumping of materials into ocean waters. If the applicable prohibitions, limits, and conditions are satisfied, it is the determination of EPA that the proposed disposal will not unduly degrade or endanger the marine environment and that the disposal will present:

(a) No unacceptable adverse effects on human health and no significant damage to the resources of the marine environment;

(b) No unacceptable adverse effect on the marine ecosystem;

(c) No unacceptable adverse persistent or permanent effects due to the dumping of the particular volumes or concentrations of these materials; and

(d) No unacceptable adverse effect on the ocean for other uses as a result of direct environmental impact.

§ 227.5 Prohibited materials.

The ocean dumping of the following materials will not be approved by EPA or the Corps of Engineers under any circumstances:

(a) High-level radioactive wastes as defined in § 227.30;

(b) Materials in whatever form (including without limitation, solids, liquids, semi-liquids, gases or organisms) produced or used for radiological, chemical or biological warfare;

(c) Materials insufficiently described by the applicant in terms of their compositions and properties to permit application of the environmental impact criteria of this Subpart B;

(d) Persistent inert synthetic or natural materials which may float or remain in suspension in the ocean in such a manner that they may interfere materially with fishing, navigation, or other legitimate uses of the ocean.

§ 227.6 Constituents prohibited as other than trace contaminants.

(a) Subject to the exclusions of paragraphs (f), (g) and (h) of this section, the ocean dumping, or transportation for dumping, of materials containing the following constituents as other than trace contaminants will not be approved on other than an emergency basis:

(1) Organohalogen compounds;

(2) Mercury and mercury compounds;

(3) Cadmium and cadmium compounds;

(4) Oil of any kind or in any form, including but not limited to petroleum, oil sludge, oil refuse, crude oil, fuel oil, heavy diesel oil, lubricating oils, hydraulic fluids, and any mixtures containing these, transported for the purpose of dumping insofar as these are not regulated under the FWPCA;

(5) Known carcinogens, mutagens, or teratogens or materials suspected to be carcinogens, mutagens, or teratogens by responsible scientific opinion.

(b) These constituents will be considered to be present as trace contaminants only when they are present in materials otherwise acceptable for ocean dumping in such forms and amounts in liquid, suspended particulate, and solid phases that the dumping of the materials will not cause significant undesirable effects, including the possibility of danger associated with their bioaccumulation in marine organisms.

(c) The potential for significant undesirable effects due to the presence of these constituents shall be determined by application of results of bioassays on liquid, suspended particulate, and solid phases of wastes according to procedures acceptable to EPA, and for dredged material, acceptable to EPA and the Corps of Engineers. Materials shall be deemed environmentally acceptable for ocean dumping only when the following conditions are met:

(1) The liquid phase does not contain any of these constituents in concentrations which will exceed applicable marine water quality criteria after allowance for initial mixing; provided that mercury concentrations in the disposal site, after allowance for initial mixing, may exceed the average normal ambient concentrations of mercury in ocean waters at or near the dumping site which would be present in the absence of dumping, by not more than 50 percent; and

(2) Bioassay results on the suspended particulate phase of the waste do not indicate occurrence of significant mortality or significant adverse sublethal effects including bioaccumulation due to the dumping of wastes containing the constituents listed in paragraph (a) of this section. These bioassays shall be conducted with appropriate sensitive marine organisms as defined in § 227.27(c) using procedures for suspended particulate phase bioassays approved by EPA, or, for dredged material, approved by EPA and the Corps of Engineers. Procedures approved for bioassays under this section will require exposure of organisms for a sufficient period of time and under appropriate conditions to provide reasonable assurance, based on consideration of the statistical significance of effects at the 95 percent confidence level, that, when the materials are dumped, no significant undesirable effects will occur due either to chronic toxicity or to bioaccumulation of the constituents listed in paragraph (a) of this section; and

(3) Bioassay results on the solid phase of the wastes do not indicate occurrence of significant mortality or significant adverse sublethal effects due to the dumping of wastes containing the constituents listed in paragraph (a) of this section. These bioassays shall be conducted with sensitive benthic organisms using benthic bioassay procedures approved by EPA, or, for dredged material, approved by EPA and the Corps of Engineers. Procedures approved for bioassays under this section will require exposure of organisms for a sufficient period of time to provide reasonable assurance, based on considerations of statistical significance of effects at the 95 percent confidence level, that, when the materials are dumped, no significant undesirable effects will occur due either to chronic toxicity or to bioaccumulation of the constituents listed in paragraph (a) of this section; and

(4) For persistent organohalogens not included in the applicable marine water quality criteria, bioassay results on the liquid phase of the waste show that such compounds are not present in concentrations large enough to cause significant undesirable effects due either to chronic toxicity or to bioaccumulation in marine organisms after allowance for initial mixing.

(d) When the Administrator, Regional Administrator or District Engineer, as the case may be, has reasonable cause to believe that a material proposed for ocean dumping contains compounds identified as carcinogens, mutagens, or teratogens for which criteria have not been included in the applicable marine water quality criteria, he may require special studies to be done prior to issuance of a permit to determine the impact of disposal on human health and/or marine ecosystems. Such studies must provide information comparable to that required under paragraph (c)(3) of this section.

(e) The criteria stated in paragraphs (c) (2) and (3) of this section will become mandatory as soon as announcement of the availability of acceptable procedures is made in the FEDERAL REGISTER. At that time the interim criteria contained in paragraph (e) of this section shall no longer be applicable. As interim measures the criteria of paragraphs (c) (2) and (3) of this section may be applied on a case-by-case basis where interim guidance on acceptable bioassay procedures is provided by the Regional Administrator or, in the case of dredged material, by the District Engineer; or, in the absence of such guidance, permits may be issued for the dumping of any material only when the following conditions are met, except under an emergency permit:

(1) Mercury and its compounds are present in any solid phase of a material in concentrations less than 0.75 mg/kg.

or less than 50 percent greater than the average total mercury content of natural sediments of similar lithologic characteristics as those at the disposal site; and

(2) Cadmium and its compounds are present in any solid phase of a material in concentrations less than 0.6 mg/kg, or less than 50 percent greater than the average total cadmium content of natural sediments of similar lithologic characteristics as those at the disposal site; and

(3) The total concentration of organohalogen constituents in the waste as transported for dumping is less than a concentration of such constituents known to be toxic to marine organisms. In calculating the concentration of organohalogens, the applicant shall consider that these constituents are all biologically available. The determination of the toxicity value will be based on existing scientific data or developed by the use of bioassays conducted in accordance with approved EPA procedures; and

(4) The total amounts of oils and greases as identified in paragraph (a)(4) of this section do not produce a visible surface sheen in an undisturbed water sample when added at a ratio of one part waste material to 100 parts of water.

(f) The prohibitions and limitations of this section do not apply to the constituents identified in paragraph (a) of this section when the applicant can demonstrate that such constituents are (1) present in the material only as chemical compounds or forms (e.g., inert insoluble solid materials) non-toxic to marine life and non-bioaccumulative in the marine environment upon disposal and thereafter, or (2) present in the material only as chemical compounds or forms which, at the time of dumping and thereafter, will be rapidly rendered non-toxic to marine life and non-bioaccumulative in the marine environment by chemical or biological degradation in the sea; provided they will not make edible marine organisms unpalatable; or will not endanger human health or that of domestic animals, fish, shellfish, or wildlife.

(g) The prohibitions and limitations of this section do not apply to the constituents identified in paragraph (a) of this section for the granting of research permits if the substances are rapidly rendered harmless by physical, chemical or biological processes in the sea; provided they will not make edible marine organisms unpalatable and will not endanger human health or that of domestic animals.

(h) The prohibitions and limitations of this section do not apply to the constituents identified in paragraph (a) of this section for the granting of permits for the transport of these substances for the purpose of incineration at sea if the applicant can demonstrate that the stack emissions consist of substances which are rapidly rendered harmless by physical, chemical or biological processes in the sea. Incinerator operations shall comply with requirements which will be established on a case-by-case basis.

[illegible]

§ 227.9 Limitations on quantities of waste material.

Substances which may damage the ocean environment due to the quantities in which they are dumped, or which may seriously reduce amenities, may be dumped only when the quantities to be dumped at a single time and place are controlled to prevent long-term damage to the environment or to amenities.

§ 227.10 Hazards to fishing, navigation, shorelines or beaches.

(a) Wastes which may present a serious obstacle to fishing or navigation may be dumped only at disposal sites and under conditions which will ensure no unacceptable interference with fishing or navigation.

(b) Wastes which may present a hazard to shorelines or beaches may be dumped only at sites and under conditions which will insure no unacceptable danger to shorelines or beaches.

[illegible]

§ 227.13 Dredged materials.

(a) Dredged materials are bottom sediments or materials that have been dredged or excavated from the navigable waters of the United States, and their disposal into ocean waters is regulated by the U.S. Army Corps of Engineers using the criteria of applicable sections of Parts 227 and 228. Dredged material consists primarily of natural sediments or materials which may be contaminated by municipal or industrial wastes or by runoff from terrestrial sources such as agricultural lands.

(b) Dredged material which meets the criteria set forth in the following paragraphs (1), (2), or (3) is environmentally acceptable for ocean dumping without further testing under this section:

(1) Dredged material is composed predominantly of sand, gravel, rock, or any other naturally occurring bottom material with particle sizes larger than silt, and the material is found in areas of high current or wave energy such as streams with large bed loads or coastal areas with shifting bars and channels; or

(2) Dredged material is for beach nourishment or restoration and is composed predominantly of sand, gravel or shell with particle sizes compatible with material on the receiving beaches; or

(3) When: (i) The material proposed for dumping is substantially the same as the substrate at the proposed disposal site; and

(ii) The site from which the material proposed for dumping is to be taken is far removed from known existing and historical sources of pollution so as to provide reasonable assurance that such material has not been contaminated by such pollution.

(c) When dredged material proposed for ocean dumping does not meet the criteria of paragraph (b) of this section, further testing of the liquid, suspended particulate, and solid phases, as defined in § 227.32, is required. Based on the results of such testing, dredged material can be considered to be environmentally acceptable for ocean dumping only under the following conditions:

(1) The material is in compliance with the requirements of § 227.6; and

(2) (i) All major constituents of the liquid phase are in compliance with the applicable marine water quality criteria after allowance for initial mixing; or

(ii) When the liquid phase contains major constituents not included in the applicable marine water quality criteria, or there is reason to suspect synergistic effects of certain contaminants, bioassays on the liquid phase of the dredged material show that it can be discharged so as not to exceed the limiting permissible concentration as defined in paragraph (a) of § 227.27; and

(3) Bioassays on the suspended particulate and solid phases show that it can be discharged so as not to exceed the limiting permissible concentration as defined in paragraph (b) of § 227.27.

(d) For the purposes of paragraph (c) (2), major constituents to be analyzed in the liquid phase are those deemed critical by the District Engineer, after evaluating and considering any comments received from the Regional Administrator, and considering known sources of discharges in the area.

Subpart C—Need for Ocean Dumping

§ 227.14 Criteria for evaluating the need for ocean dumping and alternatives to ocean dumping.

This Subpart C states the basis on which an evaluation will be made of the need for ocean dumping, and alternatives to ocean dumping. The nature of these factors does not permit the promulgation of specific quantitative criteria of each permit application. These factors will therefore be evaluated if applicable for each proposed dumping on an individual basis using the guidelines specified in this Subpart C.

§ 227.15 Factors considered.

The need for dumping will be determined by evaluation of the following factors:

(a) Degree of treatment useful and feasible for the waste to be dumped, and whether or not the waste material has been or will be treated to this degree before dumping;

(b) Raw materials and manufacturing or other processes resulting in the waste, and whether or not these materials or processes are essential to the provision of the applicant's goods or services, or if other less polluting materials or processes could be used;

(c) The relative environmental risks, impact and cost for ocean dumping as opposed to other feasible alternatives including but not limited to:

(1) Land fill;

(2) Well injection;

(3) Incineration;

(4) Spread of material over open ground;

(5) Recycling of material for reuse;

(6) Additional biological, chemical, or physical treatment of intermediate or final waste streams;

(7) Storage.

(d) Irreversible or irretrievable consequences of the use of alternatives to ocean dumping.

§ 227.16 Basis for determination of need for ocean dumping.

(a) A need for ocean dumping will be considered to have been demonstrated when a thorough evaluation of the factors listed in § 227.15 has been made, and the Administrator, Regional Administrator or District Engineer, as the case may be, has determined that the following conditions exist where applicable:

(1) There are no practicable improvements which can be made in process technology or in overall waste treatment to reduce the adverse impacts of the waste on the total environment;

(2) There are no practicable alternative locations and methods of disposal or recycling available, including without limitation, storage until treatment facilities are completed, which have less adverse environmental impact or potential risk to other parts of the environment than ocean dumping.

(b) For purposes of paragraph (a) of this section, waste treatment or improvements in processes and alternative methods of disposal are practicable when they are available at reasonable incremental cost and energy expenditures, which need not be competitive with the costs of ocean dumping, taking into account the environmental benefits derived from such activity, including the relative adverse environmental impacts associated with the use of alternatives to ocean dumping.

(c) The duration of permits issued under Subchapter H and other terms and conditions imposed in those permits shall be determined after taking into account the factors set forth in this section. Notwithstanding compliance with Subparts B, D, and E of this Part 227 permittees may, on the basis of the need for and alternatives to ocean dumping, be required to terminate all ocean dumping by a specified date, to phase out all ocean dumping over a specified period or periods, to continue research and development of alternative methods of disposal and make periodic reports of such research and development in order to provide additional information for periodic review of the need for and alternatives to ocean dumping, or to take such other action as the Administrator, the Regional Administrator, or District Engineer, as the case may be, determines to be necessary or appropriate.

Subpart D—Impact of the Proposed Dumping on Esthetic, Recreational and Economic Values

§ 227.17 Basis for determination.

(a) The impact of dumping on esthetic, recreational and economic values will be evaluated on an individual basis using the following considerations:

(1) potential for affecting recreational use and values of ocean waters, inshore waters, beaches, or shorelines;

(2) potential for affecting the recreational and commercial values of living marine resources.

(b) For all proposed dumping, full consideration will be given to such nonquantifiable aspects of esthetic, recreational and economic impact as:

(1) responsible public concern for the consequences of the proposed dumping;

(2) consequences of not authorizing the dumping including without limitation, the impact on esthetic, recreational and economic values with respect to the municipalities and industries involved.

§ 227.18 Factors considered.

The assessment of the potential for impacts on esthetic, recreational and economic values will be based on an evaluation of the appropriate characteristics of the material to be dumped, allowing for conservative rates of dilution, dispersion, and biochemical degradation during movement of the materials from a disposal site to an area of significant recreational or commercial value. The following specific factors will be considered in making such an assessment:

(a) Nature and extent of present and potential recreational and commercial use of areas which might be affected by the proposed dumping;

(b) Existing water quality, and nature and extent of disposal activities, in the areas which might be affected by the proposed dumping;

(c) Applicable water quality standards;

(d) Visible characteristics of the materials (e.g., color, suspended particulates) which result in an unacceptable esthetic nuisance in recreational areas;

(e) Presence in the material of pathogenic organisms which may cause a public health hazard either directly or through contamination of fisheries or shellfisheries;

(f) Presence in the material of toxic chemical constituents released in volumes which may affect humans directly;

(g) Presence in the material of chemical constituents which may be bioaccumulated or persistent and may have an adverse effect on humans directly or through food chain interactions;

(h) Presence in the material of any constituents which might significantly affect living marine resources of recreational or commercial value.

§ 227.19 Assessment of impact.

An overall assessment of the proposed dumping and possible alternative methods of disposal or recycling will be made based on the effect on esthetic, recreational and economic values based on the factors set forth in this Subpart D, including where applicable, enhancement of these values, and the results of the assessment will be expressed, where possible, on a quantitative basis, such as percentage of a resource lost, reduction in user days of recreational areas, or dollars lost in commercial fishery profits or the profitability of other commercial enterprises.

Subpart E—Impact of the Proposed Dumping on Other Uses of the Ocean

§ 227.20 Basis for determination.

(a) Based on current state-of-the-art, consideration must be given to any possible long-range effects of even the most innocuous substances when dumped in the ocean on a continuing basis. Such a consideration is made in evaluating the relationship of each proposed disposal activity in relationship to its potential for long-range impact on other uses of the ocean.

(b) An evaluation will be made on an individual basis for each proposed dumping of material of the potential for effects on uses of the ocean for purposes other than material disposal. The factors to be considered in this evaluation include those stated in Subpart D, but the evaluation of this Subpart E will be based on the impact of the proposed dumping on specific uses of the ocean rather than on overall esthetic, recreational and economic values.

§ 227.21 Uses considered.

An appraisal will be made of the nature and extent of existing and potential uses of the disposal site itself and of any areas which might reasonably be expected to be affected by the proposed dumping, and a quantitative and qualitative evaluation made, where feasible, of the impact of the proposed dumping on each use. The uses considered shall include, but not be limited to:

(a) Commercial fishing in open ocean areas;

(b) Commercial fishing in coastal areas;

(c) Commercial fishing in estuarine areas;

(d) Recreational fishing in open ocean areas;

(e) Recreational fishing in coastal areas;

(f) Recreational fishing in estuarine areas;

(g) Recreational use of shorelines and beaches;

(h) Commercial navigation;

(i) Recreational navigation;

(j) Actual or anticipated exploitation of living marine resources;

(k) Actual or anticipated exploitation of non-living resources, including without limitation, sand and gravel places and other mineral deposits, oil and gas exploration and development and offshore marine terminal or other structure development; and

(l) Scientific research and study.

§ 227.22 Assessment of impact.

The assessment of impact on other uses of the ocean will consider both temporary and long-range effects within the state of the art, but particular emphasis will be placed on any irreversible or irretrievable commitment of resources that would result from the proposed dumping.

Subpart F—Special Requirements for Interim Permits Under Section 102 of the Act

[redacted]

[redacted]

Subpart G—Definitions

§ 227.27 Limiting permissible concentration (LPC).

(a) The limiting permissible concentration of the liquid phase of a material is:

(1) That concentration of a constituent which, after allowance for initial mixing as provided in § 227.29, does not exceed applicable marine water quality criteria; or, when there are no applicable marine water quality criteria,

(2) That concentration of waste or dredged material in the receiving water which, after allowance for initial mixing, as specified in § 227.29, will not exceed a toxicity threshold defined as 0.01 of a concentration shown to be acutely toxic to appropriate sensitive marine organisms in a bioassay carried out in accordance with approved EPA procedures.

(3) When there is reasonable scientific evidence on a specific waste material to justify the use of an application factor other than 0.01 as specified in paragraph (a)(2) of this section, such alternative application factor shall be used in calculating the LPC.

(b) The limiting permissible concentration of the suspended particulate and solid phases of a material means that concentration which will not cause unreasonable acute or chronic toxicity or other sublethal adverse effects based on bioassay results using appropriate sensitive marine organisms in the case of the suspended particulate phase, or appropriate sensitive benthic marine organisms in the case of the solid phase; or which will not cause accumulation of toxic materials in the human food chain. These bioassays are to be conducted in accordance with procedures approved by EPA, or, in the case of dredged material, approved by EPA and the Corps of Engineers.[1]

(c) "Appropriate sensitive marine organisms" means at least one species each representative of phytoplankton or zooplankton, crustacean or mollusk, and fish species chosen from among the most sensitive species documented in the scientific literature or accepted by EPA as being reliable test organisms to determine the anticipated impact of the wastes on the ecosystem at the disposal site. Bioassays, except on phytoplankton or zooplankton, shall be run for a minimum of 96 hours under temperature, salinity, and dissolved oxygen conditions representing the extremes of environmental stress at the disposal site. Bioassays on phytoplankton or zooplankton may be run for shorter periods of time as appropriate for the organisms tested at the discretion of EPA, or EPA and the Corps of Engineers, as the case may be.

(d) "Appropriate sensitive benthic marine organisms" means at least one species each representing filter-feeding, deposit-feeding, and burrowing species chosen from among the most sensitive species accepted by EPA as being reliable test organisms to determine the anticipated impact on the site; provided, however, that until sufficient species are adequately tested and documented, interim guidance on appropriate organisms available for use will be provided by the Administrator, Regional Administrator, or the District Engineer, as the case may be.

§ 227.28 Release zone.

The release zone is the area swept out by the locus of points constantly 100 meters from the perimeter of the conveyance engaged in dumping activities, beginning at the first moment in which dumping is scheduled to occur and ending at the last moment in which dumping is scheduled to occur. No release zone shall exceed the total surface area of the dumpsite.

§ 227.29 Initial mixing.

(a) Initial mixing is defined to be that dispersion or diffusion of liquid, suspended particulate, and solid phases of a waste which occurs within four hours after dumping. The limiting permissible concentration shall not be exceeded beyond the boundaries of the disposal site during initial mixing, and shall not be exceeded at any point in the marine environment after initial mixing. The maximum concentration of the liquid, suspended particulate, and solid phases of a dumped material after initial mixing shall be estimated by one of these methods, in order of preference:

(1) When field data on the proposed dumping are adequate to predict initial dispersion and diffusion of the waste, these shall be used, if necessary, in conjunction with an appropriate mathematical model acceptable to EPA or the District Engineer, as appropriate.

(2) When field data on the dispersion and diffusion of a waste of characteristics similar to that proposed for discharge are available, these shall be used in conjunction with an appropriate mathematical model acceptable to EPA or the District Engineer, as appropriate.

(3) When no field data are available, theoretical oceanic turbulent diffusion relationships may be applied to known characteristics of the waste and the disposal site.

(b) When no other means of estimation are feasible,

(1) The liquid and suspended particulate phases of the dumped waste may be assumed to be evenly distributed after four hours over a column of water bounded on the surface by the release zone and extending to the ocean floor, thermocline, or halocline if one exists, or to a depth of 20 meters, whichever is shallower, and

(2) The solid phase of a dumped waste may be assumed to settle rapidly to the ocean bottom and to be distributed evenly over the ocean bottom in an area equal to that of the release zone as defined in § 227.28.

(c) When there is reasonable scientific evidence to demonstrate that other methods of estimating a reasonable allowance for initial mixing are appropriate for a specific material, such methods may be used with the concurrence of EPA after appropriate scientific review.

§ 227.30 High-level radioactive waste.

High-level radioactive waste means the aqueous waste resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated waste from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuels or irradiated fuel from nuclear power reactors.

§ 227.31 Applicable marine water quality criteria.

Applicable marine water quality criteria means the criteria given for marine waters in the EPA publication "Quality Criteria for Water" as published in 1976 and amended by subsequent supplements or additions.

§ 227.32 Liquid, suspended particulate, and solid phases of a material.

(a) For the purposes of these regulations, the liquid phase of a material, subject to the exclusions of paragraph (b) of this section, is the supernatant remaining after one hour undisturbed settling, after centrifugation and filtration through a 0.45 micron filter. The suspended particulate phase is the supernatant as obtained above prior to centrifugation and filtration. The solid phase includes all material settling to the bottom in one hour. Settling shall be conducted according to procedures approved by EPA.

(b) For dredged material, other material containing large proportions of insoluble matter, materials which may interact with ocean water to form insoluble matter or new toxic compounds, or materials which may release toxic compounds upon deposition, the Administrator, Regional Administrator, or the District Engineer, as the case may be, may require that the separation of liquid, suspended particulate, and solid phases of the material be performed upon a mixture of the waste with ocean water rather than on the material itself. In

---

[1] An implementation manual is being developed jointly by EPA and the Corps of Engineers, and announcement of the availability of the manual will be published in the FEDERAL REGISTER. Until this manual is available, interim guidance on the appropriate procedures can be obtained from the Marine Protection Branch, WH-548, Environmental Protection Agency, 401 M Street SW, Washington, DC 20460, or the Corps of Engineers, as the case may be.

such cases the following procedures shall be used:

(1) For dredged material, the liquid phase is considered to be the centrifuged and 0.45 micron filtered supernatant remaining after one hour undisturbed settling of the mixture resulting from a vigorous 30-minute agitation of one part bottom sediment from the dredging site with four parts water (vol/vol) collected from the dredging site or from the disposal site, as appropriate for the type of dredging operation. The suspended particulate phase is the supernatant as obtained above prior to centrifugation and filtration. The solid phase is considered to be all material settling to the bottom within one hour. Settling shall be conducted by procedures approved by EPA and the Corps of Engineers.

(2) For other materials, the proportion of ocean water used shall be the minimum amount necessary to produce the anticipated effect (e.g., complete neutralization of an acid or alkaline waste) based on guidance provided by EPA on particular cases, or in accordance with approved EPA procedures. For such materials the liquid phase is the filtered and centrifuged supernatant resulting from the mixture after 30 minutes of vigorous shaking followed by undisturbed settling for one hour. The suspended particulate phase is the supernatant as obtained above prior to centrifugation and filtration. The solid phase is the insoluble material settling to the bottom in that period.

PART 228—CRITERIA FOR THE MANAGEMENT OF DISPOSAL SITES FOR OCEAN DUMPING

[illegible]

[illegible]

§ 228.4 Procedures for designation of sites.

[illegible]

[redacted]

(e) *Dredged Material Permits.*

(1) Areas where ocean dumping of dredged material is permitted subject to the specific conditions of Dredged Material permits issued by the U.S. Army Corps of Engineers will be designated by EPA by promulgation in this Part 228, and such designation will be made based on environmental studies of each site, regions adjacent to the site, and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics. All studies for the evaluation and potential selection of dredged material disposal sites will be conducted in accordance with the appropriate requirements of §§ 228.5 and 228.6, except that:

(i) Baseline or trend assessment requirements may be developed on a case-by-case basis from the results of research, including that now in progress by the Corps of Engineers.

(ii) An environmental impact assessment for all sites within a particular geographic area may be prepared based on complete disposal site designation or evaluation studies on a typical site or sites in that area. In such cases, sufficient studies to demonstrate the generic similarity of all sites within such a geographic area will be conducted.

(2) In those cases where a recommended disposal site has not been designated by the Administrator, or where it is not feasible to utilize a recommended disposal site that has been designated by the Administrator, the District Engineer shall, in consultation with EPA, select a site in accordance with the requirements of §§ 228.5 and 228.6(a). Concurrence by EPA in permits issued for the use of such site for the dumping of dredged material at the site will constitute EPA approval of the use of the site for dredged material disposal only.

(3) Sites designated for the ocean dumping of dredged material in accordance with the procedures of paragraphs (e)(1) or (e)(2) of this section shall be used only for the ocean dumping of dredged material under permits issued by the U.S. Army Corps of Engineers.

§ 228.5 General criteria for the selection of sites.

(a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(c) If at anytime during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in §§ 228.5–228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

§ 228.6 Specific criteria for site selection.

(a) In the selection of disposal sites, in addition to other necessary or appropriate factors determined by the Administrator, the following factors will be considered:

(1) Geographical position, depth of water, bottom topography and distance from coast;

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches and other amenity areas;

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any;

(5) Feasibility of surveillance and monitoring;

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site;

(11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

(b) The results of a disposal site evaluation and/or designation study based on the criteria stated in paragraphs (1)–(11) will be presented in support of the site designation promulgation as an environmental assessment of the impact of the use of the site for disposal, and will be used in the preparation of an environmental impact statement for each site where such a statement is required by EPA policy. By publication of a notice in accordance with this Part 228, an environmental impact statement, in draft form, will be made available for public comment not later than the time of publication of the site designation as proposed rulemaking, and a final EIS will be made available at the time of final rulemaking.

[redacted]

§ 228.9 Disposal site monitoring.

(a) The monitoring program, if deemed necessary by the Regional Administrator or the District Engineer, as appropriate, may include baseline or trend assessment surveys by EPA, NOAA, other Federal agencies, or contractors, special studies by permittees, and the analysis and interpretation of data from remote or automatic sampling and/or sensing devices. The primary purpose of the monitoring program is to evaluate the impact of disposal on the marine environment by referencing the monitoring results to a set of baseline conditions. When disposal sites are being used on a continuing basis, such programs may consist of the following components:

(1) Trend assessment surveys conducted at intervals frequent enough to assess the extent and trends of environmental impact. Until survey data or other information are adequate to show that changes in frequency or scope are necessary or desirable, trend assessment and baseline surveys should generally conform to the applicable requirements of § 228.13. These surveys shall be the responsibility of the Federal government.

[redacted]

§ 228.12 Delegation of management authority for interim ocean dumping sites.

(a) The following sites are approved for dumping the indicated materials on an interim basis pending completion of baseline or trend assessment surveys and designation for continuing use or termination of use. Management authority for all sites is delegated to the EPA organizational entity under which each site is listed. The sizes and use specifications are based on historical usage and do not necessarily meet the criteria stated in this Part. This list of interim sites will remain in force for a period not to exceed three years from the date of final promulgation of this Part 228, except for those sites approved for continuing use or disapproved for use by promulgation in this Part during that period of time.

Appendix F

COMMENTS AND RESPONSES TO COMMENTS ON THE DRAFT EIS

The Draft EIS (DEIS) was issued on 9 November 1979. The public was encouraged to submit written comments. This appendix contains copies of written comments received by EPA on the DEIS. There was a great variety of comments received, thus EPA presents several levels of response:

- Comments correcting facts presented in the EIS, or providing additional information, were incorporated into the text and the changes were noted.

- Specific comments which were not appropriately treated as text changes were numbered in the margins of the letters, and responses prepared for each numbered item.

Some written comments were received after the end of the comment period. In order to give every consideration to public concerns, the Agency took under advisement all comments received up to the date of Final EIS production.

The EPA sincerely thanks all those who commented on the DEIS, especially those who submitted detailed criticisms that reflected a thorough analysis of the EIS.

COMMENT

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington D.C. 20230
(202) 377 3xxx 4335

February 4, 1980

Mr. Henry L. Longest, II
Deputy Assistant Administrator
for Water Program Operations
U.S. Environmental Protection Agency
Washington, D. C. 20460

1 Dear Mr. Longest:

This is in reference to your draft environmental impact statement entitled, "The Designation of Five Hawaiian Dredged Material Disposal Sites." The enclosed comment from the Maritime Administration is forwarded for your consideration.

Thank you for giving us an opportunity to provide this comment which we hope will be of assistance to you. We would appreciate receiving eight (8) copies of the final environmental impact statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure — Memo from: George C. Steinman
Chief, Division of Environmental Activities
Office of Shipbuilding Costs
MarAd

RESPONSE

1 EPA gratefully acknowledges the letter from the Deputy Assistant Secretary for Environmental Affairs, United States Department of Commerce.

UNITED STATES DEPARTMENT OF COMMERCE
Maritime Administration

December 28, 1979

MEMORANDUM FOR: Dr. Sidney R. Galler
Deputy Assistant Secretary for Environmental Affairs

2 Subject: Environmental Protection Agency Draft Environmental Impact Statement for the Designation of Five Hawaiian Dredged Material Disposal Sites (DES CN 7911.10)

The subject document has been reviewed for comment as requested by your memorandum of November 15, 1979. The proposed action amends the 1977 interim designation of the EPA Ocean Dumping Regulations and Criteria by altering the locations of three dump sites, adding two new dump sites, and making final designations of all five sites. All the sites are located close to shore but in deep water where open ocean conditions prevail. The dredged material, which is mostly terrestrial silt and clay mixed with sand, is dispersed rapidly at all five proposed sites. Currents generally flow alongshore or offshore.

We concur with the analyses and conclusions contained in the DEIS and have no critical comments to submit. Please send us a copy of the FEIS.

Barrett F. Ludicke

for GEORGE C. STEINMAN
Chief, Division of Environmental Activities
Office of Shipbuilding Costs

2 EPA thanks the Chief of the Division of Environmental Activities, Office of Shipbuilding Costs, Maritime Administration, United States Department of Commerce, for reviewing the Draft EIS.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Tec
Washington, D.C. 20230
(202) 377-

February 12, 1980

Mr. Henry L. Longest, II
Deputy Assistant Administrator
for Water Program Operations
3 U. S. Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Longest:

This is reference to your draft environmental impact statement entitled, "The Designation of Five Hawaiian Dredged Material Disposal Sites." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving eight (8) copies of the final environmental impact statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosures Memos from: Mr. James W. Rote
National Marine Fisheries Service
F/HP - NOAA

Mr. Robert B. Rollins
National Oceanic Survey
OA/C5 - NOAA

Mr. R. Kifer
OCZM - NOAA

3 EPA gratefully acknowledges the letter and enclosed memos from the Deputy Assistant Secretary for Environmental Affairs, United States Department of Commerce.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
Western Pacific Program Office
P. O. Box 3830
Honolulu, Hawaii 96812

January 9, 1980 F/SWR1:JJN

Mr. T. A. Wastler
Chief, Marine Protection Branch
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Wastler:

The National Marine Fisheries Service (NMFS) has reviewed the draft environmental impact statement (DOC DEIS No. 7911.10) for The Designation of Five Hawaiian Dredged Material Disposal Sites dated October 1979.

In order to provide as timely a response to your request for comments as possible, we are submitting the enclosed comments to you directly, in parallel with their transmittal to the Department of Commerce for incorporation in the Departmental response. These comments represent the views of the NMFS. The formal, consolidated views of the Department should reach you shortly.

Sincerely yours,

Doyle E. Gates
Administrator

Enclosure

cc: Gary Smith, F/SWR3, w/encl.
Office of Habitat Protection, F/HP
(4 copies) w/encl.

Comments on DEIS No. 7911.10 - The Designation of Five Hawaiian Dredged Material Disposal Sites

General Comments

The National Marine Fisheries Service (NMFS) was consulted during the planning and selection stages for the designation of deep-ocean disposal sites in the Hawaiian Islands for continued disposal of dredged material. This included narrowing an original fourteen proposed sites down to the five sites considered in the subject DEIS.

4-1 The NMFS feels that existing fisheries and endangered species under our jurisdiction will probably not be adversely impacted by the proposed action, primarily because of the depths of the selected sites and the planned infrequent use of these sites. However, because of the importance of the nearshore waters surrounding the main Hawaiian Islands to two marine animals on the endangered species list, we feel the DEIS should include sections in chapters 3 and 4 specifically dealing with endangered species. The two species of concern are the endangered humpback whale (*Megaptera novaeangliae*) and the threatened green turtle (*Chelonia mydas*). This section should include a caveat indicating that the effects of short-term turbidity, such as occurs during dredged material disposal, on humpback whales and green turtles, is not known at this time.

Specific Comments

Chapter 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION.

"Interference with Shipping, Fishing ...."

4-2 Page 2-20, paragraph 1. This paragraph states that the only fishing which occurs near the proposed disposal sites is midwater trolling. Midwater trolling should be changed to surface trolling. In addition, some bottom handlining for deep water snappers and midwater handlining for akule and large tunas occurs near several of the proposed sites.

Chapter 3. AFFECTED ENVIRONMENT

BIOLOGICAL CONDITIONS

Nekton

4-3 Page 3-14, paragraph 4. Scientific names should be used for these pelagic nektonic predators the first time they appear in the text. Common names preceding the scientific name should be the same throughout the DEIS. As an example, in this paragraph yellowfin tuna and skipjack tuna are used while on page 3-27 the Hawaiian names ahi and aku are used respectively for these tuna.

4-1 The suggested information on the two endangered species has been incorporated into Chapters 3 and 4 under sections entitled "Threatened and Endangered Species." The "caveat" concerning effects of short-term turbidity on these endangered species has been included under the same section in Chapter 4.

4-2 The suggested changes have been incorporated into the text and appear in Chapter 2 of the Final EIS under the section "Detailed Basis for Selection of the Proposed Sites," subsection "Interference with Shipping, Fishing...".

4-3 These changes have been incorporated into the text of the Final EIS and appear in Chapter 3 under the section "Recreational, Economic and Aesthetic Characteristics," subsection "Fisheries."

Page 3-14, paragraph 5. As presented in General Comments above, the discussion of endangered and threatened species should be expanded and placed in a separate section in this chapter of the DEIS.

4-4 This paragraph states that "the green sea turtle is the only common offshore reptile, whose breeding grounds are on the leeward side of the islands." Although it is the only common marine reptile in Hawaiian waters, green turtle breeding (nesting) grounds at present are entirely in the Northwestern Hawaiian Islands, primarily at French Frigate Shoals. In addition, the Hawaiian monk seal (Monachus schauinslandi) is indeed endemic to the Hawaiian Archipelago. However, it is rarely found in the main islands thus dredged material disposal at the proposed sites will not adversely impact this endangered seal.

4-5 Page 3-16, Table 3-9. Common Hawaiian Marine Mammals. There are several errors in this table as follows: 1. There is no known pilot whale, Delphinus melas. The pilot whale found in Hawaiian waters is Globicephala macrorhynchus. 2. The common name for Stenella attenuata is spotted dolphin. 3. The common dolphin, Delphinus delphis, and the Pacific white-sided dolphin, Lagenorhynchus obliguidens, are unconfirmed in Hawaiian waters; therefore they are certainly not common Hawaiian marine mammals. 4. Only one species of bottlenose dolphin occurs in Hawaii, Tursiops gilli.

Fisheries

4-6 Page 3-23, paragraph 4. This paragraph states that "commercial fishing (in Hawaii) is confined to surface or pelagic offshore fishing, with little bottom fishing." This statement is misleading. Bottomfishing for demersal snappers and groupers is an important segment of Hawaiian commercial fishing, even though the catch is relatively small compared to the pelagic fisheries.

4-7 Page 3-27, paragraph 3. The paragraph discusses fisheries in Mamala Bay and indicates that fishing for aku is the major fishery at the dredged material disposal site. Actually the majority of aku are taken well seaward of the proposed disposal site. Ulua should be followed by (Caranx and Carangoides spp.)

Chapter 4. ENVIRONMENTAL CONSEQUENCES

Fishing

4-8 Page 4-3, paragraph 3. Again the statement is made that "little or no demersal (bottom) fishing" occurs in Hawaii. This should be corrected.

4-9 Page 4-5, paragraph 4. This paragraph discusses recreational fishing from charter boats and states that mahimahi, swordfish and billfish are caught. Swordfish are not taken by recreational charter boats which fish

4-4 This information has been added to Chapter 3 of the Final EIS under the section "Threatened and Endangered Species."

4-5 Table 3-9 in the Final EIS has been changed to reflect these comments.

4-6, 4-7 This passage has been amended in the Final EIS to include this information and appears in Chapter 3 under the section "Recreational, Economic, and Aesthetic Characteristics," subsection "Fisheries." The family name Carangidae is used in the final EIS for ulua instead of the two species names suggested.

4-8, 4-9 These changes have been made and appear in Chapter 4 of the Final EIS under the section "Effects on Recreational, Economic, and Aesthetic Values," subsection "Fishing".

by surface trolling. Long-line fishing is not commonly conducted as a recreational fishing method.

We hope these comments will be of assistance to you. Please send us a copy of the final EIS as soon as it becomes available.

Rec'd PP/EC

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

OA/C52x7:SKM

TO: PP - Richard L. Lehman

FROM: OA/C5 - Robert B. Rollins

SUBJECT: DEIS #7911.10 - The Designation of Five Hawaiian Dredged Material Disposal Sites

The subject statement has been reviewed within the areas of the National Ocean Survey's (NOS) responsibility and expertise and in terms of the impact of the proposed action on NOS activities and projects.

The following comments from the Ocean Dumping and Monitoring Division, NOS, are offered for your consideration.

The letter enclosed with the DEIS is most important. It indicates that the DEIS is for site designation only. It contains information of use to determining acceptability of given dredged material for ocean dumping but it is not to be considered a final argument for such acceptability.

The EPA Ocean Dumping Regulations are specific on what needs to be considered for site designation. Those regulations are Appendix F of the DEIS and 11 specific considerations are on page F-10. These constitute the cookbook for a site designation DEIS.

On pages 2-14 to 2-21, the 11 considerations are separately discussed and this is the heart of the DEIS. The basic conclusion of the DEIS is that the five sites should be designated as dredged material disposal sites because they are locations of low resource value where any suspended or dissolved remnant of a dump will be carried seaward or parallel to the shore while being mixed with surrounding water. I have no data or information which will cause me to disagree with that conclusion.

Specific Comments:

5-1 P. xii, paragraph 4: Mention is made of a huge assimilative capacity at the disposal sites, yet a definition of assimilative capacity is not given in the DEIS. What does huge mean? Relative to what? What does "assimilative capacity" mean?

5-1 The sentence in question has been changed in the Final EIS to read: "The proposed disposal sites can receive dredged materials without jeopardizing the life-support systems of marine biota due to the extent of dilution which occurs (approximately 1:1,000,000)."

P. xii: THE EIS is riddled with confusion, three examples of which are found on this page. In paragraphs 2 and 3, the word "significant" appears twice as an adjective and in both cases it is completely unclear
5-2 as to its meaning. What is "significant dilution and transport"? In the last sentence on the page, what are "suspended particulates"? Particulate sediments? Organisms?

P. 2-18, paragraph 1: The discussion of dilution and dispersion of spoil plumes is too brief to be sufficient. What does "sufficiently diluted and dispersed" mean? By what standards, and relative to what?
5-3 The same comments apply to paragraph 2 on page 2-19. In both cases, all quantitative comments about plume behavior should be supported by a reference to the original source of the information, even though in these cases, the references are discussed in more detail in later chapters.

Page 3-3: First word on first line, "Goeggel" should not be there.

Page 3-7: The paragraph about currents includes not one reference to original sources of information. The references should be included.

Page 3-9: Under <u>Trace Metals</u>, some elements "below minimum detectable levels" - what <u>are those levels</u>? Also, the Zn and Hg concentrations
5-4 are given and said to be 10 to 1000 times higher than listed average concentrations. If the data are to be given, then some explanation of why the measured concentrations are so high should also be present.

Pages 3-10 to 3-12: The discussion and tables dealing with metal contents of sediments and organisms are meaningless as they stand. The
5-5 figures should be presented in relation to what is known of chemical dynamics and toxicities of the metals.

Pages 3-12 to 3-20: The summary of biological conditions should be presented in a comparative manner to demonstrate similarities and differences, if any, between the regions discussed and surrounding areas.
5-6 The section is incomplete without this broader, regional perspective. This section could also be improved by expanding the descriptions of the various communities with names and number of species occupying them. The last paragraph on page 3-16, for example, could be improved greatly by inclusion of a few numbers. What does "dominated in abundance and diversity" mean? How many are "several"? What does "fewer numbers" mean?

Page 4-12: It is unlikely that dredged material would be declared acceptable only on basis that Hg and Cd levels in site sediments would
5-7 increase by 50 percent or less. This criteria would be sufficient if, for some reason, bioassays were deemed unnecessary.

The example on the bottom of the page is not comprehensible. If
5-8 dredge material could be uniformly distributed in the water column, one would be seeking other disposal sites.

5-2 The word "significant" has been deleted from the two cited paragraphs in the Final EIS. The phrase "suspended particulates" has been changed to "suspended particulate matter."

5-3 The discussion of dilution and dispersion of the dredged material plume is a summary of more detailed information found in Appendices A and C of the Draft and Final EIS. However, appropriate references have been included as suggested. The word "sufficiently" has been deleted from the cited phrase.

5-4 The detection limits and an explanation of the high zinc and mercury values have been included in the Final EIS in Chapter 3 under the section entitled "Chemical Conditions," subsection "Trace Metals". The detection limits for silver, cadmium, chromium, and copper were 1 μg/liter. The detection limits for lead and nickel were 5 μg/liter and 4 μg/liter, respectively. The high values for mercury and zinc occurred due to sample contamination (K. Chave, personal communication, 1980). (See Comment and Response #9-3.)

5-5 The information contained in these tables is presented as background description for characterization of the disposal sites. Toxic concentrations of metals in sediment have not been established.

5-6 Complete biological studies were conducted (see Chapter 3 for references) at the South Oahu Site only. Chapter 3 of the DEIS described differences between the pelagic communities at this site and communities in other regions of the Hawaiian Islands. Chapter 3 discussed members of the site biota which could be potentially impacted by dredged material dumping. Regarding use of qualitative descriptors of abundances in the DEIS text, reference to an accompanying table had been omitted inadvertently. This table (3-10) had been included in the DEIS and is included in the Final EIS.

5-7 The tables and discussion using the 50% increase criterion have been deleted from this section of the Final EIS. The section entitled "Toxin Accumulation" has been rewritten as a result of Comment #25-10, and is now entitled "Trace Metal and Organohalogen Accumulation."

5-8 The example cited in the section entitled "Trace Metal and Organohalogen Accumulation" may be viewed as an extreme case, since, in reality, the metals contained in the dredged material do not readily enter solution. The example is merely illustrating that, given the volume of the disposal site and assuming that all metals contained in the dredged material entered solution completely, the increases in metal concentrations of the water column are extremely minimal.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OCZM
Washington, D.C. 20235

Rec'd PP/EC
07 JAN 1980

DATE: January 7, 1980

TO: PP/EC - R. Lehman

FROM: CZM - R. Kifer R. Kifer

SUBJECT: DEIS 7911.10 - The Designation of Five Hawaiian Dredge Material Disposal Sites - CZM Comment

Thank you for the opportunity to review and comment upon the Draft Environmental Impact Statement (EIS) for The Designation of Five Hawaiian Dredged Material Disposal Sites.

6-1 The Sanctuary Programs Office of the Office of Coastal Zone Management (OCZM) is concerned about potential impacts of the proposed action on the marine environment in general and on the particularly sensitive resources of areas which have been suggested for possible marine sanctuary status. At the present time, there are no marine sanctuaries nor active candidates for marine sanctuary designation within the proposed disposal areas. However, the interisland waters of Maui County, including waters of the Pailolo Channel near Kahului Harbor and Kahului Disposal Site, appear on the Marine Sanctuary List of Recommended Areas (44 FR No. 212 October 31, 1979). Moreover, the recent Hawaiian Humpback Whale Workshop (Maui: December 12-14, 1979) convened by OCZM recommended the establishment of a Humpback Whale Marine Sanctuary to encompass all waters within the 100-fathom isobath surrounding the High Hawaiian Islands (from Kaula Island in the northwest to the Island of Hawaii in the southeast). OCZM is discussing the outcome of the workshop with various government, scientific and environmental entities and is evaluating the recommended site according to Marine Sanctuary Regulations (44 FR No. 148 July 31, 1979) for possible selection as an Active Candidate for marine sanctuary designation. While the boundaries of the recommended marine sanctuary and proposed dredge disposal sites do not overlap, they are within close proximity of each other. It is therefore recommended that appropriate monitoring studies be undertaken to determine to what extent the marine environment within these especially sensitive areas would be affected by disposal operations, especially the likelihood of dredged materials moving into a marine sanctuary (40 CFR SS 228.10[b]) should one be designated.

6-1 Modeling studies on dredged material dispersion were discussed at length in Appendix C of the DEIS, subsection entitled "Previous Mathematical Studies." Future environmental studies to provide additional dredged material dispersion data were recommended in Appendix D of the DEIS, which included thorough characterizations of the dredged materials, turbidity and/or nephelometry profiles of the disposal site water column, and total suspended solids load. These studies will be performed at the discretion of the District Engineer (or EPA Regional Administrator), who will determine the optimal conditions for success. When any marine sanctuary near a disposal site appears to be influenced by dredged material disposal operations, the study plan will be reviewed and amended as needed.

OCZM is particularly concerned about the welfare of the endangered humpback whale (Megaptera novaeangliae) in relation to any disposal activity. Figure 3-2 (p 3-17) in the DEIS acknowledges the presence of humpback whales within the proposed disposal areas. This concurs with the findings of whale surveys conducted by the National Marine Fisheries Service (NMFS: 1976-79) and several independent scientific surveys (1976-78). While the effect of dredge disposal on humpbacks has not yet been ascertained, it is strongly recommended that, should disposal be carried out as planned, extreme caution be exercised to avoid disposal if and when humpbacks are reported at or near the disposal sites. Since
6-2 humpback residency is seasonal (winter/early spring), it is suggested that disposal be avoided during this time, especially during what are believed to be important calving, nursery, and possible courtship and breeding periods, until it is certain that dumping operations do not interfere with these key life history events. Further consultation with NOAA (NMFS and OCZM) is recommended to coordinate scheduling of disposal operations to avoid adverse impacts on the whales during their winter residence in Hawaii.

As acknowledged in the DEIS, "an effective monitoring program is usually based on a comprehensive predisposal baseline survey of the site"
6-3 (p 2-22) and of the proposed dredge operation site. OCZM therefore recommends that the following environmental parameters and consequences be given full consideration prior to dredge and disposal operations:

- relationship between and compatibility of sediments at disposal sites and those to be dredge/disposed, especially since regulations specify that "... material proposed for dumping is substantially the same as the substrate ..." at the disposal site. On page 4-19 it is stated that "the bulk of dredge material proposed for dumping at the South Oahu Site is composed of sand and gravel, and presents no great variation in disposal site substrate." No such evaluation is provided for other proposed sites and intended dredge materials. Table 4-5 (p 4-19) does, however, present grain size distribution comparisons. Sediment compositions given in this table appear to be significantly different. For example, sediment at the proposed Nawiliwili Site has a 2% silt-clay composition whereas sediment to be dredged from the Nawiliwili Harbor has a 92% silt-clay composition. Since "there is evidence that the dredged material may consist of considerable fractions of silt and clay" (p C-10), OCZM recommends further study to determine if dredged materials are compatible with sediments of the disposal site.
- the physical and chemical relationship between measured harbor sediments and sediments in the dredge vessel hoppers before release,
- the effect of turbidity on marine mammals,

F-12

6-2 Subsections entitled "Threatened and Endangered Species," relative to humpback whales and other Hawaiian waters species, have been added to the Final EIS in Chapters 3 and 4. Several factors would mitigate disposal effects on these mammals: (1) the sites are not greatly frequented by humpback whales (see Figure 3-2, Chapter 3), (2) as described in Chapter 4, humpback whales are apparently undisturbed by surface traffic not specifically directed at them (Norris and Reeves, 1978), and (3) the proposed dredged material disposal would be a short-term infrequent activity. Due to potential effects of disposal on the whales, advanced planning schedules will attempt to avoid breeding and calving seasons (November to May) until additional data are available. (See Comment and Response #15-2.)

6-3 Some of the future study subjects recommended by the Office of Coastal Zone Management (OCZM) are already included in Appendix D (e.g., physical/chemical characterization of sediments in dredged vessel hoppers, measurement of benthic biomass, and recruitment/recovery rates). Other OCZM-recommended studies are subjects for research (e.g., effects of turbidity on marine mammals, cumulative effects of organic carbon loading, and dredged material plume effects on holoplankton and meroplankton). The remaining study recommended by OCZM, "Determination of Sediment Composition," is listed in the Ocean Dumping Regulations for testing candidate materials for dumping. Except for the studies prescribed by the Ocean Dumping Regulations, all recommended studies will be given full discretionary consideration by the District Engineer (or EPA Regional Administrator).

* the organic content of dredged material,
* the cumulative effect of organic carbon loading on the ocean bottom and in overlying waters (from organic content of dredged material, biotic trapping and benthic smothering) and the potential impact of simultaneous increase in oxygen demand and reduction in primary productivity due to turbidity and phytoplankton trapping;
* the effects of suspended and settling sediment on the plankton and on recruitment/settlement of planktonic larvae and juveniles,
* measurement of benthic biomass and recruitment/recovery rates at the disposal sites and at the dredged sites,
* bioassays of key organisms at disposal sites and at dredge sites.

Thank you for considering these recommendations.

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
BUILDING 230
FT SHAFTER HAWAII 96858

PODED-PV

2 January 1980

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
US Environmental Protection Agency
Washington, DC 20460

Dear Mr. Wastler:

Inclosed are our review comments on the Draft Environmental Impact Statement (DEIS) for Hawaii Dredged Material Disposal Sites Designation. For your information, my staff has worked closely with your agency in preparing the DEIS, and the comments provided in the inclosure are mostly minor editorial suggestions. However, we suggest that you reconsider recommendations on avoiding summer disposal operations based upon reasons provided in comments 1 and 5 in the inclosure. We feel that the preparers have done a commendable job, and we have appreciated the opportunity to assist in preparation and review of the DEIS.

Sincerely yours,

for KISUK CHEUNG
Chief, Engineering Division

1 Incl
As stated

US ARMY ENGINEER DIVISION, PACIFIC OCEAN
COMMENTS ON THE DRAFT EIS:
DESIGNATION OF FIVE HAWAIIAN DREDGED MATERIAL DISPOSAL SITES
2 January 1980

NO.	PAGE	PARA	COMMENT		
7-1	General		Corps maintenance dredging schedules for Hawaiian harbors are established according to dredging requirements at Honolulu Harbor because of its larger dredging volume and relative importance among the five Federal harbors maintained by the Corps. Although the dredging cycle is 5-10 years for the harbors, all five harbors are included in each cycle, if the hopper dredge schedule allows. Also, Pearl Harbor is included in each cycle on request from the Navy. The ongoing dredging work at Honolulu Harbor is scheduled to be completed in the second half of calendar year 1980. The purpose of this work is to deepen the normal operating depths of the harbor. However, this dredging work will postpone the need for maintenance dredging in Hawaiian harbors until 1986, as now scheduled.	7-1	Noted.
7-2	xi	3	The next dumping at the Port Allen site is scheduled for 1986.	7-2	Noted.
7-3	xii	3	Suggest adding "(1,000 yd)" at the end of the sentence.	7-3	Change made.
7-4	xii	1 & 2	The next dumping at the Kahului and Hilo sites is scheduled for 1986.	7-4	Change made.
7-5	xiv	Conclusions	We recommend the conclusions be revised to read: "Efforts will be made during advanced planning to schedule disposal to avoid summer months until more data on summer fish migration and spawning are evaluated." Dredging in Hawaii depends, to a large degree, upon the availability of hopper dredges with home ports on the mainland (outside Hawaii). The owners generally assign their dredges according to priority. Therefore, the Corps cannot give assurances that dredging in Hawaii will be avoided during summer months. Based upon available information, it is highly unlikely that fish spawning or migration will be affected by infrequent and temporary disposal activities. Furthermore, observations during ocean disposal indicate that most dredged material descends quickly through surface waters and reaches the bottom within minutes. Thus, the imposition of constraints against summer disposal may have severe operational and economic consequences and is probably not environmentally justified. However, the Corps will	7-5	Change made. Information on summer spawning and migration was requested from the State of Hawaii Department of Fish and Game, and National Marine Fisheries Service (NMFS). No data are currently available for the disposal site vicinities.

Comments (continued)

NO.	PAGE	PARA	COMMENT	
5 (cont'd)			attempt to accommodate non-summer dredging by advanced scheduling. Furthermore, we suggest that EPA request input from the State of Hawaii, Division of Fish and Game and the National Marine Fisheries Service on the availability of data and significance of summer spawning and migration in the vicinity of the disposal sites.	
7-6	xiii	3	Suggest revising the third sentence to read: "However, the shrimp are not present in commercially valuable concentrations and no commercial shrimp fishing is practiced there..."	7-6 Change made.
7-7	1-3	1	Clarify that the EIS was prepared in 1975.	7-7 Change made.
7-8	1-7	2	Revise second sentence to read: "Maintenance dredging of federal projects in the Hawaiian Islands is conducted by the CE, and .....permit."	7-8 Sentence now reads: "Maintenance dredging of CE projects in the Hawaiian Islands are conducted by the CE...".
7-9	2-1	1	Suggest clarifying sentence to read: "Ocean disposal of materials from 6 deep-draft harbors should continue as the most practical method of disposal."	7-9 Change made.
7-10	2-1	2	Add to the second sentence: "The absence of continental shelves and slopes brings deep ocean waters close to shore to provide optimal locations....."	7-10 Change made.
7-11	2-1	4	Clarify the sentence to read: "Except at Alternative Site 9A, which was rejected for environmental reasons during earlier studies,...."	7-11 Change made.
7-12	2-2	2	Land disposal should be one of the alternatives listed and considered in the EIS.	7-12 Change made.
7-13	2-8	3	Suggest revising second sentence and remainder of paragraph to read: "Land based disposal for these six deep-draft harbors is discounted because of the lack of land, high cost, and public health considerations (USAED, 1975). However, land disposal and other alternatives have been adopted for the other federally maintained harbors in Hawaii, precluding the need for ocean disposal. All of these other harbors, except Kawaihae Deep Draft Harbor, are shallow draft, small-boat harbors."	7-13 An expanded discussion of land disposal including the suggested information has been added to Chapter 2 (section entitled "No-Action Alternative").

Comments (continued)

NO.	PAGE	PARA	COMMENT	RESPONSE
7-14	2-10	1	In line 11, change "Crowe" to "Chave."	Change made.
7-15	2-10	3	Suggest revising first two sentences to read: "In 1976-1977, the CE studies...contour. At that time, deep-water sites were required...."	Change made.
7-16	2-13	3	Suggest revising second sentence to read: "Site 9A was dropped from consideration early during the studies since the western edge of the site was discovered to be on a very steep cliff..."	Change made.
7-17	2-13	6	Suggest changing first sentence to read: "Despite their greater depths, the proposed and alternative sites are not far offshore compared to continental sites because of the absence of continental slopes and shelves from Hawaii."	Sentence now reads: "Despite their greater depths, the proposed and alternative sites are close to shore, and the costs for monitoring transportation are comparable to those for Continental U.S. sites."
7-18	2-14	3	Suggest clarifying the next to last sentence to read: "...it is important to note that the proposed sites have no commercial potential because of low concentrations of shrimp."	Change made.
7-19	2-16	Fig 2-6	Suggest adding the following to the caption: "Note: The vertical axis has been exaggerated 5 times relative to the horizontal axis."	Change made.
7-20	2-19	1	Suggest adding to end of the last sentence "...and are expected to remain high."	Sentence now reads: "As a consequence, monitoring costs have been and will be high."
7-21	2-21	5	Suggest revising last two lines to read: "Environmental conditions at the site after disposal operations vary from the predisposal (baseline) conditions. Therefore, an effective monitoring...."	Sentence remains as written in the DEIS since it clarifies the thought following.
7-22	2-22	1	Suggest adding to the second line: "Fortunately such environmental studies were sponsored by the Corps and the Navy and have been performed at all sites."	Sentence now reads: "Therefore, an effective monitoring program is usually based on comprehensive pre-disposal baseline surveys of the sites, which have already been performed at all sites by the CE and the Department of Navy."
7-23	2-23 & 3-29	1	The 1,558,000 cubic yards of dredged material is indicative of only 1977 dredging activity. In 1978, an additional 1,155,000 cubic yards were dredged from Pearl Harbor and ocean dumped. Therefore, the percentages for 1977-1978 should be revised accordingly.	Change made.
7-24	2-23	Table 2-1	The next scheduled dredging should be revised to 1986.	Change made.
7-25	3-1	3	Suggest revising the last half of paragraph 3 to read "...(former Pearl Harbor site). The study sites were near to each other, overlapping the proposed south Oahu site. In addition, the CE sponsored environmental	Change made.

3

Comments (continued)

NO.	PAGE	PARA	COMMENT	RESPONSE
25 (cont'd)			studies before and after disposal operations at Nawiliwili, Port Allen, Kahului, and Hilo. At least two alternative sites at each of these locations were investigated and evaluated as candidate sites before disposal and the sites utilized were also surveyed after disposal in 1977."	
7-26	3-2	3	Amplify that "using sonic depth recorders, oceanographers prepared detailed bathymetric maps for each of five selected and five alternative sites as a part of the CE sponsored studies conducted prior to 1977 disposal operations (NIC, 1977)."	7-26 Change made.
7-27	3-8, 2-3, 4-2, 4-3, 6-20		The State of Hawaii's water quality standards have been recently revised. Therefore, please update all comments referencing the standards.	7-27 Change made.
7-28	3-9	2	Clarify whether trace metals were measured in the sediments or water column.	7-28 This section on trace metals has been rewritten as a result of this comment and Comments #6-4, and #10-3.
7-29	3-16	1	Suggest adding to the beginning: "Very detailed studies of benthos were performed before and after dredging in 1977 at all sites (NIC, 1977; Goeggel, 1978; Miller and Chave, 1977a, 1978)."	7-29 Sentence not included since a discussion of the studies on the proposed sites appears at the beginning of Chapter 3 of the Final EIS.
7-30	3-18	2	Suggest including "Porcelaneous" to the glossary.	7-30 Change made.
7-31	3-22	2	Suggest emphasizing that most of these recreational activities are well shoreward of the sites.	7-31 Change made.
7-32	3-27	1	Suggest revising last part of paragraph to read: "Although there is interest to establish commercial harvesting of these species in Hawaii, it is not being practiced at the present time. Thus, the resource exists without sufficient economic incentive in Hawaii's fishery, yet still remains a potential fishery. In any case, the concentrations of shrimp at the sites are too low for commercial interest." We also suggest you coordinate the sections on the deep-water shrimp fishery with the National Marine Fisheries Service.	7-32 Revision not made since existing text already reflects the point. Deepwater shrimp fishery information was coordinated with NMFS via information from the Honolulu Laboratory.
7-33	3-27 3-28	2-4 1-2	Add to the end of these paragraphs: "The proposed site covers only a very small percentage of the area from which these statistics were gathered." We further suggest that you specify the exact percentages.	7-33 Revision added to the last paragraph in the section to avoid repetition. The exact areal percentages were unavailable. Suffice that the areal percentages were miniscule (i.e., less than 1%).
7-34	3-29	4	Suggest modifying first two sentences to read: "... dredged material are significant. However, these inputs are derived from nearby shallow water areas and consist of approximately 23 point sources....."	7-34 Change made.

Comments (continued)

NO.	PAGE	PARA	COMMENT	
7-35	3-30	Table 3-14	Include 1978 dredging of 1,155,000 cubic yards for Pearl Harbor.	7-35 Change made.
7-36	3-31	Fig 3-5	Revise percentages to consider 1978 dredging work.	7-36 Change made.
7-37	4-1	4	Suggest revising the beginning of the paragraph after the abstract to read: "Outside of Hawaii, the majority of all dredged material disposal..."	7-37 Revision not made since existing text reflects the suggestion.
7-38	4-1	4	Suggest adding at the end of third sentence: "However, such is not the case in Hawaii where a number of deep ocean environmental studies have been conducted, and deep ocean disposal is likely..."	7-38 Change made.
7-39	4-3	4	Suggest modifying the middle portion of the paragraph to read: "Therefore, the National Marine Fisheries Service, US Fish and Wildlife Service, and State of Hawaii Division of Fish and Game urged the CE to select sites outside the primary range of the shrimp, or beyond the 200-fathom (366m) isobath. This general recommendation was in part a consequence of the lack of field information from the sites which was lacking <u>at that time</u>. Now that detailed site specific data are available for all sites, the need for a depth limit was reevaluated on a site specific basis. The recommended sites are all close to or exceed the 200-fathom contour."	7-39 Change made.
7-40	4-5	1	Suggest revising second sentence to read: "The proposed south Oahu site is not favored for shrimp fishing because commercial concentrations of shrimp are lacking. Migrating shrimp have been reported at the site after disposal operations (Tetra Tech, 1977; Goeggel 1978; Chave and Miller, 1978) and may have been attracted to the disposal activity."	7-40 Change made.
7-41	4-5	3	Suggest modifying first sentence to read: "Two species of shrimp of commercial value, but not in commercial abundance, inhabit the region..."	7-41 Change made.
7-42	4-6	3	Clarify that "all sites are far removed from tourist destination areas."	7-42 Change made.
7-43	4-7	5	Modify the first sentence to read: "Dredged material characteristics vary, but two basic types have been reported: (1) harbors maintained by the Corps show a mean of 49% coral....; and (2) adding Pearl Harbor to the list, a mean for all harbors...."	7-43 Revision not made since existing text reflects the suggestion.

Comments (continued)

NO.	PAGE	PARA	COMMENT	RESPONSE
7-44	4-11	1	Please specify the location of Windom's ammonia study.	Change made.
7-45	4-18	1	Please clarify that five out of six harbors have very similar sediments and explain the origin of the two basic sediment types (marine carbonate and terrigenous basalt).	Discussion of the similarity of the harbor sediments to each other is not relevant to the paragraph cited. The crux of the paragraph in question is that the dredged sediments are sufficiently similar (both in grain size and composition) to the sediments at the proposed disposal sites, such that the severe effects anticipated are avoided when benthic organisms are buried under exotic sediments.
7-46	4-20	3	Suggest adding to last sentence: "...similar in proportion to the quantities disposed."	Revision not made since existing text reflects the suggestion.
7-47	4-21	1	Change "Liaison" to "Preservation."	Change made.
7-48	4-21	3	Clarify that the Barbers Point pipeline terminals are some 20 miles to the west of the proposed south Oahu site."	Change made.
7-49	4-21	4	Clarify that all candidate OTEC sites are many miles from any of the proposed disposal sites.	Revisions not made since existing text reflects the suggestion.
7-50	4-22	2	Suggest changing the "OCEAN INCINERATION" subheading to "INCINERATION AT SEA."	Revisions not made since existing text reflects the suggestion.
7-51	4-23	2	Suggest clarifying the first sentence to read: "Only a portion of the proposed...."	Revisions not made since existing text reflects the suggestion.
7-52	4-24	1	Suggest modifying the first effect to read: "Possible attraction to or avoidance of the area by fish."	Change made.
7-53	4-25	2	Recommend adding after the last sentence the following: "These studies will help augment comparable studies already performed at all of the sites during earlier studies."	Revision felt unnecessary.
7-54	5-1	1	The new 1978 regulations to implement the National Environmental Policy Act now require outside consultants who have contributed to the preparation of an EIS to issue a disclosure statement.	As required by NEPA, Final Regulations, 1978, a list of preparers of the EIS, their personal qualifications, and the sections of the document for which they were responsible were included in the DEIS. (See Chapter 5.)
7-55	5-2	4	Suggest adding to the biographical sketch of Mike Lee the following: "In addition, Mr. Lee prepared the 1975 EIS on Harbor Maintenance Dredging in the State of Hawaii and assisted in the development, evaluation, and review of CE sponsored environmental studies at the disposal sites."	Addition unnecessary.
7-56	5-2	5	Suggest adding the following to the biographical sketch of James Maragos: "In addition, Dr. Maragos designed and supervised all CE sponsored deep-ocean environmental studies conducted after 1975 and coordinated the results of these studies with other agencies."	Addition unnecessary.

Comments (continued)

NO.	PAGE	PARA	COMMENT		
7-57	5-2		Suggest adding brief biographical sketches for Keith Chave and Jacquelline Miller, the principal investigators for all Navy studies performed at the south Oahu site.	7-57	Addition unnecessary.
7-58	6-2	1	Suggest changing to "Bioaccumulation."	7-58	Change made.
7-59	6-2	2	Suggest revising the entry for bioassay to read: "Exposure of a test organism to samples of contaminant laden water under controlled conditions to determine the contaminant concentration lethal to the organism during various lengths of time."	7-59	Change made.
7-60	6-3	2	Add to the entries for continental shelf and slope the following: "Hawaii, an oceanic island archipelago, lacks continental shelves and slopes."	7-60	Addition unnecessary.
7-61	6-3	3	Suggest adding "Aquatic" to the beginning of the entry for crustacean.	7-61	Addition unnecessary.
7-62	6-3	4	Suggest revising the entry for current drogue to read: "...along with the current, giving the cumulative distance over a specified time period."	7-62	Change made.
7-63	6-3	6	Suggest adding to the entry for cyclonic eddies the following: "Common off the leeward sides of the major Hawaiian Islands."	7-63	Addition unnecessary.
7-64	6-4	1	Suggest revising the entry for diversity to read: "...takes into account both the number of species and relative abundance of each species."	7-64	Addition unnecessary.
7-65	6-4	10	Revise the entry for estuary to read: "A semi-enclosed, tidal, coastal body of fresh and saline water...'	7-65	Change made.
7-66	6-4	17	Suggest revising definition of Holothurian to read: "A worm-like animal, commonly called sea cucumber, which is related to sea stars, brittle stars, sea urchins, and sand dollars."	7-66	Change made.
7-67	6-6	7	Correct the definition of microgram-atom to read: "...atomic weight in grams divided by one million."	7-67	Change made.
7-68	A-1	2	Clarify in the introductory paragraph that 35 days of continuous current measurements at several depths were obtained off the south Oahu site.	7-68	Change made.

Comments (continued)

NO.	PAGE	PARA	COMMENT	RESPONSE
7-69	B-1	2	Change 1,000,000 cubic yards to 720,000 cubic yards. The quantity of dredging is estimated at 920,000 cubic yards. Of this amount, 200,000 cubic yards are to be disposed of on Sand Island.	Change made.
7-70	C-1	5	Clarify in the last sentence that, to date, modeling of dredged material deposition, particularly in deep ocean environments, has had limited success.	Change made.
7-71	C-3	1	Suggest adding the term "ablation" to the glossary.	"Ablation" has been deleted from the text of the Final EIS.
7-72	C-4	1	Suggest you clarify or speculate on the reasons why the modeling efforts were not particularly accurate (i.e., adhesion, cohesion factors, dredged material falling in chunks rather than discreet particles, water depths at sites exceeded the reasonable limits of the models, etc.).	Additional information on the modeling efforts has been added to the text of the Final EIS in this section.
7-73	C-18	3	Clarify that very extensive biological studies were performed on the benthos even though biomass was not emphasized in these studies. The investigators concentrated on other benthic parameters since biomass was so low at the sites. In addition, we suggest that more of the benthic biological data from the Corps studies be included in the appendix to provide the reader with more information on the extent of past studies on deep-water benthos at the sites.	A description of the studies on the benthos of the disposal sites appears in the body of the main text in Chapters 3 and 4 where the Existing Environment and Environmental Consequences are discussed. Further clarification is unwarranted since the appendices are supplementary to the main text and are not intended to present information of primary importance. In keeping with the Council on Environmental Quality regulations for preparing EIS's, sources of supplemental data and information are cited in the text. The reader may then refer to these sources if additional information is required. This alleviates exhaustive discussions of information not directly necessary for assessment of the proposed action.
7-74	C-18	4	Suggest that the paragraph be revised to reflect that it will not be possible from bioassays to accurately predict the effect of the accumulation of trace metals. For one, it is difficult to collect or use test organisms which naturally occur at the deep ocean disposal sites because of significant environmental factors (especially pressure and light) which cannot be duplicated in the laboratory to a satisfactory level to perform bioassay. Furthermore, the review of other data collected during the field studies indicates that bioaccumulation of trace metals at the site will not be a problem since sediment analyses indicated that heavy metal concentrations will not exceed EPA criteria.	Suggestion incorporated.
7-75	D-1	1	Suggest retitling the appendix to "FUTURE ENVIRONMENTAL STUDIES."	Change made.
7-76	E-1 to E-14		Suggest substituting the new water quality standards for the old standards.	The "old" State of Hawaii Water Quality Standards (Appendix E of the DEIS) and associated discussion (at x, xvii, xviii, 1-12, 3-8, 4-2, 4-4, and 4-23) have been deleted from the Final EIS in response to Comments #24-32 and #13-2.
7-77	General		The Navy has advised us that they request that the Draft EIS be revised to indicate that dredged material from Pearl Harbor will be disposed of at the proposed south Oahu site annually.	Change made.

HEADQUARTERS
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860

IN REPLY REFER TO:
002:09P2:SH:mm
Ser 62

11 JAN 1980

Mr. Henry L. Longest, II
Deputy Assistant Administrator
for Water Program Operations
United States Environmental
Protection Agency
Washington, D. C. 20460

Dear Mr. Longest:

Draft Environmental Impact Statement (EIS)
for Hawaii Dredged Material Disposal Sites
Designation (October 1979)

8 Your letter of November 9, 1979, forwarding the subject Draft EIS for review, has been received and reviewed with comments as follows:

a. The U. S. Navy concurs in the designation of the proposed South Oahu site as shown on Figure 2-1. It should be noted, however, that the proposed Oahu site may receive dredged material from Pearl Harbor every year vice every ten years. The dredged material will be material resulting from maintenance dredging at selected berthing areas within Pearl Harbor.

b. It is suggested that the subject report be revised to indicate that dredged material from Pearl Harbor will be disposed of at the proposed South Oahu site annually.

A letter with similar comments was provided by the Pacific Division, Naval Facilities Engineering Command, to the Department of the Army, U. S. Army Engineer District, Honolulu on 20 December 1979.

Sincerely,

R. D. EBER
CDR, [illegible]
FACIL[illegible]
BY DIRECTION OF THE COMMANDER

Copy to:
COMPACNAVFACENGCOM
CO PWC PEARL

8 EPA acknowledges the letter and associated comments from Pearl Harbor Naval base Headquarters. The suggested revisions have been made and are reflected in the following sections: Summary ("Proposed Action," "Affected Environment"), Chapter 1 ("Introduction"), Chapter 2 (synopsis box, "The Proposed Sites", "Detailed Basis for Selection of the Proposed Sites," "Proposed Use of the Sites"), and Chapter 3 ("Inputs at the Proposed Sites Other Than Dredged Material").

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

January 9, 1980

Mr. Henry L. Longest, II
Deputy Assistant Administrator
Office of Water Program Operations
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Longest:

We have completed our review of the Draft Environmental Impact Statement (EIS) for the Hawaii Dredged Material Disposal Sites Designation. We are responding on behalf of the Public Health Service and are offering the following comments for your use in the preparation of the final EIS.

We note the proposed action involves the designation of five deep-ocean sites in the Hawaiian Islands (3 sites currently being used and 2 new sites) for continued open water disposal of dredged material from six harbors.

We are primarily concerned about the adequacy of the monitoring program
to be implemented during and after dredging operations. It is important
that the designated sites and the immediate area be monitored to justify
9-1 the sites' continued designation and to document and prevent, if possible,
any adverse effects associated with open dumping. We have special concerns
regarding the potential impacts upon food-chain organisms that are directly
or indirectly consumed by people.

We recognize that all dredged materials to be dumped at the designated
sites must comply with the Ocean Dumping Regulations. However, the EIS
gives the impression that all dredged materials from Pearl, Honolulu,
Nawiliwili, Port Allen, Kahului, or Hilo Harbors are and will be acceptable
for disposal at the five designated open water sites. Is this the situa-
9-2 tion or will a case-by-case analysis be made of the sediments of each
proposed dredging area before each dredging season to determine their
continued compliance with the Ocean Dumping Regulations? The extent of
permit dredging in the six harbors and any potential "hot spots" should
be mentioned.

Total mercury concentrations were found to be variable at the proposed
South Oahu site ranging from less than 1.0 to 4.4 ug/liter with a mean of
2.1 ug/liter. Since the water quality criteria for mercury in seawater
9-3 is 0.1 ug/liter, an explanation is necessary on what may be responsible
for the high levels found at the South Oahu site. Were similar levels
found at the other sites to be designated? The possible effects of such
levels upon marine organisms should be disclosed.

9-1 Since there have been no significant adverse impacts reported or presently expected because of dredged material disposal at the proposed site, monitoring will not be performed during each disposal cycle at every site. In accordance with Section 228.9 of the Ocean Dumping Regulations, monitoring will be performed at the discretion of the District Engineer or Regional Administrator.

9-2 The need for further testing of the dredged material is determined by noncompliance of the material with the Ocean Dumping Regulations, specifically, 40 CFR Section 227.13b. Compliance with the criteria cited excludes dredged material from testing but the examination of compliance/noncompliance will be made before each dumping cycle.

9-3 The high values for mercury in the proposed South Oahu Site water column taken from Chave and Miller (1977a) are believed to be caused by contamination (K. Chave, personal communication, 1980). The mercury concentrations for all other samples (16) were below detectable limits. This information has been added to Chapter 3 (section "Chemical Conditions," subsection "Trace Metals") of the Final EIS. (See also Comment and Response #5-4.)

Page 2 - Mr. Henry L. Longest, II

9-4 In computing the "EPA criteria for cadmium, .6 mg/kg or a concentration . . .less than 50 percent greater than the average total cadmium content of natural sediments of similar lithologic characteristics as those at the disposal site," please clarify whether "natural sediments" refer to the original undisturbed sediments at a site prior to any local disposal or to any existing sediments at a disposal site.

9-5 It appears that little consideration has been given to upland disposal sites or alternative uses of dredged material. In view of the haulage distances to the designated sites and the rising costs for fuel, the EIS should address the potential energy costs for any long haulages. It may be appropriate to give consideration to pumping and stockpiling the material onshore and using it as a useful resource material rather than disposing it as a waste. Measures should also be taken to reduce the frequency and amount of dredging in the harbors.

We appreciate the opportunity to review this EIS. Please send us two copies of the final EIS.

Sincerely yours,

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services

9-4 "Natural sediments" refers to original undisturbed sediments before disposal of any material. The "50% greater" interim guideline used in the DEIS (at 4-12, 4-13, 4-14, 4-15, A-10, A-18, B-2, B-3, B-5, and C-18) was applied to a pooled mean of the cadmium and mercury concentrations, respectively, in sediment samples taken from the disposal site region.

9-5 A discussion of the feasibility of land disposal of dredged material in Hawaii has been included in the Final EIS (Chapter 2, section entitled "No-Action Alternative") in response to this comment and comment #11-1.

No up-to-date estimates of potential energy costs for ocean disposal of dredged material versus land disposal are available. In the CE EIS on Harbor Maintenance Dredging (1975), actual dredging expenditures (1968-1973) on federally funded maintenance dredging projects showed that unit costs of a project using ocean disposal ranged from \$0.46 to \$1.55/yd^3 while the unit costs of a project using land disposal ranged from \$3.11 to \$6.28/yd^3. These estimates are based on the total cost of the project.

The economics of ocean versus land disposal of dredged material in Hawaii is not the only major issue. The risk to public health must be considered since contamination of groundwater resources as a result of land disposal may occur. At the present time, the risk to public health and the cost discourage the use of land disposal. However, the need for ocean disposal must be demonstrated each time an application for ocean disposal is made. At that time, the availability of other feasible alternatives must be assessed.

Regarding measures to reduce the frequency and amount of harbor dredging, dredging of Hawaii's harbors will occur as frequently as required, and usually depends upon the shoaling rates for individual harbors. Approximate volumes of material, which might be removed during one dredging cycle, have been computed for Hawaiian harbors based on records maintained at CE.

UNITED STATES
DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY

PACIFIC SOUTHWEST REGION
BOX 36098 • 450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102
(415) 556-8200

ER-79/1079 December 18, 1979

Henry L. Longest, II
Deputy Assistant Administrator
for Water Program Operations
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Longest:

The Department of the Interior has reviewed the draft environmental statement for Dredged Material Disposal Sites Designation for Hawaii (ER 79/1079) and offers the following comments.

General Comments

The statement is outstanding for its detailed information on sediments at dredge disposal sites and its analysis of environmental impacts of dredge disposal. The only limitation appears to be in specific data on that portion of the proposed South Oahu site not covered by studies on CE Study Site 3 or the former Pearl Harbor Site.

Specific Comments

10-1 Page 3-2, Bathymetry and Page A-9, Sediments. It is stated that "With the exception of the proposed Nawiliwili and Hilo Sites, carbonate is the dominant sediment constituent" (p. 3-2, last par.), but later it is stated that "analyses show the sediment to be chiefly calcium carbonate at the proposed South Oahu, Nawiliwili, Port Allen, and Kahului Sites" (p. A-9, last par.). These statements appears contradictory with regard to the Nawiliwili Site.

10-1 The information in these two sections has been changed so that data presented are now consistent.

10-2 Page 3-3, Bathymetry and Page 3-4, Grain Size. Table 3-1 shows silty clay to be the sediment characteristic at three sites, whereas table 3-3 shows the sediment at these same sites to consist of 63 to 80 percent sand and 9 to 36 percent silt and clay. The text suggests that the differences result from differences between predisposal and post disposal surveys, but it would be helpful to clarify any such differences in the two tables.

10-2 The data presented in these two tables have been reviewed and changed and are now consistent.

10-3 Page 3-11, Table 3-6. It would be more appropriate to present the analysis of variance (A N O V A) table here instead of just the resultant mean. The reviewer can be misled by the table, especially if sample sizes vary considerably.

10-4 Page 4-16, Table 4-4. The presented water quality criteria for lead of 0.1 multiplied by 96-hour IC 50 value is for fresh water. The American Fisheries Society Water Quality Section, in their review of the 1977 EPA Red Book (April 1979) has a recommended criteria for marine waters of 4 ng/l. The lead content of sediments from Honolulu and Pearl Harbors are considerably higher than this figure. Before a final selection is made of the South Oahu site, a lead content analysis should be made of selected benthic organisms in the plume areas of the dump site. Particular attention should be paid to the shallow water area northeast of the proposed site since a strong component in the current has been identified for that direction (Chave and Miller 1978, Bathen 1974).

Thank you for the opportunity to review this EIS. If you have questions about these comments, please contact me directly.

Sincerely yours,

Patricia S Port

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEPR (w/copy incoming)
Director, Heritage Conservation & Recreation Service
Director, National Park Service
Director, Fish and Wildlife Service
Director, Geological Survey
Director, Bureau of Land Management
Reg. Dir., HCRS
Reg. Dir., NPS
Reg. Dir., FWS
Reg. Dir., GS
Reg. Dir., BLM
SHPO

10-3 The suggested information has been added to the Final EIS in the form of Table C-5.

10-4 The lead concentration criterion recommended in the American Fisheries Service (AFS) review is 0.004 mg Pb/liter (or 400 ng/liter). As stated in the DEIS, the increase of lead concentration in the water column after a single dredged material discharge is 40 ng/liter from Pearl Harbor sediments, and 131 ng/liter from Honolulu Harbor sediments. These values are liberal estimates, in that they are based on a total leach of all metals from the dumped material into the water. Total leaching does not actually occur in situ.

DEPARTMENT OF STATE

Washington, D.C. 20520

BUREAU OF OCEANS AND INTERNATIONAL
ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

February 5, 1980

Mr. T. A. Wastler
Chief, Marine Protection Branch
WH-548
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Wastler:

The Department of State has reviewed the Environmental Protection Agency's "Draft Environmental Impact Statement (EIS) for Hawaii Dredged Material Disposal Sites Designation" and would like to offer the following comments.

11-1 The London Dumping Convention (Annex III) stipulates that the practical availability of alternative land-based methods of treatment, disposal or elimination of wastes should be taken into account in establishing criteria for ocean dumping; this stipulation has been included in U.S. criteria. The DEIS should, we believe, discuss in greater detail why land-based alternatives may not be feasible in the Hawaiian case. Land-based alternatives may be feasible even if no significant environmental consequences may result from the use of ocean alternative. Also, land-based alternatives need not be ruled out even if they are more costly. We consider it important to comply with the Convention in this regard and to discuss land-based alternatives thoroughly. This is particularly important for, as Mr. Longest's transmittal states, EPA and the U.S. Army Corps of Engineers policy has been that land-based disposal sites will be used "when available and economically feasible".

11-2 Similarly, the discussion and presentation of alternative ocean sites could be strengthened. More information could be provided to explain why the South Oahu site is so large in proportion to the other sites. There should be more information to establish the acceptability of the site. The South Oahu site is located on the edge of game catch areas; since it is likely to

11-1 Additional discussion on the feasibility of land-based alternatives to ocean dumping has been included in Chapter 2 (section entitled "No-Action Alternative") of the Final EIS as a result of this comment. (See also Comments and Responses #9-5 and #24-3.)

11-2 The proposed South Oahu Site would receive significantly more material than the other proposed sites. Thus, to maintain a comparable ratio of amount of dumped material to volume of receiving water, the South Oahu Site is proportionately larger than the other sites. (See also Comment and Response #24-6.)

The State of Hawaii Fish and Game catch area consist of statistical regions into which the waters surrounding the islands (out to an offshore distance of about 100 miles) are divided. Figure 3-4, Chapter 3, which illustrates the catch areas, merely highlights the regions containing the proposed disposal sites. (See also Comment and Response #24-8.)

The reasons for not choosing the deeper Hilo Site (#9A) were given in Chapter 2 of the DEIS. No other alternative sites with depths comparable to Site 9A were considered because of lack of available data on any other possible sites in the vicinity. The chief reason for choosing Site 9 (despite the fact that Site 9 is closer than Site 9B to the commercial fishing area along the western edge of Site 9A) is that of the possible alternatives, Site 9 presented the least possibility for adverse environmental impact from disposal. (See also Comment and Response #24-7.)

receive by far the most contaminants, the EIS should make it clear why an alternative outside the catch areas was not selected to minimize catch contamination. It should also explain why site 9, relatively shallow, was chosen over 9A or 9B in deeper water particularly since the DEIS elsewhere states that deeper-water sites are generally less harmful. Since there is commercial fishing on the edge of site 9A, you may wish to point out why an alternative site was not chosen in deeper water even farther from site 9A than the recommended site 9.

An important Ocean Dumping Convention criterion is adequate characterization of the material to be dumped. The DEIS should provide more information in this respect. In order to properly determine whether proposed dumping sites are suitable to receive the intended dredged material, it is first necessary to know whether Annex I (prohibited materials) may be included in these materials. The U.S. has determined that bioassays and bioaccumulation assessments are the means by which the presence or absence of Annex I materials and compliance or non-
11-3 compliance with the Convention are to be determined with respect to solid-phase dredge materials. It is not clear from the DEIS whether tests have been made. The DEIS, page xiii, also states that the "dredged materials comply with federal regulations for minimizing environmental impacts" and (page 4) "permissible quantities of the materials prohibited except in trace amounts have been reported in dredged materials". It would be helpful if the text clarified how and where this was determined.

We appreciate the opportunity to review the draft impact statement.

Very truly yours,

Donald R. King

Donald R. King
Director
Office of Environment and Health

11-3 A section of Chapter 4 ("Toxin Accumulation") and a section of Appendix B ("Characteristics of Harbor Sediments") in the DEIS were misleading with respect to the EPA interim guidelines for sediment heavy metals in effect at the time of the last CE dredging project in Hawaii. The section in Chapter 4 has been rewritten and renamed "Trace Metal and Organohalogen Accumulation" and the section in Appendix B has been clarified on this matter.

Under the exising Ocean Dumping Regulations and Criteria, full evaluation of dredged material (i.e., further testing or bioassays) prior to disposal is required when the material does not fall into one of the three categories described in Section 227.13b (40 CFR, January 11, 1977). These tests were not performed during the last dredging cycle; therefore, interim guidelines in effect at the time (such as the 1.5 multiplication factor [Section 227.6e]) were used to provide an illustration of relative concentrations. The lack of bioassay data on the dredged material from the last dredging cycle is not meant to serve as a precedent for the exclusion of future dredged material from such testing.

Discussion of the compliance of dredged materials with the Regulations and permissible quantities of materials prohibited, except in trace amounts, was provided in Appendix B of the DEIS under the sections "Characteristics of Harbor Sediments" and "Characteristics of Materials Found in Dredge Vessel Hoppers." These sections indicated that cadmium and mercury in the harbor sediments during the last dredging cycle were below the EPA allowable limits. Organohalogen concentrations were below 0.01 μg/kg; however, bioassay data were unavailable. Although no surface sheen data, as specified by the Ocean Dumping Regulations, are available for the harbor sediments, no surface sheens were observed during disposal of the sediments dredged from Pearl Harbor. (See also Comments and Responses #24-9 and #24-10.)

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

January 14, 1980

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, DC 20460

Dear Mr. Wastler:

The Environmental Protection Agency's DEIS for Hawaii Dredged Material Disposal Sites Designation has been reviewed by individuals in the National Science Foundation's Divisions of Earth Sciences, Ocean Sciences, and Applied Research. Relevant comments from these reviewers follow:

12-1 "There seems to be very sparse and only generalized knowledge of the current patterns at each site. My concern is that due to this very limited data, they really don't know where the fine grained material will go. Some may even tend to return to shore. Without the total current regime nailed down, the rest is not too meaningful. There is no sure way of predicting where the material will end up or if it will stay where first deposited."

12-2 "The five proposed sites appear to be an adequate solution to the disposal problem...I did find one disturbing statement which may reflect people's concern for EIS studies: Dredged Material disposal has occurred at the proposed sites since 1977 and no long-term adverse effects have been demonstrated."

I hope these few remarks are helpful in completing your final EIS.

Sincerely yours,

Adair F. Montgomery

Adair F. Montgomery
Chairman, Committee on
Environmental Matters

12-1 Specific knowledge of current patterns at the five sites is presently limited. Accordingly, knowledge of fine-grained fraction dispersive patterns of the dredged material upon dumping is limited. However, Appendix D of the DEIS recommended studies to provide such information. Based upon present knowledge of material dispersal and past dumping impacts at the proposed sites, delay of site designation until study completion is not warranted. Determinations based on current patterns from another ocean disposal site outside of Hawaii are not applicable because of the localized character of current patterns.

12-2 Dredged material disposal has already occurred in varying volumes at or in the vicinity of the proposed disposal sites since the early 1900's. Studies on ocean dumping effects in Hawaiian waters have been performed periodically since 1972, and no long-term adverse effects have been demonstrated to date.

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

January 11, 1980

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

In reply, please refer to
File: EPHS-SS

Mr. Henry L. Longest, II
Deputy Assistant Administrator
for Water Program Operations
U.S. Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Longest:

Subject: Environmental Impact Statement (EIS) for the Designation of Five Hawaii Dredged Material Disposal Sites

Thank you for allowing us to review and comment on the subject EIS. We submit the following comments for your information and consideration:

1. The subject EIS should address the need to monitor dredged material from Pearl Harbor for radioactive wastes. The disposal of dredged material which may include radioactive wastes into an ocean disposal site could create adverse impacts upon the affected marine environment.

13-1 In general, the disturbance of the bottom sediments in Pearl Harbor could have adverse impacts upon fish and other marine biota.

Public Health Regulations, Chapter 37-A, Water Quality Standards, requires monitoring and surveillance to minimize the impact of dredging in a closed embayment such as Pearl Harbor. The subject EIS should describe the monitoring and surveillance procedures recommended for dredging a harbor such as Pearl Harbor.

2. Page 1-12: It is stated that once the site is designated, it must be monitored for adverse disposal impacts. Who will be monitoring the disposal site? Such monitoring will be expensive because of the depth of the ocean at the sites and the difficulty of sampling under such conditions.

13-2 On the same page, second paragraph of page 3-8, and second paragraph of page 4-23: It states that a portion of the site is within the 3-mile limit. EPA assumes that within the 3-mile limit, the State has jurisdiction; outside of the 3-mile limit, the State does not. We are not aware that this stated jurisdictional limit has been established without any question by the State.

13-1 There are no indications of the presence of radioactive wastes in the sediments from Pearl Harbor.

This EIS specifically assesses the impacts of dredged material disposal. Impacts of dredging operations at the actual site of dredging are assessed prior to approval of each project.

13-2 Monitoring of the Hawaiian dredged material disposal sites for adverse disposal impacts will be funded and administered by the Pacific Ocean Division of the CE. This has been clarified in Chapter 1 of the Final EIS under section "Federal Legislation and Control Programs," subsection "Ocean Disposal Site Designation." Discussions in the DEIS relating to the State of Hawaii jurisdiction over the South Oahu Site (DEIS 1-12, 3-8, 4-2, 4-4, and 4-23) have been deleted from the Final EIS in response to Comment #24-32.

In response to this comment, the sections in question (Chapter 3: section "Chemical Conditions," subsection "Water Quality Classification;" Chapter 4: section "Potential Conflicts with Federal, State, and Local Plans and Policies") have been deleted from the Final EIS.

3. Bottom of page 2-13: It states that the proposed and alternative sites are far offshore compared to continental U.S. sites. Why not? If monitoring wi
13-3 be very difficult, perhaps the sites should be moved further from shore. Th greater distance would diminish the need for monitoring, especially the bott conditions.

4. Top of page 2-14 and page 4-25: The stated less than 130,000 cubic yards per year "cutoff point" for monitoring requirements for disposal quantities shoulc
13-4 be discussed in more detail. How was the decision for the 130,000 yard cutoff point arrived at?

5. Figure 4-2 of page 4-10: The depository patterns of a single discharge is quite interesting. What might be even more useful would be the depository pattern at the disposal site weighed by current distribution frequency. This could be
13-5 similar to the "windrose" that's used in air pollution situations, perhaps a "current rose" could also be used to determine what the depository patterns might be at the dredge spoils disposal site.

6. Second paragraph of page 4-20: It is stated that the dredged material will not cause mounding at any of the proposed sites sufficient to cause adverse impact. What happens to the material if it doesn't mound? Where is it going? Is there
13-6 sufficient dispersal of the material such that at any one point, there will not be significant buildup of material sufficient to cause suffocation of burrowing marine organisms?

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

Sincerely,

for Brian J. J. Choy
JAMES S. KUMAGAI, Ph.D.
Deputy Director for
Environmental Health

cc: Office of Environmental Quality Control

13-3 The sentence has been changed to read: "Despite their greater depths, the proposed and alternative sites are closer to shore and the costs for monitoring transportation are comparable to those for continental U.S. sites." Great water depths dilute waste plumes close to shore, relative to similar U.S. mainland sites; those sites farther offshore would not diminish monitoring requirements. Dredged materials consist primarily of sediments, which, upon release, sink rapidly to the bottom of the site, thus bottom effects are possible and must be monitored.

13-4 The 130,000 cubic yards "cutoff point" was meant to be an estimate for establishing monitoring need. The Final EIS has been changed to explain that monitoring will be considered at the South Oahu Site during each cycle, because the greatest volume of dredged material (of all Hawaiian sites) is dumped there. If monitoring is performed and indicates adverse dumping effects at the South Oahu Site, monitoring should be considered for the other Hawaiian disposal sites, at the discretion of the CE and the EPA Regional Administrator.

13-5 In essence, the dump pattern resembles a current rose. For a "worst-case" estimate, the most conservative current speed data in a particular direction was used in dump pattern calculations. However, concerns exist with respect to the most liberal current velocity towards shore, which is mitigated by current data showing that predominant currents flow alongshore or offshore at all disposal sites. Current data on disposal sites are insufficient to provide any realistic "current rose" diagram.

13-6 Post-dump bathymetric surveys of the sites in 1977 indicated no significant changes from pre-disposal conditions, thus the material must have been uniformly dispersed over the plume area and/or carried outside the site.

Smothering of benthic fauna in certain places is possible; however, infrequent dumping leaves sufficient time for recolonization of all benthos. Furthermore, the sites do not contain (nor are they near) any important commercial living resource, critical habitats, or food source areas. In fact, the proposed sites were chosen because of these specific considerations.

GEORGE R. ARIYOSHI
GOVERNOR

RICHARD O'CONNELL
DIRECTOR

TELEPHONE NO.
548-6915

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
OFFICE OF THE GOVERNOR
550 HALEKAUWILA ST
ROOM 301
HONOLULU HAWAII 96813

January 15, 1980

Mr. T. A. Wastler, Chief
Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Wastler,

14 SUBJECT: Draft Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation

We have coordinated review of the subject EIS by State and County agencies and are forwarding the comments that have been received.

We trust that our comments will be helpful in the preparation of the Final EIS.

Sincerely,

Richard L. O'Connell
Director

Attachment

14 EPA acknowledges the Office of Environmental Quality Control, Office of the Governor, State of Hawaii, and appreciates its coordination of the review by various State and County agencies in Hawaii.

List of Commentors on the Draft EIS for Hawaii Dredged Material Disposal Sites.

Agency	Comment Date
State of Hawaii - Department of Land and Natural Resources	December 9, 1979
Department of Transportation	January 8, 1980
City and County of Honolulu - Department of Public Works	December 28, 1979
Department of General Planning	December 5, 1979
County of Maui - Planning Department	December 7, 1979
County of Hawaii - Planning Department	December 20, 1979

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES

EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

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

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

December 19, 1979

REF NO.: APO-1181

Office of Environmental
Quality Control
State of Hawaii
Honolulu, HI

Gentlemen:

We have reviewed the draft EIS for ocean dumping in Hawaii.

15-1 We note that the Maui and Hawaii Island sites are in waters less than 400 meters deep where bottom profiles are rugged. These sites are important to bottom fishing, and we prefer that sites in deeper water be chosen instead.

15-2 The draft EIS records observations of humpback whales outside of the breeding grounds. Accordingly, we recommend that dumping be scheduled so as not to interfere with migratory and behavioral patterns of the humpback during their November through May visits.

Very truly yours,

SUSUMU ONO, Chairman
Board of Land and Natural Resources

15-1 Information from the Hawaii State Department of Fish and Game indicates that the majority of fishing near these two sites occurs above 300 m. No bottom fishing is currently practiced near these sites, although organisms which could be fished commercially are present. It is important to note that use of these areas for dredged material disposal would only occur for brief periods every 10 years. Therefore, it is believed that choosing dumping locations in deeper water is unnecessary.

15-2 This recommendation has been included in the Final EIS, as a result of this comment and Comment #6-2, in the Summary (section "Conclusions"), Chapter 2 (section "Detailed Basis for Selection of Proposed Sites," subsection "Location in Relation to Breeding..."; section "Proposed Use of the Sites," subsection "Disposal Schedules"), and Chapter 4 (section "Threatened and Endangered Species").

GEORGE R. ARIYOSHI
GOVERNOR

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

RYOKICHI HIGASHIONNA
DIRECTOR

DEPUTY DIRECTORS
JAMES B. C[illegible]
JAMES B. MC[illegible]
DOUGLAS S. SA[illegible]
JACK K. S[illegible]

IN REPLY REFER TO:

January 8, 1980

STP 8.5

Dr. Richard O'Connell
Office of Environmental
Quality Control
550 Halekauwila St., Room 301
Honolulu, Hawaii 96813

Dear Dr. O'Connell:

Subject: Draft Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation

Thank you very much for forwarding the above-captioned EIS for our review. We have the following comments to offer on the subject:

16-1 1. As noted in the EIS, ocean disposal oftentimes is the most expedient, prudent, and least costly method of disposing dredged materials. The designation of ocean disposal sites in the proximity of our major commercial harbors will play an important role in the maintenance dredging program of the Corps of Engineers and State of Hawaii for these harbors. In an effort to reduce costs and bureaucratic red tape, we would like to recommend that any State dredging projects within these harbors be exempt from testing requirements if similar dredging operations in adjacent areas by the Corps had been accomplished in the reasonable past. Should historical evidence indicate that the composition of the dredged materials from the Corps' periodic maintenance projects for the harbors had remained relatively constant, we feel it can be reasonably surmised that any materials dredged from contiguous areas in the harbor under State responsibility is no different from those materials extracted from the areas under the Corps' responsibility. Therefore, to require the State to conduct costly chemical and other testing of the spoil from the State dredging projects

16-1 The Ocean Dumping Regulations are not intended to introduce unnecessary duplication of effort, or added expense, in order to determine acceptability of materials proposed for ocean disposal. In cases where dredging locations are virtually the same, differing only by the authorities who manage them, it is feasible that additional testing of dredged materials could be waived. However, this determination must be made on a case-by-case basis by the CE District Engineer who manages each disposal site.

Dr. Richard O'Connell
Page 2
January 8, 1980

STP 8.5946

would, we contend, be a duplication of effort, time consuming, and costly in terms of unnecessary energy consumption and added expense. In other words, when a permit application by the State for ocean disposal involving dredged materials from the State commercial harbors, (excluding Kawaihae Harbor) is made, EPA should review the application using the same criteria and procedures that they accord the Corps when reviewing their application for a similar dredging project.

2. All of the major State commercial harbors have been accounted for except Kawaiahae Harbor. No ocean disposal site has been designated for West Hawaii. We assume that this lack of designation stems from the fact that Kawaihae Harbor does not require maintenance dredging as frequently as the other ports and the presence of a land disposal site at the harbor. Since the master plan for the harbor requires that the vacant areas under the Harbors Division's jurisdiction be fully developed, the land disposal site will no longer be available
16-2 to accommodate the dredge material from any future harbor dredging project. With requirements for land disposal sites becoming continually more stringent, we feel it might be prudent to designate an off-shore ocean disposal site also for West Hawaii to accommodate spoils from future dredging projects. This would eliminate the need for a separate study and EIS should circumstances in the future require that such an ocean disposal site is desirable for the area.

3. State and private dredging projects must satisfy certain requirements before approval for ocean dumping is granted from EPA. In many cases, the cost to provide the necessary data for permit approval becomes proportionately untenable when compared to the overall cost of the project. It is not unusual for the required testing of dredged materials for a relatively small dredging project
16-3 to cost many thousands of dollars while, at the same time, consideration of a land disposal site may also be deemed not cost effective. The existence of these two events, then, can render many important projects of this nature to become unfeasible to pursue or deferred due to lack of funds. We

16-2 This EIS is for the purpose of designating five disposal sites necessary to fulfill present requirements of the CE, Pacific Ocean Division. Future needs for maintenance dredging and subsequent disposal will be evaluated when necessary. However, the Council on Environmental Quality Regulations for EIS preparation (40 CFR 1500) provide for evaluation of similar projects; an EIS on a future proposed dredged material ocean disposal site designation for Hawaii can "tier" upon this EIS, thus eliminating unnecessary duplications of effort and expense.

16-3 EPA is not required to test acceptability of materials from areas which require future dredging. EPA's function is that of establishing criteria and tests for acceptability of material to be ocean-dumped. Criteria and tests are developed in cooperation with the CE. Dredged material disposal projects are judged case-by-case, in accordance with Ocean Dumping Regulations, i.e., demonstration of the need for ocean dumps and environmental acceptability. Extensive testing of candidate materials is required only when these materials cannot satisfy exclusionary criteria in Section 227.13 of the Regulations. To summarize this section: materials are environmentally acceptable if they are "naturally occurring bottom material with particle sizes larger than silt" and "found in areas of high current or wave energy" or "when the material...is substantially the same as the substrate at the proposed disposal site" and from a sufficiently clean environment, so that contamination is not likely.

suggest that EPA set up specific standards peculiar to each designated ocean disposal site and test the materials from potential areas that might need dredging in the future, such as harbors, streams, rivers, canals, etc.

16-4

4. Our final comment is specific to the EIS and takes the form of a question: Under the section entitled "Benthic Impacts," Appendix C, Page C-18, it appears that a bioassay determination of toxic constituent accumulation of the trace metals manganese, lead, and copper will be required for the Pearl Harbor sediment prior to disposal at the proposed South Oahu ocean disposal site under 40CFR227.6. Should the concentration of these trace metals meet the requirements of 40CFR227.4(b), will bioassay analyses of other dredged material proposed for disposal at this site also be required if these trace metals exist in lower concentrations than in the Pearl Harbor sediments and the MPC for mercury and cadmium are exceeded?

Sincerely,

AH LEONG KAM
State Transportation Planner

16-4 Bioassays of candidate materials are compulsory if they do not comply with exclusionary criteria in Section 227.13 of the Regulations, summarized in the previous response. Bioassays determine the degree of lethality of all trace contaminants in dredged materials (including, but not limited to, trace metals, oil and grease, and organic compounds). Acceptable concentrations of specific heavy metals do not automatically imply complete environmental acceptability of the material. Toxicities of materials dredged from different locations can vary widely (dependent upon the sedimentary nature and exposure to sources of contamination); thus results of tests of specific materials are not transferable from one sample to another.

DEPARTMENT OF PUBLIC WORKS
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

WALLACE MIYAHIRA
DIRECTOR AND CHIEF ENGINEER

ENV 79-420

December 28, 1979

Mr. T. A. Wastler, Chief
Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Wastler:

Re: Draft EIS for the Designation of Five
<u>Hawaiian Dredged Material Disposal Sites</u>

We have reviewed the subject draft EIS and have the following comments.

1. We have no objection to the location of the proposed South Oahu Site in Mamala Bay for the disposal of dredged material. The proposed site will not affect the operation of the deep ocean sewer outfalls off Sand Island and Barbers Point (not shown in Figure 3-3).

2. 17-1 The proposed South Oahu site should be available for occasional City and County projects which require disposal of dredged material. Example of these projects include stream dredging and pipeline crossings across channels and harbors. The use of different types of conveyance to the dredge site other than hopper dredge vessel should be recognized. These include hopper barges.

Very truly yours,

WALLACE MIYAHIRA
Director and Chief Engineer

cc: OEQC

17-1 The proposed South Oahu Site would be available to other projects, subject to approval by EPA and the CE by means of formal permit application procedures. In the meantime, only those dumping operations that use hopper dredge vessels are anticipated for the proposed site. Usage of other means of conveyance would be evaluated during the permit application review processes.

DEPARTMENT OF GENERAL PLANNING
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813

FRANK F. FASI
MAYOR

GEORGE S. M
CHIEF PLANNING

DGP11/79-3746

December 5, 1979

Mr. Richard L. O'Connell, Director
Office of Environmental Quality Control
State of Hawaii
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. O'Connell:

18 Draft Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation, October 1979--Comments Requested November 27, 1979

We have reviewed the draft environmental impact statement with respect to our planning jurisdiction, and have no objections to the proposed south Oahu site.

Thank you for affording us the opportunity of reviewing the draft impact statement.

Sincerely,

George S. Moriguchi

GEORGE S. MORIGUCHI
Chief Planning Officer

GSM:fmt

18 EPA gratefully acknowledges the letter from the Department of General Planning, City and County of Honolulu, and thanks the Department for its review of the DEIS.

PLANNING COMMISSION
Patrick Kawano, Chairman
Marvin Rumme, Vice Chairman
Mary Cabinsky
Charles Ota
Rogelio Tacdol
Wesley Wong
Harlow Wright
Wayne Uemae, Ex-Officio
Tatsuno Imada, Ex-Officio

Elmer F. Cravalho
Mayor

Tosh Ishikawa
Planning Director

Yoshikazu "Zuke" Matsui
Deputy Planning Director

COUNTY OF MAUI
PLANNING DEPARTMENT
200 S. HIGH STREET
WAILUKU, MAUI, HAWAII 96793

December 7, 1979

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

Dear Sir:

Re: Draft Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation

We have reviewed the above referenced document and our comments are:

19-1 1. We believe said document should explain the manner, location an impact in the disposal of dredged material inconjunction with the dredging of Kahului Harbor in 1977.

19-2 2. We believe the proposed sites (7 and 7A) for Kahului Harbor is inappropriate and that alternative sites should be considered. Our understanding of the ocean currents, wind direction leaves us to believe that fish, seaweed and other ocean life could be adversely affected. The waters of the Northwest Coast of Maui (Waihee-Waiheu) is noted for fishing, seaweed gathering and other ocean related activities. Accordingly, great care should be taken to protect this resource area.

19-3 3. Additional information and impact analysis would be desirable in relating the disposal of dredged material to the near shore waters of Waihee-Waiheu.

Thank you for the opportunity to review and comment on the above referenced document.

Very truly yours,

TOSHIO ISHIKAWA
Planning Director

cc: Mayor Hannibal Tavares
T.A. Wastler, Chief,
Marine Protection Branch,
Environmental Protection Agency

19-1 The general disposal methods for dredged material at the Kahului Site, and at all Hawaiian sites, were explained in Chapter 2 of the DEIS in the section entitled "Dredging and Disposal Operations."

The disposal location is the CE Kahului Site 7A.

Impacts of the 1977 disposal of dredged material at the Kahului Site 7A were discussed in Chapters 2 and 4 of the DEIS. Briefly, studies conducted before and after dumping showed no demonstrable impacts due to disposal at the Kahului Site.

19-2 The activities cited are mostly confined to inshore waters along the stretch of island from Kahului Harbor to the northwest tip of Maui. The data on ocean current regimes for this area of Maui indicated northwest to west flows, away from these activity areas. Use of Site 7A for dredged material disposal is not expected to cause adverse impacts in this resource area.

19-3 Presentation of additional information and impact analyses relating disposal at the proposed site to waters of Waihee-Waiheu is not deemed necessary, for the same reasons stated in the previous response.

PLANNING DEPARTMENT

25 AUPUNI STREET • HILO, HAWAII 96720

COUNTY OF HAWAII

HERBERT T. MATAYOSHI
Mayor

SIDNEY M. FUKE
Director

DUANE KANUHA
Deputy Director

December 20, 1979

Mr. Richard O'Connell, Director
Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. O'Connell:

Draft EIS - Hawaii Dredged Materials
Disposal Sites Designation
October, 1979

Thank you for bringing the subject draft EIS to our attention. We have reviewed the text and have found it to be rather comprehensive in addressing the environmental issues. Please note that we do not have any objections to the proposed Hilo Harbor - Disposal Site, and have no adverse comments to offer at this time.

20-1 Based on our review, we can anticipate no potentially critical environmental constraints since the actual dredging of Hilo Harbor is sporadically scheduled (10 years). However, we would like to propose that periodic or continuous long termed monitoring of the selected disposal sites for environmental impact study should be conducted.

20-2 We have also noted that no disposal site has been designated for the West coast of Hawaii. Although there are currently no plans for the periodic dredging of Kawaihae Harbor, an associated disposal site may eventually be required. The subject document should perhaps also identify potential disposal sites in this area.

Thank you for this opportunity to review the subject draft EIS. Should you have any questions on the above, please contact us. Mahalo.

Sincerely,

SIDNEY FUKE
Director

BS:ak

20-1 In accordance with Ocean Dumping Regulations, the impact of disposal at all designated sites must be evaluated periodically and reported to Congress (Section 228.10). The District Engineer of the CE or the Regional Administrator of EPA will devise appropriate monitoring programs for each site, if deemed necessary. Appendix D in the DEIS described recommended environmental studies for the disposal sites.

20-2 The CE anticipates no need to designate a disposal site for disposal of material dredged from Kawaihae Harbor. Consideration of a disposal site for sediments from this harbor will be delayed until a demonstrated need to ocean dump occurs. No current plans exist for periodic dredging of Kawaihae Harbor, therefore, planning of a site designation is premature.

DEPARTMENT OF LAND UTILIZATION

CITY AND COUNTY OF HONOLULU

650 SOUTH KING STREET

HONOLULU, HAWAII 96813 • (808) 523-4411

FRANK F. FASI
MAYOR

TYRONE T. KUSAO
DIRECTOR

79/EC-MISC(SM)

December 12, 1979

Mr. Henry L. Longest II
Deputy Assistant Administrator
for Water Program Operations
United States Environmental Protection
Agency
Washington, D.C. 20460

Dear Mr. Longest:

Draft Environmental Impact Statement (EIS)
<u>Hawaii Dredged Material Disposal Sites Designation</u>

We have reviewed the subject document and have the following comments to offer:

1. <u>General Comment</u>: Between pages 3-6 and 3-7, pages 5-1, 5-2, 6-1, 6-2, 6-3, and 6-4 were erroneously inserted.

2. <u>Reference</u>: Page 4-25.

   <u>Comment</u>: What specific Federal, State of Hawaii, or City and County of Honolulu agencies will be responsible for
21-1 monitoring the effects of the ocean dumping in the disposal sites, e.g., collecting samples, making measurements and quantitative analysis?

We hope these comments provide useful input to this EIS.

Very truly yours,

TYRONE T. KUSAO
Director of Land Utilization

TTK:sl

21-1 **The District Engineer of the CE or the Regional Administrator of EPA will devise appropriate monitoring programs for each site, if deemed necessary. Monitoring the effects of ocean-dumping dredged material will be implemented by the CE. (See also Response #13-2).**

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

January 15, 1980

RE:0296

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Wastler:

Draft Environmental Impact Statement
for the Designation of Five
Hawaiian Dredged Material
Disposal Sites

The Environmental Center has reviewed the above cited DEIS with the assistance of Doak C. Cox, John Sorensen, Barbara Vogt, Vincent Shigekuni; Environmental Center.

In general the EIS adequately addresses the potential environmental impacts of the disposal of dredged material on the proposed five ocean sites.

22 One set of questions we have concerns the location of the proposed South Oahu site. Why is the site substantially different than the previously-used Pearl Harbor site, which appears to have been acceptable? While we realize that the new proposed site is suitable as well, why expose a new location to the dredge material given some of the uncertainties associated with long-term environmental impacts?

Second, we feel that the EIS would be more comprehensive if the list of references included our previous reviews of the "Dredge Spoil Disposal Criteria and Their Rationale" and related reviews dated January 13, 1975, July 11, 1975, and September 25, 1975. We have enclosed copies for your convenience.

We appreciate the opportunity to offer our comments on this document and hope you will find them useful.

Sincerely,

Doak C. Cox
Director

DCC/cu

Enclosures

cc: Office of Environmental Quality Control
John Sorensen
Barbara Vogt
Vincent Shigekuni

22 The proposed South Oahu Site is preferable to the former Pearl Harbor Site because it is beyond the 200-fm contour. The National Marine Fisheries Service, U.S. Fish and Wildlife Service, and State Department of Fish and Game consider that potential bottom fishing resources exist within the 200-fm contour.

ATTACHMENT TO 22

RR:0

University of Hawaii at Manoa

Environmental Center
Maile Bldg. 10 • 2540 Maile Way
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

January 13, 1976

U.S. Environmental Protection Agency
100 California Street
San Francisco, California 94111

Attn: ENPDC

Gentlemen:

DREDGE SPOIL DISPOSAL
CRITERIA AND THEIR RATIONALE

We appreciate the opportunity to comment on the "Dredge spoil disposal criteria" and "Rationale for dredge spoil disposal criteria" proposed by EPA. The following members of the University of Hawaii have contributed:

A. H. Banner (Hawaii Inst. of Marine Biology)
Doak C. Cox (Environmental Center)
Richard Grigg (Hawaii Institute of Marine Biology)
L. Stephen Lau (Water Resources Research Center)
James Maragos (Hawaii Inst. of Marine Biology)
Jacquelin Miller (Environmental Center)
Maury Morganstein (Oceanography)
Justin Rutka (Sea Grant)
Henry Gee (Water Resources Research Center)

DREDGE SPOIL DISPOSAL CRITERIA

Dredge spoil classification and site criteria

A.

The organization or classification of the material cited under the general heading "Dredge spoil classification and site criteria" is unclear. Item A. either has no title or "Dredge spoil classification and site criteria" is intended to be the title for A. If there is a classification intended, it seems to be between "unpolluted" and "polluted," but the "polluted" class is not mentioned in Section A (or elsewhere) and the choice of terminology is poor. "Sand and gravel" and "other materials" would be preferable. The usage of the

ATTACHMENT TO 22

classification appears to indicate that it serve as a criterion in addition to those in section B and C, however, "Substantially sand and gravel" is the sole criterion indicated for present site SF 8 and the proposed site at Morro Bay. A combination of the "sand and gravel" vs "other material" criterion and the section B criteria is called for at the proposed site in Suisun Bay. We assume, but it is not clear that only section B criteria apply at all sites identified other than the three mentioned above. It would seem appropriate to entitle "A" "Dredge-spoil size classification and criteria."

We suggest that a classification and criteria based on the fraction of suspended material, in addition to that based on the 200 mesh screen size, might be of importance at some near-shore disposal sites.

B. Criteria for open water sites

The title of this section is misleading. It includes criteria for fills, which are apparently intended to be mainly on land and in any case not in open water. As indicated above, it seems intended that these criteria are to be additional to those based on sediment size. Section "B" would be better titled "Other site criteria."

The subsection titles also are questionable in that the "fresh-water" criteria apply to a shallow marine or estuarine site at a proposed site at Suisun Bay and a 100 fathom marine site at Moss Landing.

1. Fresh water

2. Marine (shallow) and estuarine water

For our comments on items 1. and 2. above, see Section III, Toxic Substances, "Rationale for Dredge Spoil Disposal Criteria."

3. Marine water - 100 fathom

"The discharge shall consist entirely of dredge spoil obtained by dredging at the project site." There is no definition of the "project site." Assuming all other criteria are met, what is the rationale behind a prohibition of a combination of dredge spoil from more than one site?

4. Fill sites

Where the dredge spoil is to be disposed of as a fill on land or in shallow water, there are four or more concerns related to the effects of:

i) erosion and transportation of the fill material itself from the site;

ii) discharge of settleable material from the site;

iii) discharge of suspended material from the site; and

iv) discharge of dissolved material from the site.

ATTACHMENT TO 22

(a) A criticism of this subsection relates to the "erosion or w action" phrase. "Erosion" alone would be preferred, otherwise all erosional forces need to be considered, i.e. erosion due to rainfall, fluvial, wave or action. A more important criticism relates to the allowance of placing dredg spoils in fills liable to erosion. If the use of a fill site results from th detrimental effects of use of an adjacent marine or estuarine site, it is illo cal to allow placement in a fill from which the material will be eroded and transported to the adjacent marine or estuarine areas whether the waters are "surface waters" or deeper waters. In general fills should be especially prot from wave erosion by sea walls, rip rap, sheet piling, etc. It would seem best require that such protection be provided unless it can be shown that the erosio, transportation, and redeposition of the fill material will cause no significant problems. Fills should rarely, if ever, be placed where they are liable to fluvial erosion. Even with protection from fluvial and wave erosion, some erosion from wind, rainfall and surface flow will occur. Hence the application of the fresh water or estuarine pollutant criteria from 1 or 2 is appropriate. In addition reference should be made to whatever state or local regulations are applicable to such erosion. In Hawaii, for example, pertinent county ordinances are being developed subject to state standards.

The "Summary of DSDC Comments and Consideration Given in Revision of the DSDC" accompanying the "Criteria" and "Rationale" documents indicates (p. 3) that establishment of beach disposal sites has been recommended, and that "Dredge spoil which is essentially sand/or gravel may be discharged at a beach site so long as the spoil complies with sediment analyses for the receiving water." Dredging of sand from offshore deposits may be a useful means for the enlargement of beaches, particularly those that have retreated as a result of injudicious mining of sand from the active part of the beach system. However, the restriction to sand and gravel particle size may not ensure that the dredged material will be satisfactory for beach enlargement from either the esthetic or stability standpoints.

(b) The first clause of this subsection relates to the discharge of settleable solids, "Any discharge from a land disposal site shall not contain settleable solids in excess of 1.0 ml/l/hr. . . . ."

The concentration limit thus proposed would make sense if the settleable solids were subject to dilution as are dissolved solids. However, this is not the case. The settleable solids settle and accumulate with time on the bottom near the discharge. In highly sensitive areas such as live coral reefs, no discharge of settleable solids should be permitted. In less sensitive areas a limit should be set, not to the concentration of suspended solids, but to the total quantity of suspended solids, the product of concentration, discharge rate, and discharge duration.

The second clause, ". . . nor cause a violation of applicable water quality standards," is the only part of the dredge spoil and disposal site criteria that may relate to the discharge of suspended or dissolved solids through applicable water quality standards. In combination with subsection a), which makes metal criteria applicable, it may adequately deal with potential problems with dissolved solids, which may reach the surface and coastal waters by way of leaching and seepage. It is questionable that it deals adequately with the suspended solids.

C. Other provisions

1. The implication of this subsection is that by selective dredging, the material can be removed and disposed of separately from successive 6-foot depth increments. Although it is expected that horizontal gradients of pollutant concentrations will in general be much smaller than vertical gradients, some provision for averaging over selectively dredgeable horizontal extents as well as vertical extents would seem appropriate.

We do not have available the "Preliminary sampling and analytical procedures" referred to in subsection 3. If they do not prescribe spacing for cores, a prescription should be included in subsection 1.

Dredge spoil disposal sites

We have no comments on the specific sites listed except those in Hawaiian waters.

Assuming that previous use of the three present Hawaiian sites listed has already effected such deleterious impacts that might result from disposal of dredging spoil, we know of no reason for discontinuing their use. However, we strongly recommend that the impact of the disposal at these sites be investigated.

Concerning the proposed future sites we have the following comments:

a. Honolulu and Pearl Harbor, Oahu

This site is in an area with potential for the future harvest of large shrimp. It is near the present Honolulu site, and we see no reason why a second site in the vicinity should be used.

b. Kalaupapa, Molokai

This site also is in an area with shrimp-harvest potential. We are not aware of any needs for dredge spoil disposal at this site, but if they exist deeper sites are available at no great distance.

c. Kaunakakai, Molokai

There appears to be a mistake in the latitude identified for this site. If the site is in 150 fathoms south of Kaunakakai, it is very near an area of black coral. We recommend clarification of the location of the site and its situation in water of at least 290 fathoms.

d. Maneli, Lanai

The latitude identified for this site is in error. A site 3.7 miles south of Maneli in 190 fathoms is in an area of bamboo and gold coral. We recommend that the site be moved west or WSW to a depth of 1000 fm.

e. Kahului, Maui

The depth and location given for this site do not agree. A site at 100 fm would be close to good shrimp and crab grounds. We recommend that the site be located well beyond the 100 fm contour, and if possible to the 500 fm contour.

f. Kawaihae, Hawaii

As proposed this site would be just outside a black coral area and just inside gold and pink coral areas. We recommend that the site be located at least 10 miles offshore in 300 fm and preferably in more than 500 fm.

g. Hilo, Hawaii

A very modest increase in the distance of this site from Hilo would locate it in water of 1000 fm. depth, which we recommend.

We strongly recommend investigation of the bottom and near-bottom conditions at each of the sites proposed before it is used and monitoring of the effects of dredge spoil disposal subsequently.

Further comment

Section II of the "Rationale" document constitutes a set of criteria additional to those now included in the "Criteria" document. That section should be added to the "Criteria" document.

RATIONALE FOR
DREDGE SPOIL DISPOSAL CRITERIA

The "Rationale" document is actually a combination of rationale for some of the criteria in the "Criteria" document and additional criteria. For some of the criteria in the "Criteria" document, no rationale is presented in the "Rationale" document.

II. General requirements for open water and fill sites

This section does not present rationale. It constitutes a set of criteria additional to those in the "Criteria" document and should be transferred in its entirety to the "Criteria" document.

A. Water Uses

Two additional criteria for prohibition of dredge spoil disposal should be added tothe present five criteria:

1. Prohibition of dredge spoil disposal on coral reefs or in areas from which spoil materials may be transported and deposited on live coral reefs, except

ATTACHMENT TO 22

where the fill over the coral reef is undertaken deliberately and with all due regard to state and local regulations. The exception (which is perhaps covered in section D) should rarely be made.

2. Acknowledgement and restriction of disposal sites where crustacean fisheries may be affected should be included if the other specific fisheries are itemized.

B. Water Quality Standards

3. Is there any biological or environmental basis for the 50% figure cited? Temporarily suspended fine sediments should be included.

C. Toxic substances

1. Bioassay

Is "bioassay" the proper term or is "biological survey" what is intended?

2. This paragraph implies preliminary analyses. Who is responsible and what are the accepted analyses procedures.

III. Toxic Substances

The toxic substances in this section include only four heavy metals--mercury, cadmium, lead and zinc. While these four metals are indeed among those of high toxicity, especially the first three, several other metals such as arsenic, chromium, nickel, and copper are not included. In an earlier version of the document, most or all of these omitted metals were included. The present omission is not explained.

Section III sets forth the recommended concentrations for toxic metals (mercury, cadmium, lead, zinc) in receiving waters as contained in proposed water quality criteria published by EPA in October 1973. These concentrations are substantially higher than those known for Hawaiian coastal waters. However, there is no explicit statement in the subject review document regarding the applicability of these proposed concentrations.

The same section alludes to the concentrations of toxic pollutants in background and polluted sediments in the coastal waters and cites data from California locations. It should be pointed out that a body of similar data has been developed for some Hawaii coastal waters. These data are used in the subsequent parts of this review.

The biological significance of toxic metals in waters and sediments found in coastal water is little known and understood as the subject review document correctly points out. Here, the concept of biological availability of these toxic metals whether in coastal waters or coastal sediments is not recognized in the subject review document. A recent study conducted in Hawaii (Quality of

ATTACHMENT TO 22

Coastal Waters Project) on the biological availability of toxic metals found i coastal water and sediment to several Hawaiian estuarine biota shows that the availability is related to the type of sediment and its organic fraction. The same study found several fish off a primarily agricultural coastal land with mercury concentration over the allowable 0.5 ppm set by FDA for edible fish an yet the maximum mercuryconcentration ever found in the coastal sediment was 0.22 ppm, satisfying the proposed 1.5 ppm mercury concentration in the dredge spoil for marine (shallow) and estuarine water.

IV. Other pollutants

Criteria for pesticides in dredge spoil should be provided, but there is not enough known about all the pesticides to set quantitative limits. Unlike heavy metals which have an acute toxicity, pesticides at concentrations less than lethal doses result in chronic toxicity involving changes in (1) reproduction, i.e., chlorinated hydrocarbon activating enzymes in the liver to eliminate estrogen, making calcium unavailable for strong eggshell production in birds, (2) stimulatory effects on thyroid activity of fishes, (3) reduced number of eggs in spawning fish.

It is also difficult to come up with quantitative criteria because many insecticides such as DDT are constantly recycled in the biosphere, and food webs are complex enough so that concentrations at various trophic levels must be determined first.

V. Recommended criteria

B. Criteria for open-water sites

1. Fresh water criteria and

2. Marine (shallow) and estuarine water

We have examined the proposed criteria in the light of known published Hawaiian data. If limited in accordance with these criteria, disposal of dredged spoils will be generally acceptable in freshwater or estuarine water sites on the basis of time and areal averages of the Hawaiian data. The acceptable situations include relatively undeveloped land such as Kahana Bay area, urban domestic land development such as Hawaii-Kai Marina and Maunalua Bay, urban recreation land development like Waikiki Beach area. Sediments in Pearl Harbor and the Ala Wai Canal on Oahu would be considered polluted in terms of cadmium and zinc respectively. Also, stream sediments in Kapalama Canal in the industrial area of Honolulu would be considered polluted in terms of mercury, lead, and zinc. It should be noted that much less data are available for Hawaii streams including the above mentioned tidal affected, Kapalama Canal and Ala Wai Canal. Case-by-case study should be made involving actual dredge spoil sampling and analysis.

It should be pointed out that the proposed criteria apply to the values obtained by averaging analysis for any continuous six feet of core or to any core having a total depth less than six feet. It stands to reason that the top sections

ATTACHMENT TO 22

of the sediment would normally collect more man-developed toxic substances than the deeper sections in the sediment. The Hawaii data were all surface samples taken within the top few inches and hence, probably represent the extreme conditions representing higher concentrations of pollutants than those averaged from a 5-foot core.

Biological availability of the toxic substances in dredge spoil to marine biota is of greatest ecological importance. Hence, we question the significance of the criteria for toxic metals such as mercury, without discrimin tion of the biological availability and type of mercury.

The following comments apply to specific subsections:

1. Freshwater criteria. Because these criteria are extended in the "Criteria" document to certain marine and estuarine sites, some rationale should be presented for this extension.

4. Fill sites are not open-water sites. This section should logically be a major one--"C. Criteria for fill sites."

5. General conditions. Since these apply to both fill and open-water sites, this should also be a major section--"D. General conditions."

Further comment

No rationale is presented in the "Rationale" document for the dredge spoil disposal site selection. Appropriate rationale for continuing the use of existing disposal sites may well lie in the likelihood that most of the detrimental effects of the use of these or similar sites have already been induced if these sites have been used in the past. Clearly, part of the rationale for the proposed sites, as for the existing sites, consists of proximity to ports at which dredging has been or is to be performed. But the reasons for selecting the particular blocks of ocean proposed for the disposal of dredge spoils in the future are unclear. To what extent have depth criteria been used? To what extent have bottom slope criteria or the proximity to submarine canyons been used? To what extent are depth and bottom conditions so uniform that within wide areas the selection is arbitrary, and necessary only to confine future disposals to the same site? As indicated by our comments on specific Hawaiian sites, no consideration has been given to the distribution of sea-bottom or near-bottom resources such as manganese crusts or nodules, precious coral, or shrimp, or to the effects of disposal of dredge spoil on these resources.

ADDITIONAL COMMENT

Although we recognize that the criteria and rationale presented in the documents reviewed above pertain only to dredge spoil disposal and not to the dredging operation itself, we feel impelled to comment that many of the important

ATTACHMENT TO 22

detrimental effects of dredging in Hawaii relate to the dredging itself.

First, dredging of a living coral reef, as for ship and boat channels, directly destroys a part of the living coral reef.

Second, dredging of a reef may alter the pattern of waves, currents, and sediment transport. For example, at Kapaa, Kauai, the dredging of a coral reef led to the interruption of the pattern of shoreward sand transport and the retreat of the beach. On Oahu, the dredging of a channel connecting the exit of Ala Wai Canal with Kewalo Basin along the front of Ala Moana Park distributed a fresh-water discharge over the coral reef seaward, probably contributing to coral kill. (The fresh water discharge distribution was subsequently altered again by the dredging of the Ala Wai boat channel and blocking of the Ala Moana channel by Magic Island.)

Third, even with suction dredging, the dredging operation usually releases fine materials that can be transported in suspended form for a considerable distance causing not only turbidity in the water but detrimental effects on the biota such as coral.

Yours very truly,

Doak C. Cox
Director

cc: A. H. Banner
R. Grigg
L. S. Lau
J. Maragos
M. Morganstein
J. Rutka

ATTACHMENT TO 22

RR:0029

University of Hawaii at Manoa

Environmental Center
Maile Bldg. 10 • 2540 Maile Way
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

July 11, 1975

Mr. R. L. O'Connell, Director
Enforcement Division
U.S. Environmental Protection Agency
100 California Street
San Francisco, California 94111

Dear Mr. O'Connell:

We have received for review the revised Dredge Spoil Disposal Criteria-Revision I, pertaining to the proposed site changes for dredged material disposal sites in Hawaiian waters. We were pleased to note your attention to many of our earlier recommendations (January 13, 1975) concerning modifications to the previously proposed Hawaiian waters disposal sites.

Members of the University of Hawaii who contributed to the earlier review and who are presently on campus have been contacted for their evaluation of the currently proposed changes in site locations. The following comments have been prepared with the assistance of:

- D. C. Cox, Environmental Center
- H. Gee, Water Resources Res. Ctr.
- R. Grigg, Hawaii Inst. of Marine Biology
- J. Miller, Environmental Center
- M. Morganstein, Oceanography

In general we are in agreement with the proposed new site locations. However, we would appreciate clarification of the following points:

We note that the <u>proposed</u> sites carry a number system i.e. Hon 1, Hon 2, Hon 3, etc. We <u>similarly note</u> from your earlier documentation (10/21/74) that certain <u>existing</u> dredge spoil disposal sites carry numbers Hon 1. through Hon 3. If this <u>number</u> system is meaningful beyond the present correspondence then attention should be directed toward eliminating the ambiguity of similar numbers for the 3 existing disposal sites as compared to the first 3 new sites.

ATTACHMENT TO 22

Proposed Sites

Hon 1. Kauai-Nawiliwili 21° 55'N, 159° 17'W
Hon 2. Kauai-Hanapepe 21° 50'N, 159° 17'W

These sites were previously approved in our review and we have no additional comments.

Hon 3. Oahu-Honolulu and Pearl Harbor 21° 13'N, 157° 56' 05"W

The proposed new location for this site will increase the distance offshore from 3.3 to 5.3 nautical miles. The depth will be increased to 280 fathoms, only 30 fathoms over the previously proposed site. Since there is already an existing dredge spoil disposal site in this vicinity at 21° 14'N and 157° 54'W (Hon 1. on the Dredge Spoil Disposal Site document of 10/21/74) we do not see the need for this additional site.

Hon 4. Molokai-Kalaupapa Harbor 21° 18' 24"N, 156° 59' 48"W

The proposed new location for this site will increase the distance offshore from 3.1 to 5.3 nautical miles and the depth from 350 to 1000 fathoms. Recent observations on the northeastern tip of Molokai at 200 fth. by R. Grigg from Star II have shown the shrimp resources in this area to be too sparse to be of commercial value. Hence the original dredge spoil site at 21° 15' 00N, 157° 02' 00"W seems reasonable. Please note correct spelling of Kalaupapa and Molokai.

Hon 5. Molokai-Kaunakakai Harbor 21° 01' 30"N, 157° 09' 24"W

We had previously recommended that this site be situated in water of at least 290 fathoms so as to avoid possible damage to a known black coral area. This new site will probably be satisfactory.

Hon 6. Lanai-Manele 20° 37' 00"N, 156° 57' 48"W

The proposed new disposal site, Hon 6., for Lanai-Manele is indicated as at a depth of 300 fathoms. We wonder about the rationale for the selection of a site off Manele Bay? This site is very close to a volcanic pinnacle lying at a depth of 167 fathoms (20° 36'N and 156° 59'W). This pinnacle provides a unique habitat for Bamboo and gold coral. The protection and preservation of such a unique feature and its accompanying biota should be seriously considered. The potential dispersal of discharge material due to currents or slight errors in disposal site location could destroy this unique habitat. We strongly urge your consideration of an alternate disposal site off the commercial harbor of Kaumalapau on the west side of Lanai. The depth at approximately 5 miles west of Kaumalapau appears to be about 350 fathoms. The distance from Manele Bay to a disposal site here would not be greater than that to the proposed site. On the basis of dredge hauls in similar location it seems improbable that precious corals are present at the site off Kaumalapau.

Hon 7. Maui-Kahului Harbor 21° 04' 42"N, 156° 28' 48"W

The latitude and longitude given for this site place the site at a slightly shallower depth than the 200 fathoms indicated. Commercial shrimp and crab

ATTACHMENT TO 22

fisheries are known to exist in this general area. Extending the site approximately an additional 3' N latitutde to 21° 07' 42"N. would assure its depth in 200 fathoms. Unfortunately, our original concern as to harm to existing shrimp and crab fisheries seems still quite valid.

Region 8. Kawaihae Harbor 20° 02' 00"N, 156° 00' 00"W

The latitude and longitude given place this site in approximately 250 fathoms, not 300 as indicated. Our previously stated concerns regarding black, gold, and pink coral areas at the site remain valid. Coral reefs which occur within the Kawaihae Bay and along the whole west coast of the Kawaihae area are the most well developed and pristine reefs in the Hawaiian islands. Their preservation should be given the highest priority. Disposal sites would be as far removed as possible. Recreational use of this entire area for bottom fishing, trolling and marlin fishing is of great value and importance to the people of Hawaii. A disposal site in this area is not recommended due to the great potential for severe negative environmental impact. An alternative site 02' farther north at 20° 04' 00"N latitude would be roughly the same distance from Kawaihae Harbor but would lie in 330 fathoms. The potential negative impact should be somewhat reduced at this greater depth.

Region 9. Hawaii-Hilo Harbor 19° 46' 00"N, 154° 55' 42"W

The proposed new location will be satisfactory.

We appreciate the opportunity to have reviewed these proposed dredge spoil sites. Please keep us informed of any action taken in these matters.

Yours very truly,

Doak C. Cox /actor

Doak C. Cox
Director

cc: Col. F. M. Pender, Corps of Engr.
H. Gee
R. Grigg
J. Miller
M. Morgenstein

bcc: A. H. Banner
L. S. Lau
J. Maragos
J. Rutka

ATTACHMENT TO 22

RR:0032

University of Hawaii at Manoa

Environmental Center
Maile Bldg. 10 • 2540 Maile Way
Honolulu, Hawaii 96822
Telephone (808) 948-7361

Office of the Director

September 25, 1975

MEMORANDUM

TO: Harry Akagi, OEQC

FROM: Doak C. Cox

RE: Review of Interim Final Regulations for Discharge of Dredged and Fill Material into U.S. Waters (33 CFR 209)

The Environmental Center review of the above cited regulations has been prepared by the Center staff: Dan Burhans, Doak Cox, and Jacquelin Miller.

The Environmental Center review of earlier versions of these regulations raised several questions. Some of these are adequately covered in the revised regulations however some remain unanswered. The following comments have been developed from our review of the current interim regulations.

Section [d](2) Navigable waters (i): the term "navigable waters" is defined "to mean waters of the U.S. including the territorial seas with respect to the disposal of fill material and excluding the territorial seas with respect to the disposal of dredged material." Again we raise the question as to the basis for a distinction between the disposal of dredged or fill material. Are not similar environmental concerns applicable?

Section [e](2) Discharges of dredged material or fill material into navigable waters. We are pleased to see the modification of this section to include consideration of the quality of the material to be discharged and its affect on the water quality of the receiving water as we had recommended in our earlier review.

Section [f](3) General Policies for Evaluating Permit Applications. This section retains the procedure for simultaneous Army and State processing of an application for a Dept. of Army permit. Since the lack of authorization or

ATTACHMENT TO 22

certification by the State mandates a permit denial by the Army it would seem that delaying the Army's processing until after State approval would be a more efficient use of the Army's time. As we inquired in our earlier review, what is the rationale behind this decision.

Section [i](3) Processing applications for permits: Timing of processing of applications. (i-iv). We were pleased to note that a schedule for processing of permits is included in these revised regulations. According to the time schedules suggested it would appear that some 120 days would be the minimum response time to a permit request. This period of course would be lengthened by a minimum of 30 days if a public hearing is held.

Section [j](1) Public notice and coordination with interested parties.(viii) refers to a minimum review time of 15 days with a recommended 30 day review period. If this 15 day period is implemented the response time to a permit request could be shortened to approximately 60 days. We would strongly urge an increase in the minimum review time as given in this paragraph to 30 days. Mail turn-around times for Hawaii and parts of Alaska are surprisingly long and a 15 day review period would leave an exceedingly brief period for actual study and comment preparation on our part.

We appreciate the opportunity to offer our comments on these interim regulations. We look forward to receiving a reply to the questions and concerns we have raised.

Doak C. Cox, Director

GREENPEACE

913 Halekauwila St.
Honolulu, HI 96814
January 14, 1980

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, DC 20460

Mr. Wastler:

We have reviewed the <u>Draft Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation</u> and offer the following comments.

<u>Humpback Whales</u>

Section 228.5(b) of "Ocean Dumping, Final Revision of Regulations and Criteria" states, "Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery."

23-1 It should be noted that on December 12-14, 1979, a distinguished panel of whale scientists met as a "Technical Review Committee" in Lahaina, Maui. The meeting was sponsored by the Marine Sanctuaries Program Office. The scientists called for a National Marine Humpback Sanctuary to be established from the 100 fathom line shoreward, everywhere in the main Hawaiian Islands. The Marine Sanctuaries Program Office is now determining whether the humpback sanctuary proposal will become an active candidate for consideration. The sanctuary concept the scientists favored would place high priority on research and monitoring, with new regulations for humpback protection to be enacted with the full input and approval of county, state and federal levels of of government. The Dredge Disposal Site EIS makes no mention of a possible National Marine Sanctuary although several of the proposed and alternative disposal sites may be close enough to the 100 fathom curve so that suspended sediment and resultant turbidity could reach them. Appendix C, page C-6, states that material with a grain size greater than .18 mm will settle over an area 2500 meters long and that "the remaining sediment will be distributed outside the site over a vast area."

Humpback whales are mentioned on page 3-14, where it is stated that the whales' documented breeding grounds are not near the proposed dumping sites. It is not clear why the possible effects on breeding grounds only are considered significant in the EIS. In fact, the scientists who comprised the Technical Review Committee of Dec. 12-14 were of the opinion that there is presently no scientific evidence for site-specific breeding grounds, other than a preference for shallow water in general.

GREENPEACE FOUNDATION • P.O. BOX 30547, HONOLULU, HAWAII 96820
A NON-PROFIT ORGANIZATION • (808) 537-9605

23-1 Additional information on humpback whales has been added to the Final EIS in Chapters 3 and 4 under subsections entitled "Threatened and Endangered Species." The exact locations of humpback whale breeding grounds are presently unknown and thus could not be added to Figure 3-2 of the Final EIS.

Breeding grounds are not shown in Figure 3-2, which shows only areas of high whale use. The scale of nautical miles on this map is incorrect.

The exact findings of the Technical Review Committee should be available soon when their final report is published. It is expected that the final report will state that it is unknown whether turbidity or other pollutants have negative impaci on humpbacks, and will suggest that further research be conducted to make this dete mination. In the absence of evidence that turbidity has no negative impact on the whales, no preventable sources of turbidity should be allowed to contaminate their habitat.

The EIS contains no discussion of possible effects which ocean dumping at the proposed or alternative sites may have on humpbacks or other cetaceans. It should t noted that Figure 3-2 shows three of the proposed dumping sites as within areas wher whales were seen by Wolman and Jurasz during March, 1976.

Current

It is stated on page 2-2 that the predominant flow at the South Oahu Site is offshore. But examination of the study results shows that this clearly not the case.

It is stated on page 2-4 that the Port Allen site has "southerly current velocities of 10 to 30 cm/sec." However, the currents mentioned in Appendix A, page
23-2 A-3, are north-northwest, east, and northward.

Also on page 2-4, it is stated that the surface current at the Nawiliwili site is southerly, but it is not stated what the directions of flow were at the 50m, 180m, and 370m stations mentioned in the Appendix, page A-3.

Specific locations of studies cited in Appendix A should be shown on a map.

Oil Content of Dredged Materials

On page 2-22 it is stated that "the materials previously dumped were in compliance with the regulations, with the possible exceptions of greater amounts of oil and grease found in Pearl Harbor sediments." Page B-6 reads that "No surface sheen data, as specified in the ocean disposal criteria (40 CFR 227.6(e)(4)), are available for oil and grease concentrations in the Hawaiian harbors." The testing procedure specified in section 227.6(e)(4) would seem to be relatively simple to perform, and the resultant data could be significant if it shows that dredged material from Pearl
23-3 Harbor would not be in compliance with criteria set forth in section 227. If such material is found to be in non-compliance, will a waiver of the criteria be requested? This would result in more than 50% of the materials dumped in Hawaiian waters through 1987 being in non-compliance with the criteria set forth in section 227 (as determined from chart on page 2-23).

Initial Mixing

The EIS, in referring to concentrations of liquids, suspended particulate and solid phases of dumped material, frequently makes use of such phrases as "if distributed throughout the water column at the proposed site". It is unclear whether this refers to the entire proposed dumping site (over 1 mile in diameter) or to the
23-4 release zone as defined in the "Ocean Dumping Regulations", Section 227.28 (approximately 100 meters radius). Use of the entire site would lead to unrealistically low estimates of concentrations which will actually occur during the initial mixing period. Regulations section 227.29(b) allows for estimates of concentrations by assuming even distribution throughout the release zone when no other means of estimation are feasible.

Turbidity

It is stated on page 4-8 that "Turbidity of the receiving waters is increased
23-5 for a short period (2 to 5 hours)...." But silt and clay would take much longer

23-2 The Final EIS has been changed in response to these comments.

23-3 In the future, materials proposed for disposal must be tested in accordance with the Ocean Dumping Regulations. A request for a waiver is only one of several avenues to be taken if the material was found in non-compliance with the criteria.

23-4 The following considerations led to the use of entire site volume in the calculation of maximal concentrations: The Ocean Dumping Regulations allow maximum concentrations of the liquid, suspended particulate, and solid phases of dumped material after initial mixing to be estimated by field data on the dispersion or diffusion of the material (Section 227.29a). The field data pertinent to the Hawaiian sites discussed in Appendix C of the DEIS indicate that most of the dredged material settles to the bottom of the South Oahu Site within 30 minutes. Observations of maximum current speeds at this site yield a minimum flushing time of about one hour. Thus, it is reasonable to assume that if material was discharged at the upstream edge of the site, the discharge plume would be dispersed throughout the site to its opposite side well within the 4-hour "initial mixing" period.

23-5 The turbidity of the receiving waters of the proposed South Oahu Disposal Site is increased (over background levels) for 2 to 5 hours, after which turbidity levels return to normal, due to dispersion and diffusion.

Using a conservative current speed of 10 cm/sec, a flushing rate of 7 hours was calculated for the proposed South Oahu Site. However, current speeds at least twice, and as much as six times this speed, have been observed. These observations are discussed in Appendix A of the DEIS under the section "Currents." These speeds would yield a flushing rate of as little as 1 hour. Since the time period between dumps is about 4 hours, it is likely that the site is flushed completely between discharges and thus no cumulative water column effects of repeated dumps are expected.

to reach bottom, even as much as a few days (page C-10). Is it meant that after 2 to 5 hours, the material is so diluted as to be invisible? Additionally, no discussion is made of the cumulative effect, if any, of repeated dumps over a period of days as would occur in the dredging of a harbor.

Water Column Impacts

23-6 The distance of 24m mentioned on page C-15 should be 240 m.

23-6 Change made.

Additional Comments on Current Section

23-7 The Chave and Miller study did not measure currents for an adequate length of time. Only eight days of readings were taken. The Bathen study showed a periodicity of 11 to 14 days in the nearshore region. For 3 to 4 days in the cycle, the directional flow either decreased or reversed. If such a phenomenon occurs at the proposed site (studied by Chave and Miller), 8 days of data would not be sufficient to detect it.

23-7 Noted.

Thank you for the opportunity to comment on this Draft EIS.

Sincerely,

Kelley Dobbs

KD/dm

National Wildlife Federation

1412 16TH ST., N.W., WASHINGTON, D.C. 20036 202—797-6800

January 15, 1980

BY HAND DELIVERY

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
401 M Street S.W.
Washington, D.C. 20460

Re: Comments of the National Wildlife Federation on Draft Environmental Impact Statement (EIS) for Hawaii Dredged Material Disposal Sites Designation

Dear Mr. Wastler:

24-1 Attached please find the comments of the National Wildlife Federation on the referenced DEIS. As you will see, we have identified a number of serious legal and technical deficiencies in the Draft. We hope and expect that these will be remedied in a revised version. While most of the defects are amenable to correction in a Final EIS, those which relate to the lack of bioassay and bioaccumulation test results require--in our view--preparation and circulation of a Revised Draft EIS (or a supplement to the present Draft) containing this information, so that we and other interested parties and agencies can react to it and comment on it.

If we can be of further assistance to you or to the staff of Interstate Electronics Corporation, please do not hesitate to let me know.

Sincerely,

Kenneth S. Kamlet

Kenneth S. Kamlet
Assistant Director, Pollution & Toxic Substances

KSK/jl

cc: EPA Region IX
Honolulu District, COE
Brig. Gen. Hugh Robinson

24-1 Comments and responses #24-9, -10, -11, -13, -23, and -26 in the Final EIS address bioassay and bioaccumulation testing. There are no additional data to provide for a revised DEIS. The Final EIS will be available for public review and comment. All recipients of the DEIS will also receive a copy of the Final EIS. NWF and other interested parties and agencies are welcome to comment on EPA's responses to their DEIS comments.

National Wildlife Federation

1412 16TH ST., N.W., WASHINGTON, D.C. 20036

202—797-6800

COMMENTS OF THE NATIONAL WILDLIFE FEDERATION ON DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR HAWAII DREDGED MATERIAL DISPOSAL SITES DESIGNATION (OCTOBER 1979)

January 15, 1980

The National Wildlife Federation ("NWF"), by far the nation's largest private conservation organization, with over 4 million members and supporters, believes that the Draft EIS is deficient in a number of significant respects which are set forth in detail below. Our major concerns can be summarized as follows:

1) The Draft fails to adequately consider the availability of land-based alternatives. Conclusory references to a prior Corps of Engineers EIS, which misstate its conclusions and fail to even summarize its analysis, fall far short of the detailed consideration of alternatives required by the National Environmental Policy Act ("NEPA").

2) The Draft fails to adequately consider even alternatives to the locations and dimensions of <u>ocean</u> disposal sites.

3) The Draft fails to adequately describe the dredged material which the sites discussed are being designated to receive. Although bioassay and bioaccumulation testing are the mandatory regulatory bases for determining the environmental acceptability of dredged material for ocean dumping, the Draft limits its description of the dredged material involved to incomplete and out-of-date chemical test results.

4) The Draft seems to unjustifiably minimize the potential impact of ocean dumping at the proposed dumpsites on nearby and potential fishery resources.

5) The Draft makes numerous undocumented assertions calculated to minimize the overall environmental consequences of dredged material ocean disposal. All evidence or indications inconsistent with the authors' apparent preconceived notions are disregarded.

6) The Draft contains numerous distortions and misstatements of applicable legal requirements under the Ocean Dumping Law, the Convention, and the Criteria.

I. Inadequate Consideration of Land-Based Alternatives

1. The transmittal letter (dated November 9, 1979) from Henry L. Longest, II (Deputy Assistant Administrator for Water Program Operations) accompanying the Draft EIS states that: "EPA and COE policy on the ocean dumping of dredged material has been that land-based disposal sites will be used when available and economically feasible." The Ocean Dumping Criteria define the feasibility and practicability of using an alternative in §227.16(b), as follows: "alternative methods of disposal are practicable when they are available at reasonable incremental cost and energy expenditures, which need not be competitive with the costs of ocean dumping, taking into account the environmental benefits derived from such activity, including the relative adverse environmental impacts associated with the use of alternatives to ocean dumping."

In marked contrast to these requirements, the Draft EIS asserts that reliance on land-based alternatives "is feasible only under two conditions: (1) existence of technologically, environmentally

24-2 and economically feasible land-based disposal methods; and (2) evidence that ocean disposal causes significantly adverse environmental consequences, thus precluding this consideration." DEIS, at 2-8 (emphasis added). The Draft, thus, incorrectly makes the demonstration of significant adverse effects of ocean dumping a prerequisite to the consideration of land-based alternatives--an approach not sanctioned by the Criteria and, in fact, legally precluded by the Ocean Dumping Law and the Convention (which make consideration of alternatives mandatory in all cases).

2. The Draft EIS makes the flat assertions that ocean disposal is the "most viable" means for disposal of the dredged material (p. 1-1), and that an earlier "U.S. Army Engineer District... EIS entitled Harbor Maintenance Dredging in the State of Hawaii" concluded that "ocean disposal of dredged material is the best method at least cost, and presents the lowest risks to public

24-3 health compared to land disposal ...." (p. 1-3). The Draft elsewhere asserts that "[o]cean disposal of dredged materials is preferred to other alternatives because of the lower costs and low potential risks" (p. 2-1). No explanation or justification is given for these conclusory assertions. The earlier Corps EIS is the only source of authority provided for any of these statements and no details are provided.

24-2 The Final EIS has been changed to read: "This alternative is only feasible under either of two conditions: (1) existence of technologically, environmentally, and economically feasible land-based disposal methods, or (2) evidence that ocean disposal causes adverse environmental consequences which preclude its use."

24-3 See Response #11-1.

After a fair bit of time and effort, NWF succeeded in obtaining a copy of the September 1975 Corps EIS so heavily relied upon by the present Draft. Contrary to the representations made in the Draft, the Corps EIS states the following:

> "Although ocean dumping is considered the primary method, land disposal has been used in the past and can be a viable alternative in the future." (At 3).
>
> "Land disposal may be more feasible in the future, if dredged spoil can be used for construction and industrial application by governmental agencies and industrial organizations." (At 3).
>
> "Land disposal is a viable alternative to ocean dumping of dredge spoil in Hawaii; however, there are some inherent problems with land disposal that presently make it less desirable and more costly than ocean disposal. At the present time land disposal of dredge spoil is not practiced in Hawaii in relation to the maintenance of Federal harbors." (At 47).

It is essential, as the Draft itself mentions in passing (at 2-18) that, "[i]n all cases, in accordance with Subpart C, the need for ocean disposal must be demonstrated." The present Draft fails to do so.

3. Another example of the Draft's uncritical and incomplete analysis of land-based alternatives can be found on page 2-18. The statement is made that in addition to receiving dredge spoils
24-4 from six Hawaiian harbors, the designated sites may be receiving "similar types of dredge material" contributed by "Hawaii or counties in Hawaii" from "other coastal areas." There is absolutely no indication as to the need for ocean disposal in this regard, where dredged material from these areas has been disposed of in the past, and what alternatives will exist in the future.

24-4 The DEIS indicates that dredged material from many sources may be proposed for disposal at the sites once they are designated. This is merely a general statement. The site designation procedure does not determine what specific materials may be dumped in future. EPA determines acceptability of candidate materials through the permit process, by means of the procedures in Part 227 of the Ocean Dumping Regulations and Criteria. Actual details, such as need for ocean disposal and future disposal alternatives, in addition to other factors, will be addressed as part of the site management process, after applications for ocean dumping permits are evaluated.

II. Inadequate Consideration of Alternative Site Locations and Dimensions

1. The Draft proposes the designation of five sites. Only a very limited number of alternative ocean disposal sites have been considered (which is okay for the most part), and almost nothing is said about the selection of site dimensions and configurations and possible alternatives.

24-5 NWF is concerned that the range of options has been so restricted, that the environmental review process and opportunity for outside input have become trivial exercises. For example, the Draft notes at one point that "[t]he proposed and alternative sites are near each other, therefore the comparison of economic factors between sites are minimal" (at 2-2). NWF is concerned that the proposed and alternative sites are near enough and similar enough to one another that comparison of environmental factors between them is not much less "minimal."

24-6 2. Examples can be given of where important decisions on site size and location were made implicitly without discussion or elaboration or opportunity for input or review. One example is the proposed South Oahu Site. The careful reader in reviewing the Draft--e.g., Fig. 2-1 (at 2-3) and p. 2-15-- would be struck by the fact that this site is disproportionately large in relation to other proposed sites. Why is this? The only clue given in the Draft is an assertion that "the size of Site 3 is no longer sufficient to accommodate the estimated amount of future dredged material for both Pearl and Honolulu harbors" and that "[t]he proposed South Oahu Site...merely represents an expansion of this site [which site?--Site 3 or the former Pearl Harbor Site?] where no adverse environmental impacts have occurred" (at 2-11). No

24-5 Sites (i.e., locations, configurations, and dimensions) previously recommended by EPA, the CE, and other Government agencies, previous disposal sites, or areas located away from steep bathymetric areas were given preferential consideration as possible sites for designation. Based upon these criteria, at least two sites were considered for each harbor.

Although the proposed and alternative sites are similar, comparative evaluation of all alternatives and environmental characteristics favored selection of sites for designation that will result in the least environmental impact due to disposal. Detailed comparative evaluations for all the sites were presented in Chapter 2 of the DEIS.

24-6 The proposed South Oahu Site will receive significantly more materials than all other proposed sites; thus, to maintain a comparable ratio of amounts of dumped material relative to volumes of receiving waters, the South Oahu Site is proportionately larger than the other sites. (See also Response #11-2.)

No evidence of mounding, which would impede navigation, exists at Site 3, which has historically received material only from Honolulu Harbor, or the former Pearl Harbor Site, which has received material only from Pearl Harbor. The proposed South Oahu Site is larger in volume and surface area than Site 3. Since it will receive material dredged from both harbors, it is proposed for designation.

indication is given as to whether the previous sites have begun to fill up to the point that navigation is being impeded. No indication is given as to how many years' capacity the proposed site (given the proposed site size) will have, and how much of a difference moving the site further from shore would make.

Explicit discussion of the choice of site dimensions is especially important in view of the directive of §228.5(d)--noted in passing in the Draft on pp. 2-14 - 2-15--that the sizes of ocean disposal sites be minimized to facilitate regulation, monitoring, and surveillance. See also, §228.5(b) (dealing with choice of site locations and boundaries).

3. Another example concerns the selection of proposed site 9 (Hilo Site), pictured in Figure 2-5 (at 2-9). As is indicated by even casual examination of the figure, locations 9 and 9B are both within the 400-meter depth contour, while location 9A--only a short distance away--is beyond the 1000-meter depth contour. If it is true, as the Draft repeatedly asserts, that the deeper the water at the site, the better, why was the deeper alternative
24-7 not chosen in this case? Although the Draft, a few pages later (at 2-13) does indicate that Site 9A was dropped from consideration because "(1) the western edge of the site is on a very steep cliff and in an area of strong upwelling, and (2) the majority of the commercial fishing in the Hilo area is along the western edge of Site 9A...," no reason is given for not considering some other site of comparable depth further north, south, or east. (Also, if the concern was interference with or contamination of commercially caught fisheries on the western edge of Site 9A, why was Site 9 proposed for designation--which is not that far from Site 9A and is to the north and west of Site 9A?).

24-7 See response #11-2.

4. One final example concerns the location of the proposed South Oahu Site. Figure 3-4 (at 3-25) indicates that this site appears
24-8 to straddle two State Fish and Game Catch Areas (##401,421). Why does the Draft fail to discuss this, and why is no consideration given to choosing an alternative safely outside of these areas? (While the other proposed dumpsites are also within Catch Areas, they are seemingly so far within such areas that ready relocation might be much more difficult and involve much more distance than in the case of the South Oahu Site; also, the latter site will receive the most heavily contaminated dredge spoils, so that it is most important for this site to be kept as far as possible from important fisheries).

24-8 See response #11-2.

III. Inadequate Characterization of the Dredged Material to be Dumped at the Proposed Sites

1. Fundamental to the determination of whether a particular ocean site is suitable to receive dredge spoils is information concerning the characteristics of the dredge spoils in question--including detailed information on the toxicity and biological availability of associated contaminants. Under the Ocean Dumping
24-9 Criteria (§§ 227.6, 227.13), the acceptability of dredged material for ocean dumping is principally determined through bioassay and bioaccumulation testing. Unfortunately, as the Draft EIS notes on p. 4-12, "[n]o bioassay data are available for dredged material previously dumped at any of the [proposed] sites."

24-9 See response #11-3.

2. This deficiency by itself would be bad enough. The Draft EIS, however, compounds the problem by misleading the reader into thinking that a full evaluation of dredged material is possible
24-10 even absent such test results. For example, the Draft makes the flat (and untrue) statement (at 4-3) that "permissible quantities

24-10 See response #11-3.

of the materials'prohibited except in trace amounts' have been reported in dredged materials." It also states (at xiii) that "[t]he dredged materials comply with federal regulations for minimizing environmental impacts." In point of fact, determinations of compliance with the Criteria (and as to whether "permissible quantities" of Annex I constituents have been exceeded) can only be made on the basis of bioassay and bioaccumulation test results. To the extent the Draft suggests (at 4-12, B-2) that 1.5X ambient sediment concentrations of mercury and cadmium serves as an alternative regulatory criterion that may be freely substituted for the results of bioassay and bioaccumulation tests, it is simply in error. (See, §227.6).

3. On bioaccumulation potential, the Draft asserts that the "potential for bioaccumulation is extremely low," citing "[s]tudies of sediment and tissue analysis at the former Pearl Harbor and Honolulu Sites" (at 4-15). Apart from the mere citation of two references, however, no documentation or details are provided. For example, there is no discussion of what
24-11 specifically these studies found, or of whether the study design adequately reflects the requirements for field assessments of bioaccumulation potential as set forth in the EPA-Corps Implementation Manual. The Final EIS should describe in some detail the results of these studies and indicate how closely they satisfy (or fall short of satisfying) Implementation Manual procedures.

4. The information on sediment composition that is provided in the Draft is spotty, incomplete, and often out of date. The
24-12 Draft indicates that (as of 1973) there were "approximately 23 point sources" which served as sources of potential contamination

24-11 The text in the Final EIS has been changed to provide more discussion of potential bioaccumulation in Chapter 4, under the subsection entitled "Trace Metal and Organohalogen Accumulation."

24-12 Information on sediment chemistry presented in the DEIS is derived principally from five studies. The data are summarized in Table B-1 of the DEIS. These data represent the most complete and current information available on the Hawaiian harbors. The studies span 1973 to 1978.

Under the section entitled "Other Waste Inputs," the DEIS states that there were 23 point-source inputs to the proposed South Oahu Site area in 1973. Of these 23, 15 discharged into Pearl Harbor and 8 into Mamala Bay, where no dredging occurs. Of the waste from the 15 Pearl Harbor point-sources, 97% consisted of power-plant cooling water, which, upon discharge, was essentially unchanged from its initial characteristics. In 1979, 95% of the waste generated by the 22 point-sources in Pearl Harbor consisted of thermal discharge. (See Chapter 3, Table 3-15.) It is expected that the number of point-sources discharging to Pearl Harbor will decrease to approximately 12 before the next dredging cycle because sewage sources will be diverted through the Honouliuli Treatment Facility (S. Konno, personal communication, 1980).

Concerning oil and grease, no surface sheen test data, as specified by the Ocean Dumping Regulations, are available for the harbor sediments. However, as stated in Appendix B of the DEIS in the subsection entitled "Characteristics of Harbor Sediments," oil sheens were not observed during the disposal of Pearl Harbor dredged material, which is the only harbor where oil and grease content is elevated.

of the dredged material to be dumped at the South Oahu Site (at 3-29). Elsewhere the Draft indicates (at 4-7) that "Pearl Harbor dredged material [to be dumped at the South Oahu Site] reportedly contains 11.9 g/kg of oil and grease." This corresponds to an astounding 11,900 ppm. Oil is an Annex I constituent which is subject to strict prohibitions under the Ocean Dumping Convention. The Draft also states that, "[i]n 1979, the number of point-source outfalls increased to 44" (at 3-31)--making it very likely that even the limited sediment chemistry information presented in the Draft is obsolete.

In short, despite good reason to be concerned about the ability of dredged material--particularly from the Pearl Harbor Site--to satisfy the Ocean Dumping Criteria, and despite major unknowns about potential adverse environmental impacts associated with ocean dumping this material, the Draft seems totally unconcerned. Worse, it affirmatively misleads the reader into believing that there is no cause for concern.

5. The Ocean Dumping Criteria, in Part 228, clearly contemplate that site designation studies will be done--at least
24-13 where existing information is incomplete or inadequate to properly and fully characterize a proposed ocean dumpsite. NWF feels strongly that bioassay and bioaccumulation test results must be available--and reflected in a Revised Draft EIS, open to public and interagency review and comment--before a Final EIS may be issued and the proposed site designations may be finalized.

24-13 Existing information is adequate to characterize the sites proposed for final designation. Once the sites are designated, their use will be based in part on bioassay and bioaccumulation test results required for evaluating candidate materials, in accordance with the Ocean Dumping Regulations.

6. The problem is not resolved by glib generalizations to
24-14 the effect that "[m]aterials which do not comply with MPRSA will not be ocean-dumped." (At 4-24).

IV. Inadequate Discussion of Potential Impacts on Nearby and Potential Fisheries

1. The Draft makes the flat and undocumented assertion that "[i]nterference with fishing...is insignificant since fishing near the proposed sites is minimal and presently limited to mid-water trolling." (At 2-20). Elsewhere, however, the Draft notes that up to 12% of the "dollar equivalent amount" of commercially valuable fish caught in Hawaiian coastal waters is caught "in the fishery zones (where the proposed sites are located)..., with
24-15 the majority caught near Hilo." (At 3-23). Similarly, Figure 3-4 (at 3-25) indicates that all of the proposed dumpsites are located within "State Fish and Game Catch Areas." And the Draft indicates that the majority of commercial fishing occurs near the western edge of Site 9A, which is not far from Site 9, the proposed Hilo Site (at 2-13, 4-5). Moreover, the Draft indicates (at xiii) that "three of the proposed sites have water depths within the range of commercially valuable shrimp." (This statement is later contradicted by the flat assertion (at 2-14) that "the proposed sites have no commercial potential"([at least as far as "commercial bottom trawling" is concerned]).

2. Although the Draft indicates (at 4-5) that "[r]ecreational fishing from charter boasts is widely practiced throughout the
24-16 Hawaiian Islands, mainly for offshore sport fish," the flat contention is made that "disposal will not adversely affect this activity"--because "such fish are taken by trolling...or by

24-14 The statement made in the DEIS "materials which do not comply with MPRSA will not be ocean-dumped." summarizes the spirit of MPRSA. As such, it is appropriate to include in the EIS.

24-15 State of Hawaii Fish and Game areas consist of statistical regions in which the waters surrounding the islands are divided. Figure 3-4 (Chapter 3) merely emphasizes the boundary regions of the proposed disposal sites. (See also Comments and Responses #11-2 and #24-8.)

Two species comprise most of the fish taken in the fishing zones surrounding the proposed sites; they are taken primarily from the Hilo area. Catches of these large game fish should not be disturbed by disposal activities. The fish are highly motile and dumped dredged materials will not release potentially harmful elements to the water column in concentrations sufficiently high to affect the fish. Most important, the total time during which disposal is planned (45 hours every 5 years, maximum) will present slight, if any, possibility of impacts upon fisheries.

Hilo Sites 9 and 9A are fairly close to each other. However, the bottom topographies of the sites are quite different. Additionally, Site 9A is located adjacent to an area of strong upwelling. Factors such as bottom topography and proximity to areas of upwelling significantly affect the character of the fauna in the sites, thus some areas are better for fishing than others; such is the case with Sites 9 and 9A. Site 9A supports fishing activity, and was eliminated as an alternative. (See also Comments and Responses #11-2 and #24-7.)

It is true that some of the proposed sites are within the range of commercially valuable shrimp. However, these shrimp are not presently being taken from Hawaiian waters for commercial purposes. In addition, the shrimp are not sufficiently abundant at the proposed site locations to support a fishery; thus, the proposed sites assertedly possess no commercial fishing potential.

24-16 Upon release from the barge, most of the dredged material sinks rapidly to the bottom. The DEIS states that plumes in the water column have not been visible more than 5 hours. Thus, the material quickly disperses horizontally and vertically. Ingestion of dump-associated particulates by pelagic fish is possible; however, the time during which material resides in the water column is short.

long-line fishing." The similar statement is made later (at 4-25) that sportfishing "is independent of the quality of bottom conditions." This, it seems to us, is not nearly as self-evident as the authors' of the Draft would have us believe. In the first place, DMRP studies have demonstrated that most contaminants associated with dredged material will be associated with the sediment particles that ultimately settle to the bottom. Before these particles reach the bottom they will be available for ingestion by fish occupying mid- and upper water levels. In the second place, it is well known that dumps attract fish and other mobile organisms--thus maximizing the period of potential contact between fish and contaminated sediment particles. And in the third place, many benthic organisms--which will come in direct and sustained contact with settled dredged material--serve as important prey organisms to fish, including fish taken by "trolling" and "long-line fishing."

3. Even the Corps' 1975 EIS Hawaiian Harbor Maintenance Dredging acknowledges that dredge spoil ocean dumping may adversely affect "benthic fishery and precious coral resources" (at 46), and that "[a]t present there is no adequate means to identify
24-17 the potential long-range harmful effects of the leaching out of toxic or bioaccumulative pollutants into the marine environment after the disposal of polluted dredge material" (at 42). The Final version of the present EIS should endeavor to do a more honest and analytical job of evaluating the risks to fishery resources.

The notion that "dumps attract fish and other mobile organisms" is unsubstantiated.

Sportfishing in Hawaiian waters is mainly for large game fish. These fish feed primarily on other pelagic organisms - smaller fish, squid, and crustaceans. Thus, benthic organisms do not serve as "important prey organisms to fish taken by trolling and long-line fishing."

24-17 The DEIS has established that no benthic fisheries exist near any of the proposed disposal sites, nor are any of the sites near areas of precious coral harvesting.

The statement quoted from p. 42 of the CE EIS is true. However, within the same paragraph the CE EIS also recommends that disposal of dredged material containing high heavy-metal concentrations be performed at "disposal sites with little or no biotic activity, and which are located away from valuable fishery, nursery, and spawning grounds." The five sites proposed comply with this recommendation.

The DMRP examined leaching of heavy metals from sediments. The tests (Lee et al., 1975; Chen et al., 1976) indicated that, under certain conditions (i.e., oxidizing or reducing environments), some trace metals were released from dredged material into seawater in concentrations above background levels. However, the actual increases over background values were miniscule, so that considerable analytical difficulties were encountered. Furthermore, there is little evidence to indicate that such low levels would cause adverse effects on marine organisms during the extremely short time before the concentrations were diluted to the original background levels, or if the metals were precipitated (Pequegnat, et al., 1978). This information has been included in Chapter 4 ("Trace Metal and Organohalogen Accumulation") of the Final EIS.

4. One cannot point simply, as the Draft EIS does, to the asserted reduced biological productivity of the continental slope (at xiii), as a sufficient basis for regarding deep ocean dumpsites as automatically preferable to ones located closer to shore, or certainly as being of no environmental concern. For example, since deep-sea organisms must do a much more effective
24-18 job than their nearer shore counterparts of scavenging for scarce food, their ability to bioaccumulate toxic dredge spoil contaminants may far exceed that of more abundant nearer shore organisms--perhaps more than offsetting their lessened abundance in terms of environmental impact potential. In this regard, it is relevant that "[m]ost organisms from the sites are detritivores...which feed on organic particulate materials attached to sand grains or in the water column, larger organic remains..., and feces from marine animals" (at 3-18)--precisely the sorts of things that dredge spoil dumping will introduce.

Also, it is well-known that deep-sea organisms are more sensitive to environmental stress than their nearshore counterparts (since they are less accustomed to abrupt changes in environmental conditions).

V. Unjustified and Inadequately Documented Conclusion that the Environmental Consequences of Dredge Spoil Ocean Disposal Are Minimal

1. The Draft repeatedly asserts (see, e.g., at xii, 2-8, 2-10, 2-19, 2-22, 4-20) that the "[e]nvironmental consequences of deep-ocean disposal of dredged material are minimal." See also,
24-19 DEIS, at 4-1. And, while the Draft states that "[e]nvironmental consequences of dredged material disposal at the proposed sites

24-18 The generally reduced biological productivity of deep-ocean sites, as compared to shallow continental shelf sites, is cited in the DEIS Summary as merely one reason why deep sites are preferable. Also significant is the increased dilution provided by a deep site.

It is true that most benthic organisms at the sites are detritivores. However, the inferred link between this feeding characteristic and potential effects of dredged material dumping is not valid. The relationship between the scavenging ability of deep-sea organisms and their ability to bioaccumulate contaminants has not been established. Bioaccumulation can occur a number of ways; ingestion of contaminated materials is indeed one mechanism. However, the degree to which elements bound to sediments are available to organisms, even upon ingestion, is relatively unknown. For instance, many elements simply pass through the digestive tracts of these organisms remaining bound to the sediment and are therefore unavailable to the animal.

The relative sensitivity to stress of deep-sea organisms, as compared to near-shore organisms, is the subject for current study (Murphy et al., 1979). Clones of pelagic diatoms taken from ocean waters have been observed to be more sensitive to chemical stress than clones from coastal waters. The inference drawn from this observation is that the coastal organisms have adapted to the typical stressful conditions in coastal waters receiving high use, and that their oceanic counterparts have not adapted to stress because waters far from shore are not experiencing the same level of use. The application of these observations to deep-sea benthic organisms is tenuous.

Little is known of deep-sea organisms, especially regarding their ability to withstand stress. In addition, the degree of stress induced by dumping dredged materials is expected to be minimal. Use of the sites will be infrequent, and the amounts of materials dumped at the sites will be relatively slight, with the exception of the proposed South Oahu Site. Therefore, considerable time and opportunity for recolonization will occur. The proposed South Oahu Site will be monitored to determine benthic effects (see Appendix D of the DEIS and the Final EIS for a description of these environmental studies).

Ref: Murphy, L.S., P. Hoar, and R.A. Belastock, 1979. The effect of industrial wastes on marine phytoplankton at Deepwater Dumpsite 106. Prepared for the National Oceanic and Atmospheric Administration. 21 pp.

24-19 The proposed sites are not used for benthic fishing (DEIS, p. 4-3), nor are they near areas where corals are harvested (DEIS, p. 4-22).

were assessed on the bases of past studies by the CE and the Department of the Navy" (at xii-xiii), as noted previously, the Corps EIS on which reliance is placed in fact acknowledges that "[t]here will be a risk that benthic fishery and precious coral resources may be adversely affected." (Corps EIS, at 46).

2. The Draft inappropriately minimizes the potential for attraction of nuisance species at the proposed sites (at 2-21).

24-20 As has been demonstrated by extensive studies by Dr. Thomas Sawyer of the National Marine Fisheries Service (Oxford, MD laboratory), dredged material ocean dumpsites often produce gill fouling of crabs and fish by encrustations of pathogenic protozoa.

3. Inadequate attention is given to cumulative impacts (at 2-23)--especially in light of the fact that disposal at the South Oahu Site is expected to occur every 4 hours (at 4-3), and

24-21 the resultant disposal plume is expected to persist for 1-5 hours (at 4-6). This suggests that a steady supply of dredge spoil contaminants may be constantly introduced during a dumping operation with little or no time between dumps for dispersion or recovery.

24-22 4. Insufficient attention is given to possible impacts on the endangered monk seal and humpback whale (at 3-14, 3-17).

5. The Draft unjustifiably fails to consider bioaccumulation

24-23 and uptake of contaminants among the "unavoidable environmental effects" associated with the proposed site designations. At 4-24.

6. While noting the presence of enormous quantities of oil and grease in Pearl Harbor dredged material (at 4-7), the Draft

24-24 fails to adequately address the implications of the presence in the same dredged material of oil-soluble chlorinated hydrocarbons (at 4-12, 4-15, B-9).

24-20 Gill-fouling in benthic organisms has been the subject of much study by Dr. Sawyer and others, in organisms collected from Maine to North Carolina, including organisms from disposal sites of all types; however, the data are inconclusive. Occurrence of gill-fouling is widespread; it is not limited to dumpsite areas, but also occurs far away from dumpsites (Sawyer et al., 1977). In light of this observation, the labeling of protozoans associated with gill-fouling as nuisance species due to dredged material disposal is inappropriate.

Ref: Sawyer, T.D., S.A. MacLean, J.E. Bodammer, and B.A. Harke. 1977. Gross and microscopial observations on gills of rock crabs (Cancer irroratus) and lobsters (Homarus americanus) from nearshore waters of the eastern United States. In Proceedings of the Second Biennial Crustacean Health Workshop, April 20-22, 1977. TAMU-S6-79-114. July 1979.

24-21 Dumping will occur for a maximum of 45 hours during a 5-year period. The DEIS states that the plume occurring after a single dump has been observed to persist for 1 to 5 hours within the site. Thus, the material will be greatly diluted and dispersed before the next load is introduced to the site 4 hours later, and the potential for cumulative impacts on the water column will be negligible.

24-22 Additional information on the monk seal and humpback whale has been added to Chapters 3 and 4 of the Final EIS under sections entitled "Threatened and Endangered Species." (See also Comments and Responses #7-2, #24-1.)

24-23 Potential for bioaccumulation is discussed in Chapter 4 of the Final EIS within the section entitled "Other Environmental Effects." Bioaccumulation has not been labeled an "unavoidable effect" because tissue and sediment analysis after dredged material disposal have shown no evidence of accumulation. Potential for bioaccumulation of constituents in materials intended for future disposal will be evaluated before approval for disposal of those materials.

24-24 Despite the presence of elevated quantities of oil and grease in Pearl Harbor sediments, concentrations of chlorinated hydrocarbons were found to be low in Pearl Harbor sample materials from the dredging vessel. Therefore, the DEIS justifiably refrains from addressing the suggested implications.

7. The discussion of oxygen demand (4-11) inappropriately considers the amount of oxygen depletion that would occur averaged
24-25 over the entire dumpsite. In practice, higher, more localized depletions are likely to be far more significant biologically (i.e., it does an organism at point A within a dumpsite absolutely no good if all its oxygen is gone to know that there is adequate oxygen elsewhere within the site).

8. The Draft dismisses the possibility of adverse environmental impacts associated with heavy metal content on the basis
24-26 that metal concentrations in harbor sediments are low "and thus do not present a serious threat of accumulation in the biota." At 4-12. What is not considered, and should be, is the fact that the total amount of persistent metals introduced into an area may become significant over time, even though concentrations at any given time may be relatively low.

VI. Distortions and Misstatements of Applicable Legal Requirements

1. Table 1-1 (at 1-6) gives a misleading impression of the
24-27 relative roles of EPA and the Corps in the "[d]etermination of locations for dredged material disposal sites."

2. The same table incorrectly suggests that NOAA's
24-28 responsibilities are limited to "long-term monitoring and research" and exclude short-time ocean dumping research.

3. The Draft incorrectly summarizes (at 1-9) Criteria requirements applicable to the liquid phase (in terms of assuring
24-29 that "trace contaminant" levels are not exceeded). On the one hand, §227.13(l) of the Criteria makes compliance with the requirements of §227.6 (subsection (c)(1) of which absolutely precludes dumping

24-25 Slight localized oxygen depletions after dumping have occurred. Severe oxygen depletions occur when organically rich material is degraded by chemical or biological processes which require oxygen; in addition, inputs of oxygen to the reaction location must be limited so that oxygen in the area is not overly renewed. Neither of these conditions would occur with the proposed dredged material dumping. Most of the material descends rapidly through the water column, thus precluding oxygen depletions, except for slight temporary depressions described in Chapter 4 of the DEIS.

Extensive laboratory studies (Lee et al., 1975) of oxygen uptake by dredged materials on the bottom, indicate that even under worst-case conditions (e.g., extreme suspended loads of materials which exhibit high oxygen demand, and no flushing of the overlying water), only about 6% of the oxygen contained in overlying water would be required in the first hour after disposal; the rate of oxygen uptake would decrease over time. Therefore, oxygen depletions associated with bottom reactions are not expected.

24-26 The amount of a metal in a given amount of sediment (i.e., the concentration of that metal) remains the most important consideration in determining its potential for impacting organisms. The key factor lies in the exposure of site organisms to metals in natural and dumped sediments. If the natural sediments and dumped materials contain metals in comparable concentrations, the animals will experience identical exposure. The volume of dumped material is inconsequential in this case because exposure is unrelated to volume of sediment, whether naturally occurring or not. This can be demonstrated with a simple example: An organism which is exposed to 10 g of material containing an element in a concentration of 1 ppm, experiences the same degree of exposure to that element as an organism exposed to 10,000 g of material containing 1 ppm of the same element.

24-27 Table 1-1 in the Final EIS has been changed to clarify the roles of EPA and CE.

24-28 Table 1-1 in the Final EIS has been changed to clarify NOAA's responsibilities.

24-29 The summarization of the criteria has been revised in Chapter 1 of the Final EIS.

dredged material the liquid phase of which contains major constituents which exceed "applicable marine water quality criteria") a mandatory prerequisite for the liquid phase of dredged material. On the other hand, §227.13(2) suggests that in limited circumstances, bioassays must be used to ensure compliance with the limiting permissible concentration. (The net effect of these two provisions would appear to be that compliance with applicable marine water quality criteria is required in all cases; however, bioassays must be done in addition, "when the liquid phase contains major constituents not included in the applicable marine water quality criteria, or there is reason to suspect synergistic effects of certain contaminants." The Draft simplistically (and inaccurately) boils this down into an alternative requirement (at whose option?) that either the liquid fraction be shown to not exceed the marine water quality criteria, or that it be shown to contain contaminants only in nontoxic and nonbioaccumulative form.

24-30 4. As previously noted, the Draft (at 4-12, B-2) incorrectly states that the Criteria specify a solid-phase limit for mercury and cadmium based on a factor of 1.5X ambient levels of these metals.

24-31 5. The discussion of Impact Categories I and II (at 1-10 - 1-11) is incomplete in failing to indicate the consequences of classifying an activity into one of the two categories.

24-32 6. The Draft incorrectly states that within the 3-mile limit ocean dumpsites are subject "to regulation by the State of Hawaii" under Section 404 of the Clean Water Act of 1977. (At 1-12).

24-30 See Comment #24-9 and Comment and Response #11-3.

24-31 A discussion of the consequences has been added to Chapter 1 of the Final EIS.

24-32 The Section entitled "State Control Programs" in the DEIS has been deleted from the Final EIS in response to this comment with the intent of excluding material which may confuse the reader. (See also Comments and Responses #7-76 and #13-2.)

In fact, as is made clear in Section 106 of the Ocean Dumping Law: "After the effective date of this subchapter, no State shall adopt or enforce any rule or regulation relating to any activity regulated by this subchapter." (§106(d)).

24-33 7. The Draft incorrectly states the goal of the MPRSA as preventing "significant" degradation or endangerment of the marine environment or public health...." (At 4-1). In fact, the Act seeks to avoid "unreasonable" degradation or endangerment. Clearly, even insignificant degradation can be unreasonable if acceptable land-based alternatives are readily available.

24-34 8. The Draft improperly compares (at 4-14, B-3) contaminant levels in dredged material to corresponding levels "in disposal site sediments." Where, as here, dumpsites have been previously used, it is obvious that one's point of reference should be uncontaminated sediments in the vicinity of the proposed dumpsite--not already contaminated sediments within that dumpsite.

24-35 9. The practice, referred to in several places in the Draft (at 4-25, B-1, B-7) of collecting dredged material samples for analysis "from the dredge vessel hoppers after they have been filled in the harbor and before release at a site" is inconsistent with the liquid-, particulate-, and solid-phase definitions specified in the Criteria (§227.32) and could considerably understate the impact potential associated with dredged material.

24-36 10. The discussion in the Draft (at B-7, B-9) indicates that an inadequate number and diversity of sediment samples were taken and analyzed to properly portray the dredged material subject to ocean dumping. As noted in the Implementation Manual, a minimum of three samples must be taken and tested at each dredging site.

24-33 No mention of the MPRSA or its goals is given on p. 4-1 of the DEIS. The DEIS stated on p. 1-5 that "MPRSA regulates the transport and ultimate disposal of waste materials in the ocean."

24-34 Studies conducted at the Pearl Harbor Site have shown no significant difference between contaminant levels in dumpsite and control site sediments. The former Pearl Harbor Site received the majority of the dredged materials dumped in the last dredging cycle, so that any effects of dumping would be most obvious at this site. Although similar environmental studies have not been conducted at other Hawaiian sites, based upon the Pearl Harbor observations, no discernable difference is expected between sediments at the proposed sites and their respective control areas. Thus, comparing contaminant levels in dredged material to corresponding levels in disposal site sediments is justified.

24-35 The DEIS presents data on the physical and chemical characteristics of Hawaiian dredged materials dumped prior to the bioassay testing procedures established by EPA/CE in 1977. These data came from samples taken from the dredge vessel hoppers and are the only data presently available for describing the materials in the EIS. In the future, materials will be evaluated in accordance with Part 227, Subpart B of the Ocean Dumping Regulations and Criteria. Only materials which satisfy the environmental impact criteria will be permitted for dumping.

24-36 Materials intended for future dumping must be tested in accordance with the EPA/CE Implementation Manual. The manual was not available for use at the time the dredged material samples mentioned in this comment were analyzed.

VII. Miscellaneous Comments

24-37 1. The Draft notes in several places (at xiv, 2-17, 2-24, 4-24) the desirability of restricting dredged material disposal to avoid the summer spawning period. Such a restriction should be made an explicit condition of the published site designation (if it is decided to proceed to final site designation) and of any future permits issued for ocean dumping at these sites.

24-38 2. The Draft fails to discuss the pros and cons of dispersal versus containment philosophies for dredged material management. E.g., should the objective of site selection and management be maximum dispersion or maximum containment? The objective selected will have crucial bearing on the desired dumpsite characteristics. Yet the Draft freely treats "strong bottom current action" (a dispersive force) as a virtue in one paragraph (at 2-11) and the status of a site as a "more stable depositional site" as a virtue in the very next paragraph (at 2-12). Elsewhere, great reliance is placed on the likelihood of dilution and dispersal (at 2-18). The Final EIS should address this issue in detail.

24-39 3. The Draft contains conflicting information about the physical characteristics of the dredged material to be dumped at the proposed sites. For example, in the text on pp. 3-2 and 3-3, the carbonate and basalt values for sediments at the proposed Nawiliwili Site are given as 74% and 12% for a 1977 study and as 27% and 46% for a 1978 study. Table 3-2, however, gives the entirely different and unexplained values of 30% and 6%, citing the same two studies (at 3-3). Similarly, the pre- and post-dumping

24-37 No stage in the life histories of any commercially valuable organisms found in the Hawaiian Islands is known to be dependent on the proposed sites or on their respective vicinities. Little is known about summer fish migration or spawning, but available information suggests that these are unimportant at the sites. However, efforts will be made by the CE during advanced planning to schedule disposal to avoid summer months until further data on summer fish migration and spawning are evaluated.

24-38 The cited inconsistency between statements regarding dynamic versus stable sites is a result of a misreading of the DEIS. As stated in the DEIS on p. 2-11, the proposed site (1) is preferred over the alternative site (1A) for several reasons, two of which are:

1. The proposed site (1) has only moderate bottom current activity, whereas evidence of strong bottom current activity was indicated at the alternative site (1A).

2. The proposed site (1) shows less variability of sediment regimes and is a more stable depositional site than site 1A, the alternative.

24-39 The data are, in fact, not conflicting. The carbonate and basalt values given in the text are pre-disposal (Neighbor Island Consultants, 1977) and post-disposal (Goeggel, 1978). Table 3-2 lists carbonate and basalt values which are mean values of all the raw data contained in the cited sources, as the table correctly states.

Sediment size data listed in Table 3-1 and Table 3-3 have been rectified in the Final EIS.

sediment sizes given in Table 3-1 (at 3-3), in Table 3-3 (at 3-4), and in the text on pages 3-4, 4-7, and B-2 seem contradictory and impossible to reconcile. The Final EIS should attempt to present this information more clearly and consistently (or explain the inconsistencies).

4. Because it is true that "[a] change in substrate may

24-40 be expected to cause the species to shift" (at 4-18), special attent: must be focused on disparities in grain size between pre- and post-disposal sediments at the proposed dumpsites. Despite evidence referenced elsewhere (see previous comment) of major shifts in grain size after dumping, the Draft seeks to minimize these differences--although it is noted in passing that "[w]hile sand usually predominates at the other proposed sites, primarily silt will be dumped" (at 4-17). More needs to be said about the environmental significance of this shift.

24-40 The proposed Nawiliwili Site was the only location for which a "major shift" in grain size after dumping was reported. However, the study reporting the pre-disposal data (Neighbor Island Consultants, 1977) indicated:

> "The sediments...lacked significant sediment within the clay size range. Cores could not be recovered from the site because of the boulder pavements, so a grab-sampler was used. It may be possible that the clay fraction of these samples was washed out of the grab sampler during recovery..."

If this were the case, the loss of the clay fraction during pre-disposal sampling would account for the apparent shift to finer-grained sediments in the post-disposal sediments.

Furthermore, the study reporting the post-disposal data (Goeggel, 1978) indicated that:

> "Size analysis of the Nawiliwili samples indicate Phase III (post-disposal) sediments are consistently finer than those from Phase I (pre-disposal). Whether this is within the natural range of size frequency variations, or whether this is from mixing of dredge spoils is difficult to determine without corroborative data from other methods of analysis, such as mineralogy or tagging studies."