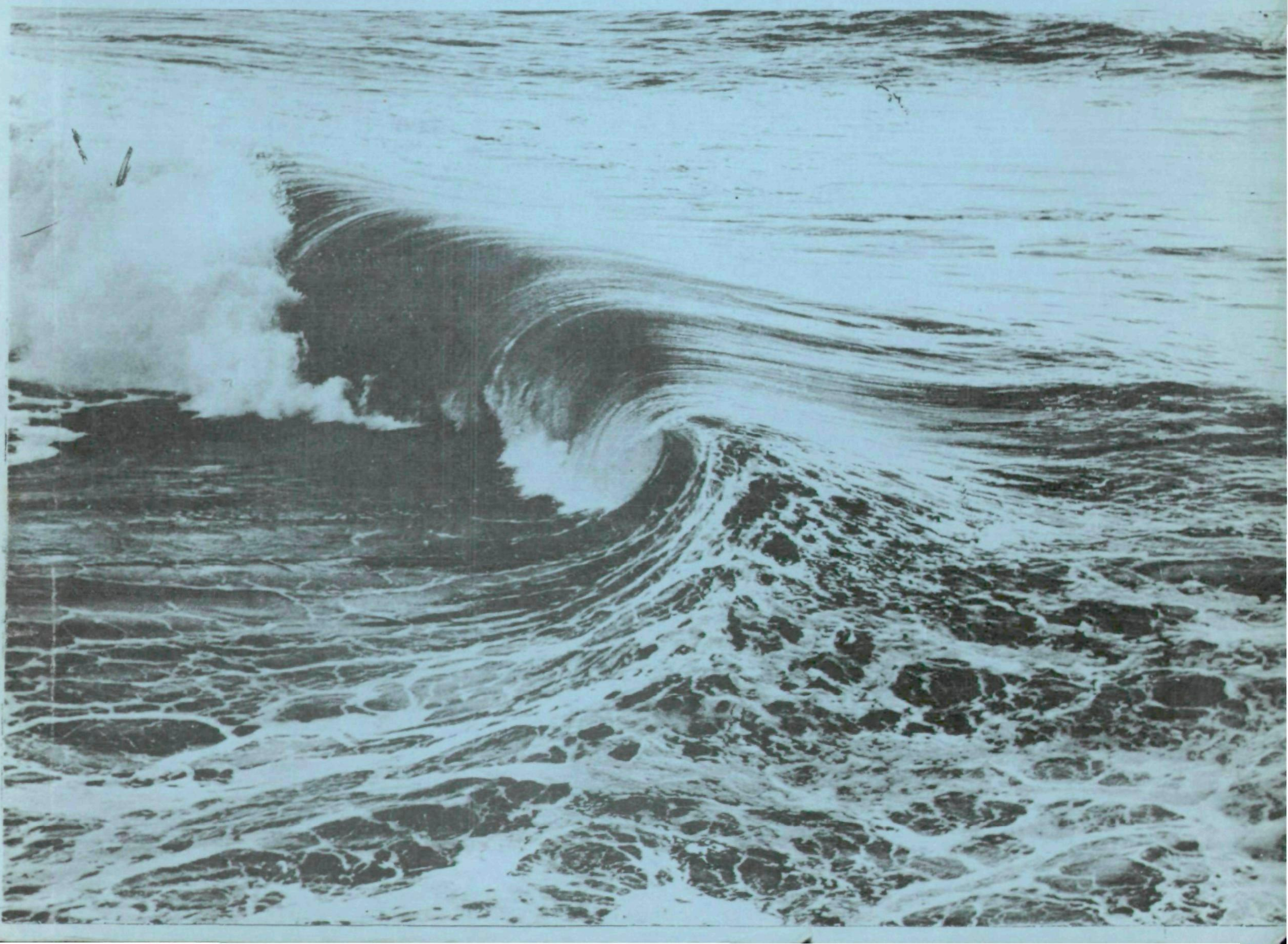
United States
Environmental Protection
Agency

Office of Water
Criteria and Standards
Washington, D.C. 20460

Final
March 1983

Environmental Impact Statement (EIS) for the Portland, Maine Dredged Material Disposal Site Designation



METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measure

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.54	centimeters	cm
ft	feet	30.	centimeters	cm
yd	yards	0.9	meters	m
fm	fathoms	1.8	meters	m
mi	statute miles	1.6	kilometers	km
nmi	nautical miles*	1.9	kilometers	km

*1 nautical mile = 6.076 feet = 1.15 statute miles

Symbol	When You Know	Multiply by	To Find	Symbol
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
nmi^2	square nautical miles	3.4	square kilometers	km^2
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2.000 lbs)	0.9	tonnes†	t

†1 tonne = 1.000 kg = 1 metric ton

Symbol	When You Know	Multiply by	To Find	Symbol
		VOLUME		
fl oz	fluid ounces	30	milliliters	ml
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	0.55(°F) - 32	Celsius temperature	°C
		VELOCITY		
in/s	inches per second	2.5	centimeters per second	cm/s
ft/s	feet per second	30	centimeters per second	cm/s
ft/min	feet per minute	0.5	centimeters per second	cm/s
mph	miles per hour	1.6	kilometers per hour	kph
kn	knots**	51.	centimeters per second	cm/s
kn	knots (nautical miles per hour)	1.9	kilometers per hour	kph

**1 knot = 1.15 mph

Approximate Conversions from Metric Measure

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
m	meters.	0.6	fathoms	fm
km	kilometers	0.6	statute miles	mi
km	kilometers	0.5	nautical miles*	nmi

*1 nautical mile = 6.076 feet = 1.15 statute miles

Symbol	When You Know	Multiply by	To Find	Symbol
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	11.	square feet	ft^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
km^2	square kilometers	0.3	square nautical miles	nmi^2
		MASS (weight)		
g	grams	0.4	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes†	1.1	short tons (2.000 lb)	

†1 tonne = 1.000 kg = 1 metric ton

Symbol	When You Know	Multiply by	To Find	Symbol
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.1	quarts	qt
l	liters	0.3	gallons	gal
m^3	cubic meters	35.	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	1.8(°C) +32	Fahrenheit temperature	°F
		VELOCITY		
cm/s	centimeters per second	0.4	inches per second	in/s
cm/s	centimeters per second	0.03	feet per second	ft/s
cm/s	centimeters per second	2.0	feet per minute	ft/min
cm/s	centimeters per second	0.02	knots (nautical miles per hr)**	kn
kph	kilometers per hour	0.6	miles per hour	mph
kph	kilometers per hour	0.5	knots	kn

**1 knot = 1.15 mph

ENVIRONMENTAL PROTECTION AGENCY
FINAL
ENVIRONMENTAL IMPACT STATEMENT (EIS)
FOR
PORTLAND, MAINE
OCEAN DREDGED MATERIAL DISPOSAL
SITE DESIGNATION

Prepared by: U.S. Environmental Protection Agency
Criteria and Standards Division
Washington, D.C. 20460

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT
FOR
PORTLAND, MAINE OCEAN DREDGED MATERIAL DISPOSAL SITE

( ) Draft

(x) Final

( ) Supplement to Draft

Environmental Protection Agency

1. Type of Action

   (X) Administrative/Regulatory Action

   ( ) Legislative Action

2. Brief description of background of proposed action and its purpose.

   The purpose of the action is to provide an environmentally acceptable ocean site for the disposal of materials dredged from the Portland Harbor, Maine and vicinity, in compliance with EPA Ocean Dumping Regulations.

3. Summary of the major beneficial and/or adverse effects associated with the proposed action.

   The major benefit of the proposed action is the provision for an environmentally acceptable location for the disposal of dredged materials. Adverse effects associated with the proposed action include the following effects on the environment: (1) mounding of dredged material at the site, and (2) smothering of some benthic organisms due to burial under dredged material.

4. Alternatives considered, including the proposed action.

The alternatives considered in this EIS are: (1) no action, which would not be designating a Portland Harbor, Maine site for continued used, and (2) use of an ocean disposal site for dredged materials (e.g., the Existing Site or an Alternative Site located near the Wilkinson Basin).

5. Comments have been requested from the following:

Federal Agencies and Offices

Council on Environmental Quality
Department of Commerce
  Maritime Administration
  National Marine Fisheries Service
  National Oceanic and Atmospheric Administration
Department of Defense
  Army Corps of Engineers
  Department of the Navy
Department of Health and Human Services
Department of the Interior
  Bureau of Land Management
  Bureau of Outdoor Recreation
  Fish and Wildlife Service
  Geological Survey
Department of Transportation
  Coast Guard
  National Science Foundation

State Agencies and Offices

State of Maine Planning Office
State of Maine Department of Conservation
State of Maine Department of Environmental Protection
State of Maine Department of Marine Resources

Private Organization

American Littoral Society
Center for Law and Social Policy
Environmental Defense Fund, Inc.
League of Women Voters
National Academy of Sciences
National Wildlife Federation
Resources for the Future
Sierra Club
Water Pollution Control Federation

Academic/Research Institutions

Ira C. Darling Center
Bigelow Laboratory for Ocean Sciences

6. The Final statement was officially filed with the Director, Office of Environmental Review, EPA.

7. Comments on the Final EIS are due within 30 days from the date of EPA's publication of Notice of Availability in the Federal Register which is expected to be ________________.

   Comments should be addressed to:

   Frank G. Csulak
   Criteria and Standards Division (WH-585)
   Environmental Protection Agency
   401 M Street, SW
   Washington, D.C. 20460

Copies of the Final EIS may be obtained from:

Environmental Protection Agency
Criteria and Standards Division (WH-585)
Washington, D.C. 20460
202/245-3036

Environmental Protection Agency
Region I
John F. Kennedy Federal Building
Room 2203
Boston, MA 02203
617/223-5061

The Final statement may be reviewed at the following locations:

Environmental Protection Agency
Public Information Reference Unit, Room 2404 (Rear)
401 M Street, SW
Washington, D.C. 20460

Environmental Protection Agency
Region I
John F. Kennedy Federal Building
Room 2303
Boston, MA 02203
617/223-5061

SUMMARY

This Environmental Impact Statement (EIS) provides information required for the decisionmaking process, with respect to final designation of a Portland, Maine, Ocean Dredged Material Disposal Site (ODMDS). the purpose of the proposed action is to provide the most feasible and environmentally acceptable ocean location for the disposal of material primarily dredged from Portland, Maine Harbor Channel System.

A disposal site in the ocean is needed to receive material dredged from the Portland Harbor area. Without dredging, operating depths in the Harbor would decrease, thus limiting economically important ship traffic to Portland, Maine. In evaluating alternative methods for the disposal of dredged material, the U.S. Army Corps of Engineers (CE) has demonstrated that disposal in the ocean is the most reasonable method at present.

Portland Harbor (Fore River) originates at the headwaters of Stroudwater River. The Stroudward River flows in an easterly direction through Garham and South Portland for approximately 16 miles before emptying into the upstream reaches of the Fore River. The Fore River continues in an easterly direction for approximately five additional miles before emptying, into Casco Bay at the entrance to Portland Harbor. The basin drains an area of 54 square miles.

The Environmental Protection Agency (EPA), the agency responsible for designating ocean disposal sites, approved the Existing Portland ODMDS (Figure S-1) for interim use in 1979, based on historical use of the disposal site (the Existing Site was used in about 1946 for material dredged from the Portland Harbor Channel System). The use of any site under interim designation will continue only if EPA grants the site final designation. EPA must either terminate the interim site or designate it for continued use by July 1984, when Portland Harbor ODMDS interim designation expires.

PURPOSE OF AND NEED FOR ACTION

Portland Harbor, Maine, is approximately 100 nmi northeast of Boston, Massachusetts, at the south end of Casco Bay, Maine. It is the leading port in northern New England, handling over 13.5 million tons in 1979. Periodic maintenance dredging of a navigable shipping channel and turning basin is necessary for the continued viability of industry, commercial fisheries, and sportfishing in the Gulf of Maine, and for the import of products into New England.

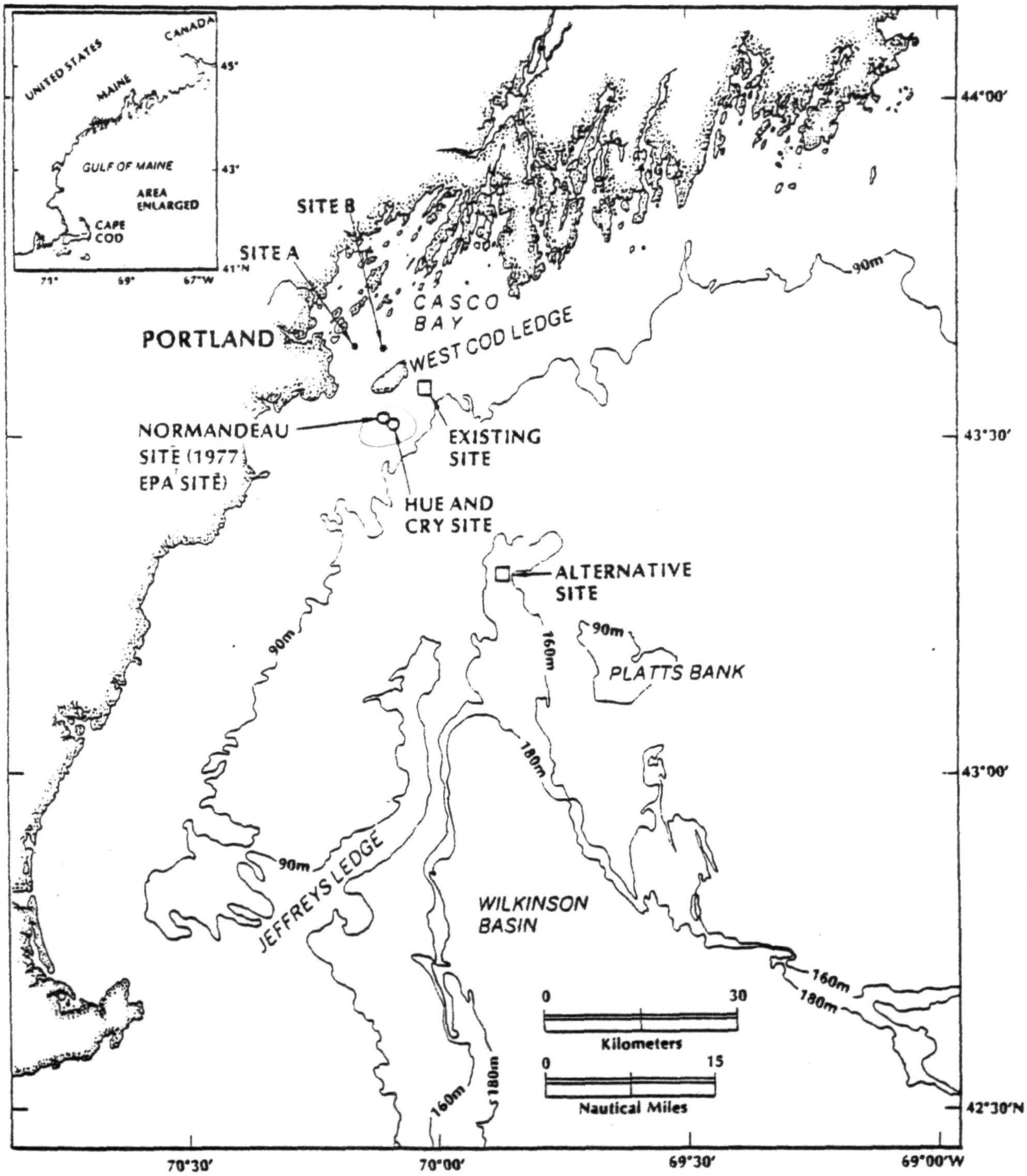


Figure S-1. Locations of the Existing and Alternative Sites

After the most recent disposal of dredged material from Portland Harbor at a different site in 1972, and with recognition that a large amount of material would need to be dredged in the near future, the CE and others initiated studies for locating a suitable disposal site. The CE determined that land-based disposal techniques, such as landfill and constructing marshes, are not feasible in the Portland area. Since 1974 several potential ocean disposal sites, in water depths ranging from 35 to 65m, and within several miles of the Portland lighted horn buoy (approximately 11 nmi from the Harbor entrance), have been investigated.

In 1977, EPA designated a Portland ODMDS, 1 nmi in diameter, centered at 43°32'18"N, 70°06'06"W, as an interim (tentative) location for disposal purposes, in compliance with the Marine Protection, Research, and Sanctuaries Act (MPRSA) 40 CFR §228.12. This site had been studied by Normandeau Associates Inc. in 1974. When the Draft EIS for the Portland Harbor Maintenance Dredging Project was released in 1977, the CE expected to use point dumping disposal in the ocean at 43°31'40"N, 70°06'06"W (within the interim site designated by EPA in the 1977 Ocean Dumping Regulations and Criteria, 40 CFR §228.12; Figure S-1). When the proposal for this site was presented to local fishermen, it was rejected because of its proximity to a prime fishing area.

In March 1979 the CE published a draft Supplement to the Draft EIS for the Maintenance Dredging of Portland Harbor, providing the rationale for the change in site location to the Existing Site, as opposed to the site originally presented in the Draft EIS. The Final EIS for Maintenance Dredging of Portland Harbor, Portland, Maine, published by the CE in June 1979, concluded that disposal of dredged material from the habor at the Existing Site is the most environmentally and economically feasible disposal alternative. The center coordinates of Existing Site are 43°34'18"N; and 70°06'06"W.

The purpose of this EIS is to provide the required information to aid in the decisionmaking process, resulting in the proposed final designation of a Portland ODMDS for continued use as an ocean site for the disposal of dredged material.

SELECTION OF ALTERNATIVE SITES

Dredging is necessary for safe navigation in Portland Harbor. The no-action alternative is not considered an acceptable alternative because EPA is required to decide the fate of the interim site, the location of which was changed to the Existing Site (i.e., final designation or termination of dumping). Because land disposal alternatives have been determined by the CE to be environmentally unacceptable in the Portland area, an ocean site is necessary.

EPA and the CE have evaluated the need for dumping in the ocean and alternatives to dumping in the ocean in accordance with Ocean Dumping Regulations (40 CFR Part 227 Subpart C). Criteria used for site selection are based on considerations of potential interferences by disposal operations with other marine activities and resources, potential perturbations of water quality, impacts on beaches or other amenity areas, previous uses of the dredged material disposal site, and geographic location.

After screening various alternative sites, the Existing Site and an Alternative Site near the Wilkinson Basin are considered in this EIS for designation. The Existing Site was used in about 1946 as a primary disposal site for sediments dredged from channels of Portland Harbor. Detectable impacts of dredged material disposal in this site have been limited to mounding, smothering of some benthic organisms, and temporary disturbances of demersal fish assemblages.

The CE used two sites close to shore in 1962 and 1970 (Sites A and B, Figure S-1) for dredged material disposal. However, additional use of these sites is not recommended because the sites are within lobster fishing grounds, an important commerical fishery resource. Furthermore, there is no demonstrated need for additional sites based on present and expected dredged material volumes. Designation of another site in lieu of the Existing Site, in similar water depths, is not recommended because there would be no significant change or benefits to the ecosystem.

The Alternative Site is in the Gulf of Maine and is not seaward of the true East Coast Continental Shelf; however, it does fulfill some of the same environmental conditions of deepwater (i.e., low-energy and low biomass). Wilkinson Basin has not been used previously for dredged material disposal, and the potential adverse effects of dredged sediment on indigenous organisms and resources are presently unknown.

Other sites on the Continental Slope, beyond the Gulf of Maine, would present four problems: (1) the greater distance (240 nmi) from shore increases the potential for navigational errors, (2) longer transit time would increase the potential for short dumping due to emergency during adverse weather conditions, (3) great water depth (>200m) would result in the deposition of dredged materials over a larger area than projected for the Existing Site, and (4) cost to transport the dredged material would be excessive.

PROPOSED ACTION

After reviewing all reasonable alternatives the EPA and CE proposed that the Existing Site be designated for disposal of dredged materials from the Portland Harbor Channel and vicinity.

Since 1972 ocean dumping of dredged material has been regulated by the EPA. Section 102(a) of the Marine Protection, Research, and Sanctuaries Act (MPRSA) authorizes the EPA to regulate, by permit, the dumping of materials into ocean waters. Consequently, EPA promulgated the Final Ocean Dumping Regulations and Criteria in 1977 (40 CFR Part 228). These regulations approved the Portland interim ODMDS and several other existing ODMDS in New England for dumping on an interim basis "pending completion of baseline or trend assessment surveys and designation for continuing use or termination of use" (40 CFR §228.12). Formal designation is accomplished by amending 40 CFR 228.12(b) of the EPA

Ocean Dumping Regulations and Criteria, which identify dredged material disposal sites for use under the provisions of the Ocean Dumping Regulations. (Federal legislation regulating ocean dumping is described in Chapter 1.) The decision to accept a site for final designation is based on compliance with site selection criteria (40 CFR 228.5 and 228.6a), which ensures that disposal of dredged material will not degrade or endanger the marine environment, and will not cause unacceptable adverse human health effects or other permanent adverse effects. The criteria are applied to the potential effects caused by dredged material disposal at the Existing Site and the Alternative Site in Chapter 2.

CONTINUED USE OF THE EXISTING SITE

The locations of the Existing Site, the Alternative Site, Sites A and B, the Hue and Cry study area, and the Normandeau study area (also known as the 1977 EPA interim site) are shown in Figure S-1. The Existing Site has an area of 1 nmi^2 is 6.72 nmi offshore, in water depths ranging from 40 to 65m and whose center coordinate is 43°34'18"N; and 70°06'06"W. The Alternative Site is 21.5 nmi offshore, over the axis of a trough and seaward of the 170m isobath.

Records of dumping before 1962 are incomplete. The National Oceanic and Atmospheric Administration (NOAA), National Ocean Survey (NOS) reported that the 5 nmi^2 disposal area noted on navigation charts was established by the Boston Office of the War Department in 1943 for the disposal of dredged material from Portland Harbor. The CE reported that in 1945 and 1946 major dredging projects were authorized. From those notes it is surmised that the material dredged during 1943 through 1946 was disposed at the site designated in 1943, which now incorporates the Existing Site. However, since 1946 dredged material, with the exception of the present project, has been dumped at nearshore Sites A and B. Site A received 225,000 yd^3 in 1962, and Site B received 21,000 yd^3 in 1970. The Alternative Site has never been used for the disposal of dredged material.

The criteria used in Chapter 2 to evaluate the Existing Site are summarized in Table S-1. The Existing Site is the recommended location for the disposal of dredged material. All other nearshore sites were rejected because of their proximity to prime fishery areas. The site has been used in the past and no adverse effects resulting from disposal are known or are reported. Mounding, changes in sediment texture and chemistry, and smothering of benthic organisms are restricted within the site boundaries, and most likely within the small basin at its center. Designation of the Alternative Site is not recommended because dumping would have unknown and possibly deleterious effects on organisms, and the longer distance and transit time would create an added economic and energy consumption burden. The longer transit time increases the probability of short dumping and involves difficulties of site monitoring and surveillance. Finally, no baseline data currently exist for the Alternative Site; consequently, predisposal data would be needed so that subsequent changes could be assessed.

AFFECTED ENVIRONMENT

Distributions of biological communities along the coast of Maine appear to be related to depth and stability of seafloor sediments. For example, the biomass and density of benthic organisms decreases with increasing distance from shore, and is associated with an increase in silt content. Relative to other nearshore areas along the Maine coast, the Existing Site does not sustain a large and diverse benthic fauna.

Little information is available on benthic and nektonic communities inhabiting the Alternative Site. Investigations of the biota from adjacent Shelf areas have demonstrated low abundances of several commercially important finfish and shellfish species.

TABLE S-1
SUMMARY OF THE 11 SITE-SELECTION CRITERIA AS APPLIED TO THE EXISTING AND ALTERNATIVE SITES

40 CFR §228.6 Criteria	Existing Site	Alternative Site
1. Geographical position, depth of water, bottom topography, and distance from coast	See Figure S-1; 6.8 nmi offshore; 39m to 64m deep; rough, irregular rocky outcrops around a 600m by 600m basin	See Figure S-1; 21 nmi offshore; 180m deep, flat mud-covered bottom
2. Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases	Some occurrence of lobster migration on a seasonal basis through the general region	No known breeding or spawning grounds in the region
3. Location in relation to beaches and other amenity areas	6.8 nmi from shore; because of the water depth and current directions, dredged material is not likely to reach adjacent beaches	21 nmi from shore; because of the water depth and distance from shore, dredged material is not likely to reach adjacent beaches
4. Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any	850,000 yd^3 of cohesive material (sand, silt, and clay) from the channels and turning basin (last project); no future projects identified; no packing, bottom dump release from barge	Same as Existing Site
5. Feasibility of surveillance and monitoring	CE provides an observer on each tug; monitoring is not a problem	CE could provide an observer; monitoring is more difficult due to greater distance offshore and greater depth
*6. Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any	Rapid settling, minimal horizontal or vertical stratification; major portion of material will remain within the site	Due to greater depth, more mixing and dispersal is expected
*7. Existence and effects of current and previous discharges and dumping in the area (including cumulative effects)	Effects are minor and restricted to the site; significant adverse effects have not been noted outside the site	No sediments have been dumped in this area
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	No interference is expected	Same as Existing Site
*9. The existing water quality and ecology as determined by available data trend assessment, or baseline surveys	High water quality with slightly elevated hydrocarbon concentrations; infaunal community has high variability, and epifauna dominated by suspension feeders attached to rocky surfaces	No data, but presumed to be same as Existing Site
10. Potentiality for the development or recruitment of nuisance species in the disposal site	The dredged material does not contain material known to cause development or recruitment of nuisance species	Same as Existing Site
11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance	No known features exist at or near the site	Same as Existing Site

* Criterion especially relevant to site selection

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

TABLES

Number

ILLUSTRATIONS

Figures

CONTENTS (Continued)

ENVIRONMENTAL CONSEQUENCES

No irreversible or significant adverse environmental impacts have been observed at the Existing Site. Potential environmental consequences of dredged material disposal at the Existing Site are summarized below. Commercial lobster fishing commonly occurs inshore and seaward of the site, but is almost nonexistent within the site. Previous dumping has produced no detectable effects on commercial finfish species. Sport and commercial troll fisheries are not active in the vicinity of the Existing Site. No fishing currently exists at or near the Alternative Site; therefore, no potential interference by disposal of dredged material is expected. Thus, little interference with fishing is expected from disposal operations at either alternative.

The dredged material is predominantly fine sand, silt, and clay, and creates some temporary turbidity. However, previous dumping of dredged materials at the Existing Site has not caused any significant adverse aesthetic effects, and such effects would not be expected if the dredged materials were dumped at the Alternative Site.

Changes in water chemistry occur immediately following disposal activities, but conditions return to predisposal levels within a short time. Dredged material disposal has caused no detectable changes in water quality at the Existing Site.

Previous dumping of dredged material at the Existing Site has caused no obvious long-term adverse affects on benthic communities. Direct burial by dredged material produces a temporary change in the benthic community, primarily by smothering some organisms.

Dredged materials have not been dumped at the Alternative Site; thus, the full potential for significant adverse environmental impact is unknown. A predisposal study is recommended to identify potential impacts, if the site is to be used. No mitigating action is necessary for dredged material disposal at the Existing Site.

ORGANIZATION OF THE EIS

The EIS is organized into six Chapters and three Appendixes. Four Chapters comprise the main body of the EIS:

- Chapter 1 specifies the purpose and need for the Proposed Action, (i.e., final designation of a Portland ODMDS). Background information on the disposal of dredged material is presented, together with the legal framework guiding the EPA in the selection and designation of disposal sites. Responsibilities of the CE in disposal of dredged material in the ocean are provided, and the history of dredged material disposal at the Existing Site is presented.

- Chapter 2 discusses alternative locations for the disposal of dredged material in the ocean and the no-action alternative. The Existing and Alternative Sites are evaluated using the 11 site selection criteria listed at 40 CFR §228.6. Guidelines for a monitoring plan are also presented.

- Chapter 3 describes the affected environment of the Existing and Alternative Sites.

- Chapter 4 describes the potential environmental consequences of dredged material disposal at the Existing and Alternative Sites.

Chapters 5 and 6 and Appendixes A, B, and C provide supplementary information. Chapter 5 lists the authors of the EIS. Chapter 6 contains the glossary, list of abbreviations, and references cited in the text. Mathematical conversion factors are provided on the inside front cover. Appendix A provides Interstate Electronics Corporation (IEC) survey data and supplemental oceanographic data; Appendix B describes the Existing Site, based on data from a photographic survey; Appendix C provides land disposal comments and responses; Appendix D provides COE Report on bioassay and bioaccumulation testing; and Appendix E provides comments and responses on DEIS.

Chapter 1

PURPOSE OF AND NEED FOR ACTION

Shipping is a major component of commerce in Portland, Maine. As a result of natural shoaling, the Fore River channel must be dredged periodically to maintain an operating depth of 10.7m (35 ft). Ocean dumping is the most feasible means to dispose of dredged material. The action proposed in this EIS is the final designation of an environmentally acceptable Portland Ocean Dredged Material Disposal Site.

GENERAL

The Action proposed in this Environmental Impact Statement (EIS) is the final designation for continuing use of an Ocean Dredged Material Disposal Site (ODMDS) in the Portland, Maine area. The purpose of the proposed action is to provide the most environmentally acceptable location for the disposal of materials dredged from Portland, Maine. The EIS presents the information needed to evaluate the suitability of ocean disposal areas for final designation for continuing use, and is based on one of a series of disposal site environmental studies. The environmental studies and final designation process are being conducted in accordance with the requirements of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) (86 Stat. 1052), as amended (33 U.S.C.A. §1401 et seq.); the Environmental Protection Agency's (EPA) Ocean Dumping Regulations and Criteria (40 CFR 220-229); and other applicable Federal environmental legislation.

Land-based alternatives for the disposal of dredged materials are unavailable at reasonable environmental and economic costs; therefore, alternatives in the ocean have been investigated (see Chapter 2 and Appendix C).

In 1977, EPA designated a Portland ODMDS at 43°32'18"N, 70°06'06"W, 1 nmi in diameter, as an interim (tentative) ocean location for the disposal of dredged material 40 CFR §228.12. When the Draft EIS for Portland Harbor Project was issued, the CE expected to dump the material at a specific point at a buoy located at 43°31'40"N, 70°06'06"W (within the interim site designated by EPA). This site had been studied by Normandeau Associates, Inc. (1974a,b) (Figure 1-1). On the basis of further studies, the CE contractor suggested that the disposal site be moved about 0.5 nmi southeast of the previous site. Coordination with concerned Federal and State agencies was initiated to determine if the site was acceptable to all involved agencies. However, in April 1977, when the CE notified the public about the new disposal site, the local fishing community objected because the new location was in one of their fishing grounds. The fishermen were also opposed to relocating the site to its designated interim location, and suggested a previously designated area at 43°34'06"N, 70°02'00"W (Figure 1-1). This area, beyond the 3-nmi limit of the Territorial Sea, was established by the Boston Office of the War Department in 1943 for the disposal of materials dredged from Portland Harbor. Major dredging projects were authorized for Portland Harbor (CE, 1979), and it is surmised (in the absence of actual records) that the site was used for the disposal of dredged material between 1943 and 1946. Based on this indication of prior use, studies of the area and recommendations from the fisheries industry and the Maine State Department of Marine Resources, a site (hereinafter, the Existing Site) has been defined as a 1 nmi^2 area, centered at 43°32'18"N, 70°06'06"W, with corner coordinates of 43°33'36"N, 70°02'30"W; 43°33'36"N, 70°01'06"W; 43°34'36"N, 70°02'30"W; 43°34'36"N, 70°01'06"W (Figure 1-1). The site is 6.8 nmi offshore and has an average depth of 50m. In March 1979 the CE published a draft Supplement to the Draft EIS for the "Maintenance Dredging of Portland Harbor," which provides for the change in disposal site location from the original EIS.

The Portland, Maine site would be designated for the disposal of dredged material. The site may be used for the disposal of dredged material only after evaluation of each Federal project or permit application has established that the disposal is within site capacity and in compliance with the criteria and requirements of EPA and CE regulations.

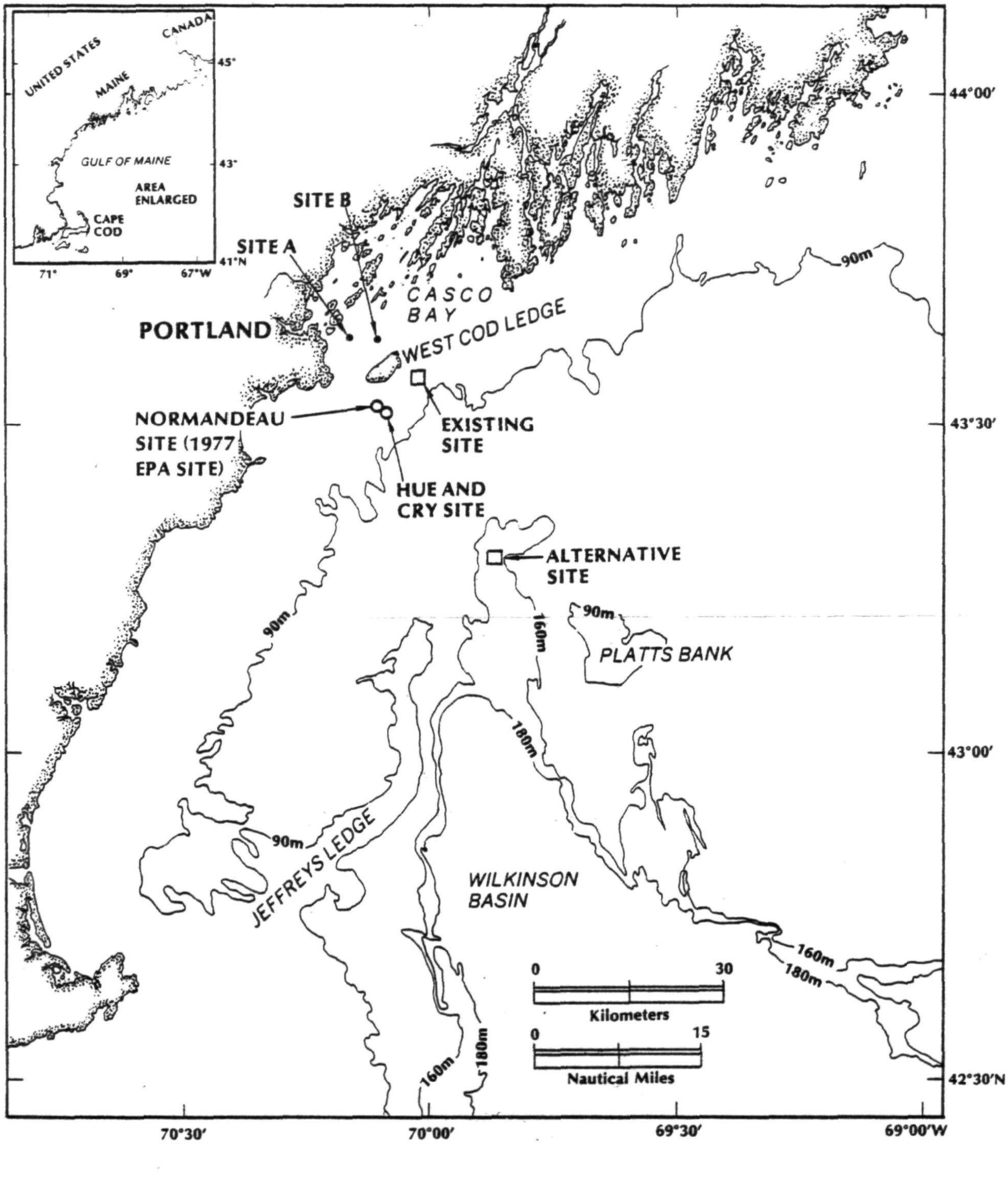


Figure 1-1. Portland ODMDS

PURPOSE AND NEED

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The MPRSA was enacted in October 1972. Congressional intent for this legislation as expressed in the Act is:

> Sec. 2(b). The Congress declares that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, amenities, or the marine environment, ecological systems, or economic potentialities.
>
> (c). It is the purpose of this Act to regulate (1) the transportation by any person of material from the United States and, in the case of United States vessels, aircraft, or agencies, the transportation of material from a location outside the United States, when in either case the transportation is for the purpose of dumping the material into ocean waters and (2) the dumping of material transported by any person from a location outside the United States if the dumping occurs in the territorial seas of the contiguous zone of the United States.

Title I of the MPRSA, which is the Act's primary regulatory section, authorizes the Administrator of EPA (Section 102) and the Secretary of the Army acting through the CE (Section 103) to establish ocean disposal permit programs for nondredged and dredged materials, respectively. Title I also requires EPA to establish criteria, based on those factors listed in Section 102(a), for the review and evaluation of permits under the EPA and CE permit program. In addition, Section 102(c) of Title I authorizes EPA, considering criteria established pursuant to Section 102(a), to designate recommended ocean disposal sites or times for dumping of nondredged and dredged material.

CORPS OF ENGINEERS NATIONAL PURPOSE AND NEED

Section 103 of Title I requires the CE to consider in its evaluation of Federal projects and Section 103 permit applications the effects of ocean disposal of dredged material on human health, welfare, or amenities, or the marine environment, ecological systems, and economic potentialities. As part of this evaluation, consideration must be given to utilizing, to the extent feasible, ocean disposal sites designated by the EPA pursuant to Section 102(c). Since 1977 the CE has used those ocean disposal sites designated by EPA on an interim basis. Use of these interim-designated sites for ocean disposal has been an essential element of CE compliance with the requirements of the MPRSA and its ability to carry out its statutory responsibility for maintaining the nation's navigable waterways. To continue to maintain U.S. waterways, the CE considers it essential that environmentally acceptable ocean disposal sites be identified, evaluated, and permanently designated for continued use pursuant to Section 102(c). These sites will be used after review of each project has established that the proposed ocean disposal of dredged material is in compliance with the criteria and requirements of EPA and CE regulations.

CORPS OF ENGINEERS LOCAL NEED

Portland Harbor is the leading port in northern New England in terms of tonnage. Foreign and domestic cargo ships carried over 13.5 million tons of cargo to and from this port in 1979. As a result of natural shoaling, Portland Harbor Channels must be periodically dredged to safely accommodate ship traffic: **"As a result of a hydrographic survey conducted between March and June 1974, the New England Division determined that dredging was required in the 35-foot [10.7m] Fore River Channel and Turning Basin. In some areas, shoaling has reduced the channel depth to only 30 feet [9m] at mean low water. The dredging will restore the project depth of 35 feet to accommodate shipping" (CE, 1979).**

The need is to consider the various disposal alternatives including ocean disposal for disposal by large quantities of material generated from annual dredging of the port.

Dredging of the channel to a safe operating depth of 35 ft is critical to the shipping economy and to sustain a vital component of Maine's economy. The CE maintains the channel in the harbor as part of a Federal project for the New England region. The CE published an EIS in June 1979 titled "Maintenance Dredging Portland Harbor, Portland, Maine," concluding that disposal of dredged material from the harbor into the ocean was the most environmentally and economically feasible method.

EPA PURPOSE AND NEED

As previously stated, the CE has indicated a need for locating and designating environmentally acceptable ocean dredged material disposal sites to carry out its responsibilities under the MPRSA and other Federal statutes. Therefore, in response to the CE's stated need, EPA, in cooperation with the CE, has initiated the necessary studies pursuant to the requirements of 40 CFR 228.4(e) to select, evaluate, and possibly designate the most suitable sites for the ocean disposal of dredged material. This document has been prepared to provide the public and decisionmakers with relevant information to assess the impacts associated with the final designation for one of the sites proposed for final designation as the Portland ODMDS. It is not anticipated that the CE will conduct any further environmental studies with respect to the selection of this site.

INTERIM DUMPING SITES

On 11 January 1977, EPA promulgated final Ocean Dumping Regulations and Criteria to implement MPRSA. The Regulations set forth criteria and procedures for the selection and designation of ocean disposal sites. In addition, the regulations designated 129 ocean sites for the disposal of dredged material to allow the CE to fully comply with the purpose and procedural provisions of the MPRSA. These sites could be used for an interim period by the CE, pending completion of site designation studies as required by the Regulations. Use of the interim-designated sites by the CE would be dependent on compliance with the requirements and criteria contained in EPA's Ocean Dumping Regulations and Criteria.

Those sites given interim designation were selected by EPA in consultation with the CE, with the size and location of each site based on historic use. The interim designation would remain in force for a period not to exceed 3 years from the date of the final promulgation of the Regulations. However, due to the length of time required to complete the necessary environmental studies and operating restraints of both a technical and budgetary nature, environmental studies were not completed within the approved 3-year period. As a result, the Regulations were amended in January 1980 to extend the interim designation for those sites currently under study for a period not to exceed 3 years, while the remaining sites' interim status was extended indefinitely, pending completion of studies and determination of the need for continuing use. The Regulations were amended in February 1983 to extend the interim site designaiton for a period not to exceed 18 months, pending completion of EIS's and formal rulemaking procedures (40 CFR Part 228 [WH-FRC-2297-7]).

SITE STUDIES

In mid-1977, EPA, by contract, initiated environmental studies on selected nondredged material disposal sites. The studies were designed to characterize the sites' chemical, physical, and biological features and to provide the data needed to evaluate the suitability of each site for continuing use. All studies are being conducted in accordance with the appropriate requirements of Part 228 of the EPA Ocean Dumping Regulations and Criteria. Results of these studies are being used in the preparation of an EIS for each site where such a statement is required by EPA policy. The CE, to assist EPA in its national program for locating and designating suitable sites for the ocean disposal of dredged materials, agreed in 1979 to join the contract effort by providing funds for field surveys to collect and analyze baseline data. Data from each field survey and other relevant information are being used by EPA in disposal site evaluation study and EIS's to ascertain the acceptability of an interim site and/or another site(s) for final designation. In addition to providing funds, the CE agreed to further assist EPA by providing technical review and consultation.

The EPA, in consultation with the CE, selected 25 areas containing 59 interim-designated ODMDS's for study under the EPA contract. Regional priorities and possible application of the data to similar areas were considered in this selection process. For some selected areas an adequate data base was found to exist; consequently, field studies for these areas were considered unnecessary for disposal site evaluation studies. For the remaining selected areas, it was determined that surveys would be required for an adequate data base to characterize the areas' physical, chemical, and biological features and to determine the suitability of one or more sites in these areas for permanent designation. Field surveys were initiated in early 1979 and were completed in mid-1981.

The studies are directed to the evaluation of alternative ocean disposal sites for the disposal of dredged material in an area. Based on the data from the disposal site evaluation study and other relevant information, an EIS will be prepared for each of the 25 selected areas. These EIS's only address those issues germane to the selection, evaluation, and final designation of environmentally acceptable ODMDS's. As a result, the data and conclusions contained in Chapters 2, 3, and 4 are limited to those significant issues relevant to site designation (i.e., analyses of impacts on site and adjacent area from the disposal of dredged material). Non-ocean disposal alternatives (e.g., upland, beach nourishment) are not addressed in the EIS's since site designation is independent of individual project disposal requirements. However, in the event that non-ocean disposal alternatives have been previously addressed by Federal projects or Section 103 permit application EIS's, a summary of the results and conclusion is included in Chapter 2.

SITE DESIGNATION

In accordance with the EPA's Ocean Dumping Regulations and Criteria, site designation will be by promulgation through formal rulemaking. The decision by EPA to designate one or more sites for continuing use will be based on appropriate Federal statutes, disposal site evaluation study, EIS, supporting documentation and public comments on the Draft EIS, Final EIS, and the public notice issued as part of the proposed rulemaking.

In the event that the selected area is deemed suitable for final designation, it is EPA's position that the site designation process, including the one or more disposal sites evaluation study and the development of the EIS, fulfill all statutory requirements for the selection, evaluation, and designation of an ODMDS.

The EIS and supporting documents provide the necessary information to determine whether the proposed site(s) is suitable for final designation. In the event that an interim-designated site is deemed unacceptable for continuing use, the site's interim designation will be terminated and either the no-action alternative will be selected (no site will be designated) or one or more alternative sites will be selected/designated. Furthermore, final site designation infers only EPA's determinations that the proposed site is suitable for the disposal of dredged material. Approval for use of the site will be determined only after review of each project to ensure that the proposed ocean disposal of dredged material is in compliance with the criteria and requirements of EPA and CE regulations.

LEGISLATION AND REGULATION BACKGROUND

FEDERAL LEGISLATION

Despite legislation dating back almost 100 years for the control of disposal into rivers, harbors, and coastal waters, ocean disposal of dredged material was not specifically regulated in the United States until passage of the MPRSA in October 1972. The first limited regulation was provided by the Supervisor of New York Harbor Act of 1888, which empowered the Supervisor (a U.S. Navy line officer) to prevent the illegal deposit of obstructive and injurious materials in New York Harbor, its adjacent and tributary waters, and Long Island Sound. In 1952 an amendment provided that the Secretary of the Army appoint a Corps of Engineers officer as Supervisor and, since that date, each New York District Engineer has automatically become the Supervisor of the Harbor. In 1958 an amendment extended the act to apply to the harbors of Hampton Roads, Virginia, and Baltimore, Maryland. Under the 1888 act, the Supervisor of the Harbor established sites in the Hudson River, Long Island Sound, and Atlantic Ocean for dumping certain types of materials. Further limited regulation was provided by the River and Harbor Act of 1899, which prohibited the unauthorized disposal of refuse into navigable waters (Section 13) and prohibited the unauthorized obstruction or alteration of any navigable water (Section 10).

The Fish and Wildlife Coordination Act was passed in 1958. Its purpose was "...to provide that wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs...." The law directed that water-resource projects, including channel deepening, be performed "with a view to the conservation of wildlife resources by preventing loss of and damage to such resources...." This was a first step towards concern for ocean areas. After the passage of this law, the CE (backed by judicial decisions) could 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) of 1969 (PL 91-190, 42 USC Parts 4321-4347, 1 January 1970) reflected public concern over the environmental effects of man's activities. Subsequently, particular attention was drawn to the effects of dredged materials by the River and Harbor Act of 1970 (PL 91-611). This act initiated a comprehensive nationwide study of dredged material disposal problems. Consequently, the CE established the Dredged Material Research Program (DMRP) in 1973, a 5-year, $30-million research effort. Objectives were (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 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 (FWPCA), later amended by the Clean Water Act of 1977, and (2) the MPRSA. Section 404 of the FWPCA established a permit program, administered by the Secretary of the Army acting through the Chief of Engineers, to regulate the discharge of dredged material into the waters of the United States (as defined at 33 CFR 323.2(a)). Permit applications are evaluated using guidelines jointly developed by EPA and the CE. Section 404(c) gives the EPA Administrator authority to restrict or prohibit dredged material disposal if the operation will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding grounds), wildlife, or recreational areas. Procedures to be used by EPA in making such a determination are found at 40 CFR 231.

MPRSA regulates the transportation and ultimate dumping of barged materials in ocean waters. The act is divided into three parts: Title I--Ocean Dumping, Title II--Comprehensive Research on Ocean Dumping, and Title III--Marine Sanctuaries. This EIS is concerned only with Title I of the act.

Title I, the primary regulatory section of MPRSA, establishes the permit program for the disposal of dredged and nondredged materials, mandates determination of impacts and alternative disposal methods, and provides for enforcement of permit conditions. The purpose of Title I is to prevent or strictly limit the dumping of materials that would unreasonably affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. Title I of the act provides procedures for regulating the transportation and disposal of materials into ocean waters under the jurisdiction or control of the United States. Any person of any nationality wishing to transport waste material from a U.S. port, or from any port under a U.S. flag, to be dumped anywhere in the oceans of the world, is required to obtain a permit.

Title I prohibits the dumping into ocean waters of certain wastes, including radiological, biological, or chemical warfare agents, and all high-level radioactive wastes. In March 1974, Title I was amended (PL 93-253) to bring the act into full compliance with the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, discussed below under "International Considerations." The provisions of Title I include a maximum criminal fine of $50,000 and jail sentence of up to 1 year for every unauthorized dump or violation of permit requirements, or a maximum civil fine of $50,000. Any individual may seek an injunction against an unauthorized dumper with possible recovery of all costs of litigation.

FEDERAL CONTROL PROGRAMS

Several Federal departments and agencies participate in the implementation of MPRSA requirements, 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, which were revised in January 1977 (40 CFR 220-229). The Ocean Dumping Regulations established the procedures and criteria to apply for dredged material permits (Part 225), enforce permit conditions (Part 226), evaluate permit applications for environmental impact (Part 227), and designate and manage ocean disposal sites (Part 228).

OCEAN DUMPING EVALUATION PROCEDURES

The Ocean Dumping Regulations specify the procedures for evaluating the effects of dredged material disposal. The EPA and CE evaluate Federal projects and permit applications for non-Federal projects to determine (1) whether there is a demonstrated need for ocean disposal and that other environmentally sound and economically reasonable alternatives do not exist (40 CFR 227 Subpart C), and (2) compliance with the environmental impact criteria (40 CFR 227 Subparts B, D, and E). Figure 1-2 outlines the cycle used to evaluate the acceptability of dredged material for ocean disposal.

Under Section 103 of MPRSA, the Secretary of the Army is given the authority, with certain restrictions, to issue permits for the transportation of material dredged from non-CE projects for ocean disposal. For Federal 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-Federal dredging projects involving disposal of dredged material. Consequently, both Federal and non-Federal dumping requests undergo identical regulatory reviews. The only difference is that, after the review and approval of the dumping request, non-Federal projects are issued an actual permit. The CE is

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
	Research on alternative ocean disposal techniques
U.S. Department of the Army Corps of Engineers	Issuance of permits for transportation of dredged material disposal
	Recommendation of 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	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

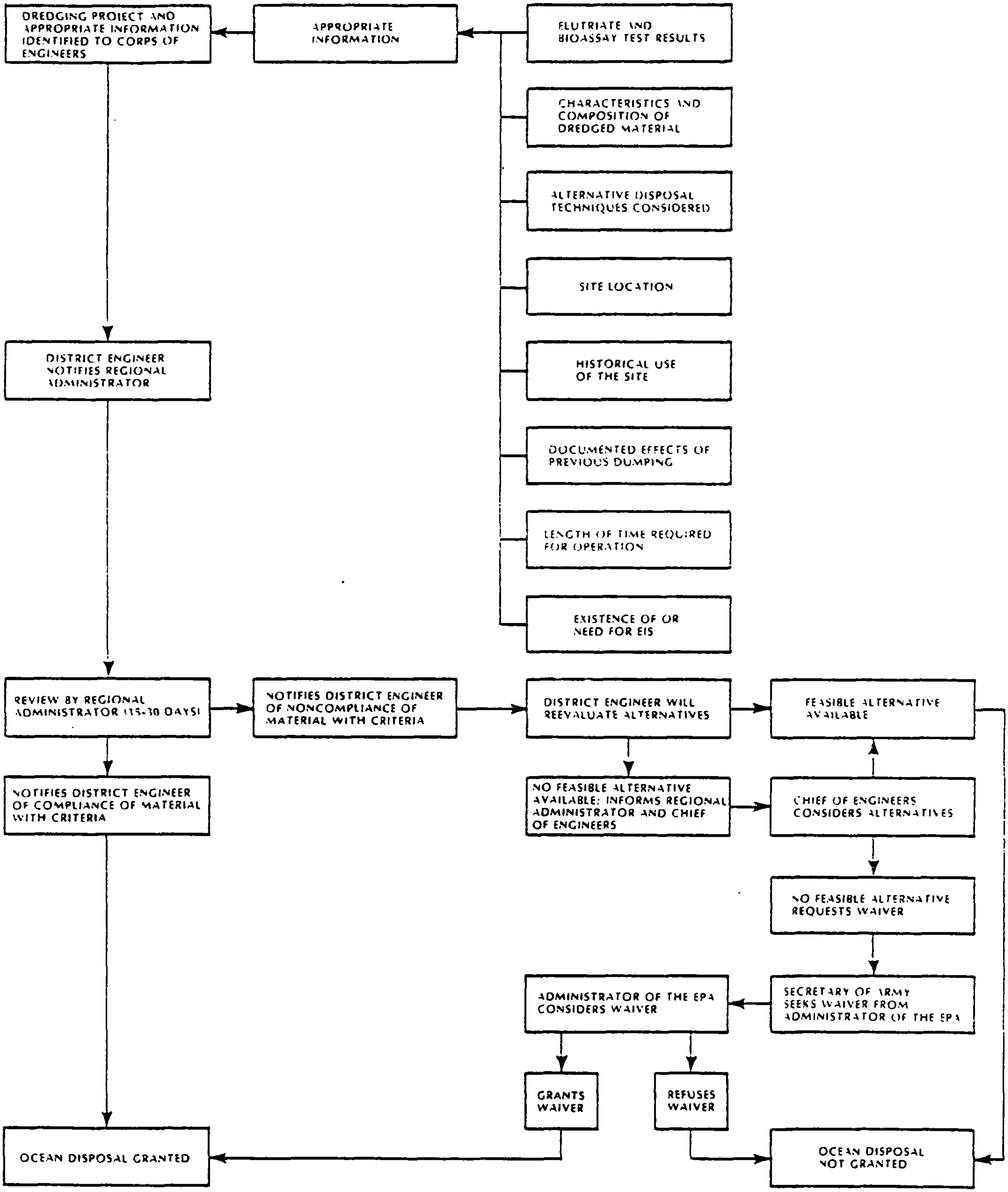


Figure 1-2. Dredged Material Evaluation Cycle

responsible for evaluating disposal applications and granting permits to dumpers of dredged materials; however, dredged material disposal sites are designated and managed by the EPA Administrator or his designee. Consequently, dredged material generated by Federal and non-Federal projects must satisfy the requirements of the MPRSA (as detailed in the Ocean Dumping Regulations) to be acceptable for ocean disposal.

ENVIRONMENTAL IMPACT CRITERIA

Section 103(a) of the MPRSA states that dredged material may be dumped into ocean waters after determination that "**the dumping will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, or economic potentialities.**" This applies to the ocean disposal of dredged materials from both Federal and non-Federal projects. To ensure that ocean dumping will not unreasonably degrade or endanger public health and the marine environment, the Ocean Dumping Regulations restrict the transportation of all materials for dumping, specifically:

- Prohibited materials: High-level radioactive wastes; materials produced or used for radiological, chemical, or biological warfare; materials insufficiently described to apply the Criteria (40 CFR 227); and persistent inert synthetic or natural materials which float or remain suspended and interfere with fishing, navigation, or other uses of the ocean.

- Constituents prohibited as other than trace contaminants: Organohalogens; mercury and mercury compounds; cadmium and cadmium compounds; oil; and known or suspected carcinogens, mutagens, or teratogens.

- Strictly regulated materials: Liquid waste constituents immiscible with or slightly soluble in seawater (e.g., benzene), radioactive materials, wastes containing living organisms, highly acidic or alkaline wastes, and wastes exerting an oxygen demand.

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 and is composed predominantly of sand, gravel, or shell...

- When: (i) the material proposed for dumping is substantially the same as the substrate at the proposed disposal site; and (ii) the [proposed dredging] site...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. (40 CFR 227.13(b))

If dredged material does not meet the above criteria, then further testing of the liquid, suspended particulate, and solid phases is required. The Ocean Dumping Regulations require that the liquid phase "not contain... constituents in concentrations which will exceed applicable marine water quality criteria after allowance for initial mixing" (40 CFR 227.6), and that "bioassays on the liquid phase of the dredged material show that it can be discharged so as not to exceed the limiting permissible concentration..." (40 CFR 227.13).

The suspended particulate and solid phases must be tested using bioassays which can demonstrate that dredged materials will not cause the "occurrence of significant mortality or significant adverse sublethal effects including bioaccumulation due to the dumping..." and that the dredged material "can be discharged so as not to exceed the limiting permissible concentration...." The bioassays ensure that "no significant undesirable effects will occur due either to chronic toxicity or to bioaccumulation." The required testing ensures that dredged material contains only constituents which 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. (40 CFR 227.6)

PERMIT ENFORCEMENT

Under MPRSA, the Commandant of the U.S. Coast Guard (USCG) is assigned responsibility by the Secretary of Transportation for conducting surveillance of disposal operations to ensure compliance with the permit conditions and to discourage unauthorized disposal. Alleged violations are referred to EPA for appropriate enforcement. Civil penalties include a maximum fine of $50,000; criminal penalties involve a maximum fine of $50,000 and/or a 1-year jail term. Where administrative enforcement action is not appropriate, EPA may request the Department of Justice to initiate relief actions in court for violations of the terms of MPRSA. Surveillance is accomplished by means of spot checks of disposal vessels for valid permits, interception or escorting of dump vessels, use of shipriders, and aircraft overflights during dumping.

The Commandant of the Coast Guard has published guidelines for ocean dumping surveillance and enforcement in Commandant Instruction 16470.2B, dated 29 September 1976. An enclosure to the instruction is an Interagency Agreement between the CE and the USCG regarding surveillance and enforcement responsibilities over federally contracted ocean dumping activities associated with Federal Navigation Projects. Under the agreement, the CE "recognizes that it has the primary surveillance and enforcement responsibility over these activities." The CE directs and conducts the surveillance effort over CE contract dumpers engaged in ocean disposal activities, except in New York and San Francisco; the USCG retains primary responsibility for surveillance in these two areas. In all other areas, the USCG will respond to specific requests from the CE for surveillance missions. The USCG retains responsibility for surveillance of all dredged material ocean dumping activities which are not associated with Federal Navigation Projects.

OCEAN DISPOSAL SITE DESIGNATION

EPA is conducting studies of various disposal sites in order to determine their acceptability. The agency has designated a number of existing disposal sites for use on an interim basis until studies are completed and formal designation or termination of each site is decided (40 CFR 228.12, as amended 16 January 1980, 45 FR 3053).

Under Section 102(c) of 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. If it appears that a proposed site can satisfy the general criteria, then the specific criteria for site selection will be considered. Once designated, the site may be monitored for adverse disposal impacts. The criteria for site selection and monitoring are detailed in Chapter 2.

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 (London Dumping Convention), which became effective in August 1975, upon ratification by 15 contracting countries including the United States (26 UST 2403: TIAS 8165). There are now 44 contracting parties. 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 and prohibit disposal without permits. Certain hazardous materials are prohibited (e.g., radiological, 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, or natural materials that float or remain in suspension) are also prohibited as other than trace contaminants. Other materials (e.g., arsenic, lead, copper, zinc, cyanides, fluorides, organo-silicon, and pesticides) are not prohibited from ocean disposal, but require special care. Permits are required for ocean disposal of materials not specifically prohibited. The nature and quantities of all ocean-dumped 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.

U.S. ocean dumping criteria are based on the provisions of the London Dumping Convention (LDC) and include all the considerations listed in Annexes I, II, and III of the LDC. Agreements reached under the LDC also allow exclusions from biological testing for dredged material from certain locations. These agreements are also reflected in the U.S. ocean dumping criteria. Thus, when a material is found to be acceptable for ocean dumping under the U.S. ocean dumping criteria, it is also acceptable under the LDC.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Chapter 2 discusses alternative ocean locations for the designation and disposal of dredged materials from the Portland Harbor channel system, as well as the no-action alternative. The 11 criteria at 40 CFR 228.6 are the basis for comparing environmental impacts associated with disposal at each site. The Existing Site is environmentally and economically acceptable for dredged material disposal. Minor environmental impacts resulting from dredged material disposal at the Existing Site are smothering of benthic fauna and formation of mounds. On the basis of previous use and the absence of significant adverse impacts, EPA proposes that, in accordance with 40 CFR 228.5, the Existing Site receive final designation.

The proposed action is the permanent designation of the Exising Site for the disposal of dredged materials from the Portland Harbor Channel System. Based on an evaluation of a number of alternatives, the EPA has determined that the proposed site for the disposal of dredged material in the Existing Site. The dredged material is a result of the operation and maintenance of the Portland, Harbor Channel System.

The alternatives considered were:

- No-Action: The No-Action alternative to final designation is not considered acceptable. The interim designation of the Existing Site ODMDS will expire in February 1983 without the permanent designation of that site or an alternative site for continuing use.

- Non-Ocean Disposal: The non-ocean disposal alternatives are not evaluated since designation of an environmentally acceptable ocean disposal site is independent of individual project disposal requirements. The non-ocean disposal alternatives must be evaluated during the consideration of each permit application for non-Federal projects and in the preparation of project EIS's for Federal projects.

TABLE 2-1
ALTERNATIVE SITE SUMMARY

Sites Eliminated from Further Consideration	Reason
Land	CE determination
Coastal marshland	Environmental damage
Shallow water (historical sites)	Lobster fishery
Other nearby sites	Most would be acceptable except when they are in known fishery areas. No obvious advantage.
Off the Continental Shelf	Environmentally acceptable, but not economical, due to distance of 240 nmi. No obvious advantage.
Sites Considered for Detailed Evaluation	**Reason**
Deepwater (near Wilkinson Basin)	Closest area for comparison
Existing Site	Acceptable environmentally and to the fishing industry

- Ocean Disposal Alternatives Rejected: A number of alternative ocean disposal sites were considered and rejected after initial evaluation. The sites and the reasons for their rejection are shown in Table 2-1.

- Ocean Disposal Alternatives Considered in Detail: The initial evaluation indicated that two ocean disposal sites were potentially environmentally acceptable for the disposal of dredge material. This EIS have been evaluated in detail the following sites.

  - The interim site, known as the Existing Sites
  - A new location in the Wilkinson Basin

- Ocean Disposal Alternatives Rejected: A number of alternative ocean disposal sites were considered and rejected after initial evaluation. The sites and the reasons for their rejection are shown in Table 2-1.

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  - The interim site, known as the Existing Sites
  - A new location in the Wilkinson Basin

NO-ACTION ALTERNATIVE

The No-Action alternative to the proposed action would be refrain from designating an EPA-approved ocean site for the disposal of dredged material from the Portland Harbor channel system. The Existing Site is currently designated on an interim basis. The interim designation is scheduled to expire in February 1983, unless formal rulemaking is completed earlier that either: (1) designates the interim site for continuing use, or (2) selects and designates and alternative site.

By taking no action, the present ocean disposal site would not receive a final designation, nor would an alternative ocean disposal site be designated. Consequently, the CE would not have an EPA-recommended ocean disposal site available in the area. Therefore, the CE would be required to either: (1) justify an acceptable alternative disposal method (e.g., land based), or (2) develop information sufficient to select an acceptable ocean site for disposal or (3) modify or cancel a proposed dredging project that depends upon disposal in the ocean as they only feasible method for the disposal of dredged material. Based on these factors the No-Action Alternative is not considered to be an acceptable alternative to the proposed action.

LAND-BASED DISPOSAL

The purpose and need for disposal of dredged material in the ocean is presented in Chapter 1. The feasibility of using land-based alternatives for disposal of dredged material in the Portland area is discussed and considered impractical in "Final Environmental Statement, Maintenance Dredging Portland Harbor, Portland, Maine" (CE, 1979).

Neither land-based disposal nor any other feasible alternatives mentioned in the Ocean Dumping Regulations and Criteria (40 CFR §227.15) are being permanently set aside in favor of disposal in the ocean. The need for dumping in the ocean must be demonstrated each time an application for a dumping permit is made. At that time the availability of other feasible alternatives must be assessed. The CE (1979) stated with regard to Portland:

> Land Disposal
>
> 6.04 Land disposal could be accomplished using a hydraulic or a clamshell dredge. However, neither method as associated with the dredging of Portland Harbor would be feasible because of the absence of larger available land areas in the waterfront area. In the case of hydraulic dredging, a slurry of sediment and water is sucked from the bottom and pumped to an on-shore area. The average dredge can pump material approximately 30-40 feet in elevation including the depth of the channel, and one mile in distance. These limitations can be increased if additional dredges or booster pumps are plugged into the pipeline to increase the pumping capacity of the system. However, extra dredges and pumps significantly increase the cost of the dredging project to a point where it would far exceed the cost of disposing of the dredged material at sea.
>
> 6.05 If a clamshell dredge is used in conjunction with a land [disposal] area, the sediment would be excavated and placed in scows. The scows would then have to be maneuvered to an area adjacent to a waterway where the material would be off-loaded and allowed to dry. If this area was not available permanently, then the material would have to be handled a third time by placing it in trucks. This would create yet another problem due to the social impacts of increased trucking in the Portland area.

6.06 Another alternative would be to construct marshes from the dredged materials. Although this would be an ideal use for the material, there is insufficient information on the requirements of New England marshes for this to be a feasible alternative.

In the process of selecting a disposal site, land disposal alternatives were considered by the CE when evaluating the need for disposal. Based on the foregoing, the CE determined a need for an ocean disposal site. This EIS addresses the issues pertinent to the selection of an environmentally acceptable ocean disposal site(s). The evaluations and selection of an environmentally acceptable ODMDS are independent of individual project requirements. Non-ocean disposal alternatives will be considered along with the ODMDS in planning of disposal of material from future Federal and permitted dredging projects (see designation statement, page 1-2; also pages 1-8 and 1-9).

DISPOSAL IN THE OCEAN

The disposal of Portland Harbor channel system sediments in the ocean is the most feasible disposal method. Selecting a disposal site in the ocean requires identifying and evaluating suitable areas for receiving dredged sediments. Identification of such areas is based on information obtained from environmental research, State and Federal resource agencies, and district and divisional offices of the CE. Specific alternative (or candidate) sites may be identified within these areas based on historic and current use of the area, presence of previously used disposal sites, and recommendations from district and divisional offices of the CE. Evaluation of specific viable alternative sites or areas are based on the 11 specific site selection criteria listed at 40 CFR 228.6 of the Ocean Dumping Regulations.

SELECTION OF ALTERNATIVE SITES

The general criteria in the Ocean Dumping Regulations (40 CFR 228.5) used to select a disposal site in the ocean include:

- **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.

- Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality...can 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.

- The sizes of ocean disposal sites will be limited in order to localize...any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts.

- ...wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

Sites initially considered include the Existing Site, two other sites near the Existing Site (Normandeau Site [interim EPA site] and Hue and Cry Site), the two old nearshore sites A and B, and a site near the Wilkinson Basin; the latter is referred to as the Alternative Site (Figure 1-1).

Because no other ocean disposal sites in the Portland area have received final designation, the alternative of using another designated site cannot be considered. An alternative site off the Continental Shelf was rejected because the cost of transporting the material would be excessive and no significant environmental benefits would be derived.

The Continental Margin adjacent to Portland can be divided into three regions corresponding to the nearshore, mid-Shelf, and Shelf-break environments. Potential for adverse effects from dredged material disposal on fisheries, ecology, and navigation is different for each environment.

Dredged material disposal is not expected to have a significant impact on water quality, endanger marine resources, or introduce nuisance species into the Existing Site. The effects of sediment disposal on benthic organisms depend on the mobility and specific tolerance to changes in sediment texture. Based on studies at the Existing and other disposal sites, it is unlikely that previous and present dumping have caused significant changes in benthic diversity and density due to burial of sessile infauna. However, subsequent changes in fish food availability may cause a temporary decrease in demersal fish abundance and diversity.

Fishing activities are significant in the nearshore region; lobster, salmonids, and several species of demersal finfish occur throughout the nearshore and adjacent shallow Shelf areas. Previous disposal of dredged material has not noticeably affected nearshore fisheries. Further offshore the mid-Shelf region also supports a valuable commercial bottom fishery. Because of the importance of fisheries in many coastal areas of the U.S., Pequegnat et al. (1978) advocated dredged material disposal sites seaward of the 500m isobath.

Dredged material disposal has not previously occurred at either mid-Shelf or outer Shelf locations in the Portland area. Mid-Shelf and outer Shelf sediments are characteristically more stable than nearshore sediments (Carey, 1972); therefore, benthic organisms occurring in these regions may be more sensitive to sediment changes (Oliver et al., 1977).

The Existing Site is inshore of heavily fished Shelf areas and offshore of the major lobster and recreational fishing grounds. Some lobstering occurs in the vicinity of the Existing Site, especially in winter, but the catch is low (CE, 1979). The Existing Site is inside the precautionary zone for navigation, but outside the navigation channels, and disposal operations are not expected to be a hazard to commercial and recreational vessel traffic. Although no records are on file at the CE, the site was probably used in 1946 or 1947 when an indetermine amount of Portland Harbor dredged material was dumped. The Federal Channel maintenance dredging project occurred during 1979 to 1981 and various private dredging projects in the area have been occurring and are still in progress. The presently active private dredging is expected to result in an additional 800,000 yd^3 deposited at the existing site.

No pre- or post-disposal data were collected in the vicinity of the Existing Site during the 1940's to 1960's. Selection of the Existing Site for dredged material disposal was based on recommendations of the local fishing industry, recent scientific studies, and historical use of the site. Recent disposal of dredged sediment has produced only localized, minor, and reversible adverse impacts: mounding, smothering of benthic organisms, and, possibly, a temporary decrease in the abundances of demersal fish. Disposal of dredged material in previously used nearshore sites (i.e., Sites A and B) (Figure 1-1) would not significantly ameliorate any adverse effects on the environment, and may conflict with commercial fisheries. Therefore, designation of nearshore sites, other than the Existing Site, is not recommended or considered further in this EIS.

The only large, deep basins having silty-clay bottom sediments on the eastern Continental Shelf are in the Gulf of Maine. Wilkinson Basin is the closest basin to Portland, approximately 21 nmi (39.9 km) southeast of the Harbor. The Basin is 35.1 nmi (65 km) long, 5.4 nmi (10 km) wide (within the 180m isobath), and trends northwest to southeast. It is flat-bottomed and contains silty-clay sediments resembling Portland dredged material. Similarities is sediment composition and proximity to Portland suggests the possible use of the Wilkinson Basin as acceptable area from which a site suitable for dredged material disposal could be selected.

In 1974 Wilkinson Basin was selected as a Geotechnical Test Area because it is a shallow-water analogue of a deep-sea basin near academic institutions. The test area is defined by the 260m contour and was created to provide an area for Research, Development, Test, and Evaluation (RDT&E) of undersea systems (Richards, 1970; Hulbert and Given, 1975). Subsequent studies have examined the engineering, physical, and chemical aspects of Basin sediments (Parker, 1973; Hulbert and Given, 1975; Faas and Nittrouer, 1976; Perlow and

Richards, 1977). In order not to interfere with the research area, yet offer an alternative deepwater site, a 1-nmi square near the Wilkinson Basin centered at 43°18'N, 69°52'W (hereinafter, the Alternative Site) has been selected for consideration as an alternative in this EIS. The Alternative Site provides an dredged material disposal site in deep water, but it is not beyond the Continental Shelf, and was not chosen by Pequegnat et al., (1978) as one of the potential "favorable disposal areas" (areas below the 300-m isobath) off the northeastern Continental Shelf. The site overlies the axis of a depression at the head of the basin in water depths of about 180m; fishery resources are not abundant, and the site is probably beyond the depth where dumping would interfere with these resources. Other potential sites beyond the nearshore Shelf have been rejected because there would be no significant environmental benefits, and would probably require greater transit distance, time, and expense.

Dumping has occurred previously at the Existing Site and no significant adverse environmental effects have been reported. Multiple sites are not needed to facilitate dredged material disposal, or accommodate larger volumes of dredged material. On the basis of previous use, cost effectiveness, and the absence of significant adverse impacts, continued use of the Existing Site is proposed.

Additional shallow-water sites are not needed for continued dredged material disposal at this time and, therefore, are not recommended for final designation.

DETAILED CONSIDERATION OF THE ALTERNATIVE SITES

Part 228 of the Ocean Dumping Regulations and Criteria describes general and specific criteria for selection of sites to be used for ocean waste disposal. Section 228.6 of the Ocean Dumping Regulations lists 11 specific criteria to be considered when selecting a disposal site. The 11 criteria constitute "an environmental assessment of the impact of the use of the site for disposal" (40 CFR §228.6[b]), and are the bases for final site selection. The alternative sites considered for final designation within the context of the 11 criteria are the Existing Site and the Alternative Site. Information in Chapters 3 and 4 is utilized in the following discussion for comparison of the sites under each criterion.

(1) GEOGRAPHICAL POSITION, DEPTH OF WATER, BOTTOM TOPOGRAPHY AND DISTANCE FROM COAST (40 CFR §228.6[a][1])

EXISTING SITE

The Existing Site is 6.8 nmi offshore of the closest point of land and 11 nmi from the entrance to Portland Harbor (Figure 1-1). Water depths at the site range from 39 to 64m. Bottom topography is characterized by rough, irregular rocky outcrops with topographic changes (relief) on the order of 20m. A fine-grained sand- and silt-covered basin (approximately 600 by 600m) in the center of the site (43°34'06"N, 70°01'48"W) is marked by a buoy for point disposal of dredged material.

ALTERNATIVE SITE

The Alternative Site is 21 nmi offshore and at a water depth at about 180 m (Figure 1-1). The site overlies the axis of a trough oriented in a northest-southeast direction; the upper trough topography is characterized by a broad flat valley with little relief.

(2) LOCATION IN RELATION TO BREEDING, SPAWNING, NURSERY, FEEDING, OR PASSAGE AREAS OF LIVING RESOURCES IN ADULT OR JUVENILE PHASES (40 CFR §228.6[a][2])

EXISTING SITE

Breeding, spawning, nursery, and passage activities of some commercially important finfish and shellfish species occur on a seasonal basis across the western Shelf of the Gulf of Maine. Effects of dumping on such activities are unknown; however, past dredged material disposal is not known to have caused detectable, significant, or irreversible effects on living resources. There are no known or proposed sanctuaries in the vicinity of either site. Upon the recommendation from commercial fishermen, the Existing Site was located between the inshore fishing grounds for lobster and the offshore dragging areas for finfish.

During the spawning season, from late spring to midsummer, lobster (Homarus americanus) move into shallow water (less than 20m) inshore of the Existing Site. The eggs are carried by the females for 10 to 11 months, hatching from May through July, with a peak in late June to early July. The larvae remain in the planktonic form for 2 to 3 months before settling to the bottom as juvenile lobsters. The probability that dredged material disposal at the Existing Site will interfere with lobster spawning is small. Some larvae, however, may be affected by transient postdisposal effects (e.g., turbidity plume, possible low dissolved oxygen), especially between May and October. This interference should not significantly affect the larvae because disposal occurs irregularly and affects a small area.

Impacts of dredged material disposal on demersal fish at the Existing Site are probably only temporary changes in (1) abundance, (2) numbers of species, (3) mean size, and (4) food preferences. It is unlikely that disposal activities will interfere with commercially important fish because of their mobility; however, commercial fish that lay demersal eggs could be affected. Two species of nearshore commercial finfish common in the Gulf of Maine have demersal eggs (Bigelow and Schroder, 1953; TRIGOM, 1976), although neither are likely to deposit eggs within the Existing Site. The Atlantic herring (Clupea harengus) lays eggs on clean sand or gravel in areas of high current flow. The Existing Site has fine sediment with minimal water motion; it is unlikely that herring will utilize this area. The winter flounder (Pseudopleuronectes americanus) lays demersal eggs in estuaries, at depths less than 10m, and should be unaffected.

ALTERNATIVE SITE

Although site-specific biological information is not available for the Alternative Site, no commercial or recreational fishing occurs within the area. Some submarine canyons are known to be spawning grounds for certain fish and squid species (Pequegnat et al., 1978). It is not presently known whether the Alternative Site is used as a spawning and nursing ground. Species which may use the area include gray sole (*Glyptocephalus cynoglosus*), American dab (*Hippoglossoides platessoides*), winter flounder (*Pseudopleuronectes americanus*), cod (*Gadus morrhua*), haddock (*Melanogrammus aeglefinis*), silver hake (*Merluccius bilinearis*) and pollock (*Pollachius virens*). Potential effects of dredged material disposal on these species are unknown.

(3) LOCATION IN RELATION TO BEACHES AND OTHER AMENITY AREAS (40 CFR §228.6[a][3])

EXISTING SITE

The Existing Site is 6.8 nmi from the nearest point of land. Distance from shore, water depth, and configuration of the basin (in the center of the site) will decrease the possibility of dredged material reaching beaches or other amenity areas. The fate of dredged sediments at the Existing Site is shown to remain within the dumpsite.

ALTERNATIVE SITE

Significant quantities of dredged material released at the Alternative Site could not reach coastal beaches or other amenity areas because the Site is 21 nmi from shore, and the current regime will most likely transport sediments into deeper water.

(4) TYPES AND QUANTITIES OF WASTES PROPOSED TO BE DISPOSED OF, AND PROPOSED METHODS OF RELEASE, INCLUDING METHODS OF PACKING THE WASTE, IF ANY (40 CFR §228.6[a][4])

Dredged material to be dumped in the ocean must conform to EPA criteria set forth at 40 CFR §227.13 of the Ocean Dumping Regulations. Sediments dredged from the channels and turning basin of Portland Harbor and vicinity are the only material presently being disposed of at the designated site. These sediments are composed of fine sand, silt and clay. The dredged material is transported by a barge equipped with a bottom dump release mechanisms and is not packed in any manner. Approximately 1 million yd^3 of material has been disposed of at the site. Future dredging volumes may contribute an additional amount of 200,000 yd^3 if the navigational safety of the channels necessitates future dredging efforts.

The CE combines the costs of dredging and disposal to obtain a dredged material unit cost. Travel time is a component of the unit cost; consequently, an increase in distance from dredging site to disposal site increase total costs. The Existing Site is closer than the Wilkinson Site to the dredging area; therefore, its use would minimize transport costs. Use of the Alternative Site in the Wilkinson Basin area would increase the round trip transit distance by 30 nmi and total transit time by 5 hours, resulting in approximately $1.50/$yd^3$, based on $0.05/$yd^3$/mi (Conner 1979) increase in costs, or a total increase in transportation cost of about $1,275,000.

(5) FEASIBILITY OF SURVEILLANCE AND MONITORING (40 CFR §228.6[a][5])

EXISTING SITE

The CE provides a shiprider to confirm that dumping is in the proper location.

ALTERNATIVE SITE

The Alternative Site is in deeper water and further distance from Portland Harbor making it more costly to monitor than the Existing Site. Predisposal surveys would be required.

(6) DISPERSAL, HORIZONTAL TRANSPORT, AND VERTICAL MIXING CHARACTERISTICS OF THE AREA INCLUDING PREVAILING CURRENT DIRECTION AND VELOCITY, IF ANY (40 CFR §228.6[a][6])

EXISTING SITE

Current velocities range from 0 to 16 cm/s at the Existing Site. Currents are influenced by tides in a rotational manner, but net water movement is to the southwest (DAMOS). The CE (1979) reported that Portland Harbor dredged material (primarily fine sand, silt, and clay) is cohesive; therefore, rapid settling of the released sediments should occur. Minimal horizontal mixing or vertical stratification of dumped materials should occur, resulting in low suspended sediment concentrations after disposal.

Previous studies have demonostrated the relative immobility of dredged sediments dumped at the Existing Site (DAMOS), suggesting that a major portion of dredged sediment dumped at the site will remain within site boundaries, and, most likely, within the basin at the center of the Existing Site.

ALTERNATIVE SITE

The greater water depths at the Alternative Site should increase dispersal of dredged material during settling. Bottom current velocities at the Alternative Site have not been determined; however, anticipated slow currents should tend to minimize horizontal transport and resuspension of bottom sediments.

(7) EXISTENCE AND EFFECTS OF CURRENT AND PREVIOUS DISCHARGES AND DUMPING IN THE AREA (INCLUDING CUMULATIVE EFFECTS) (40 CFR §228.6[a][7])

EXISTING SITE

Several industrial and municipal outfalls are located in Portland Harbor. Although these outfalls are 11 nmi from the Existing Site, they represent the closest point-source discharges of pollutants. Because of the distance involved and dilution factors associated with mixing, outfalls in Portland Harbor are not expected to have a measurable effect on the Existing Site.

Sediments collected from the disposal area contain higher levels of mercury, cadmium, lead, and saturated and aromatic hydrocarbons than do sediments at control stations near the Existing Site and on Georges Bank. These higher trace metal and hydrocarbon concentrations probably reflect contaminants present in dredged material dumped at the site.

Mussels (*Modiolus modiolus*) monitored at the Existing Site and at a control station on Bulwark Shoals indicated that tissue concentrations of cadmium, chromium, cobalt, copper, iron, mercury, nickel, and zinc were (5% to 55%) higher at the Existing Site than at the control station (DAMOS). While high cadmium concentrations may be associated with naturally occurring upwelling (Stephenson et al., 1979), high zinc levels are probably associated with anthropogenic inputs (Phillips, 1976a,b). Trace metal concentrations in tissues of crustaceans and and other benthic organisms collected at the Existing Site were below FDA Action Levels (DAMOS).

ALTERNATIVE SITE

There has been no previous dumping at the Alternative Site or at any other known deepwater site in the vicinity of Portland.

(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 (40 CFR §228.6[a][8])

EXISTING SITE

Extensive shipping, fishing, recreational activities, and scientific investigations take place in the Gulf of Maine throughout the year. However, previous dredged material disposal operations are not known to have interfered with these activities. The Bureau of Land Management does not currently plan to lease any areas on the nearshore Continental Shelf adjacent to the Existing Site for oil and gas exploration. Mineral extraction, desalination, and aquaculture activities do not presently occur near the Existing Site.

ALTERNATIVE SITE

Dredged material disposal at the Alternative Site would not interfere with shipping or fishing. Recreation and mineral extraction activities do not occur. The Alternative Site is in an area where disposal operations would not interfere with research in the Wilkinson Basin.

(9) THE EXISTING WATER QUALITY AND ECOLOGY OF THE SITE, AS DETERMINED BY AVAILABLE DATA OR BY TREND ASSESSMENT OR BASELINE SURVEYS (40 CFR §228.6[a][9])

EXISTING SITE

The water quality and benthic ecology of the Existing Site were surveyed in 1977 and 1978 by NUSC, and again in 1979 and 1980 by IEC/EPA. In general, samples taken at the Existing Site indicate high water quality, typical of Gulf of Maine waters. Dissolved oxygen levels are near saturation year-round, and trace metal (lead, mercury, and cadmium) concentrations are low. Concentrations of suspended solids decrease from the surface to 50m, then increase as a result of bottom sediment resuspension (Spencer and Sachs, 1970). The water column at the Existing Site is almost totally free of chlorinated hydrocarbons; only small amounts (10 to 100 μg/liter) have been detected.

The infaunal communities within the Existing Site have a high degree of natural variability and an inconsistent pattern of species distribution. The soft-bottom benthos sampled by DAMOS was dominated by molluscs, whereas IEC/EPA surveys in 1979 and 1980 found the dominant taxa to be polychaetes. Although different sampling methodologies may account for some of the observed variability, a large variability among the benthic fauna is common in the Gulf of Maine (Harris and Mathieson, 1977).

The epifaunal community associated with rocky surfaces was dominated by attached suspension feeders. Photographs reveal that brachipods (*Terebratulina septentrionalis*) and a solitary sponge (*Polymastia infragilosa*) were the most abundant organisms. Barnacles (*Balanus balanus*), tunicates, bryozoans, and several species of encrusting and erect sponges were common on rock surfaces with little or no sediment. Mobile organisms (crustaceans, asteroids, ophiuroids, and demersal fish) were uncommon.

ALTERNATIVE SITE

Baseline surveys have not been conducted at the Alternative Site; however, the Alternative Site should possess higher water quality than the Existing Site, because of the greater distance from shore. The infaunal and epifaunal communities are probably similar to those at the Existing Site.

(10) POTENTIALITY FOR THE DEVELOPMENT OR RECRUITMENT OF NUISANCE SPECIES IN THE DISPOSAL SITE (40 CFR §228.6[a][10])

EXISTING SITE

There are no known components in the dredged material, or consequences of its disposal, which would result in nuisance fauna at the Existing Site. Previous surveys at the Existing Site did not detect the development or recruitment of nuisance species (DAMOS).

ALTERNATIVE SITE

There are no known components in the dredged material, or consequence of its disposal, which would attract or result in nuisance species at the Alternative Site.

(11) EXISTENCE AT OR IN CLOSE PROXIMITY TO THE SITE OF ANY SIGNIFICANT NATURAL OR CULTURAL FEATURES OF HISTORICAL IMPORTANCE (40 CFR §228.6[a][11])

EXISTING SITE

The State of Maine Department of Archeology inventory of cultural/historical resources for the Portland area, do not report any resource in the immediate vicinity of the Existing Site. Berman (1972) did not report any historic shipwrecks in the area, nor did the bathymetric and side-scan sonar surveys (conducted for the Disposal Area Monitoring System [DAMOS] program in 1978) reveal any identifiable features of historical importance.

ALTERNATIVE SITE

No significant historical features are expected to exist at the Alternative Site; however, to verify the presence or absence of significant natural and cultural features, a predisposal survey would be needed.

CONCLUSIONS

Alternatives considered in detail for the disposal of dredged material from the Portland Harbor channel system are the Existing Site and the Alternative Site (near the Wilkinson Basin). The considerations for final site designation, based on the 11 specific site criteria (40 CFR §228.6), are summarized in Table 2-2. Final designation of the Existing Site is proposed for the following reasons:

- Dredged material from the ship channels in similar in grain size to natural sediments in the central basin of the Existing Site; thus, sediment suitability for fauna occurring in and around the site would not be altered significantly. Sediments at the Alternative Site are finer-grained; therefore, benthic ecology is more likely to be altered by disposal of dredged material.

- No significantly adverse effects have been observed after recent dredged material disposal at the Existing Site. Site-specific investigations (NUSC/IEC, 1977 to 1980) have noted only slight, temporary changes in benthic infaunal density and diversity, and concomitant localized changes in demersal fish populations following dredged material disposal. Effects of dredged material disposal on the ecology at the Alternative Site are unknown, but may be greater than those at the Existing Site.

- Dredged material disposal at the Existing Site causes temporary localized shoaling within the site, but will not create a navigational hazard due to water depth (40 to 65m). Probability of short dumping outside Existing Site boundaries is slight due to its location and the navigation buoy located at the center of the site. Because of the greater water depth at the Alternative Site, localized shoaling would not be a navigational problem. However, increased transit time to the Alternative Site would increase the probability of emergency dumping on sensitive mid-Shelf fishing grounds.

- At the Existing Site the impact of dredged material disposal on fisheries in minimal and would consist of possible temporary changes in demersal finfish availability within the site. There are no anticipated or observed

TABLE 2-2
SUMMARY OF THE 11 SITE-SELECTION CRITERIA AS APPLIED TO THE EXISTING AND ALTERNATIVE SITES

40 CFR 228.6 Criterion	Existing Site	Alternative Site
1. Geographical position, depth of water, bottom topography, and distance from coast	See Figure 2-1; 6.8 nmi offshore; 39m to 64m deep; rough, irregular rocky outcrops around a 600m by 600m basin	See Figure 2-1; 21 nmi offshore; 180m deep, flat mud-covered bottom
2. Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases	Some occurrence of lobster migration on a seasonal basis through the general region	No known breeding or spawning grounds in the region
3. Location in relation to beaches and other amenity areas	6.8 nmi from shore; because of the water depth and current directions, dredged material is not likely to reach adjacent beaches	21 nmi from shore; because of the water depth and distance from shore, dredged material is not likely to reach adjacent beaches
4. Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any	350,000 yd^3 of cohesive material (sand, silt, and clay) from the channels and turning basin (last project); no future projects identified; no packing, bottom dump release from barge	Same as Existing Site
5. Feasibility of surveillance and monitoring	CE provides an observer on each tug; monitoring is not a problem	CE could provide an observer; monitoring is more difficult due to greater distance offshore and greater depth
*6. Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any	Rapid settling, minimal horizontal or vertical stratification; major portion of material will remain within the site	Due to greater depth, more mixing and dispersal is expected
*7. Existence and effects of current and previous discharges and dumping in the area (including cumulative effects)	Effects are minor and restricted to the site; significant adverse effects have not been noted outside the site	No sediments have been dumped in this area
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	No interference is expected	Same as Existing Site
*9. The existing water quality and ecology as determined by available data trend assessment, or baseline surveys	High water quality with sightly elevated hydrocarbon concentrations; infaunal community has high variability, and epifauna dominated by suspension feeders attached to rocky surfaces	No data, but presumed to be same as Existing Site
10. Potentiality for the development or recruitment of nuisance species in the disposal site	The dredged matarial does not contain material known to cause development or recruitment of nuisance species	Same as Existing Site
11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance	No known features exist at or near the site	Same as Existing Site

* Criterion especially relevant to site selection

adverse effects to anadromous, pelagic, or lobster fisheries. The possible loss of any existing feeding grounds would be insigificant in comparison to the total feeding area available in the Gulf of Maine. Impacts of dredged material disposal on potential fishery resources at the Alternative Site are unknown but are considered to be similar to those at the Existing Site.

- Disposal would be significantly more cost effective at the Existing Site than at the Alternative Site because of the greater transit distance to the latter site.

- The effects of dredged material disposal are known for the Existing Site; surveillance and monitoring are significantly easier due to the site's proximity to shore and the relatively shallow water depths. In contrast, baseline data are unavailabe for the Alternative Site; surveillance and monitoring would be more difficult due to greater depths and distance from shore.

Therefore, in accordance with the Ocean Dumping Regulations, EPA proposes that the Existing Portland Dredged Material Disposal Site receive final designation.

RECOMMENDED USE OF THE SITE

All future uses of the Existing Site for ocean dumping must comply with the EPA Ocean Dumping Regulations and Criteria. Dredged material from the Portland Harbor Channel System will be dumped at the site if the material is determined to be acceptable for ocean disposal. Use of the site will be managed by the CE to minimize adverse impacts.

PERMISSIBLE MATERIAL LOADINGS

Recent ongoing dredged material disposal at the Existing Site has caused only localized mounding and minor impacts to the benthic fauna (described in

Chapters 3 and 4). It is difficult to assign an upper loading limit beyond which significant adverse effects might occur. Additional dredging, with volumes up to an additional 4 million yd^3 over the next 10 years, would probably also result in insignificant adverse impacts. If dredged material volumes are substantially increased above historic volumes, the CE monitoring effort should be intensified to identify and, if necessary, mitigate potential adverse effects. The monitoring program would indicate whether disposal volumes should be changed.

DISPOSAL METHODS

Material is dredged, transported by barge, and discharged at a specific point within the disposal site. Present disposal methods practiced by the CE at the Existing Site are acceptable for future dumping.

DISPOSAL SCHEDULE

Schedules of dredging and disposal operations are dependent only on the availability of the dredge, tug, barge, and weather conditions. Historically, the operational schedule has been conducted at any time, weather permitting. This schedule can be continued, as it has been proven to be feasible.

MONITORING THE DISPOSAL SITE

Ocean Dumping Regulations establish that impacts of dumping in a disposal site and surrounding marine environment may be evaluated periodically. Information used in making the disposal impact evaluation may include data from monitoring surveys. Thus, "if deemed necessary," the CE's District Engineer (DE) and the EPA Regional Administrator (RA) may establish a monitoring program to supplement historical site data. The DE and RA develop the monitoring plan by determining appropriate monitoring parameters, frequency of sampling, and areal extent of the survey. Factors considered in making determinations include frequency of disposal, volumes of material to be disposed of, physical and chemical natures of the dredged material, dynamics of the site physical processes, and life histories of the monitored species.

The primary purpose of the monitoring program is to determine whether disposal at the site is significantly affecting areas outside the site, and to detect long-term effects of disposal. The monitoring plan for the disposal site is intended to ensure detection of long-term adverse impacts, especially irreversible impacts and those which involve irretrievable loss of important resources. Such impacts are assessed by comparing environmental conditions before and after the onset of disposal operations, to detect any long-term adverse alterations of the site. An effective monitoring program is based on comprehensive predisposal environmental information and the predicted effects of disposal activities. 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, such as prevailing currents and sediment transport). Results of an adequate survey will provide early indication of potential adverse effects outside the site.

GUIDELINES FOR THE MONITORING PLAN

Historically, no significant adverse effects from disposal at the Existing Site have been observed. Monitoring requirements for the site are minimized by the nature of the dredged material and its similarity to sediments in the basin at the center of the disposal site. Many physical parameters will not be affected significantly by disposal (e.g., temperature or salinity). Physical parameters that show significant disposal variation (e.g., turbidity) return quickly to ambient levels.

The CE District Engineer and EPA Regional Administrator may choose, however, to monitor selected parameters in order to separate natural environmental fluctuations from those caused by dredged material disposal. Requirements for a monitoring plan for the Existing Site can be determined by applying the following six considerations.

MOVEMENT OF MATERIALS INTO ESTUARIES OR MARINE SANCTUARIES, OR ONTO OCEANFRONT BEACHES, OR SHORELINES

The nearest estuary is Presumpscot River, approximately 12 nmi from the Existing Site. Transport of dredged materials over significant distances is unlikely, based on available ocean current data. Net transport of sediments from the Existing Site will be in a northeasterly and southwesterly direction; therefore, movement of materials onto local beaches (westerly) is unlikely.

MOVEMENT OF MATERIALS TOWARD PRODUCTIVE FISHERY OR SHELLFISHERY AREAS

Commercially important organisms in the vicinity of the Existing Site are mobile and adapted to natural sediment movements. Portland Harbor dredged material is similar to sediments at the site. If dumped material entered the natural transport cycle, it would present minimal stresses to fisheries, because it most likely would be transported into deeper waters. However, a transect should be monitored in the direction of the fisheries grounds, wherein CHC's and metals are measured in fisheries organisms (such as lobster and quahogs).

ABSENCE FROM THE DISPOSAL SITE OF POLLUTION-SENSITIVE BIOTA CHARACTERISTIC OF THE GENERAL AREA

Although a major portion of material dredged from the Portland Harbor area is fine sand, silt and clay in a low-energy environment and is generally not excluded from furture testing under the specified exclusion criteria, on a case by base basis, material from the area could qualify for an exclusion depending on particular circumstances (e.g., glacial clays and tills from deep improvement projects).

PROGRESSIVE, NONSEASONAL, CHANGES IN
WATER QUALITY OR SEDIMENT COMPOSITION AT THE
DISPOSAL SITE, ATTRIBUTABLE TO DREDGED MATERIAL

Measurable changes in water quality due to dredged material disposal are unlikely to occur or be detectable because of:

- Limited release of contaminants to the water column (because contaminants are usually bound for fine-grained sediments)
- Transient nature of water overlying the site
- Natural variability in water-column parameters

Sediments at the center of the Existing Site are now primarily dredged materials from previous dumping and should not change significantly as a result of continued disposal. However, in order to detect any transport of dumped material outside the site, sediment geochemical parameters (e.g., levels of trace metals and CHC's) should be monitored at the site and along transects of possible transport (i.e., northeast-southwest).

PROGRESSIVE, NONSEASONAL CHANGES IN COMPOSITION
OR NUMBERS OF PELAGIC, DEMERSAL, OR BENTHIC BIOTA AT
OR NEAR THE DISPOSAL SITE, ATTRIBUTABLE TO DREDGED MATERIAL

Benthic infauna and epifauna on rocky bottoms (particularly species that are least resistant to dredged material effects) provide an effective index for determining dredged material impacts. Survey transects should be established along which organisms would be sampled twice a year. The transect would cover the site, as well as areas upcurrent and downcurrent (northeast-southwest) from the site. The survey design will facilitate detection of any biotic changes that extend past site boundaries. Species that could be considered for monitoring should be the dominants listed in Appendices A and B.

ACCUMULATION OF MATERIAL CONSTITUENTS (INCLUDING HUMAN PATHOGENS) IN MARINE BIOTA AT OR NEAR THE SITE

Concentrations of trace metals and hydrocarbons in sediments at the Existing Site are higher than levels from a nearby control area (IEC and SAI data 1979, 1980). However, the Mussel Watch Program has revealed no significant differences in water quality between the disposal site and the same control site. Similarly, no significant accumulations of trace metals have been detected in the tissues of crustaceans and other benthic invertebrates collected from the disposal site. As mentioned earlier, fisheries species should be collected along transects toward known fishing grounds and analyzed for CHC's and trace metals.

Chapter 3

AFFECTED ENVIRONMENTS

This chapter describes the relevant environmental characteristics of the Existing and Alternative Sites evaluated in Chapter 2. Physical processes at both the Existing Site and Alternative Site are influenced by tidal and oceanic currents; sediment movement is influenced by currents and internal waves. Sediments at the center of the Existing Site are composed of silt, clay, and fine to medium-grained sands; sediments in the Alternative Site also contain relatively high percentages of silts and clays. The Existing Site does not support a large, diverse biological community or any commercially important species. Relatively little is known about the indigenous biological community of the Alternative Site, and few commercial species have been found in the area.

The shoreline north of Portland is known for its scenic beauty. The long rocky peninsulas and many islands of massive rock ledge outcrops are covered with a thin veneer of sediment and soil, and only a few miles of shoreline have a natural beach or are composed of easily erodible material (CE, 1971).

The shoreline south of Portland contains most of Maine's recreational beaches. It is estimated that only 30% of this region is rocky or of ledge rock construction. Many of the beaches are crescent-shaped and situated between projecting rocky headlands. In general, the beaches consist of high-quality sand which is suitable for recreational activities. The State of Maine has developed two State parks within the area: Crescent State Beach at Cape Elizabeth, and Popham State Park at Phippsburg. Other popular public beaches include York, Ogunquit, Wells, Kennebunk, and Old Orchard.

ENVIRONMENTAL CHARACTERISTICS

The Existing Site is 6.8 nmi off Cape Elizabeth, on the nearshore Shelf in the western Gulf of Maine, in water depths of 40 to 65m. The Gulf is a broad depression on the Shelf between Cape Cod and Nova Scotia and is separated from the open Atlantic Ocean by Georges Bank on the southeast and by the Scotian Shelf on the northeast.

Environmental data for the Existing Site and adjacent nearshore waters have been collected over the past 10 years, but information for the Alternative Site is seriously limited.

METEOROLOGY

Climatic parameters of interest at an ODMDS are air temperature, rainfall, winds, storm occurrences, and fog. Air temperature interacts with surface waters and, particularly during warm periods, influences the vertical stability of the water. Rainfall increases coastal freshwater runoff, thereby decreasing surface salinity and intensifying the vertical stratification of the water. Coastal runoff may also contribute suspended sediments and various chemical pollutants. Winds and storms can generate waves and currents that stir up and transport dredged material. A high incidence of fog during particular seasons can affect navigational safety and limit disposal operations.

The Appalachian Mountains to the west and the Atlantic Ocean to the east have a significant influence on climate in the Portland area. This area lies in the global zone of westerly winds and in the path of tropical air masses moving up from the Gulf of Mexico. Interaction between northward-moving, warm air masses from the south, and eastward-progressing continental air masses from the west, often causes rapid climatic changes and major storms. The climate is moderated substantially by the effects of the ocean and large bays along the coast; air temperatures are generally colder in the inland areas. Climatic data have been obtained from U.S. naval ships passing coastwise, as well as across the Gulf of Maine; but these are far from being representative, synoptic, or uniform.

TEMPERATURE

Portland has an annual average temperature of 7°C, a mean daily maximum of 26.1°C, and a mean daily minimum of -11.3°C. Extremes range from a high of 39.4°C to a low of -39.4°C (National Weather Service, personal communication*).

Precipitation

Average annual precipitation is approximately 104 cm. Precipitation is generally 10 cm greater along the coast than in nearby inland areas. Fluctuations in average precipitation are common, resulting in extreme high or low streamflows. Periods of low precipitation, such as the droughts of the 1930s and the 1960s, can last for months or years over large areas. Thunderstorms occur mainly during summer and on an average of 20 days per year, with the coastal area receiving fewer than inland areas. On the average, tornados occur once a year, predominantly in July. Fog is prevalent along the coast of Maine. Thirty-year records at Portland show that heavy fog (visibility < 0.2 mile) occurs 52 days per year (U.S. Department of Commerce, NOAA, irregular).

Wind

The average wind velocity is from 15 to 18.5 km/hr; winds from the west dominate. In winter most winds emanate from the northwest and are associated with the frequent inflows of polar air from the interior land masses of the United States and Canada. These winds are frequently strong and usually are attended by a dry air mass. Winds from the sea account for only 10% of the winter winds in Maine, and these are dominated by the lower wind speeds. High wind speeds come from every sector, however, as these are associated with storm activity. High seas during wind-driven winter storms occasionally cause serious damage to the coast.

* National Weather Service, Portland, Maine, 1981

In spring winds at Portland come from the west (including the northwest and southwest) but the south winds increase in frequency due to the onset of sea breeze conditions. By summer, south winds clearly dominate, especially at the stations closest to the shore. These winds, caused by well-developed sea breeze conditions, transport sea fogs and moisture inland. The occasional storm of tropical origin in summmer or fall may result in winds of near-hurricane force. Fall winds patterns resemble the annual average at Portland with western winds dominating (Fefer and Schetting, 1980).

PHYSICAL CHARACTERISTICS

Physical oceanographic parameters determine the nature and extent of the mixing zone, thereby influencing sediment transport and the chemical environment at an ODMDS. Strong temperature or salinity gradients inhibit mixing of surface and bottom waters, whereas waves aid mixing, resuspend bottom sediments, and affect the turbidity of the water. Currents, especially bottom currents, determine the direction and influence the extent of sediment transport. Tidal currents may contribute to the transport of dumped material, but usually do not add net directional effects.

WATER MASSES

Surface waters of the Gulf of Maine are distinctly coastal in nature, and are colder and less saline than surface Slope Waters to the east. Coastal Water is formed largely by the mixing of (1) Slope Water entering from Georges Bank, (2) water entering from over the Scotian Shelf through the Northeast Channel, and (3) estuarine water from shore (TRIGOM, 1974), as shown in Figure 3-1. During summer, surface water from the Gulf Stream enters the region. This water characteristically is warmer and more saline than Coastal Water (Emery and Uchupi, 1972).

CURRENTS

General circulation in the Gulf of Maine has been described by Bigelow (1927) and is summarized in Figure 3-1. A counterclockwise gyre is present in

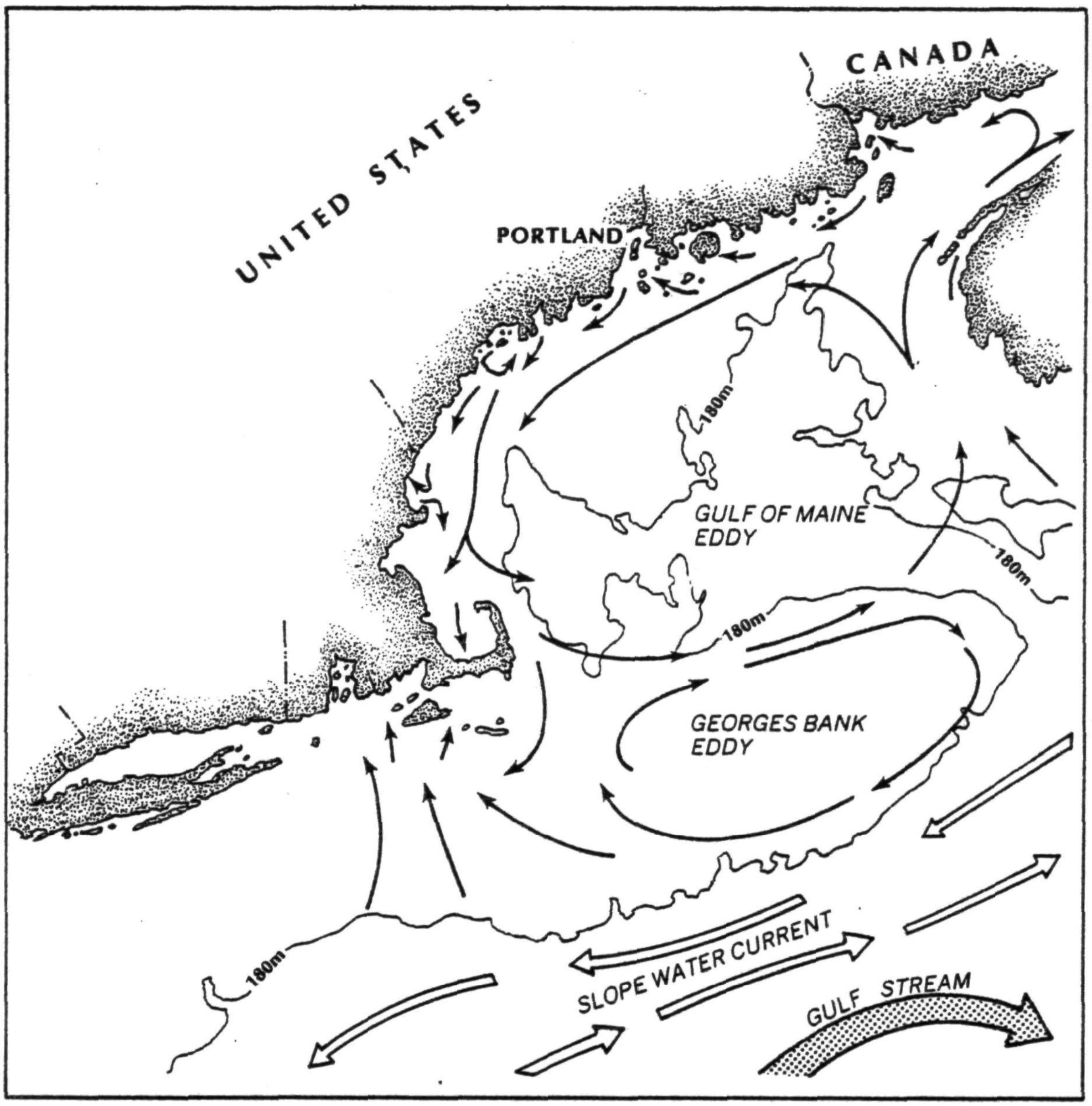

Figure 3-1. Surface Currents Within Slope Water and Coastal Water Masses
Source: DOC, 1973

the Gulf and a clockwise gyre occurs over Georges Bank to the southeast. The seasonal gyre system reaches maximum intensity in late May (Brown and Beardsley, 1978).

Tidal forces are the main contributor to surface current speed and direction in the Gulf of Maine; wind drift contributes little to current development and speed (Brown and Beardsley, 1978). Maximum surface current speeds occasionally reach 45 cm/s, but mean speeds are approximately 15 cm/s (Normandeau Associates, 1974). Near-bottom currents are affected by local topography; maximum recorded speeds are 30 cm/s; mean speeds are approximately 12 cm/s (NUSC, 1977, 1979). Currents at the disposal site are primarily rotary, with dominant directions to be north-northeast and south-southwest (NUSC, 1979). Water mass transport during summer months is mainly toward the north or east, and in winter, to either the northwest or southwest. Table 3-1 summarizes known current data near the Existing Site.

TEMPERATURE STRUCTURE

Surface water in the Gulf of Maine displays strong horizontal (onshore-offshore) temperature gradients. An increase in temperature of 5° to 10°C has been observed within 30 nmi, west to southeast (ICNAF, 1974). This gradient is characteristic of the transition zone between Coastal and Slope Water. Except during winter, when mixing with surface waters occurs, a distinct region of cold (< 5°C) water (from 100 to 150m depths) generally is observed in the Gulf of Maine (ICNAF, 1974). Bottom waters (150 to 250m) in the Gulf of Maine are slightly colder than midwaters.

Surface waters of the Gulf of Maine display the seasonal temperature variations characteristic of northern temperate climates. The annual range in surface water temperatures recorded at the Portland Lightship is from 2.8°C to 15.5°C, as shown in Figure 3-2 (Emery and Uchupi, 1972). During spring and early summer increased insolation forms a stable layer of warm surface water, extending down to depths of 10 to 40m. Below the thermocline bottom water temperatures remain fairly constant and cold throughout the year. The difference between surface and bottom water at the Portland Lightship is 0° to 8°C, as shown in Figure 3-3.

SALINITY STRUCTURE

Seasonal variations in salinity are minimal within the coastal waters of the Gulf of Maine. As a result of coastal runoff and lower salinity coastal water moving westward from Nova Scotia, salinities are low (compared to open

TABLE 3-1
EXISTING CURRENT DATA COLLECTED NEAR THE EXISTING SITE

Investigator	Time Period	Depth Level (m)	Maximum Speed (cm/s)	Dominant Direction Avg Speed (cm/s)	Maximum Direction (to)	Dominant Direction (to)	Number of Stations	Wind (from) (m/s)
Normandeau (1974)	May 18 to Jun 12, 1974	1.5*	8.32 25.5 10.4 15.6	3.12 9.36 4.16 4.16	S SW S S	N to S NE to SW S S	4 (1 depth ea.)	Mean: 4.4 Max: 10.4 Various
Normandeau (1974)	Sep 24 to Oct 22, 1974	12 27 40	45.0 31.2 28.1	17.7 14.07 7.3	E E E	E N E	1 (3 depths)	Mean: 0.04 Max: 10.4 North
NUSC (1978)	Aug 5 to Sep 26, 1978	1.5**	30.0	7.0	N	NE	1 (at bottom)	N/A
NUSC (1979)	Jan 12 to Feb 17, 1977	15 19 1†	28.0 23.0	15.9 11.6	N to E -	N to E -	1 (surface & bottom)	N/A
WHOI (Vermersh, 1979)	Nov 21 to Jan 9, 1975	33 68 98	28.5 20.0	7.0 3.7	SW NW	SW NW	3 (3 depths)	
WHOI (Vermersh, 1979)	Nov 21 to Jan 9, 1975	33 68 118 190	37.5 25.0 13.5 -	8.8 3.2 1.1 -	SW SW SE -	NW NW NW -		Mean: 8.0 Max: 15.9 South
WHOI (Vermersh, 1979)	Nov 21 to Jan 9, 1975	33 68 98	28.0 - -	4.0 - -	SW -	NW -		

NUSC = Naval Undersea Systems Center
WHOI = Woods Hole Oceanographic Institution

* 4 current meters, all approximately 1.5m above the seafloor
** 1 current meter, approximately 1.5m above the seafloor
† 1 current meter, approximately 1m above the seafloor

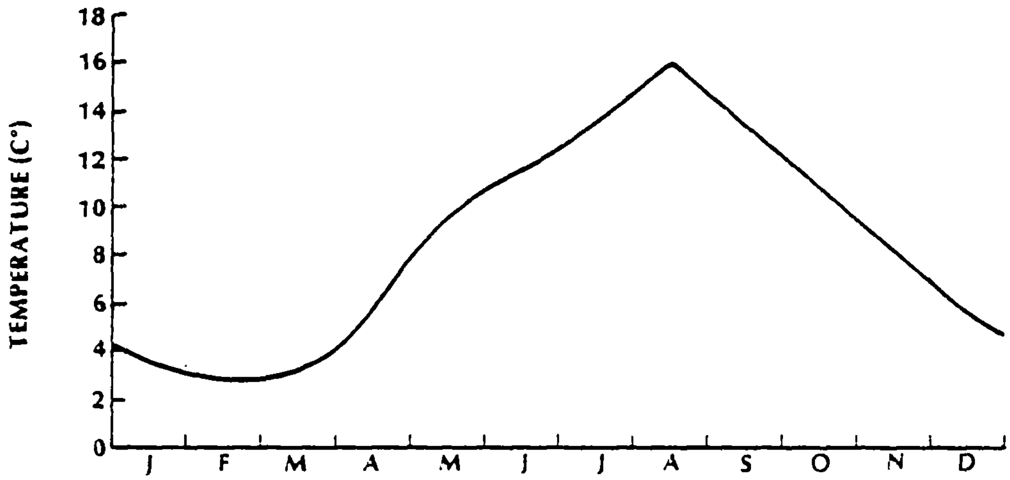

Figure 3-2. Monthly Cycle of Surface Water Temperatures Near Portland Lightship
Source: Adapted from Emery and Uchupi, 1972

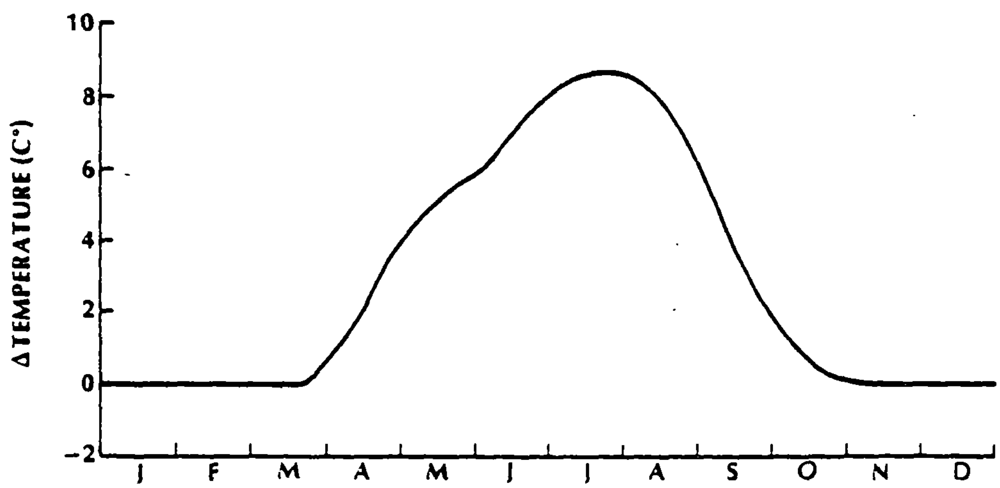

Figure 3-3. Temperature Differential (°C) Between Surface and Bottom Waters Near Portland Lightship
Source: Adapted from Emery and Uchupi, 1972

ocean water) throughout most of the year, never rising higher than $33^{o}/oo$. Lowest salinities ($<31^{o}/oo$) generally occur near the surface during April, May, and June, corresponding to the period of highest river runoff (Emery and Uchupi, 1972).

During winter months at the Existing Site (November through March), well-mixed water of nearly constant salinity ($\sim 32.5^{o}/oo$) extends to the seafloor. With the formation of a seasonal thermocline in the spring, surface salinities reflect riverine input, whereas midwater salinities remain relatively constant (TRIGOM, 1974).

WAVES

Wave height distributions show that waves 1m or greater occur 40% of the time, and waves greater than 7m occur only 0.10% of the time (Thompson and Harris, 1972). The dominant direction is from the east and east-northeast. Extremely large waves are infrequent because of the protection afforded to the area by Georges Bank.

GEOLOGICAL CHARACTERISTICS

Geological information relevant to an ODMDS includes bathymetry, sediment characteristics, and dredged material characteristics. Bathymetric data provide information on bottom stability, persistence of sediment mounds, and shoaling. Differences in sediment grain size distribution between natural sediments and dredged material may be used as a tracer to determine the area of bottom influence of the dredged material because sediment characteristics strongly determine the composition of the resident benthic biota. Changes in sediment size at the Existing Site (caused by disposal) could produce changes in the composition of the benthic biota.

BATHYMETRY

The floor of the Gulf of Maine is extremely irregular, due in part to outcrops of bedrock and to the occurrence of large boulders. Furthermore, the Gulf is characterized by deep basins, low swales, ridges, and flat-topped banks and ledges. On the basis of data obtained from continuous seismic profiling, Uchupi (1966) and Oldale and Uchupi (1970) suggested that the Gulf of Maine probably was formed by a combination of preglacial fluvial erosion and Pleistocene glacial erosion.

There is a transition zone separating the offshore and inshore areas, ranging from 2 to 10 nmi offshore. Zonation may also be noted in the distributions of flora and fauna within the area.

Surveys of the Existing Site (Figure 3-4) were conducted from 1977 to 1980 by DAMOS, NUSC, SAI, and IEC. The Existing Site is extremely rugged due to many large rock outcrops. Nowhere in the region is there a smooth bottom (characteristic of areas receiving large amounts of sediment); however, numerous pockets of fine-grained sand and silt do exist. Side-scan sonar records across the Existing Site indicate a basin at the center, approximately 600m square and 60m deep, surrounded by rocky outcrops rising to a depth of 40m. This specific basin within the Existing Site has been used as the point disposal location (PDL) for the dumping of dredged material. Other areas within the Existing Site received dredged material 35 years ago.

SEDIMENTS

Georges Bank acted as a barrier or breakwater to the Gulf of Maine during most of the Recent rise of sea level, thereby protecting the Gulf from much of the reworking effects of waves, and allowing the deposition of fine-grained sediments. The Gulf of Maine is a low-energy environment, as demonstrated by the large quantity of relatively unstable and altered minerals, and poor sediment sorting (Ross, 1970).

Surface sediments on the Continental Margin can be classified into two groups: Recent (riverine and deepsea pelagic) sediments and relict (glacial) sediments. This classification is based on analysis of the sand fraction and on the depositional history of the sediments. The distribution of the different sediment types is shown in Figure 3-5 (Ross, 1970).

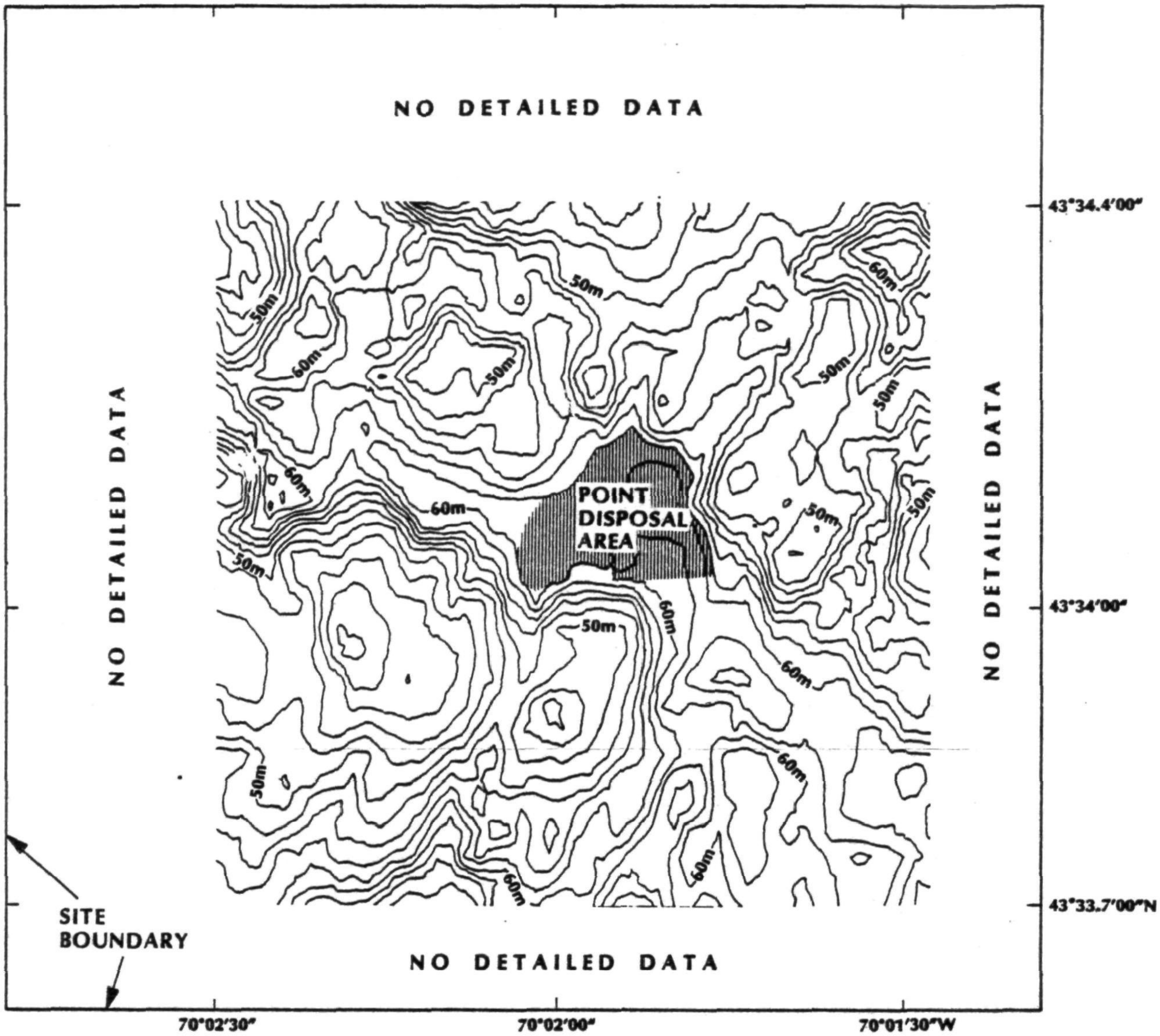

Figure 3-4. Bathymetry of the Existing Site (November 1978)
Source: SAI, 1980a

The seafloor at the Existing Site is predominantly rocky with several small sediment-covered basins, such as the basin located at the center of the Site. During EPA/IEC surveys (Appendix A), sand and silt/clay contents ranged from 11.7% to 75% and 18.2% and 88.3%, respectively. Sediments from the Existing Site center generally contained less than 30% sand and up to 75% silt and clay. Samples taken at an EPA/IEC control station, located 1.8 nmi southeast

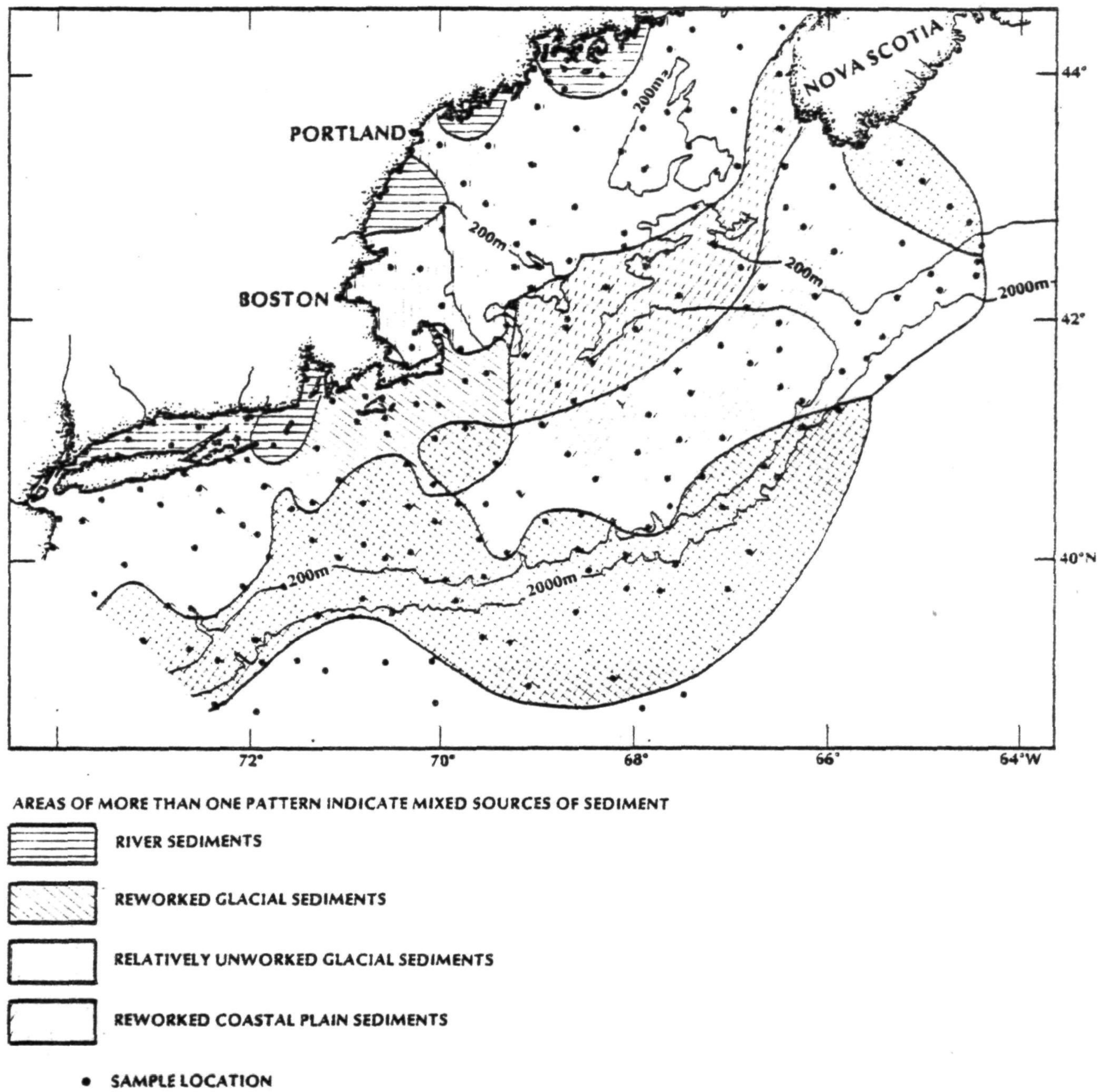

Figure 3-5. Bottom Sediments on the Continental Margin
Source: Ross, 1970

of the center of the Existing Site, contained sediments of varying texture. A sediment sample collected 0.5 nmi northwest of the center, however, was very coarse and contained almost no silt or clay. These variations suggest that the sediment distribution is extremely patchy in this part of the Gulf of Maine.

SEDIMENT TRANSPORT

Transport of sediments depends on particle size and density, as well as the speed and direction of bottom water movements. For sediments with densities similar to quartz, relationships between grain sizes and the velocities necessary to erode and transport are reasonably well known. Table 3-2 gives some representative values.

Bottom currents near the Existing Site (Table 3-1) may attain velocities of 20 cm/sec, which would not erode the silts, sands and transport then out of the area. There is insufficient information to make a reasonable estimate of the quantities or tates of sediment transport.

CHEMICAL CHARACTERISTICS

WATER COLUMN

The chemical parameters pertinent to evaluation of an ODMDS include nutrients important to phytoplankton growth (e.g., nitrate and phosphate), dissolved and particulate trace metals (e.g., Cd, Hg, and Pb), and hydrocarbons (e.g., PCB,

TABLE 3-2
REPRESENTATIVE EROSION AND
TRANSPORT VELOCITY THRESHOLDS FOR QUARTZ SEDIMENTS

Sediment Size Class	Sediment Size Range (mm)	Minimum Erosion Threshold Speed (cm/s)	*Minimum Transport Threshold Speed (cm/s)
Gravel	< 2	40	15
Sand	0.0625 to 2	25	0.5
Silt	0.0039 to 0.0625	20	0.1

* Assumes material suspended by processes other than water flow

Source: After Hjulstrom, 1939

DDT, and phenol). Potential impacts depend on the concentrations of constituents released from dredged material, and physical factors such as mixing and dilution rates; however, because of the transient nature of water masses, adverse effects are expected to be minor.

Nutrients and Dissolved Oxygen

Nutrients and dissolved oxygen levels in the coastal waters of the Gulf of Maine display marked seasonal variations typical of midlatitude waters. A spring phytoplankton bloom occurs in late March, in response to high levels of nutrients and increasing light levels. Throughout the bloom there is a rapid removal of nitrate, phosphate, and silicate from surface waters in the photic zone (Riley and Chester, 1971). Periodic mixing in the spring (caused by storms) replenishes the nutrients and allows continued growth. However, increasing insolation warms the surface waters, and a strong thermocline is established between 10 and 40m by early summer. The thermocline inhibits vertical mixing and, hence, nutrient inputs to surface waters. In the fall and winter the combined effect of storms and the cooling of surface water breaks down the thermal stratification established in summer and allows mixing. Winter mixing, which can extend to about 150m in the Gulf of Maine, returns nutrients to surface waters from the nutrient-rich bottom waters.

Surface waters are 90% to 100% saturated with dissolved oxygen in winter because of turbulence from storms. Oxygen levels in the warm surface waters of summer are somewhat lower than in winter, but remain near saturation as a result of oxygen released during photosynthesis. The decomposition of sinking organic debris tends to reduce oxygen levels in bottom waters to below saturation. Winter mixing replenishes dissolved oxygen to bottom waters (Riley and Chester, 1971).

Suspended Solids and Turbidity

Suspended solids off the coast of Maine consist of both inorganic and organic components. Concentrations of both components decrease in a seaward direction, whereas the relative amount of organic material incorporated in the suspended sediment increases (Emery and Uchupi, 1972). Inorganic components are composed of: (1) feldspar, quartz, mica, and clay, (2) pollutants, and (3) iron oxide aggregates (flocs) formed by reaction of iron-rich effluents from coastal marshes and estuaries. Organic material from biological productivity consists primarily of aggregates and partially organic siliceous and calcareous skeletal debris (Emery and Uchupi, 1972). The recent EPA/IEC survey at the Existing Site showed low levels of suspended particulate matter (0.14 to 0.75 mg/liter) and no consistent vertical distribution (Appendix A).

Trace Metals

Trace elements are present in varying amounts in coastal waters. The most important pathways by which trace elements reach the ocean are: (1) land runoff, (2) atmospheric fallout, and (3) direct inputs by man. Trace elements are generally removed from the dissolved state by adsorption on suspended matter, and slowly deposited on the ocean floor. Resuspension of bottom sediments by burrowing animals, storm action, or bottom currents may reintroduce trace elements into the base of the water column.

Concentrations of lead, mercury, and cadmium, measured in June 1979 (Appendix A) in the water at the Existing Site (Table 3-3) were low (< 0.1 µg/liter) and comparable to levels measured elsewhere in the Gulf of Maine (ERCO, 1978). No information is available for waters within the Alternative Site, but the values are not expected to be significantly different.

Organic Matter

Little is known about the chemistry of organic matter in the Gulf of Maine; however, it is assumed to be composed of particulate and dissolved material from biological sources (seagrasses, algae, zooplankton) and anthropogenic inputs (industrial, municipal, and agricultural runoff). Dissolved organic

TABLE 3-3
DISSOLVED AND PARTICULATE TRACE METALS

	Particulate (µg/liter)			Dissolved (µg/liter)		
	Hg	Pb	Cd	Hg	Pb	Cd
Station 1 (disposal site)	0.001	0.045	0.065	0.03	0.11	0.061
Station 6 (control)	0.001	0.044	0.073	0.003	0.14	0.11

carbon (DOC) levels in the Gulf of Maine are highest near the surface (80 to 120 µg-at C/liter), then uniform from a depth of 50m to the bottom (50 to 70 µg-at C/liter) (TRIGOM, 1974). Increased particulate organic carbon (POC) levels are associated with phytoplankton blooms (Emery and Uchupi, 1972).

Dissolved hydrocarbons in Georges Bank seawater ranged from 10 to 100 µg/liter; levels in surface and bottom water did not differ significantly (ERCO, 1978). Detailed analysis revealed that 60% to 80% of the hydrocarbons were weathered No. 2 fuel oil or other fossil fuels, indicating a considerable anthropogenic input (ERCO, 1978).

Chlorinated hydrocarbons (CHC's) are ubiquitous anthropogenic contaminants in the marine environment. Water at the Existing Site is relatively free of dissolved CHC's, with only traces of the pesticide dieldrin measured (Appendix A).

SEDIMENTS

A variety of trace constituents, such as trace metals, petroleum and chlorinated hydrocarbons, and other organic materials (commonly expressed as total organic carbon [TOC]) can accumulate in sediments. Elevated levels of marine sediment contaminants are generally the result of anthropogenic inputs, such as municipal and industrial wastes, urban and agricultural runoff, atmospheric fallout from urban centers, and accidental spillage.

Sediments high in silts and clays have a greater absorptive capacity for trace contaminants and typically have higher TOC levels than coarser material. Accumulation of trace elements and chlorinated and petroleum hydrocarbons in sediments may have short- or long-term negative effects on marine organisms. Many benthic organisms are nonselective deposit feeders that ingest substantial quantities of suspended and bottom sediments. The potential for bioaccumulation of trace contaminants (e.g., mercury, cadmium, lead, and some chlorinated hydrocarbons) by these organisms is an important environmental concern, especially if transmission to humans is possible.

High concentrations of organic materials in sediments could lead to anoxic conditions and produce hydrogen sulfide and metal sulfides. Oxidation of these sulfides is responsible for much of the initial consumption of oxygen immediately following dredged material disposal. Significantly lowered oxygen levels in sediments or near-bottom waters can adversely affect marine organisms.

Contaminant levels in fine sediments from the Point Disposal Location (PDL) near the center of the Existing Site were much higher than levels from Station 7 outside the Existing Site with similar sediments. Concentrations for some parameters (e.g., oil and grease) were similiar to Portland Harbor sediments while other parameters (e.g., trace metals) had lower concentrations at the Existing Site than in Portland Harbor sediments (see Appendix A for details).

CONTAMINANTS IN BIOTA

Data on tissue concentrations of trace metals and organic pollutants (e.g., pesticides, PCB's) are unavailable for phytoplankton and zooplankton populations near the Existing Site. Trace metal concentrations have been examined in some benthic species, but levels of organic pollutants in these species are unknown. Data indicate that no significant uptake of trace metals is occurring and there is no apparent danger to human health.

DAMOS initiated a Mussel Watch Program that monitored the uptake of trace metals by mussels at Bulwark Shoals (control area) on West Cod Ledge (Figure 2-1) and at the Existing Site. This program was designed to provide baseline tissue levels of trace metals prior to disposal activities. Mussels (Modiolus modiolus) were collected monthly from each area and the solf tissues were analyzed. Results indicate that in all cases the values from mussels in the disposal site were slightly higher than those from the control area (Table 3-4).

Trace metal concentrations in benthic animals within the Existing Site were measured by DAMOS. Tissue levels of mercury, cadmium, copper, lead, and zinc were examined in Cardium sp. and Astarte sp. (both clams), and Terebratulina septentrionolis (brachiopod). During EPA/IEC surveys crustaceans were collected from the Existing Site and their tissues were analyzed for accumulations of mercury, cadmium, and lead (Appendix A). Mercury levels in the crustacean tissues were nearly two orders of magnitude lower than the FDA Action level. No Action levels have been established for trace metals other than mercury in marine tissues.

TABLE 3-4
TRACE METAL ACCUMULATION IN MUSSEL TISSUE
(Modiolus modiolus) FROM BULWARK SHOALS CONTROL AREA AND THE EXISTING SITE
mean (ug/g) dry weight

Area	Number of Individuals	Cd	Cr	Co	Cu	Fe	Hg	Ni	Zn
Bulwark Shoals	19	9.07	0.78	0.40	31.00	124.82	0.23	2.15	258.92
Disposal Site	6	12.50	0.98	0.62	33.58	156.02	0.28	2.85	270.63

Source: Modified from SAI, 1980

BIOLOGICAL CHARACTERISTICS

Biota in the water column and in benthic environments of the Existing Site are described in this section. Water column biota include phytoplankton, zooplankton, and nekton; benthic biota include infaunal and epifaunal organisms and demersal fish. Benthic biota, especially the infauna, can be sedentary, and may not be able to readily emigrate from areas of disturbance. Infauna, therefore, are important indicators of environmental conditions. Dredged material disposal causes only short-term effects on planktonic communities because of the natural patchiness of the species and the movement of the water masses they inhabit. Nekton are highly mobile and normally are unaffected by disposal of dredged material.

PHYTOPLANKTON

Diatoms and dinoflagellates are the major types of phytoplankton within the coastal areas of the Gulf of Maine, and their population dynamics are closely correlated with the annual cycles of nutrients and light energy. Phytoplankton populations begin to increase in early spring, as they utilize the increasing levels of light and the high concentrations of nutrients in the water column resulting from winter mixing. Within the Gulf of Maine the spring bloom begins in the coastal area off Cape Elizabeth, which includes the Existing Site (TRIGOM, 1974; BLM, 1977). The boreal diatom *Thalassiosira* sp. begins to increase in late March and is the first dominant, followed by *Chaetocerus debilis* and *C. decipiers*. Populations decline from late April or early May until a second, but much smaller, phytoplankton increase occurs during July through August (at Cape Elizabeth). The late summer increase results from storm-induced breakdowns of water stratification, with subsequent introduction of nutrients into the surface waters; sufficient light is still available to support a phytoplankton bloom. The latter bloom usually involves the neritic diatoms *Skeletonema*, *Guinardia*, *Leptocylindrus*, and *Rhizosolenia*. The phytoplankton populations progressively decrease as light levels decrease, and minimal levels are reached in winter. The small winter populations generally are dominated by the dinoflagellate *Ceratium* or the diatom *Coscinodiscus*, and sometimes by the diatoms *Rhizosolenia* or *Thalassiosira* (TRIGOM, 1974; BLM, 1977).

Primary productivity in the region surrounding the Existing and Alternative Sites is highest during the spring blooms. Emery and Uchupi (1972) estimated productivity values of over 0.5 g C/m^2/day for coastal waters of the Gulf of Maine.

ZOOPLANKTON

Population cycles of zooplankton often are closely correlated with the seasonal cycles of phytoplankton, since many zooplankters utilize the phytoplankton as food. These herbivorous zooplankters form the second trophic level of the marine food chain, and in turn may be fed upon by predatory zooplankton and nekton which form higher trophic levels. At the Existing Site zooplankton begin to increase in late March and are dominated by copepods (Bigelow, 1927; Sherman, 1968, 1970; TRIGOM, 1974; BLM, 1977). The herbivorous Calanus finmarchicus is the most abundant species of copepod, with populations increasing to a peak in May, then declining. Pseudocalanus minatus and Centropages typicus, also herbivorous, follow in June. Other important planktonic species in this area include the herbivorous and predatory copepods Oithona similis, Temora longicornis, Metridia lucens, Acartia longiremis, and Tortanus discaudatus and the predatory chaetognath Sagitta elegans. Mean annual volumes of zooplankton near the Existing and Alternative Sites (4 $cc/100m^3$) are intermediate between high values recorded from the western Gulf of Maine and low values from the eastern Gulf (Sherman, 1970).

NEKTON

As a group nekton occupy most levels of the marine food chain. For example, herring and menhaden occupy the second trophic level as they feed on phytoplankton. Predatory fishes, squid, and marine mammals comprise the higher trophic levels.

Many nektonic species are vertical migrators, moving into shallower waters (<200m) only at night. Some species, such as the boreal squid Illex illecebrosus, move into shallow waters on a seasonal basis. This commonly occurring species ranges into the inshore area of the Gulf of Maine during spring and summer and returns to offshore areas in fall (Gosner, 1971).

Numerous species of demersal and pelagic fishes are associated with the Gulf of Maine coastal areas and are present to some degree at the Existing Site. A list of the common species and their general distribution is presented in Table 3-5. Most of these fishes (77%) are demersal, feeding predominantly on bottom organisms such as polychaetes, molluscs, and small crustaceans.

Some fish species migrate seasonally (BLM, 1977). Fishes moving north into the Gulf of Maine and beyond during summer and returning south in the fall include: spiny dogfish (Squalus acanthias), silver hake (Merluccius bilinearis), red hake (Urophycis chuss), white hake (U. tenuis), American shad (Alosa sapidissima), striped bass (Morone saxatilis), butterfish (Poronotus triacanthus), and Atlantic menhaden (Brevoortia tyrannus). A few species, such as the Atlantic herring (Clupea harengus) and Atlantic cod (Gadus morhua), migrate south from the Gulf of Maine before winter. Other species display seasonal onshore-offshore movements within the Gulf.

It is difficult to determine accurately the types and abundances of demersal fishes occurring within the Existing Site, as the area is characterized by rugged bathymetry, and it is hazardous to employ trawling gear. However, Normandeau Associates (1974) conducted a 30-minute trawl in a relatively level area 0.5 nmi from the Existing Site. Several Atlantic cod (Gadus morhua), American plaice (Hippoglossoides platessoides), goosefish (Lophius americanus), and yellowtail flounder (Limanda ferruginea) were collected. It is reasonable to assume that most of the common Gulf of Maine fishes (including commercial species) are present to some degree within the Existing Site (Table 3-5).

Little is known about the demersal fishes associated with the Alternative Site, but many of the common Gulf of Maine fishes can be expected to occur. A survey conducted by NOAA (1976a,b) 5 nmi northeast of the Alternative Site

TABLE 3-5
FISH SPECIES OCCURRING IN THE NORTHERN COASTAL AREA OF THE NORTH ATLANTIC

Type*	Common Name	Scientific Name	Habitat*	Distribution**
	Spiny dogfish	*Squalus acanthias*	P	Nearshore to offshore
	Little skate	*Raja erinacea*	D	Nearshore to offshore
	Barndoor skate	*R. laevis*	D	Nearshore to offshore
	Winter skate	*R. ocellata*	D	Nearshore to offshore
	Thorny skate	*R. radiata*	D	Banks, basin, offshore to oceanic
	American eel	*Anguilla rostrata*	D	Freshwater to estuarine
	Blueback herring	*Alosa aestivalis*	P	Estuarine to coastal
	Hickory shad	*A. mediocris*	D	Estuarine
S,C	Alewife	*A. pseudoharengus*	P	Freshwater to coastal
S	American shad	*A. sapidissima*	P	Estuarine to coastal
C	Atlantic menhaden	*Brevoortia tyrannus*	P	Coastal
C	Atlantic herring	*Clupea harengus harengus*	P	Coastal, banks
	Capelin	*Mallotus villosus*	P	Nearshore to offshore
S	Rainbow smelt	*Osmerus mordax*	P	Estuarine to nearshore
	Goose fish	*Lophius americanus*	D	Nearshore to oceanic
	Fourbeard rockling	*Enchelyopus cimbrius*	D	Nearshore to offshore
S,C	Atlantic cod	*Gadus morhua*	D	Coastal, banks to oceanic
C	Haddock	*Melanogrammus aeglefinus*	D	Coastal to offshore
C	Silver hake	*Merluccius bilinearis*	P	Coastal to offshore
	Atlantic tomcod	*Microgadus tomcod*	D	Estuarine to nearshore
S,C	Pollock	*Pollachius virens*	P	Coastal, banks
	Red hake	*Urophycis chuss*	D	Nearshore to oceanic
C	White hake	*U. tenuis*	D	Nearshore to oceanic
	Ocean pout	*Macrozoarces americanus*	D	Nearshore to coastal, banks, basins
	Mummichog	*Fundulus heteroclitus*	D	Estuarine to nearshore
	Atlantic silverside	*Menidia menidia*	D	Estuarine to nearshore
	Threespine stickleback	*Gasterosteus aculeatus*	D	Freshwater to nearshore
	Northern pipefish	*Syngnathus fuscus*	D	Estuarine to nearshore
S	Striped bass	*Morone saxatilis*	D	Nearshore, estuarine
S	Bluefish	*Pomatomus saltatrix*	P	Nearshore to offshore
	Scup	*Stenotomus chrysops*	D	Nearshore to offshore
	Tautog	*Tautoga onitis*	D	Estuarine and nearshore
	Cunner	*Tautogolabrus adspersus*	D	Nearshore to coastal banks to offshore
	Snakeblenny	*Lumpenus lumpretaeformis*	D	Nearshore to offshore
	Daubed shanny	*L. maculatus*	D	Offshore, basin
	Radiated shanny	*Ulvaria subbifurcata*	D	Nearshore to coastal, basin
	Rock gunnel	*Pholis gunnellus*	D	Nearshore to coastal banks to offshore
	Atlantic wolffish	*Anarhichas lupus*	D	Nearshore to offshore
	American sand lance	*Ammodytes americanus*	D	Nearshore, edges of banks
S	Atlantic mackerel	*Scomber scombrus*	P	Coastal to offshore
	Butterfish	*Peprilus triacanthus*	P	Nearshore to offshore
S,C	Redfish or ocean perch	*Sebastes marinus*	D	Nearshore to banks, basin to oceanic
	Northern searobin	*Prionotus carolinus*	D	Nearshore to offshore
	Sea raven	*Hemitripterus americanus*	D	Nearshore to offshore
	Grubby	*Myoxocephalus aenaeus*	D	Nearshore to coastal
	Longhorn sculpin	*M. octodecemspinosus*	D	Estuarine to coastal, banks to offshore
	Shorthorn sculpin	*M. scorpius*	D	Nearshore to coastal
	Alligatorfish	*Aspidophoroides monopterygius*	D	Coastal, banks, basin
	Lumpfish	*Cyclopterus lumpus*	D	Nearshore to coastal
	Fourspot flounder	*Paralichthys oblongus*	D	Banks, coastal to offshore
	Windowpane	*Scophthalmus aquosus*	D	Nearshore to coastal
C	Witch flounder	*Glyptocephalus cynoglossus*	D	Coastal to oceanic, banks, basin
C	American plaice	*Hippoglossoides platessoides*	D	Coastal, banks, basin, oceanic
	Yellowtail flounder	*Limanda ferruginea*	D	Coastal to offshore, banks
	Smooth flounder	*Liopsetta putnami*	D	Estuarine to nearshore
S,C	Winter flounder	*Pseudopleuronectes americanus*	D	Estuarine, banks to offshore

** Nearshore = Coastline to 15m
Coastal = Out to 91m
Offshore = 91m to the Continental Slope
Basin = Deep basin of the Gulf of Maine
Banks = Shallow, offshore banks
Oceanic = Pelagic fish of open ocean habitat

* P = Pelagic
C = Commercially important
D = Demersal
S = Sportfish

Sources: Adapted from Bigelow and Schroeder, 1953; TRIGOM, 1974; BLM, 1977; Fefer and Schettig, 1980 revealed moderate abundances of witch flounder, but other species were absent or uncommon. Moderate amounts of American plaice, red and white hake, and cod were collected 11 nmi from the Alternative Site (NOAA, 1976a,b).

BENTHOS

The disposal site is within the Western Atlantic Boreal Province, ranging from northern Massachusetts and New Hampshire to Maine. Several studies have documented the high species richness of this province. The distributions of species are disjunct and discontinuous.

Numerous investigators have discussed the relationships between substrate type and biological communities (e.g., Nichols, 1970; Gray, 1974; Rhoads, 1974). The highly variable nature of bottom types within the Gulf of Maine has a major effect on the distribution and abundance of the various species. This geological diversity, along with temporal changes, probably accounts for the high sample-to-sample variability and clumped spatial distributions of species observed in past studies of the Gulf of Maine and the Existing Site.

Coastal Maine has been characterized by Fefer and Schettig (1980), who divided it into six coastal regions for organizational purposes (Figure 3-6). The Existing Site lies within Region 1. In general, the infauna and epifauna in this region are similar to those present throughout the Gulf of Maine and the Western Atlantic Boreal Province. The number of species in Region 1, however, is the lowest of all regions (Larson, 1979).

The Existing Site is situated within an area of rugged, rocky outcrops interspersed with a few local sedimentary basins. The Point Disposal Location is within the largest of these basins; it has an area of 0.11 nmi^2 and a water depth of 62m. Surrounding rocky outcrops rise to a depth of 40m (i.e., 20m high) (Figure 3-4). Within this basin, sediments consist of fine sand, silt, and clay, and bottom currents are weak, both features indicative of a low-energy environment (DAMOS).

The communities on bottoms composed of fine-grained, soft sediment near the Existing Site tend to be diverse and dominated by polychaetes and molluscs

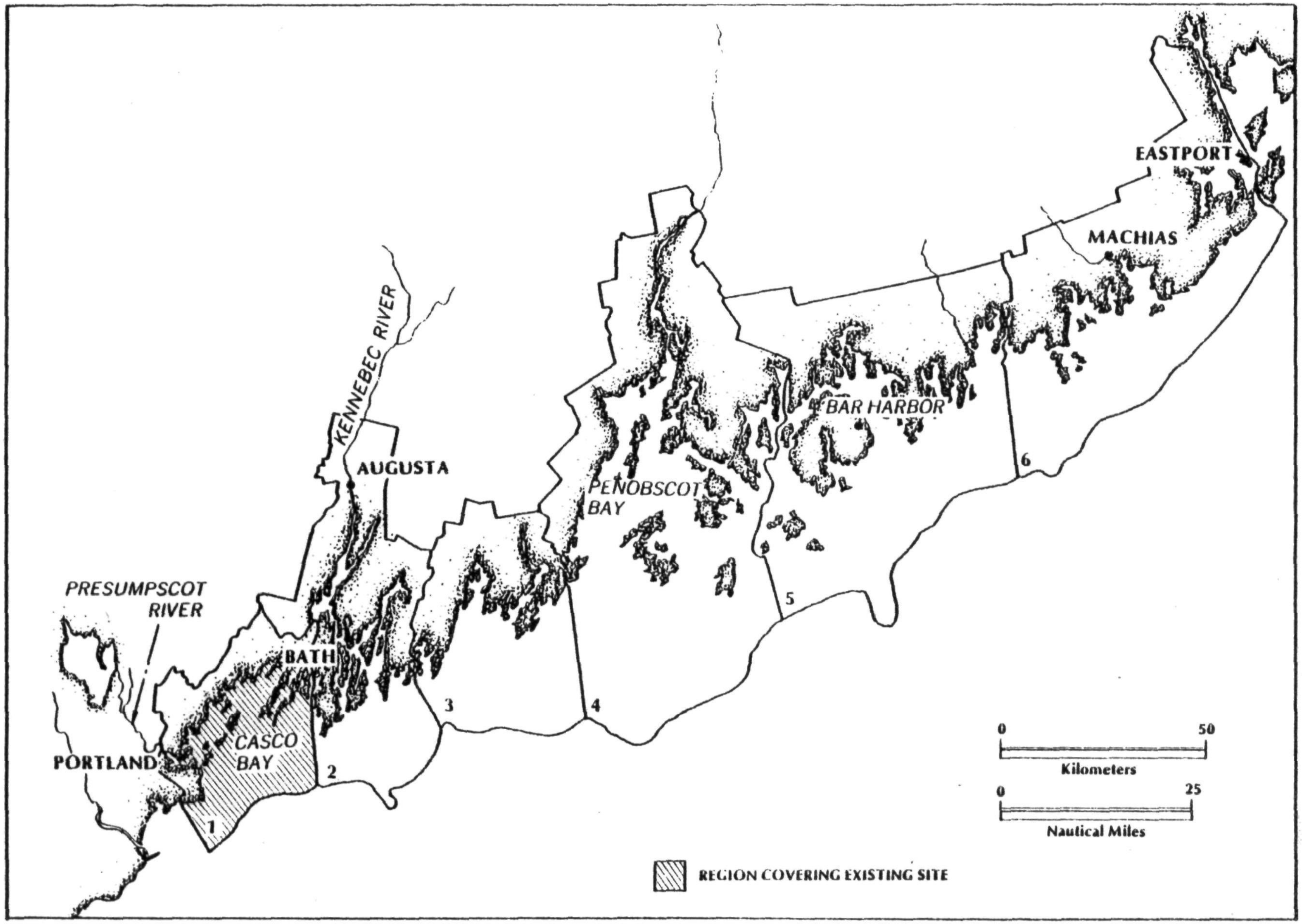

Figure 3-6. Maine Coast Characterization by Region
Source: Fefer and Schettig, 1980

(DAMOS). Basin slopes and sediment pockets among rocky outcrops often contain organisms attached directly to rock as well as buried within the sediment. These communities are somewhat less diverse and contain fewer numbers of polychaetes than the fine sediment communities.

The infauna communities at the Existing Site are dominated by polychaetes (Table 3-6); molluscs and crustaceans are relatively unimportant. The species composition of the infauna communities reflects the substrate patchiness and temporal heterogeneity of the site. Sample-to-sample variability was very high and only three dominant species were common to both EPA/IEC surveys (Appendix A).

The high degree of natural variability of the infauna communities observed within the Existing Site is consistent with other investigations in the Boreal Province. Long-term studies have revealed high variability among the benthic fauna in the southern portion of the Province (Harris and Mathieson, 1977). Samples taken throughout the province usually fail to reveal consistent patterns of species distribution (R. Morton, personal communication*).

TABLE 3-6
DOMINANT POLYCHAETE SPECIES PRESENT
AT THE EXISTING SITE IN JUNE 1979 AND APRIL 1980

Ampharete artica
Anobothrus gracilis
Arcidea quadrilobata
Paraonis gracilis
Prionospio malmgreni

Note: Other species (molluscs, crustaceans, etc.) were not considered dominant (Appendix A)

* R. Morton, Science Applications Inc. (SAI), 1980

Rocky outcrops are suitable for epifaunal communities dominated by attached suspension feeders and mobile predators. Rocky areas are difficult to sample,which may account for the low species diversity reported for rocky outcrops in past investigations.

Epifaunal communities were examined using remote-controlled cameras and are discussed in detail in Appendix B. The epifauna community associated with rocky surfaces was dominated by attached suspension feeders. Photographs reveal that brachiopods (Terebratulina septentrionalis) and the solitary sponge (Polymastia infrapilosa) were the most abundant organisms, both occurred in nearly all photos of rocky areas. Barnacles (Balanus balanus) and several species of encrusting and erect sponges were common on rock surfaces with little or no sediment, as were tunicates (Ascidia callosa) and unidentified clumps of bryozoans and/or hydroids. A few anemones were present and tubicolous polychaetes were noted within isolated sediment pockets.

Mobile organisms were uncommon. A few asteroids, ophiuroids, small crabs, shrimp, holothuroids, and urchins were noted. Large crustaceans and benthic fishes were not observed.

Evidence of recent and extensive sediment deposition, most likely due to dumping, was found at four of the eight photo stations, with two areas characterized by an almost complete absence of life. Patterns of sedimentation and associated fauna are discussed further in Appendix B.

MARINE MAMMALS

Cetaceans

Numerous species of cetaceans have been observed in the Gulf of Maine, but only five species are common within the inshore and coastal waters (Table 3-7). Coastal abundances appear to be greatest during spring and summer; however, this may not be an accurate assessment, as little data have been collected during winter (BLM, 1977). The importance of the Gulf region

TABLE 3-7
CETACEANS COMMONLY OBSERVED IN THE GULF OF MAINE

Species	Common Name
Phocoena phocoena	Harbor porpoise
Balaenopterra physalus	Finback whale
B. acutorostrata	Minke whale
Megaptera novaengliae	Humpback whale
Globicephala melaena	Pilot whale

Source: BLM, 1977

to cetaceans is unknown. Offshore areas may serve as a migratory passage between northern feeding grounds and southern breeding grounds, or as feeding areas (TRIGOM, 1974; Fefer and Schettig, 1980).

Feeding habits of the common whales are fairly well known (BLM, 1977; Fefer and Schettig, 1980). Baleen whales filter small food items from the water using a variety of techniques. The humpback (Megaptera novaeangliae) and the finback (Balaenoptera physalus) whales feed on herring or capelin. The minke whale (B. acutorostrata) feeds on herring, sand-lance, cod, and squid. The harbor porpoise (Phocoena phocoena) and the pilot whale (Globicephala melaena) are toothed and capture individual herring and squid, respectively. The pilot whale tends to follow the seasonal migrations of squid (i.e., inshore during the spring and offshore in fall) (Sergeant and Fisher, 1957).

Pinnipeds

Five species of pinnipeds have been recorded from the Gulf of Maine; however, only harbor seals (Phoca vitulina) are common.

Approximately six harbor seals/nmi^2 were counted within the 4m to 20m depth interval between Cape Elizabeth and Cape Small, a zone 6 nmi inshore of the Existing Site (TRIGOM, 1974). Harbor seals generally inhabit inlets, islets, and reefs, where they form small, isolated populations. Mixing between the populations is limited. During winter harbor seals move offshore and rarely haul out onto land. They return to the nearshore area in spring. Pupping occurs on relatively protected beaches during May. Harbor seals generally eat one fish meal each day (Boulva and McLaren, 1979).

Gray seals (Halichoerus grypus) are uncommon in the Gulf of Maine, although scattered individuals occur near the Existing Site during the spring and summer (Waters, 1967; Andrews and Mott, 1967). The only breeding colony in the U.S. consists of about 15 individuals on the shoals around Muskeget Island near Nantucket (Andrews and Mott, 1967), 122 nmi south of the Existing Site and 100 nmi south of the Alternative Site. Probably fewer than 30 seals exist there (Fefer and Schettig, 1980).

The normal distribution of harp seals (Pagophilus groenlandicus), hooded seals (Crystophora cristata), and walruses (Odobenus rosmarus) is far to the north and they rarely occur in the Gulf of Maine.

RARE AND ENDANGERED SPECIES

More than 20 species of marine mammals occur in the North Atlantic, of which six species (all whales) are classified as endangered. These species occur within the Gulf of Maine, and at least two may be expected to occur near the Existing Site. The finback whale (Balaenoptera physalus) is the most common of all the large whales in this region and is sighted frequently within inshore waters and bays. The humpback (Megaptera novaeangliae) and sei (B. borealis) whales routinely are observed, the humpback often within the nearshore waters during summer and the sei further offshore. The blue (B. musculus), right (Eubaleana glacialis), and sperm (Physeter catadon) whales occur mainly in deeper waters and are rarely observed.

The southern bald eagle (Haliaeetus leucocephalus) is the only endangered bird species occurring along the coast of Maine. According to Fefer and Schettig (1980), bald eagles nesting in Maine represent more than 90% of the known eagle population breeding in the northeastern U.S. Approximately 75% of Maine's breeding and wintering populations occur along the coast, and more than half of these eagles occur in eastern Coastal Maine (Regions 5 and 6) (Figure 3-6). No occupied breeding sites are known to exist in the vicinity of the Existing Site (Region 1) since State nesting surveys began in 1962. This area receives only light and variable use by wintering eagles (Fefer and Schettig, 1980).

There are five species of sea turtles known to be summer residents of the Gulf of Maine; all may occur near the Existing Site. Three of these species are endangered: the Atlantic ridley (Lepidochelys kempii), the leatherback (Dermochelys coriacea), and the hawksbill (Eretmochelys imbricata). The ridley wanders widely from nearshore to offshore waters. They occur in the Gulf of Maine from July to November only as juveniles that have drifted north in the Gulf Stream and then into the Gulf of Maine. After maturing they are able to swim against the current and return south. The leatherback occasionally enters shallow bays and estuaries and large populations occur in the Gulf of Maine from June to November. The hawksbill is an occasional straggler from southern areas. None of these rare and endangered species are restricted to the Existing Site, although most may be expected to pass through the area at some time.

PRESENT AND POTENTIAL ACTIVITIES IN THE VICINITY OF THE EXISTING SITE

FISHERIES

The Gulf of Maine supports a significant commercial fishery for finfish and shellfish. Nearly 30% of the total New England commercial catch is landed in Maine, second only to Massachusetts in total fish landed (Fefer and Schettig, 1980). Maine's commercial catch is dominated by lobster, followed by shrimp, ocean perch, Atlantic herring, and sea scallops.

Commercial fishing in Maine essentially is confined to inshore fishing grounds, with less than 1% of the catch (dollars and pounds) from offshore Georges Bank (DOI, 1977). The Portland fishing fleet operates almost exclusively within the Gulf of Maine. During 1974 and 1975 this fleet consisted of 72 trawlers, 19 concentrating on shrimp (DOI, 1977).

Dragging or trawling grounds for demersal species are restricted to continuous stretches of relatively smooth bottom. Although dragging operations are not conducted at the Existing Site because of the rugged topography, several nearby bottoms are important dragging grounds (Figure 3-7). The Edge of the Bottom, the primary dragging ground for Portland-based fisherman, is 1.5 nmi southeast of the Existing Site. As many as 25 vessels may fish this region (DAMOS). Hue and Cry Gulley is an important dragging ground 4 nmi southwest of the Existing Site. Others areas include Eagle Island Narrows, Ordnance Tow, and Second Edge. The finfish catch from these areas includes Atlantic cod Gadus morhua), haddock (Melanogrammus aeglefinis), winter flounder (Glyptocephalus cynoglossus), and other groundfish (Figure 3-7).

The 10 most valuable finfish species landed at Portland in 1974 and 1975 are listed in Table 3-8. Atlantic herring was the dominant catch, and lobster was the most valuable. Approximately half of these species are demersal, and several probably range from the dragging grounds into the Existing Site even though the depths and substrates are quite different. Gill nets are set in areas south and southwest of the Existing Site.

Life histories of the more important commercial finfish are summarized briefly in Table 3-9. Most of these species produce pelagic eggs at spawning areas far offshore of the Existing Site. The silver hake (Merluccius bilinearis), however, spawns within a broad, nearshore spawning area extending from Cape Cod to the Bay of Fundy (DAMOS); this area includes the Existing Site. The Atlantic herring (Clupea harengus) spawns demersal eggs, which are deposited in nearshore gravels, but the CE has been assured by Department of Marine Resources Laboratory at Booth Bay, Maine that **"the proposed site is the best choice in the immediate area, because both further up and down the coast are know herring spawning grounds" (CE, 1979).**

The lobster fishery is extremely valuable in Maine, worth $23.2 and $27.5 million in 1974 and 1975, respectively. Lobsters begin to migrate from cold, offshore waters toward shallower and warmer waters in late spring. Consequently, most fishing efforts begin in water less than 70m deep and are

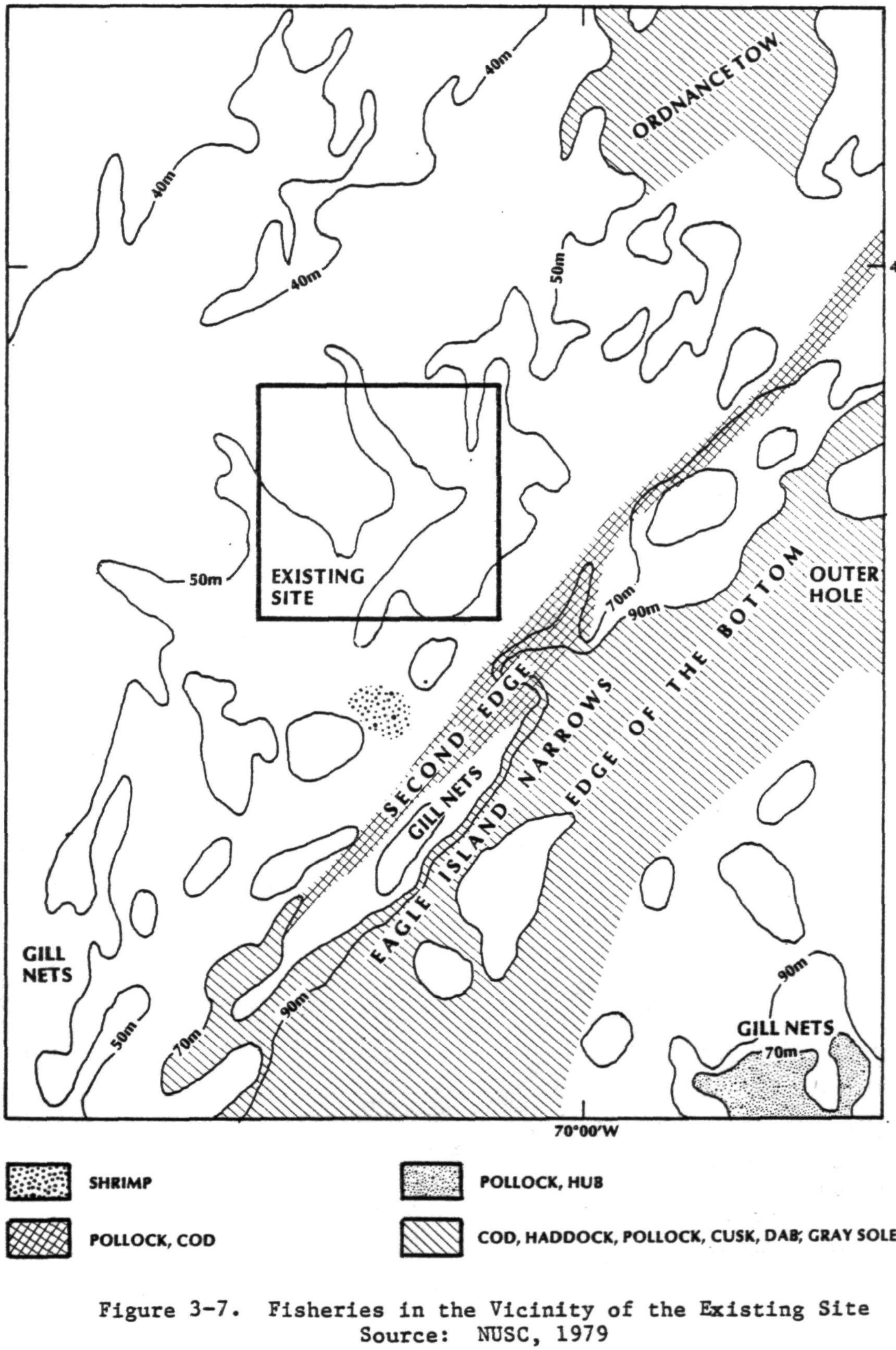

Figure 3-7. Fisheries in the Vicinity of the Existing Site
Source: NUSC, 1979

TABLE 3-8
MARINE LANDINGS INTO PORTLAND HARBOR FOR 1974 AND 1975

Finfish (1974)			Finfish (1975)		
Species	Dollar Value (Thousands)	Pounds (Thousands)	Species	Dollar Value (Thousands)	Pounds (Thousands)
Ocean perch	2,327	30,626	Ocean perch	1,979	21,514
Atlantic herring	1,793	47,398	Atlantic herring	1,423	38,248
Atlantic cod	541	4004	Atlantic cod	911	5,595
Pollock	328	3,594	Pollock	547	5,917
White hake	266	3,777	White hake	365	4,559
Silver hake	175	2,861	Haddock	276	776
Atlantic menhaden	155	10,149	Witch flounder	258	771
Witch flounder	144	574	American plaice	243	1,84
Bluefin tuna	135	239	Swordfish	198	146
American plaice	124	722	Atlantic menhaden	196	13,958
Shellfish (1974)			**Shellfish (1975)**		
American lobster	23,213	16,458	American lobster	27,479	17,008
Shrimp	3,463	9,768	Sea scallops	3,020	1,594
Sea scallops	723	455	Shrimps	1,938	7,004
Sea mussels	83	308	Sea mussels	198	612

Sources: Fisheries Statistics of the U.S., 1974 and 1975

TABLE 3-9
LIFE HISTORY OF NEARSHORE COMMERCIAL FINFISH IN THE GULF OF MAINE

Species	Depth Preference	Food	Movements	Breeding Season	Eggs and Larvae
Redfish or ocean perch (Sebastes marinus)	80 to 200 ft; demersal rock or mud	Shrimps, mysids, euphausids, small fishes	Common in water cooler than 50°F; move into shallower water during winter	July to August	Ouo Viviparous; larvae released from females; Larvae live close to surface
Atlantic herring (Culpea harengus)	Pelagic	Copepods and other zooplankton	Juveniles are near-shore closer in the summer than winter adults	Spawn August to December from north to south on falling water temperature	Demersal; gravel bottoms, in less than 300 ft, larval period 5 to 8 months; metamorphose close to shore
Atlantic cod (Gaddus morrhua)	Tide line - 1,500 ft; demersal but will leave bottom	Mollusks, crabs, other bottom invertebrates	Nonmigratory, move to spawning grounds, slight inshore-offshore	Late February to June	Buoyant; eggs 14 to 30 days; 2 months pelagic larvae
Pollock (Pollachius virens)	Surface - 600 ft; pelagic	Larger zooplankton, especially enphausiids and fish	Mature wander, move to spawning grounds in southern Gulf of Maine in winter	November to February	Buoyant; 2 months to end of larval period
White hake (Urophycis tenuis)	Tide line - 1.800 ft; demersal and soft bottom	Small crustaceans, squid, some small fish	Young disperse to deeper water, adults are non-migratory, slight inshore offshore	Fall and winter	Buoyant
Silver hake (Merluccius bielinearis)	Tide line - 900 to 2,400 ft; off Shelf in winter epipilagic	Shrimp, squid, fish	Migrate offshore in late fall; other movements governed by prey and temperature	July to August September	Buoyant; 2 or 3 months to end of larval period
Atlantic menhaden (Brevoortia tyrannus)	Pelagic	Diatoms, small zooplankton	Juveniles: estuary move to coastal and offshore at end of first year. Adults: north into Gulf of Maine in summer, move south in winter	July to August	Buoyant; pelagic; larvae enter estuary and metamorphose into juveniles
Witch flounder (Glyptocephalus cynoglosus)	Some 60 to 90 ft; but 360 to 900 ft; demersal	Small invertebrates of all types	Stationary	Late spring and summer peak spawning in July to August	Buoyant; long pelagic period up to 4 to 6 months
Haddock (Melanogrammus aeglefinis)	Few less than 30 to 60 ft, most 150 to 450 ft	Varied diet: brittle stars bivalves, polychaetes, crabs, squid, sea urchins	Wandering in Gulf of Maine, move to spawning grounds	Late February to May peak March, April	Buoyant, eggs and larvae Pelagic 3 months
American plaice (Hippaglossoides platessoides)	Tide Line - +2,000 ft; demersal	Invertebrates of all types	Stationary	Peak in May and June	Buoyant, pelagic period 3 to 4 months

Sources: Bigelow and Shroeder, 1953; TRIGOM, 1976 concentrated in areas less than 20m deep by midsummer. Limited observations suggest that some lobsters remain in deeper water throughout the year (NUSC, 1979).

Lobsters begin to return to deeper waters in the fall, where they are fished during the winter. However, winter fishing occurs on a much smaller, scale, due to adverse weather conditions. The Existing Site is seaward of the major lobster fishing area. The Edge of the Bottom and Inner Edge (Figure 3-7) have been productive for northern shrimp (Pandalus borealis), veilding catches when shrimp disappeared from other areas of the cost (DAMOS, 1979). The shrimp fishery has declined in recent years.

Scallops and mussels are the only molluscs commercially harvested in Maine. These relatively minor fisheries are located within a few hundred meters of the shore and not near the Existing Site. Scallops and mussels were not present in biological samples collected from the Existing Site during the following surveys: Normandeau, 1974; NUSC, 1977; IEC, 1979, 1980.

GENERAL MARINE RECREATION

Recreation is primarily associated with coastal parks and beaches, boating, and sportfishing. The Existing Site is 6.8 nmi from the nearest point of land, and its location has an insignificant impact on these activities.

Sport fisheries 3 nmi southwest of the Existing Site include limited bottom fishing from party boats. Tuna tend to traverse the Edge of the Bottom (Figure 3-7), thus a wide-ranging sportfishery for giant tuna occasionally is present (NUSC, 1979).

SHIPPING

Portland is a natural deepwater harbor, ice-free, enclosed, and only 3 nmi from open sea. The inner harbor has a waterfront, providing berths for oil tankers, cargo ships, fishing boats, and government vessels. It has complete inland transportation services, efficient ship servicing, and modern equipment to handle various types and volumes of cargo. Portland Harbor is the leading port in northern New England in terms of tonnage. Foreign and domestic cargo ships carried over 13.5 million tons of cargo to and from this port in 1979. The Existing Site is located inside the Precautionary Zone, but infrequent dumping will not affect shipping.

MILITARY ACTIVITIES

There are no known military activities in the area of the Existing Site that would be affected by dredged material disposal.

OIL AND GAS EXPLORATION AND DEVELOPMENT

The nearest present and proposed oil and gas leases, as part of the BLM Outer Continental Shelf (OCS) Oil and Gas Lease Sale No. 42, are on Georges Bank, far to the east and south of the Existing and Alternative Sites (BLM, 1977). There is no activity at or near the Sites, and there are no plans for exploratory drilling near the Sites.

MARINE SANCTUARIES

There are no marine sanctuaries designated in this region of the State that would be affected by dredged material disposal at the Existing Site.

The action of establishing a State Register of Critical Areas signaled official recognition of the need to protect Maine's natural diversity. The State of Maine Planning Office is charged with administering the Critical Areas Program created by the State Legislature in 1974 (Martin, 1979). Listed in their summary of the register of critical areas are:

- No. 42 Western Beach Least Tern and Piping Plover Nesting Area - A sandy beach area in Scarborough, 12 nmi from the Existing Site.

- No. 68 Upper Goose Island Heronny - A Great Blue Heron rookery in Harpswell, 14 nmi from the Existing Site.

No. 80 Stockman Island Eider Nesting Area in Cumberland, 105 nmi from the Existing Site.

No. 267 Sister Island Ledge Seabird Nesting Area - A colony of Common Terns in Freeport, 20 nmi from the Existing Site.

No. 269 Eagle Island Seabird Nesting Area - Breeding Eiders and a night heron population in Harpswell, 9 nmi from the site.

None of these sites are close enough to be affected by disposal at the Existing Site.

ACTIVE OCEAN DISPOSAL SITES (OTHER THAN THE EXISTING SITE)

Other ocean disposal sites in the vicinity of the Existing Site have been used in the past for dredged material disposal. All of these have been discontinued and it has been determined that they are not in favorable locations for future use. CE (1979) contains a history of dredging and disposal activities at those other sites, and Chapters 1 and 2 of this EIS contain a detailed discussion concerning the selection of the Existing Site. There are no other active ocean disposal sites off the coast of Maine.

PRESENT AND FUTURE STUDIES

Studies are being conducted at the Existing Site by Science Applications Inc. of Newport, Rhode Island as part of the ongoing Disposal Area Monitoring System (DAMOS) program for the New England Division, U.S. Amry Corps of Engineers, Waltham, Massachusetts. These studies are conducted semianually and include bathymetry, sediment chemistry, infauna analysis, and sampling for the Mussel Watch Program. Chemistry samples and the analyzed data are provided to the CE.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Most of the dredged material is expected to be retained within the boundaries of the Existing Site because of local bathymetric and oceanographic conditions. Adverse effects on fisheries resources, navigational safety, and aesthetics are minimized, thus eliminating the need for mitigating measures. Baseline data are unavailable for the Alternative Site near the Wilkinson Basin, and potential effects of dredged material on this area have not been established.

This chapter provides the scientific and analytical basis for evaluating and comparing the alternatives described in Chapter 2. Accordingly, the effects of dredged material disposal are classified under several headings. The public health and safety section discusses potential health and navigational hazards resulting from disposal activities. The ecosystem section describes the environmental effects of dredged material disposal and emergency dumping on water quality, sediment chemistry, and biota. A discussion of the effects of dumping on recreation, economics, and aesthetics of the area forms another section. In accordance with NEPA, adverse environmental effects and mitigating measures, short-term use versus long-term productivity, and irreversible and irretrievable commitments of resources are summarized.

The Existing Site is an offshore area of rugged, rocky outcrops interspersed with sediment traps or basins. Sediments within these basins closely resemble the fine sand, silt, and clay sediments dredged from Portland Harbor. The Existing Site has a moderate depth (62m), fine-grained sediments, weak currents, and can be characterized as a low-energy environment. Consequently, most of the dredged material will remain where it is dumped, and will not create a navigational hazard through shoaling. Transport of dredged material and disposal activities will not endanger public health and safety. Bacteria and viruses that may be associated with dredged material will not pose a threat to public health, as most will be killed soon after exposure to seawater and there are no shellfish beds in the immediate area. Most trace metals and chlorinated hydrocarbons will remain adsorbed onto sediment particles during and after disposal. However, these chemicals may be bioaccumulated by marine organisms, causing an unknown effect.

Potential adverse effects of dredged sediments on the biota include: (1) localized burial of exposed rocky outcrops and associated epifauna, and temporary or localized burial of some infaunal organisms within the sediment basins interspersed among the rocky outcrops, (2) temporary displacement of demersal finfish and lobster due to disturbance of their food sources and/or shelter, (3) changes in physical and chemical characteristics of sediments and water, and (4) introduction of pollutants to the surrounding sediments. The mobility of finfish and lobsters and the absence of detectable releases of toxic substances or a persistent turbidity plume minimizes the effects of dredged material disposal on commercially important species.

The Alternative Site is a deep, low-energy environment with fine-grained sediments or muds. Because of the depth (180m) dredged material may be dispersed over a large area following disposal. Mounding may occur, but will not create a navigational hazard because of the great depths.

Disposal activities at the Alternative Site are not expected to pose a threat to public health or water quality. Some trace metals may be added to the sediments but should not cause significant adverse effects.

Temporary and/or localized burial of benthic organisms may occur as a result of disposal activities. The effect of this impact is expected to be minimal. Little is known about the biota associated with the Alternative Site.

EFFECTS ON PUBLIC HEALTH AND SAFETY

One of the primary concerns of Federal regulatory agencies regarding ocean dumping is to provide guidelines to ensure that the health and safety of the public are not threatened. Three potential problems are: (1) shoaling of sediments within the disposal site, thus creating a potential navigation hazard, (2) tug and barge interference with boat traffic during transit to and from the disposal site and during dumping operations, and (3) introduction of potentially harmful pollutants and/or micro-organisms (bacteria, viruses) to the disposal site and surrounding environment.

SHOALING

EXISTING SITE

The bottom topography at the Existing Site is rugged, characterized by rocky outcrops and topographic lows (basins). Bottom sediments composed of clay, silt, and fine sand suggest that the site is a low-energy environment. The area is too deep to be significantly affected by storm waves or swells that could resuspend dredged material (Farrell, 1972), and may be too shallow desecent (Pequegnat et al, 1978). Furthermore, the rugged topography will retard the formation of the horizontally spreading bottom surge created by impact of the dredged material on the bottom (Holliday, et al., 1978). Therefore, most dredged material will be retained within the disposal site.

The largest of the sediment basins (0.11 nmi^2) is 62m deep and is used as the Point Disposal Location. The basin is surrounded by rocky outcrops 20m in height. Assuming a minimum depth of 50m for the top of a dredged material mound, the containment capacity of the basin is estimated to be 5 to 7 million yd^3 (DAMOS). Consequently, effects of shoaling will be minimal since the disposed material will not fill the basin to the level of the surrounding perimeter. No threat to navigation is expected.

ALTERNATIVE SITE

Localized shoaling of dredged material could occur at the Alternative Site, but would not pose a threat to navigation because of the great depths (180m). The presence, direction, and rate of sediment transport from the mound cannot be determined since site-specific, bottom current data are unavailable.

INTERFERENCE WITH NAVIGATION

EXISTING SITE

Tug and barge traffic between the dredging site and the disposal site will not interfere significantly with commercial shipping traffic. However, tug and barge traffic may be required to follow specific routes to avoid interference with lobster pot sets and dragging activities for finfish and shellfish. Dredging personnel are responsive to fishing interests and conflict is not expected.

ALTERNATIVE SITE

The Alternative Site is situated between the main approach channels to Portland Harbor from 3 and 7 nmi the nearest points of the southern and eastern channels, respectively. Neither the transit nor the discharge phases of dredged material disposal at the alternative site would affect navigation.

INTRODUCTION OF POTENTIALLY HARMFUL TOXINS AND/OR ORGANISMS

HARMFUL TOXINS

CE bioassay studies indicate that the discharges of dredged material from the Portland Harbor area would be ecological acceptable according to the criteria established in the ocean dumping regulations. In addition, most of the bioaccumulation tests performed indicate no potential for xemobiotic constituents of the material to accumulate in the human food chain. Mercury has not been demonstrated to biomagnify in the ecological food web.

Trace metals and chlorinated hydrocarbons (pesticides and derivatives) are unlikely to be released into the water during descent of the dredged material, as they are strongly adsorbed onto sediment particles (Chen et al., 1976; Murray and Norton, 1979). Trace metal and chlorinated hydrocarbon release is mitigated primarily by the pH and redox potential characteristic of seawater. Large variations in these parameters are required for major releases to occur, but these variations are unlikely, as seawater is highly buffered (Baram et al., 1978) and dilution factors are large, especially in well-mixed coastal waters.

Trace metals and chlorinated hydrocarbons are often concentrated in bottom sediments, but there is little evidence of these materials leaching into the overlying water (Chen et al., 1976; Murray and Norton, 1979). Benthic infauna may or may not accumulate toxins from the sediments (Hirsch et al., 1978; Swartz et al., 1979); however, the possibility of contaminating finfish and shellfish exists.

MICROBIOLOGY

Total and fecal coliforms may be indicators of contamination from sewage inputs, and signal the possibility that pathogenic organisms may be present. Human pathogenic bacteria and viruses released into the ODMDS from disposal of contaminated sediments may threaten nearby shellfish beds. Shellfish are able to filter and concentrate bacteria and viruses during feeding, thus human consumption of contaminated organisms could be potentially harmful. Sediments because the harbor received raw sewage from numerous sewer outfalls prior to installation of a secondary treatment plant at Fish Point in 1979 (CE, 1979a,b).

Some bacteria may remain alive within sediments deposited at the Existing or Alternative Sites because bacteria are actively adsorbed by clays and silts (Weiss, 1951). Attachment to particles during sedimentation (associated with disposal activities) will remove most bacteria from suspension and associated bacteria will remain primarily attached to the particles. Bacteria will utilize nutrients contained in disposal sediments (Gerba and McLeod, 1976), and their subsequent survival and reproduction will depend on the amount of organic material available.

Deposition of dredged material at the Existing or Alternative Sites may elevate concentrations of bacteria and viruses in the water after disposal, but those organisms are expected to be killed or removed quickly (Buelow et al., 1968). Certain characteristics of seawater rapidly kill enteric bacteria (Fisher, 1970). The most significant of these are the poorly understood bactericidal properties of seawater and predation by protozoans and nannoplankton. Consequently, water at the disposal site should not be significantly contaminated by enteric bacteria during the brief disposal activities. No threat to human health is expected at either the Existing or Alternative Sites because:

- Filter-feeding shellfish are uncommon in the disposal area, and the nearest commercially fished clam beds are over 6 nmi from the disposal sites (Coastal Planning Program, 1977)

- No recreational activities, such as swimming or diving, occur in the disposal areas

EFFECTS ON THE ECOSYSTEM

This section discusses the possible effects of dredged material disposal on water quality, sediments, and biota of the Existing and Alternative Sites. Certain factors can prevent or mitigate effects of ocean-disposed dredged material. Such mitigating processes include the ability of many benthic fauna to withstand burial, and to enter and recolonize the site.

WATER AND SEDIMENT QUALITY

EXISTING SITE

Baseline and monitoring investigations were not performed when the Existing Site was last used as a dump site about 1946. Recent investigations in other areas, however, provide a model for the effects of dredged material disposal on water and sediment characteristics.

Silty-clay sediments are being dredged from Portland Harbor by a clamshell dredge and transported in bottom-dumping scows. Dredged material excavated in this manner retains much of the in-place density because little or no water is added during clamshell dredging operations (Baram et al., 1978). As a result, most material falls rapidly to the bottom in the form of cohesive clods when released from the scow (Pequegnat et al., 1978). A bottom surge forms upon impact, composed of dredged material and indigenous sediment. The bottom surge is usually confined to a circular area approximately 200m in radius (Bokuniewicz et al., 1976), and is further restricted at the Existing Site because of the rugged topography (Holliday et al., 1978).

Turbidity of receiving waters is unavoidably increased temporarily; the amount of time the turbid plume is present is related to the general oceanographic conditions. Fine particles arising from partial collapse of the dredged material clods during descent and at impact forms a disposal plume (Pequegnat et al., 1978). Typically, the plume dissipates after a few hours. Numerous studies have concluded that the suspended loads are not sufficiently great to cause any short- or long-term adverse effects, except in those systems sensitive to water clarity, such as coral reefs and kelp beds (Flemer, 1970; Hirsch et al., 1978; Baram et al., 1978). Therefore, the short duration and irregular occurrence of a disposal plume at the Existing Site can be expected to have a minimal effect on the nektonic and benthic organisms.

The deposition of dredged material may release nutrients and/or toxic trace metals to the water. Nutrient releases may stimulate biological activity and may lead to localized population increases or "blooms" of phytoplankton

(Chen et al., 1976; Pequegnat et al., 1978). Ammonia is the only nutrient consistently released in great volumes during disposal operations (Windom, 1972, 1975, 1976). An increase in ammonia concentrations can stimulate productivity, but high concentrations may be toxic to some organisms (Natarjan, 1970; Brown and Currie, 1973; EPA, 1976). Rapid dilution and transport, however, are expected to reduce the concentrations to ambient levels before toxic or biostimulation effects can occur. Consequently, no significant adverse effects from nutrient release are expected as a result of dredged material disposal at the Existing Site.

Disposal operations at the Existing Site are not likely to have significant adverse effects on water quality. Toxic trace metal release from descending dredged material is controlled primarily by chemical properties of the water column, particularly the pH and redox potential (Baram et al., 1978). For example, manganese is released under reducing and oxidizing environments, whereas iron and, possibly, lead are released under reducing conditions (Lee et al., 1975). Other trace metals are reabsorbed, not released, or released in small amounts only (Chen and Wang, 1976; Lee et al., 1976). Large variations in pH and redox potential, which would allow major releases of trace metals, are unlikely because ocean waters are highly buffered (Baram et al., 1978).

Dredged sediments contain substances which are susceptible to oxidation by dissolved oxygen; thus these sediments often exert a slight oxygen demand as they descend through the water column. The initial oxygen decrease depends somewhat on the type of material dumped; clean sand/gravel O_2 demand being the lowest, and O_2 demanded by anoxic and organically-rich sediments being the highest (Baram et al., 1978). Surface dissolved oxygen concentrations were reduced by up to 2 ppm for 2 minutes before returning to ambient levels during pipeline disposal operations involving silt in San Francisco Bay (Tetra Tech, 1977). It is anticipated that dumping from a barge at the Existing Site will not reduce oxygen concentrations by this magnitude. However, even changes of this magnitude are unlikely to produce harmful effects on fishes or other organisms. Fishes can either swim to other areas or endure temporary reductions in dissolved oxygen levels to as low as 3 ppm (Prager, 1974), and numerous species of invertebrates can respire anaerobically during such periods of oxygen depletion (Moore, 1962).

Variations in nearshore concentrations of suspended solids nutrients and dissolved oxygen are often correlated with tidal periodicity (Holton et al., 1978) and/or seasonal resuspension of sediments from shallow areas (TRIGOM, 1974). Consequently, the natural fluctuation of these variables may be greater than, or obscure any changes resulting from, the disposal of dredged materials.

Sediments in the Existing Site and Portland Harbor were analyzed by NUSC (1971). Results indicate that concentrations of mercury, cadmium, and lead were higher in the harbor sediments than in disposal area sediments (Table A-7). Consequently, deposition of Portland Harbor areas sediments may elevate the concentrations of some trace metals in Existing Site sediments. This increase is not expected to significantly affect water quality because several studies (CE, 1982; Chen and Wong, 1976; Murray and Norton, 1979) suggest that the majority of trace metals are likely to remain within the sediment, with negligible release or leaching into the water column.

ALTERNATIVE SITE

Disposal operations at the Alternative Site may affect a larger area than at the Existing Site, simply because of the greater depths (180m) and greater dispersion. After disposal at a deepwater site the dredged material will remain in a cohesive clod and reach terminal velocity shortly after release from the scow. Shear stresses will rapidly develop within the clod, allowing entrainment of ambient water which will decrease the density and descent speed. As no pycnocline exists in winter months off Portland (Emery and Uchupi, 1972), the descending cloud will exhibit minimal collapse before bottom impact. In summertime, however, the descending cloud will encounter a pycnocline within the first 50m (Emery and Uchupi, 1972), and may suffer extensive vertical collapse and horizontal spreading before reaching the bottom (Pequegnat et al., 1978).

The topography of the Alternative Site is flat and featureless. Consequently, the bottom surge formed by the impact of the descending dredged material and indigenous sediment will not be restricted and can be expected to extend for at least 200m from the impact point (Bokuniewicz et al., 1976).

As discussed for the Existing Site, disposal operations at the Alternative Site are not likely to have long-term adverse effects on water turbidity or water quality. Deposition of Portland Harbor sediments, however, may elevate the concentrations of some trace metals within the sediments at the Alternative Site as is noted at the Existing Site.

BIOTA

In general, dredged material disposal presents four potential problems to aquatic organisms at disposal sites: (1) direct burial, (2) temporary increases in turbidity, (3) changes in physical and chemical characteristics of sediments and water, and (4) the introduction of pollutants. The conclusions of the DMRP concerning the impact of dredged sediments on biota are discussed below.

EXISTING SITE

Plankton

Effects of dredged material disposal on phytoplankton, zooplankton, and ichthyoplankton are difficult to assess because of high natural variability. In addition, the influence of tidal and river discharges, and diurnal changes in zooplankton and ichthyoplankton abundances, increase the difficulty of measuring disposal effects. Sullivan and Hancock (1977) concluded that for most oceanic areas natural fluctuations in plankton populations are so large that field surveys would not be useful for detecting the impacts of dredged material disposal.

Releases of dredged material will cause a short-term increase in turbidity. The usual result is a localized decrease in light penetration with a concomitant reduction of photosynthetic activity (Windom, 1976; Stern and Stickle, 1978), but the turbidity plumes are not persistent (Boone et al., 1978). No long-term changes in dissolved nutrients, trace metal concentrations, or phytoplankton primary productivity are attributable to dredged material disposal (Wright, 1978; Hirsh et al., 1978) and long-term adverse changes are not expected at the Existing Site.

Benthos

Many factors are important in determining the mortality and recovery of benthic organisms subjected to burial by the disposal of dredged material. Numerous investigations have demonstrated that disposal has a profound impact on the less mobile species, whereas active species are able to escape burial (Oliver et al., 1977; Richardson et al., 1977). Mortality is minimized and recovery maximized at sites which are naturally unstable due to wave or current action, and when the physical characteristics of the dredged sediments are similar to those at the disposal site (Saila et al., 1972; Oliver et al., 1977). Other factors which are important are the frequency of disposal, size of disposal area, and distance from colonizing sources (Oliver et al., 1972).

At the Existing Site dredged material composed of silt and fine sand will be dumped on a highly heterogenous bottom, ranging from exposed and rugged rocky outcrops to small sedimentary basins filled with silt and fine sand. Because of its depth (62m) and basin configuration, the Point Disposal Location is not significantly affected by waves and currents, and is considered a low-energy environment (DAMOS). Consequently, disposed material is likely to remain in the area.

Based on photographs of the disposal site (Appendix B), a diverse community inhabits the rocky outcrops. The community is dominated by attached species, such as brachiopods, erect and encrusting sponges, barnacles, anemones, tunicates, bryozoans and/or hydroids. Mobile species, such as asteroids, ophiuroids, and sea urchins, are present in low numbers. Large crustaceans were not observed, although their absence may be a sampling artifact, since highly mobile species may avoid the camera equipment.

Deposition of dredged material on the rocky outcrops will drastically alter the associated community. Many species will survive light sedimentation, although reproduction and subsequent larval settlement rates may be reduced. Increasing levels of sedimentation resulting from prolonged disposal operations will kill progressively more of the attached species, as well as the less mobile forms. A thick layer of fine-grained sediment will destroy rocky outcrop habitats. Because the Existing Site is a low-energy environment, the sediment layer will likely remain for a long period of time. Smothering of organisms is expected at the immediate dumpsite.

Deposition of dredged material into the sedimentary basins will modify the infaunal communities, although not as drastically as for the rocky substrate. Recovery should be relatively rapid.

The infaunal communities are dominated by polychaetes, although molluscs and crustaceans are present. Many of the polychaetes (20% to 50%) are small, tubicolous suspension feeders and may be smothered by dredged material. Most burrowers and deposit feeders will be relatively unaffected by light to moderate amounts of sedimentation.

Other small sedimentary basins within the Existing Site contain sediments similar in characteristics to the dredged material. By encroaching on the rocky habitats, disposal of dredged material may increase sediment surface areas of these basins. Assuming that the predisposal and postdisposal sediments are similar, the larger postdisposal sedimentary areas may support more species than the smaller predisposal areas because of the increased area available for colonization by sediment dwelling species. Larger surface areas support greater numbers of species (May, 1975).

Recovery rates within sedimentary basins may be fairly high because natural sediments and dredged material are similar and recolonization sources are nearby. Areas of similar sediment characteristics may serve as recolonizing sources. These areas include other basins within the ODMDS which are not affected by disposal, and areas to the south and west of the ODMDS. However, recolonization will be retarded if the dredged material contains excessive amounts of toxic substances (Engler, 1976; Prater and Anderson, 1977) and/or if disposal activities occur frequently over a prolonged period of time (Murray and Norton, 1979). However, neither of these conditions should occur, and recolonization is expected to occur rapidly. Most areas within the ODMDS are not unique to the region, and therefore, even worst-case effects do not represent a significant loss or impact.

Finfish and Shellfish

Dredged material disposal may be expected to affect the various life stages of finfish and shellfish in several ways:

- Interfere with feeding, respiration, and/or development
- Release toxic substances that will affect the general health of the organisms
- Interfere with feeding areas
- Interfere with nursery grounds

Adults of pelagic finfish are unlikely to be affected directly by dredged material disposal. Individuals are not dependent on specific areas and are expected to escape or avoid regions of disposal activity. Although populations of demersal fish may be restricted to local areas, these fishes are mobile, and burial by dumping would be unlikely.

Little is known about the effects of suspended sediment on egg and larval development of any fish species. No adverse effects have been observed in the development of winter flounder eggs covered with 3 mm of fine sediments; these fish spawn demersal eggs in estuarine areas and may be adapted to withstand thin layers of sediments (Baram et al., 1978). In another study, however, suspended sediment was found to have adverse effects on the larval stages of both winter flounder and striped bass (O'Connor et al., 1977).

Numerous laboratory experiments have reported suffocation of pelagic and demersal finfish by suspended sediment (Rogers, 1969; Sherk et al., 1974). The concentrations and exposures utilized, however, were unrealistically high compared to actual oceanic conditions (Baram et al., 1978). Suffocation of finfish by the deposition of dredged material at the Existing Site is not expected because of the rapid dilution and transient nature of the suspended sediment, and also because the fish are mobile and can avoid the turbid plume.

Dredged materials do not release significant amounts of toxic substances (e.g., trace metals, chlorinated hydrocarbons) as they descend to the bottom, but may adsorb some minute amounts of trace metals from the water during descent (Baram et al., 1978). Additional studies suggest that there is little leaching of toxic substances from newly deposited sediments into overlying water (Murray and Norton, 1979).

The extent to which benthic infauna can accumulate toxic substances from sediments is unclear. Some investigators report no accumulation (Hirsch et al., 1978), whereas others demonstrate significant bioaccumulation leading to death (Baram et al., 1978; Murray and Norton, 1979). If toxic substances are present, finfish that are relatively restricted to the region surrounding the Existing Site may or may not indirectly accumulate toxic substances from the dredged material via the food chain, or direct assimilation through gills and other membrances.

Numerous studies have demonstrated a correlation between polluted sediments and the incidence of finfish and shellfish disease, although no single causative factor has been identified (Mahoney et al., 1973; Young and Pearce, 1975; Ziskowski and Mirchelano, 1975; O'Connor, 1976; Murray and Norton, 1979). Consequently, it is not possible to predict whether deposition would induce finfish and shellfish disease at the Existing Site. Current levels of infection are not well documented.

Dredged material disposal may affect the diet and abundance of groundfish. In studies at the Columbia River ODMDS, Oregon, Durkin and Lipovsky (1977) attributed apparent changes in food preference and the decreases in finfish abundance, numbers of species, and mean size, to disposal operations. These effects were temporary, however, as food consumption patterns and abundances were similar to levels in control organisms within 1 to 6 months after disposal.

The adult Maine lobster (Homarus americanus) is highly tolerant to siltation and is not significantly or adversely affected by direct dredged material disposal. Some developmental stages of lobster larvae, however, are sensitive to specific particle size ranges and/or certain concentrations of suspended sediment (Cobb, 1976, cited in Baram et al., 1978).

Dredged material disposal may indirectly affect adult lobsters by altering or eliminating shelter. Atlantic lobsters are non-migratory when shelter and food are available, and seek hiding places in crevices, between boulders, and under rocks, algae, and bottom debris (Dow et al., 1975). The topography at the Existing Site is rocky, making it a suitable habitat for lobsters. Disposal of dredged material may decrease the desirability of this habitat, and the limited fishing effort in the area may indicate that few lobsters are present (NUSC, 1979).

All life stages of lobsters, shrimps, and crabs are susceptible to trace concentrations of commercial insecticides, especially chlorinated hydrocarbons and organic phosphates (Dow et al., 1975). These chemicals enter the marine environment primarily through freshwater runoff and atmospheric fallout.

The amount of chlorinated hydrocarbons (DDT, PCB) in sediments collected from the Existing Site are substantially less than for major harbor areas in the New York Bight (West et al., 1976; West and Hatcher, 1980).

Recent CE (1981, 1982) bioaccumulation studies concluded that five constituents (Cd, Hg, PCBs, DDT, and petroleum hydrocarbons) did not represent an unacceptable hazard to marine organisms through the mechanism of bioaccumulation.

Of all the trace metals, elevated levels of dissolved copper cause the highest rate of mortality in lobsters. An appreciable increase in the cooper concentration in water may cause death (Dow et al., 1975). The concentration of copper in sediments dredged from Portland Habor is substantially higher than that present in sediments at the Existing Site. However, the majority of trace metals (including copper) in dredged material remain associated with the particulate material and are not expected to enter the dissolved phase during or after dumping (Chen et al., 1976; Murray and Norton, 1979). Consequently, lobster mortality due to dissolved copper toxicity is not expected at the Existing Site. Bioaccumulation studies for trace metals have not been performed for sediments at the Existing Site.

Marine Mammals

Dredged material disposal involves negligible risk to marine mammals. Most marine mammals tend to avoid human activities; therefore, the probability of an animal colliding with a tug and barge, or being caught in the release of dredged material, is small. Whereas the ability of whales to avoid collision with a hopper dredge may seem intuitively obvious, scars left by the propellers of high-speed outboard motor boats have occasionally been noted on seals and sea lions. The slow speed of a hopper dredge, however, allows ample response time for marine mammals to avoid the vessel. Cetaceans and pinnipeds are strong swimmers and are expected to escape the dredged material release zone.

Presumably, most cetaceans migrate through the Gulf of Maine to southern breeding grounds or northern feeding areas. However, it is not known that they migrate through the Existing Site. Considering the brief presence in the area and infrequent feeding of whales during migration, the limited size of the site, and the trace levels of constituents in the dredged material and their limited bioavailability, a threat to whales by contamination from dredged material disposal at the Existing Site is not expected. Exceptions are the harbor porpoise, which inhabit the coastal area throughout the year, and the pilot whale, which apparently follows the seasonal onshore-offshore migrations of squid. The infrequent disposal of dredged material at the Existing Site is not expected to significantly alter the migrations or movements of cetaceans.

Significant uptake of contaminants by prey organisms, and possible depletion of the latter, are highly unlikely due to the short postdisposal residence time of dredged material in the water column, and the dynamics of fish and zooplankton populations. Even in a worst-case analysis, it is inconceivable that migrating whales could be affected by the limited amounts of water column organisms affected by disposal at the Existing Site.

Much of this analysis applies to pinnipeds as well. Harbor seals breed, feed, and migrate throughout the Gulf of Maine, but these activities are confined primarily inshore of the Existing Site. A few gray seals are present in the warmer months. The breeding and haulout areas of harbor and gray seals are far from the Existing Site and no impact is expected. The lack of significant expected impact on the fish populations suggests that pinniped food quality or quantity will not be affected.

<u>Threatened and Endangered Species</u>

Six species of endangered whales and three species of endangered turtles have been observed within the Gulf of Maine at certain times of the year. Only the finback and humpback whales and the ridley and leatherback turtles occur in the vicinity of the Existing Site. Infrequent and localized ocean disposal of dredged material is not expected to have a significant effect on any of these endangered species.

The bald eagle commonly occurs along the Gulf of Maine coast, but no nests have been located within 22 nmi from the Existing Site within the past 18 years. Furthermore, Maine eagles nesting near marine environments tend to utilize nonfish prey, especially during winter (Fefer and Schettig, 1980). Consequently, it is unlikely that dredged material disposal at the Existing Site would interfere with the nests or food resources of this endangered bird.

ALTERNATIVE SITE

No site-specific information regarding the composition and abundances of the Alternative Site fauna is available. The site is only 15 nmi southeast of the Existing Site and is subjected to similar oceanographic conditions. Consequently, planktonic and nektonic species at the Alternative Site are likely to resemble those at the Existing Site. The effects of dredged material disposal are expected to be similar at both sites.

Benthic communities at the two sites may not be comparable. In general, benthic communities in the Gulf of Maine vary widely from one area to another, reflecting the complex and variable bathymetry of the Gulf. The Alternative Site is nearly 150m deeper than the Existing Site and is characterized by soft, brown and gray sediments. Consequently, the deposition of silty-clay dredged materials could cause a minimal change in sediment texture, and subsequent recovery of the impacted infauna communities may occur rapidly. However, insufficient information exists for the Alternative Site to justify designation as a disposal area without additional study.

EMERGENCY DUMPING

The seafloor between the dredging site and disposal area is composed primarily of rocky outcrops, with some accumulations of gravel. Deposition of the silty-clay dredged material as a result of short dumping would add sediment that is different from natural sediments. This could have several adverse effects. First, rock-associated epifauna might be killed and recovery rates of this community could be very long. Secondly, important lobster fishing grounds are located in this area during summer and short dumping may reduce sources of food or shelter. Finally, Atlantic herring may be affected, as they spawn demersal eggs on clean sand or gravel in nearshore areas of high current flow.

Short dumping would be expected to result in significant adverse effects, as these areas are important shellfish and finfish fishing grounds. The possibilities of an emergency dump increase if the disposal site is moved further offshore, particularly during marginal and deteriorating weather conditions. It is, therefore, important to maintain the disposal site as near as possible to the dredging area.

EFFECTS ON RECREATION, ECONOMICS, AND AESTHETICS

FISHERIES

EXISTING SITE

A previously proposed dredged material disposal site was rejected by commercial fishermen because they believed its use would interfere with fishing activities (NUSC, 1979). Subsequently, the fishermen recommended the Existing Site's location because of its limited interference with commercial fishing. This site was specifically selected for the following reasons: (1) it was not within a dragging area, (2) it was situated at least a mile from any tow path, and (3) the bathymetry and current speed and direction would prevent the transport of material toward the dragging grounds (NUSC, 1979).

The nearest primary dragging ground is approximately 1.5 nmi to the east (offshore) of the Existing Site. In summer up to 10 vessels per day may fish these areas, and the number increases to as many as 25 vessels per day in the winter and early spring (NUSC, 1979).

Commercial finfish are mobile and direct burial of pelagic or demersal species is not expected. Furthermore, dredged material will not significantly effect the dragging grounds as bathymetric and oceanographic conditions will confine most of the dredged material to the disposal area. Disposal is not expected to result in measured suffocation from gill clogging or exposure to toxic substances.

Most of the commercially important finfish spawn pelagic eggs far offshore of the Existing Site and will not be affected by dredged material disposal. The silver hake, however, spawns pelagic eggs in a broad, nearshore spawning area extending from Cape Cod to the Bay of Fundy. The Existing Site is within this region but represents an extremely small portion of the total area. Consequently, dredged material disposal will not significantly affect the recruitment of silver hake to the Gulf of Maine. Two other commercial species spawn demersal eggs, but neither are likely to utilize the benthos at the Existing Site. The Atlantic herring requires clean sand or gravel in nearshore regions of high current flow, and the winter flounder prefers shallow estuarine water.

Most of the lobster fishery occurs inshore of the Existing Site. Lobsters move shoreward into warmer water beginning in late spring, and by mid-summer, most lobstering is confined to waters less than 20m deep. The fishery moves into deeper water during November to April and the Existing Site experiences minor lobstering during this period. Less than five vessels fish this depth region, although several hundred pots may be set (NUSC, 1979).

Adult lobsters are highly tolerant of siltation and disposal activities should not affect either resident or migrating lobsters within the Existing Site. Some developmental stages of lobster larvae are sensitive to suspended solids; lobster larvae are present in the water from May to October and may be locally affected by dredged material disposal during this period. The disposal plume, however, is relatively small and lasts a short time, and should not significantly affect lobster recruitment within the Gulf of Maine.

ALTERNATIVE SITE

According to a survey of demersal fish conducted by NOAA (1976a,b) commercial species of finfish and shellfish are not abundant in deeper areas immediately surrounding the Alternative Site. Witch flounder were moderately abundant at an area 5 nmi northeast of the Alternative Site, but other species were absent or uncommon. Moderate amounts of American plaice and low numbers of red and white hake, cod, and shrimp were present at a station 11 nmi from the Alternative Site.

Jeffreys Ledge and Platts Bank (Figure 1-1) are two of the major fishing grounds in the North Atlantic (TRIGOM, 1974). They are 10 nmi southwest and southeast of the Alternative Site, respectively, and are much shallower than the Alternative Site. Haddock and silver hake (seasonally) form the major fisheries in these areas; redfish, American plaice, and witch flounder are somewhat less important. Jeffreys Ledge is an important sportfishing area as well, where anglers catch cod, haddock, cusk, and halibut (DOI, 1977). Disposal of dredged material at the Alternative Site is not expected to affect the fisheries on Jeffreys Ledge or Platts Bank.

No spawning grounds are known to occur within the Alternative Site, although silver hake and Atlantic herring spawn in nearby (2.2 nmi), nearshore areas (NUSC, 1979). Neither are likely to be affected by dredged material disposal, for reasons discussed previously. Consequently, dredged disposal activities are not expected to adversely affect fisheries within Wilkinson Basin.

AESTHETICS

Disposal of dredged materials at either the Existing or Alternative Site will create a near-surface turbidity plume which may require several hours to dissipate. Most of the dredged material will fall rapidly as an intact, dense cloud, but fine particles arising from partial collapse of the cloud during descent and at impact will form a plume (Pequegnat et al., 1978). At either site surface currents will transport the plume horizontally. Disposal operations are conducted infrequently, however, and effects on aesthetics are temporary and will, most likely, only be noticed by boaters operating in the immediate area.

Excessive noise resulting from dredged material disposal is unlikely at either the Existing or Alternative Site. Disposal activities require a tug and barge and operational sounds will be similar to sounds from other boat traffic in the area.

The dredged material contains highly reduced sediments and the aromatic smell will be quite apparent when near the barge. This effect is temporary and will be noticed only in a small area during transport and dumping.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

None of the environmental effects attributed to dredged material disposal at the Existing Site are known to degrade the marine environment outside the actual disposal site. Only relatively minor effects have occurred within the site itself. Consequently, mitigating measures are not required to protect the environment outside of the Existing Site, since significant unavoidable adverse environmental effects do not occur.

Unavoidable adverse effects which occur within the site include minor changes in bathymetry, sediment grain size distribution, demersal fish distribution, and benthic community composition. Only bathymetric changes (mounding) can be significantly mitigated by the site designation. The other changes are minor and localized at the Existing Site. Similar slight effects would be expected to occur within any designated site over a soft sediment substrate in the Gulf of Maine.

Mounding is not a problem at the Existing Site even though point dumping is employed, because the site is a natural sediment basin or pocket located in deep water (60m). This basin can accommodate all of the material generated by the Portland dredging activities over the next 5 years and still maintain a water depth in excess of 40m.

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Disposal operations do not interfere with the long-term use of any of the resources of the area. Neither commercial nor sportfishing efforts in the Site vicinity are significant or could be impaired by disposal operations. The associated species of finfish and shellfish of the region are not endangered by the disposal operations. In particular, the valuable lobster fishery shoreward of the site is not affected by dredged material disposal operations.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

The only irreversible or irretrievable resources committed to the disposal operation are:

- Loss of energy in the form of fuel for the dredge and tug
- Loss of economic resource because of the cost associated with the dumping operation (opportunity costs)

These losses, however, are insignificant in comparison with the advantages of disposing of Portland Harbor dredged material at the Existing Site, as discussed in Chapter 2.

CHAPTER 5

COORDINATION

This Final EIS was issued by the Environmental Protection Agency's Ocean Dumping EIS Task Force. This document was based on a Preliminary Draft EIS prepared by Interstate Electronic Corporation. Reviews and revisions were prepared by Frank G. Csulak. Additional reviews and support were provided by the members of the EIS Task Force:

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Commenters on the Draft EIS

The following persons submitted written comments on the Draft EIS. Their letters and responses can be located in Appendix E.

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Preparation of the Preliminary EIS was a joint effort employing many scientific and technical members of the Ocean Science Department in the Oceanic Engineering Operation of Interstate Electronic Corporation.

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Chapter 6

GLOSSARY, ABBREVIATIONS, AND REFERENCES

GLOSSARY

ABUNDANCE	The number of individuals of a species inhabiting a given area. Normally, a community of several component species will inhabit an area. Measuring the abundance of each species is one way of estimating the comparative importance of each component species.
ADSORB	To adhere in an extremely thin layer of molecules to the surface of a solid or liquid.
ALKALINITY	The number of milliequivalents of hydrogen ions neutralized by one liter of seawater at 20°C. Alkalinity of water is often taken as an indicator of its carbonate, bicarbonate, and hydroxide content.
AMBIENT	Pertaining to the undisturbed or unaffected conditions of an environment.
AMPHIPODA	An order of crustaceans (primarily marine) with laterally compressed bodies, which generally appear similar to shrimp. The order consists primarily of three groups: hyperiideans, which inhabit open ocean areas; gammarideans, which are primarily bottom dwellers; and caprellideans, common fouling organisms.
ANTHROPOGENIC	Relating to the effects or impacts of man on nature. Construction wastes, garbage, and sewage sludge are examples of anthropogenic materials.
APPROPRIATE SENSITIVE BENTHIC MARINE ORGANISMS	Pertaining to bioassay samples required for ocean dumping permits, "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" (40 CFR §227.27).
APPROPRIATE SENSITIVE MARINE ORGANISMS	Pertaining to bioassay samples required for ocean dumping permits, "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" (40 CFR §227.27).
ASSEMBLAGE	A group of organisms sharing a common habitat.

BACKGROUND LEVEL — The naturally occurring concentration of a substance within an environment which has not been affected by unnatural additions of that substance.

BASELINE CONDITIONS — The characteristics of an environment before the onset of an action which can alter that environment; any data serving as a basis for measurement of other data.

BASELINE SURVEYS AND BASELINE DATA — Surveys and data collected prior to the initiation of actions which may alter an existing environment.

BENTHOS — All marine organisms (plant or animal) living on or in the bottom of the sea.

BIOACCUMULATION — The uptake and assimilation of materials (e.g., heavy metals) leading to elevated concentrations of the substances within organic tissue, blood, or body fluid.

BIOASSAY — A method for determining the toxicity of a substance by the effect of varying concentrations on growth or survival of suitable plants, animals or micro-organisms; the concentration which is lethal to 50% of the test organisms or causes a defined effect in 50% of the test organisms, often expressed in terms of lethal concentration (LC_{50}) or effective concentration (EC_{50}), respectively.

BIOMASS — The quantity (wet weight) of living organisms inhabiting a given area or volume at any time; often used as a means of measuring the productivity of an ecosystem.

BIOTA — Animals and plants inhabiting a given region.

BIOTIC GROUPS — Assemblages of organisms which are ecologically, structurally, or taxonomically similar.

BLOOM — A relatively high concentration of phytoplankton in a body of water resulting from rapid proliferation during a time of favorable growing conditions generated by nutrient and sunlight availability.

BOD — Biochemical Oxygen Demand or Biological Oxygen Demand; the amount of dissolved oxygen required by aerobic micro-organisms to degrade organic matter in a sample of water usually held in the dark at 20°C for 5 days; used to assess the potential rate of substrate degradation and oxygen utilization in aquatic ecosystems.

BOREAL — Pertaining to the northern geographic regions.

CEPHALOPODS — Exclusively marine animals constituting the most highly evolved class of the phylum Mollusca (e.g., squid, octopus, and *Nautilus*).

CHAETOGNATHA	A phylum of small planktonic, transparent, wormlike invertebrates known as arrow-worms; they are often used as water-mass tracers.
CHLORINITY	The quantity of chlorine equivalent to the quantity of halogens contained in 1 kg of seawater; may be used to determine seawater salinity and density.
CHLOROPHYLL _a_	A specific chlorophyll pigment characteristic of higher plants and algae; frequently used as a measure of phytoplankton biomass.
CHLOROPHYLLS	A group of oil-soluble, green plant pigments which function as photoreceptors of light energy for photosynthesis and primary productivity.
COELENTERATA	A large diverse phylum of primarily marine animals, members possessing two cell layers and an incomplete digestive system, the opening of which is usually surrounded by tentacles. This group includes hydroids, jellyfish, corals and anemones.
COLIFORMS	Bacteria residing in the colons of mammals; generally used as indicators of fecal pollution.
CONTINENTAL RISE	A gentle slope with a generally smooth surface between the Continental Slope and the deep ocean floor.
CONTINENTAL SHELF	That part of the Continental Margin adjacent to a continent extending from the low water line to a depth, generally 200m, where the Continental Shelf and the Continental Slope join.
CONTINENTAL SLOPE	That part of the Continental Margin consisting of the declivity from the edge of the Continental Shelf down to the Continental Rise.
CONTOUR LINE	A line on a chart connecting points of equal elevation above or below a reference plane, usually mean sea level.
CONTROLLING DEPTH	The least depth in the approach or channel to an area, such as a port, governing the maximal draft of vessels which can enter.
COPEPODS	A large diverse group of small planktonic crustaceans representing an important link in oceanic food chains.
CRUSTACEA	A class of arthropods consisting of animals with jointed appendages and segmented exoskeletons composed of chitin. This class includes barnacles, crabs, shrimps and lobsters.
CURRENT DROGUE	A surficial current measuring assembly consisting of a weighted current cross, underwater sail or parachute and an attached surface buoy; it moves with the current so that average current velocity and direction can be obtained.

CURRENT METER An instrument for measuring the speed of a current, and often the direction of flow.

DECAPODA The largest order of crustaceans; members have five sets of locomotor appendages, each joined to a segment of the thorax; includes crabs, lobsters, and shrimps.

DEMERSAL Living at or near the bottom of the sea.

DENSITY The mass per unit volume of a substance, usually expressed in grams per cubic centimeter (1g water in reference to a volume of 1 cc @ 4°C).

DETRITIVORES Animals which feed on detritus; also called deposit-feeders.

DETRITUS Product of decomposition or disintegration; dead organisms and fecal material.

DIATOMS Microscopic phytoplankton characterized by a cell wall of overlapping silica plates. Sediment and water column populations vary widely in response to changes in environmental conditions.

DIFFUSION Transfer of material (e.g., salt) or a property (e.g., temperature) under the influence of a concentration gradient; the net movement is from an area of higher concentration to an area of lower concentration.

DINOFLAGELLATES A large diverse group of flagellated phytoplankton with or without a rigid outer shell, some of which feed on particulate matter. Some members of this group are responsible for toxic red-tides.

DISCHARGE PLUME The region of water affected by a discharge of waste which can be distinguished from the surrounding water.

DISPERSION The dissemination of discharged matter over large areas by natural processes (e.g., currents).

DISSOLVED OXYGEN The quantity of oxygen (expressed in mg/liter, ml/liter or parts per million) dissolved in a unit volume of water. Dissolved oxygen (DO) is a key parameter in the assessment of water quality.

DIVERSITY (species) A statistical measurement which generally combines the measure of the total number of species in a given environment and the number of individuals of each species. Species diversity is high when it is difficult to predict the species or the importance of a randomly chosen individual organism, and low when an accurate prediction can be made.

DOMINANT SPECIES — A species or group of species which, because of their abundance, size, or control of the energy flow, strongly affect a community.

EBB CURRENT, EBB TIDE — Tidal current moving away from land or down a tidal stream.

ECHINODERMS — Exclusively marine animals which are distinguished by radial symmetry, internal skeletons of calcareous plates, and water-vascular systems which serve the needs of locomotion, respiration, nutrition, or perception; includes starfishes, sea urchins, sea cucumbers and sand dollars.

ECONOMIC RESOURCE ZONE — The oceanic area within 200 nmi from shore in which the adjacent coastal state possesses exclusive rights to the living and non-living marine resources.

ECOSYSTEM — The organisms in a community together with their physical and chemical environments.

EDDY — A circular mass of water within a larger water mass which is usually formed where currents pass obstructions, either between two adjacent currents flowing counter to each other, or along the edge of a permanent current. An eddy has a certain integrity and life history, circulating and drawing energy from a flow of larger scale.

ENDEMIC — Restricted or peculiar to a locality or region.

ENTRAIN — To draw in and transport by the flow of a fluid.

EPIFAUNA — Animals which live on or near the bottom of the sea.

EPIPELAGIC — Of, or pertaining to, that portion of the oceanic zone into which enough light penetrates to allow photosynthesis; generally extends from the surface to about 200m.

ESTUARY — A semienclosed coastal body of water which has a free connection to the sea, commonly the lower end of a river, and within which the mixing of saline and fresh water occurs.

FAUNA — The animal life of any location, region, or period.

FINFISH — Term used to distinguish "normal" fish (e.g., with fins and capable of swimming) from shellfish, usually in reference to the commercially important species.

FLOCCULATION — The process of aggregating a number of small, suspended particles into larger masses.

FLOOD TIDE, FLOOD CURRENT — Tidal current moving toward land, or up a tidal stream.

FLORA	The plant life of any location, region, or period.
GASTROPODS	Molluscs which possess a distinct head (generally with eyes and tentacles), a broad, flat foot, and usually a spiral shell (e.g., snails).
GYRE	A closed circulation system, usually larger than an eddy.
HERBIVORES	Animals which feed chiefly on plants.
HOPPER DREDGE	A self-propelled vessel with capabilities to dredge, store, transport, and dispose of dredged materials.
HYDROGRAPHY	That science which deals with the measurement of the physical features of waters and their marginal land areas, with special reference to the factors which affect safe navigation, and the publication of such information in a form suitable for use by navigators.
ICHTHYOPLANKTON	That portion of the planktonic mass composed of fish eggs and weakly motile fish larvae.
INDICATOR SPECIES	An organism so strictly associated with particular environmental conditions that its presence is indicative of the existence of such conditions.
INDIGENOUS	Having originated in, being produced, growing, or living naturally in a particular region or environment; native.
INFAUNA	Aquatic animals which live in the bottom sediment.
INITIAL MIXING	Dispersion or diffusion of liquid, suspended particulate, and solid phases of a waste material which occurs within 4 hours after dumping.
IN SITU	[Latin] In the original or natural setting (in the environment).
INTERIM DISPOSAL SITES	Ocean disposal sites tentatively approved for use by the EPA.
INVERTEBRATES	Animals lacking a backbone or internal skeleton.
ISOBATH	A line on a chart connecting points of equal depth below mean sea level.
ISOTHERMAL	Approximate equality of temperature throughout a geographical area.
LARVA	A young and immature form of an organism which must usually undergo one or more form and size changes before assuming characteristic features of the adult.

LITTORAL	Of or pertaining to the seashore, especially the regions between tide lines.
LONGSHORE CURRENT	A current which flows in a direction parallel to a coastline.
LORAN-C	Long Range Aid to Navigation, type C; low-frequency radio navigation system having a range of approximately 1,500 mi radius.
MAIN SHIP CHANNEL	The designated shipping corridor leading into a harbor.
MAINTENANCE DREDGING	Periodic dredging of a waterway, necessary for continued use of the waterway.
MESOPELAGIC	Pertaining to depths of 200m to 1,000m below the ocean surface.
MICRONUTRIENTS	Microelements, trace elements, or substances required in minute amounts; essential for normal growth and development of an organism.
MIXED LAYER	The upper layer of the ocean which is well mixed by wind and wave activity.
MLT	Mean Low tide; the average height of all low tides measured over an 18.6-year period at a specific site.
MLW	Mean Low Water; the average height of all low waters at a specific place.
MOLLUSCA	A phylum of unsegmented animals most of which possess a calcareous shell; includes snails, mussels, clams, and oysters.
MONITORING	As used herein, observation of environmental effects of disposal operations through biological and chemical data collection and analyses.
NEKTON	Free swimming aquatic animals which move independently of water currents.
NEMATODA	A phylum of free-living and parasitic unsegmented worms; found in a wide variety of habitats.
NERITIC	Pertaining to the region of shallow water adjoining the seacoast, and extending from the low-tide mark to a depth of about 200m.
NEUSTON	Organisms which are associated with the upper 5 to 20 cm of water; mainly composed of copepods and ichthyoplankton.
NUISANCE SPECIES	Organisms of no commercial value, which, because of predation or competition, may be harmful to commercially important organisms.

NUTRIENT-LIGHT REGIME — The overall combination of nutrients and light in the environment as they relate to photosynthesis.

OMNIVOROUS — Pertaining to animals which feed on animal and plant matter.

ORGANOHALOGEN PESTICIDES — Pesticides whose chemical constitution includes the elements carbon and hydrogen, plus a common element of the halogen family: bromine, chlorine, fluorine, or iodine.

ORTHOPHOSPHATE — One of the salts of orthophosphoric acid; an essential nutrient for plant growth.

OXIDE — A binary chemical compound in which oxygen is combined with another element, metal, nonmetal, gas, or radical.

PARAMETER — Values or physical properties which describe the characteristics or behavior of a set of variables.

PATHOGEN — An entity producing or capable of producing disease.

PCB(s) — Polychlorinated biphenyl(s); any of several chlorinated compounds having various industrial applications. PCB's are highly toxic pollutants which tend to accumulate in the environment.

PELAGIC — Pertaining to water of the open ocean beyond the Continental Shelf and above the abyssal zone.

PERTURBATION — A disturbance of a natural or regular system; any departures from an assumed steady state of a system.

pH — The acidity or alkalinity of a solution, determined by the negative logarithm to the base 10 of the hydrogen ion concentration (in gram-atoms per liter), ranging from 0 to 14 (lower than 7 is acid, higher than 7 is alkaline).

PHOTIC ZONE — The layer of a body of water that receives sufficient sunlight for photosynthesis.

PHYTOPLANKTON — Minute passively floating plant life in 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 in a body of water.

PLUME — A patch of turbid water, caused by the suspension of fine particles following a disposal operation.

POLYCHAETA — The largest class of the phylum Annelida (segmented worms); benthic marine worms distinguished by paired, lateral, fleshy appendages provided with bristles (setae) on most segments.

PRECIPITATE — A solid which separates from a solution or suspension by chemical or physical change.

PRIMARY PRODUCTIVITY — The amount of organic matter synthesized by producer organisms (primarily plants) from inorganic substances per unit time and volume of water. Plant respiration may or may not be subtracted (net or gross productivity, respectively).

PROTOZOANS — Mostly microscopic, single-celled animals which constitute one of the largest populations in the ocean. Protozoans play a major role in the recycling of nutrients.

QUALITATIVE — Pertaining to the non-numerical assessment of a parameter.

QUANTITATIVE — Pertaining to the numerical measurement of a parameter.

RECRUITMENT — Addition to a population of organisms by reproduction or immigration of new individuals.

RELEASE ZONE — An area defined by the locus of points 100m from a vessel engaged in dumping activities; will never exceed the total surface area of the dumpsite.

RUNOFF — That portion of precipitation upon land which ultimately reaches streams, rivers, lakes and oceans.

SALINITY — The amount of salts dissolved in water; expressed in parts per thousand ($^o/oo$, or ppt).

SEA STATE — The numerical or written description of wind-generated waves on the surface of the sea; ranges from 1 (smooth) to 8 (mountainous).

SHELF WATER — Water which originates in, or can be traced to the Continental Shelf, differentiated by characteristic temperature and salinity.

SHELLFISH — Any invertebrate, usually of commercial importance, having a rigid outer covering, such as a shell or exoskeleton; includes some molluscs and arthropods; term is the counterpart of finfish.

SHIPRIDER — A shipboard observer, assigned by the U.S. Coast Guard to ensure that a waste-laden vessel is dumping in accordance with permit specifications.

SHORT DUMPING — The premature discharge of waste from a vessel anywhere outside designated disposal sites. This may occur legally under emergency circumstances, or illegally to avoid hauling to a designated site.

SLOPE WATER	Water which orginates from, occurs at, or can be traced to the Continental Slope, differentiated by characteristic temperature and salinity.
SPECIES	A group of morphologically similar organisms capable of interbreeding and producing fertile offspring.
STANDARD ELUTRIATE ANALYSIS	A test used to determine the types and amounts of constituents which can be extracted from a known volume of sediment by mixing with a known volume of water.
STANDING STOCK	The biomass or abundance of living material per unit volume of water, or area of sea-bottom.
SUBSTRATE	The solid material upon which an organism lives, or to which it is attached (e.g., rocks, sand).
SURVEILLANCE	Systematic observation of an area by visual, electronic, photographic, or other means for the purpose of ensuring compliance with applicable laws, regulations, permits, and safety.
SUSPENDED SOLIDS	Finely divided particles of a solid temporarily suspended in a liquid (e.g., soil particles in water).
THERMOCLINE	A vertical temperature gradient in some layer of a body of water, which is appreciably greater than the gradients above or below it; a layer in which such a gradient occurs.
TRACE METAL OR ELEMENT	An element found in the environment in extremely small quantities; usually includes metals constituting 0.1% (1,000 ppm) or less, by weight, in the earth's crust.
TRANSMITTANCE	In defining water clarity, an instrument which can transmit a known quantity of light through a standard distance of water to a collector. The percentage of the beam's energy which reaches the collector is expressed as transmittance.
TREND ASSESSMENT SURVEYS	Surveys conducted over long periods to detect shifts in environmental conditions within a region.
TROPHIC LEVELS	Discrete steps along a food chain in which energy is transferred from the primary producers (plants) to herbivores and finally to carnivores and decomposers.
TURBIDITY	Cloudy or hazy appearance in a naturally clear liquid caused by a suspension of colloidal liquid droplets, fine solids, or small organisms.
VECTOR	A straight or curved line representing both direction and magnitude.

WATER MASS	A body of water, identified by its temperature-salinity values, or chemical composition, consisting of a mixture of two or more water types.
ZOOPLANKTON	Weakly swimming animals whose distribution in the ocean is ultimately determined by current movements.

ABBREVIATIONS

BLM	Bureau of Land Management
C	Carbon
°C	Degrees Centigrade
CE	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
DA	District Administrator (CE)
DAMOS	Disposal Area Monitoring System
DMRP	Dredged Material Research Program
DO	Dissolved Oxygen
DOC	U.S. Department of Commerce
DOC	dissolved organic carbon
DOI	U.S. Department of the Interior
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FDA	Food and Drug Administration
FWPCA	Federal Water Pollution Control Act
FWPCAA	Federal Water Pollution Control Act Amendments
g	gram(s)
hr	hour(s)
IEC	Interstate Electronics Corporation
IMCO	Inter-Governmental Maritime Consultative Organization
k	kilogram(s)
kHz	kilohertz
km	kilometer(s)
kn	knot(s)
m	meter(s)
m^2	square meter
mg	milligram(s)
mlt	mean low tide
mlw	mean low water
mm	millimeter(s)
MPRSA	Marine Protection, Research, and Sanctuaries Act

N	north
ng	nanogram
NEPA	National Environmental Policy Act
nmi	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOO	Naval Oceanographic Office
NTU	Nephelometric turbidity units
NUSC	Naval Underwater Systems Center
OCS	Outer Continental Shelf
ODMDS	Ocean Dredged Material Disposal Site
PL	Public Law
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand = $^{o}/oo$
$^{o}/oo$	parts per thousand
%	percent
RA	Regional Administrator (EPA)
s	second(s)
SAI	Science Applications Inc.
TOC	total organic carbon
TRIGOM	The Research Institute Gulf of Maine
TSS	total suspended solids
μ	micron
μg	microgram(s)
μg-at	microgram atom(s)
umole	micromole
USCG	U.S. Coast Guard
USGS	U.S. Geological Survey
W	west
wt	weight
yd	yard(s)
yd^3	cubic yard(s)
yr	year(s)

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Appendix A

SURVEY METHODS, RESULTS, AND INTERPRETATIONS

Appendix A

CONTENTS

ILLUSTRATIONS

TABLES

Appendix A

SURVEY METHODS, RESULTS, AND INTERPRETATIONS

Field surveys at the Portland, Maine ODMDS were conducted between 15 and 19 June 1979, and between 8 and 11 April 1980, by Interstate Electronics Corporation (IEC) under contract to EPA (Contract Number 68-01-4610). The purpose of the surveys was to collect biological, chemical, geological, and physical oceanographic data to assess the effects of dredged material disposal on the marine environment and to augment existing information for the area. A major consideration of survey design was to assess whether any adverse effects measured within the ODMDS were detectable outside of the site boundaries.

The standard IEC/EPA survey program was planned for the first survey in June 1979. Because of extensive rock outcrops on the seafloor, weather, and equipment conditions, the first survey sampling was limited to the water column at all stations, and box cores at Stations 4 and 7. Based on the information obtained in 1979 about the seafloor at the Existing Site, a revised survey plan to examine the biota associated with the rock outcrops was developed. In 1980 sediment samples were collected at Stations 1 and 7 (Figure A-1). In addition, eight new stations were established in and around the Point Disposal location (PDL) in the topographically complex area to collect videotape and black and white photographs for analysis of the epifauna (Figure B-1).

Physical/chemical and biological (infauna) survey results and discussions are presented herein; additional biological data (epifauna) are discussed in Appendix B, and these discussions are summarized in Chapter 3. Methods of data collection, analysis, and procedures are presented in the following sections.

METHODS

The first survey operation (June 1979) was conducted using the Ocean Survey Vessel ANTELOPE; the second survey (April 1980) was conducted from the RV

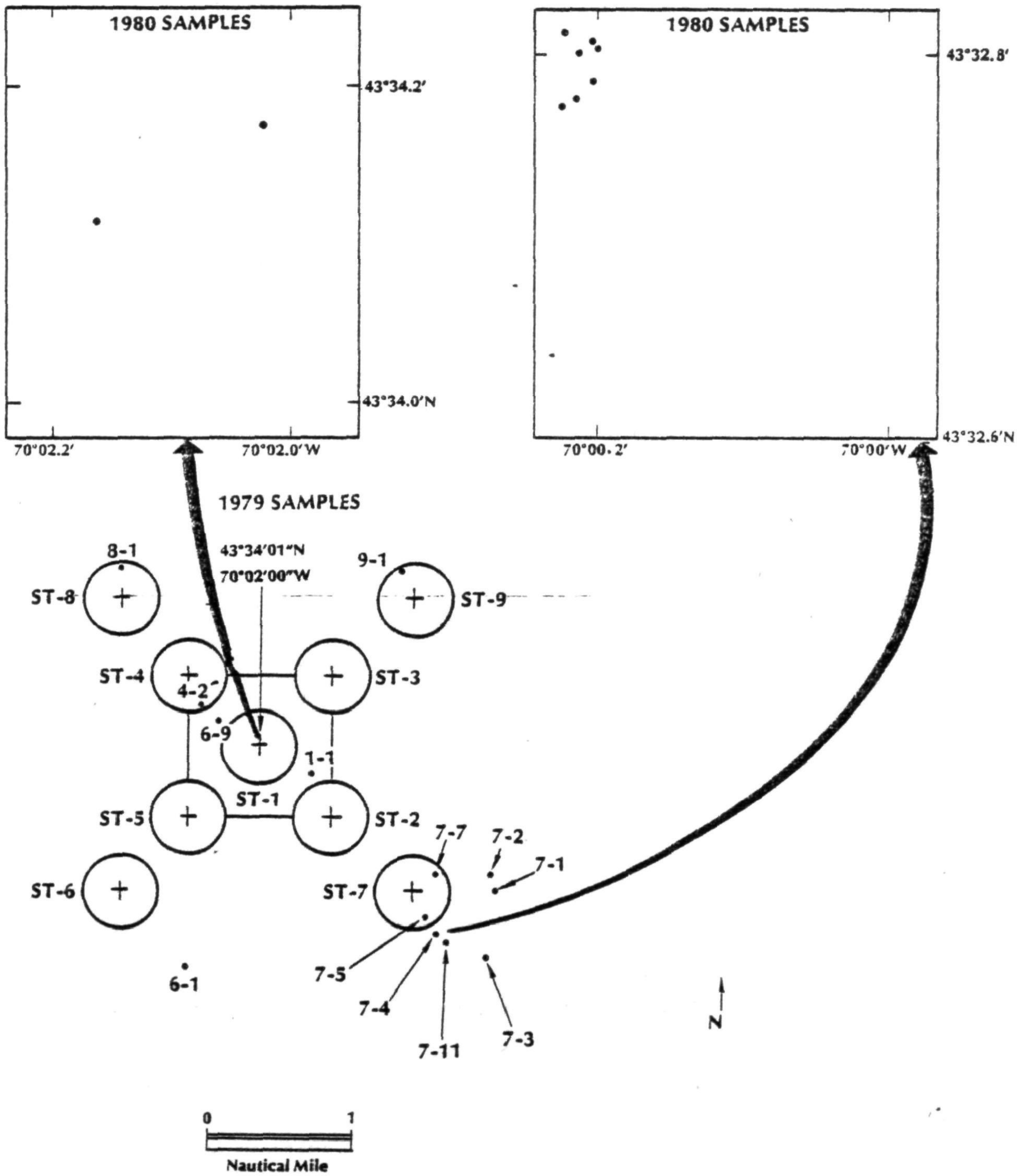

Figure A-1. Station Locations for the EPA/IEC Survey of Portland, Maine ODMDS (June 1979 and April 1980)

EDGERTON (Massachusetts Institute of Technology). Loran-C or radar range and bearing positioning were used for navigation providing accuracy within 0.25 nmi.

Stations 1 through 5 were located inside the ODMDS, and Stations 6 to 9 were positioned outside the site as controls (Figure A-1). Due to the rocky substrate, replicated bottom samples were obtained only at Stations 1 and 7, with a single cast at Station 4. Sample requirements, coordinates, and water depths for all stations are presented in Table A-1.

Several physical and chemical oceanographic measurements were performed aboard the ANTELOPE (June 1979). Benthic video tapes and still photographs were taken from the EDGERTON (April 1980); all other detailed chemical, geological, and biological analyses were performed at shore-based laboratories listed in Table A-2.

Sampling equipment, procedures, and preservation methods were in accordance with the "Oceanographic Sampling and Analytical Procedures Manual" (IEC, 1980). A summary of these methods is presented in the following sections.

WATER COLUMN MEASUREMENTS

Shipboard Procedures

Conductivity and temperatures profiles were measured with a Plessey CTD, and data were stored on 9-track disks. A rosette sampler equipped with 30-liter Go-Flo bottles was used to collect surface and near-bottom samples for suspended solids and dissolved oxygen, and for salinity and temperature calibration samples; middepth samples were collected for analysis of dissolved and particulate trace metals and chlorinated hydrocarbons (CHC). Salinity samples were analyzed with a Beckman salinometer. Surface and bottom water temperatures were measured using reversing or bucket thermometers. Turbidity was measured with a Hach laboratory turbidimeter; dissolved oxygen was determined using a modified Winkler method (Strickland and Parsons, (1968); and pH was measured with a Beckman pH meter. Water samples for total suspended solids and trace metals (particulate and dissolved) analyses were

TABLE A-1
SURVEY SAMPLING REQUIREMENTS FOR PORTLAND, MAINE ODMDS AND VICINITY

	WATER COLUMN								SEDIMENT STATIONS					BIOTA		
	INSTRUMENT ARRAY ONE DROP PER STATION	ROSETTE WATER SAMPLER ONE DROP PER STATION							BOX CORER TWO DROPS PER STATION					BOX CORER FIVE DROPS PER STATION		LOBSTER POTS
		SURFACE & BOTTOM					MIDWATER									
		STANDARD GO-FLO					TEFLON-LINED GO-FLO		CORE SAMPLE					CORE SAMPLE		LOBSTER/CRAB TISSUE
STATION NUMBER	PROFILES OF SALINITY, pH, TEMPERATURE, TURBIDITY	CALIBRATION SAMPLES: SALINITY, TURBIDITY, pH, TEMPERATURE	SUSPENDED SOLIDS	DISSOLVED OXYGEN	DISSOLVED TRACE METALS	PARTICULATE TRACE METALS	CHLORINATED HYDROCARBON SCAN	GRAIN SIZE, ARTIFACTS	TOTAL ORGANIC CARBON/OIL & GREASE	TRACE METALS	CHLORINATED HYDROCARBON SCAN(1)	PETROLEUM HYDROCARBON SCAN	MEIOFAUNA (N/H RATIO) (2)	GRAIN SIZE	MACROINFAUNA (0.5 mm)	TRACE METALS
001		*	*	*	*	*		†	†	†	†	†			†	*†
002					NO SAMPLES											
003					NO SAMPLES											
004								*					*			
005					NO SAMPLES											
006		*	*	*	*	*										
007		*	*	*				*†	*†	*†	†	†	*		†	
008		*	*	*												
009		*	*	*												

NUMBER LATITUDE LONGITUDE DEPTH	001 43°34.1'N 70°02.0'W 42.7m	002 43°33.6'N 70°01.3'W 50.3m	003 43°34.6'N 70°01.3'W 43.3m	004 43°34.6'N 70°02.7'W 42.7m	005 43°33.6'N 70°02.7'W 44.5m	006 43°33.1'N 70°03.3'W 40.0m	007 43°33.1'N 70°00.5'W 68.6m	008 43°35.2'N 70°03.3'W 30.5m	009 43°35.2'N 70°00.5'W 48.8m

NOTES:
- * Collected in June 1979
- † Collected in April 1980
- (1) Composite sample from both box cores
- (2) Two subsamples from one box core at each designated station
- (3) Lobster pots will be substituted for trawl/dredge

TABLE A-2
LABORATORIES PERFORMING ANALYSIS OF SAMPLES FROM PORTLAND, MAINE ODMDS

Biology	Chemistry	Geology
Taxon, Salem, MA * Donald Reish, Long Beach, CA	ERCO, Cambridge, MA * LFE, Richmond, CA	ERCO, Cambridge, MA

* Denotes quality control laboratory

transferred from Go-Flo bottles to 2-liter pressure filtration bottles, then filtered through Nucleopore filters. The filtrate was collected for dissolved trace metals analysis in precleaned bottles acidified with Ultrex nitric acid. Measured water volumes were pressure-fed directly from Go-Flo bottles through Amberlite XAD resin columns for extraction of CHC's (Osterroht, 1977). Filters for particulate trace metals and suspended solids, and resin columns for CHC's, were processed in a positive pressure clean hood and frozen until analyzed.

Laboratory Methods

Total suspended solids were determined gravimetrically on an electrobalance (Meade et al., 1975). Filters containing particulate trace metal samples were leached for 2 hours with 1N Ultrex nitric acid. Leachates were analyzed for Cd and Pb by graphite furnace Atomic Absorption Spectrophotometry (AAS), and for Hg by cold-vapor AAS (EPA, 1979).

Dissolved Hg was analyzed by cold vapor AAS following an acid-permanganate digestion and reduction with hydroxylamine sulfate and stannous sulfate (EPA, 1979). Dissolved Cd and Pb were concentrated using a chelation-solvent extraction method (Sturgeon et al., 1980) and analyzed by graphite furnace AAS.

CHC's were eluted from resin columns with acetonitrile. The elutriate was extracted three times with hexane, evaporated to near dryness, fractionated on florisil columns, and analyzed by electron-capture gas chromatography

(Osterroht, 1977). The chromatogram was scanned for presence of polychlorinated biphenyls (PCB) (Arochlor 1016, 1221, 1232, 1242, 1248, 1254, 1260, and 1262), and various pesticides (aldrin, dieldrin, endrin, heptachlor, DDT) and derivatives βBHC, DDD, DDE, and heptachlor expoxide).

GEOCHEMISTRY AND GRAIN SIZE ANALYSIS

Shipboard Procedures

Fifty grams of sediment were removed from 0.06 m^2 box cores at each station sampled (see Table A-1) and frozen for grain size analysis. Sediment samples for geochemical analyses (trace metals, oil and grease, total organic carbon [TOC] and CHC's) were collected from the surface 2 cm of two cores per station, stored in acid-cleaned Teflon jars, and frozen.

Laboratory Methods

Sediment grain size was determined by washing sediment samples through 2,000- and 62-μm mesh sieves to separate gravel, sand, and silt/clay fractions following a procedure described by Folk (1978). Sand/gravel fractions were separated with 1 phi (Ø) interval sieves, dried, and weighed. The silt/clay fractions were analyzed using the pipette method (Rittenhouse, 1933).

Trace metals (Cd and Pb) were leached from 5 to 10g of sediments for 2 hours with 25 ml of 1N nitric acid, and analyzed by graphite furnace AAS. Mercury was leached from 5 to 10g of sediment at 95°C with aqua regia and potassium permanganate, reduced using hydroxylamine sulfate and stannous sulfate, and analyzed by cold-vapor AAS (EPA, 1979).

Oil and grease were extracted from 100g sediment samples with an acetone-hexane mixture, dried, and quantified gravimetrically according to the method of American Public Health Association (APHA) (1975). TOC in sediments was measured with a Perkin-Elmer Model 240 Elemental Analyzer (Gibbs, 1977).

CHC's were soxhlet extracted from sediment samples using a 1:1 acetone-hexane solvent. The extract was evaporated, cleaned on a florisil column, fractionated on a silicic acid column, and analyzed by electron capture gas chromatography (EPA, 1974). An additional acid cleanup step was required for analysis of PCB's. Petroleum hydrocarbons were extracted from sediments with a methylene dichloride-methanol azeotropic mixture, and analyzed by column and glass capillary gas chromatography (Brown et al., 1979).

Elutriate analyses were performed in accordance with the specifications of EPA/CE (1977). Sediments and unfiltered disposal site water were mixed at a 1:4 ratio, and mechanical- and air-agitated for 30 minutes. After a 1-hour settling period, test water was filtered, acidified with Ultrex hydrochloric acid, and analyzed for trace metals using techniques described above.

BIOLOGICAL MEASUREMENTS (Including Tissue Chemistry)

Shipboard Procedures

Five macrofaunal samples were collected at Stations 4 and 7 (June 1979) and Stations 1 and 7 (April 1980) using a 0.06 m^2 box core and washed through a 0.5-mm screen; organisms were preserved in 10% formalin in seawater and stored until analysis. Two 3.5-cm diameter subcores were taken from one box core at Station 4 during the June 1979 survey, and preserved for enumeration of meiofauna.

Lobster traps were used in 1979 and 1980 to collect crustaceans for analysis of tissue concentrations of CHC's and trace metals. Crustaceans were sorted in stainless steel trays and enumerated. Specimens were transferred from the trays to acid-rinsed plastic buckets, and then into clean plastic bags and frozen for trace metal analyses. Additional specimens were transferred to stainless steel buckets with stainless steel forceps, wrapped in aluminum foil, placed in polyethylene bags, and frozen for CHC analysis.

Laboratory Methods

Six dominant macrofaunal species were selected by Interstate biologists for enumeration in all samples collected. Selection of species was based on the inspection of initial laboratory data (species abundance throughout the site), feeding type, and known association with environmental conditions, particularly substrates. Each of the six dominant species was enumerated in all five station replicates, and mean species abundances were calculated for each station. Nematodes and harpacticoid copepods were separated from the meiofauna samples and counted. All samples were transferred to 70% alcohol for storage.

Analysis of Cd and Pb concentrations in tissues followed techniques described by EPA (1977). Approximately 5 to 10g of homogenized tissue were digested with nitric acid and hydrogen peroxide while heated. The digests were then evaporated, diluted to volume with deionized water, and analyzed with flame or flameless AAS. Analyses of Hg concentrations in tissue required digestion of an 8g to 10g sample with concentrated nitric and sulfuric acids and potassium permanganate, reduction of the ionized mercury with hydroxylamine and stannous sulfates, and analysis with cold-vapor AAS (EPA, 1979).

Tissue analyses for CHC's required homogenization of 50g of tissue with sodium sulfate, extraction with hexane, cleanup, fractionation, and analysis with electron capture gas chromatography (EPA, 1974).

COMPUTER DATA ENTRY AND ANALYSIS

All data were entered into the Interstate computerized Oceanic Data and Environmental Evaluation Program (ODEEP) data base. Statistical analyses included calculation of means, variances, correlations, and analysis of variance. These statistics were run for the various partitions in the data: surveys, stations, station depth, and cast number for each variable analyzed. Correlations were run between parameter values measured in individual sediment samples (casts).

RESULTS AND DISCUSSION

Water Column Characteristics

In June 1979 surface waters were warmer and less saline than bottom waters (Table A-3). Temperatures varied only slightly for both surface

TABLE A-3
WATER COLUMN PARAMETERS (EPA/IEC SURVEY, JUNE 1979)

Station	Sample Depth (m)	Temperature (°C)	Salinity (°/oo)	Total Suspended Solids (mg/liter)	Turbidity (NTU)	Dissolved Oxygen (ml/liter)	Dissolved Oxygen (% Saturation)	pH
	2	11.60	30.850	0.14	0.59	6.10	118.5	8.2
1	11	-	-	-	0.42	-	-	-
	55	6.09	32.204	0.34	0.66	6.86	89.2	7.9
	3	11.05	30.790	0.44	0.42	6.16	119.5	8.3
6	18	-	-	-	0.28	-	-	-
	42	6.20	32.156	0.53	0.32	6.84	90.5	8.1
	2	11.09	30.905	0.59	0.42	6.16	115.7	8.2
7	13	-	-	0.37	-	-	-	-
	20	-	-	0.68	-	-	-	-
	90	5.45	32.376	-	0.76	6.95	85.9	7.9
	2	11.18	30.684	0.21	0.58	6.15	114.3	8.2
8	6	-	-	0.56	-	-	-	-
	15	6.78	31.793	0.18	0.27	6.77	95.9	8.0
	2	11.30	30.937	0.75	0.51	6.13	118.8	8.3
9	14	-	-	0.27	0.39	-	-	-
	33	6.20	32.106	0.54	0.41	6.84	88.7	8.0

Note: Data represent individual determinations

\- Not analyzed

(11.0 to 11.6°C) and bottom (5.4 to 6.8°C) waters. Surface salinities ranged from 30.68 to 30.94 $^{o}/oo$ ppt, while bottom salinities ranged from 31.79 to 32.38 $^{o}/oo$. Surface waters were supersaturated with dissolved oxygen (all values above 100%), while bottom waters were near saturation (86 to 96%). All total suspended solids and turbidity levels were low and did not show consistent patterns with depth; overall ranges were 0.14 to 0.75 mg/liter and 0.27 to 0.76 NTU, respectively.

Survey values are comparable to other data reported for the area (TRIGOM, 1976). Surface and bottom (40m) temperatures averaged 13.9°C and 6.7°C, respectively; average salinities were 31.5$^{o}/oo$ and 32.4$^{o}/oo$, respectively. Ranges in temperatures were 10.0° to 18.6°C for surface waters, and 4.2° to 12.2°C for bottom waters. Dissolved oxygen was reported at or near saturation in both surface and bottom waters. Suspended solids did not vary in concentration in the top 100m.

Concentrations of dissolved and particulate trace metals taken at mid-depth were low (<0.1 µg/liter), and did not show any spatial trends which could be attributed to dredged material disposal at the site. Dieldrin was the only chlorinated hydrocarbon detected; it was present in trace amounts (1.38, 1.66 ng/liter) both inside and outside the site (Table A-4).

TABLE A-4
MIDDEPTH LEVELS OF DISSOLVED CHLORINATED HYDROCARBONS AND DISSOLVED AND PARTICULATE TRACE METALS (EPA/IEC SURVEY, JUNE 1979)

Station	Sample Depth (m)	Trace Metals (µg/liter)						
		Particulate			Dissolved			
		Hg	Pb	Cd	Hg	Pb	Cd	Dieldrin*
1	11	0.001	0.045	0.065	0.030	0.11	0.061	1.38
6	18	0.001	0.044	0.073	0.003	0.14	0.110	1.66

Note: Data represent individual determinations

* Dieldrin was the only chlorinated hydrocarbon (pesticide, PCB) detected

Sediment Characteristics

During the June 1979 survey replicated bottom samples were taken only at Station 7 and showed a heterogeneous distribution of grain sizes; sand and fines (silt and clay) content ranged from 11.7% to 75.1% and from 18.2% to 88.1%, respectively. The single sample from Station 4 had 54.6% gravel and 41.5% sand, indicating the coarse nature of the sediments at this location (Table A-5). The bottom at other stations was rocky and could not be sampled with grab or coring devices. Similar sampling difficulties were encountered during April 1980; however, two or more samples were obtained at Station 1 (center of ODMDS) and Station 7 (control). Sediments retrieved during this survey were predominantly fine-grained and relatively similar in texture (overall range 73.1% to 87.7% fines) for both stations; little or no gravel was observed (Table A-6).

Comparing both surveys, sediments from the center of the Existing Site (April 1980) contained levels of mercury, cadmium, and lead 3 to 12 times higher than sediments from control Station 7, just outside the site (Tables A-5 and A-6). Since sediments from both areas were predominantly fine-grained, the differences in metal concentrations probably reflected contaminants present in dredged material dumped at the ODMDS. Both locations (inside and outside the ODMDS) contained levels of trace metals higher than the levels present in sediments from Georges Bank, an offshore area removed from known sources of pollution (ERCO, 1978). However, trace metal levels from the ODMDS and control stations were generally lower than levels present in Portland Harbor sediments (Table A-7).

Total organic carbon (TOC) levels in sediments from the ODMDS (Station 1) and control (Station 7) were comparable, ranging from 9.7 to 19.5 mg/g (Tables A-5 and A-6). TOC is composed of material of biogenic (marine and terrestrial) and anthropogenic (industrial and municipal) origin. The levels found at and near the Existing Site are greater than open ocean values, but similar to other levels in the coastal zone of the general region (ERCO, 1978).

TABLE A-5
SEDIMENT TRACE METALS, OIL AND GREASE,
TOC, AND GRAIN SIZE (EPA/IEC SURVEY, JUNE 1979)

Station (Cast #)	Oil & Grease (mg/g)	TOC (mg/g)	Trace Metals (μg/g)			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Fine* (%)
			Hg	Cd	Pb					
4 (2)	-	-	-	-	-	54.62	41.55	1.49	2.34	3.83
7 (2)	-	-	-	-	-	2.78	35.34	44.52	17.36	61.88
7 (3)	1.030	18.90	0.06	0.03	9.57	0.00	11.69	35.55	52.54	88.09
7 (4)	0.296	11.20	0.05	0.03	15.17	12.44	55.83	10.86	16.45	27.31
7 (5)	-	-	-	-	-	6.22	23.73	34.79	35.26	70.05
7 (7)	-	-	-	-	-	6.70	75.06	8.13	10.11	18.24
7 (11)	-	-	-	-	-	9.29	66.08	12.70	11.93	24.63

Note: Data represent individual determinations

- Not analyzed

TOC = Total organic carbon

* Silt and clay

TABLE A-6
SEDIMENT TRACE METALS, OIL AND GREASE,
TOC, AND GRAIN SIZE (EPA/IEC SURVEY, APRIL 1980)

Station (Cast #)	Oil & Grease (mg/g)	TOC (mg/g)	Trace Metals (μg/g)			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Fine* (%)
			Hg	Cd	Pb					
1 (6)	2.55	19.5	0.31	0.46	54	0.21	26.70	28.20	44.89	73.09
1 (7)	3.08	9.7	0.36	0.44	67	0.36	24.91	30.85	43.87	74.72
7 (1)	2.08	14.3	0.06	0.04	20	0.17	12.08	34.39	53.35	87.74
7 (2)	1.58	14.8	0.07	0.04	20	0.00	11.77	26.12	62.15	88.27
7 (3)	-	-	-	-	-	0.00	25.71	60.58	13.71	74.29
7 (4)	-	-	-	-	-	0.00	19.02	67.89	13.09	80.98
7 (5)	-	-	-	-	-	0.00	21.61	65.65	12.74	78.39
7 (6)	-	-	-	-	-	0.00	20.91	64.71	14.38	79.09
7 (7)	-	-	-	-	-	0.00	18.12	65.02	16.86	81.88

Note: Data represent individual determinations

- Not analyzed

TOC = Total organic carbon

* Silt and clay

TABLE A-7
TRACE METAL CONCENTRATIONS IN SEDIMENTS
(μg/g)

Area	Source	Mercury	Cadmium	Lead	Number of Samples
Existing Site	IEC, 1980*	0.34	0.45	60	2
Station 7 (Control)	IEC, 1980*	0.07	0.04	20	2
Station 7 (Control)	IEC, 1979*	0.06	0.03	12	2
Georges Bank	ERCO, 1978**	†	0.01 to 0.03	1 to 7	††
Portland Harbor	CE, 1979**	0.46	3.49	90	18
	NUSC, 1979**	0.40	1.09	54	4

* Using the weak-acid leach technique
** Method not reported
† Not analyzed
†† Not recorded

Most CHC's in sediments collected (April 1980) from the center of the Existing Site (Station 1) were present at higher concentrations than in the control area just outside the Site (Station 7) as shown in Table A-8. Levels in both areas, however, were much lower than amounts present in or near major ports, such as Los Angeles-Long Beach Harbor, and the New York Bight (Chen et al., 1976; West et al., 1976; West and Hatcher, 1980). Comparable data are unavailable for CHC's in Portland Harbor sediments or offshore areas.

Oil and grease concentrations in sediments from Station 1 (2.6 to 3.1 mg/g) and Control Station 7 (0.3 to 2.1 mg/g) are shown in Tables A-5 and A-6. Concentrations at both stations were similar to concentrations in Portland Harbor (CE, 1979). A more detailed analysis identified the distribution and the biogenic and anthropogenic sources of hydrocarbon compounds (Table A-9). Sediments collected from the disposal area (Station 1) contained high levels (> 300 ppm) of both saturated and aromatic hydrocarbons; several sources may have contributed to this input (Table A-9). The predominant source indicated by the analyses was No. 2 fuel oil, spilled either at the Existing Site or into harbor sediments (later dredged and dumped at the Existing Site). The low alkane/isoprenoid ratio in these sediments, relative to higher ratios for fresh oil, suggests substantial (80%) biochemical degradation of the alkanes

TABLE A-8
CHLORINATED HYDROCARBONS IN SEDIMENTS (EPA/IEC SURVEY, APRIL 1980) (ng/g)

Station (cast)	PCB	Pesticides and Pesticide Derivatives**			
	(Arochlor 1260*)	pp'DDE	pp'DDD	Chlordane	Heptachlor
1 (6)	32.60	2.91	20.40	ND	0.21
1 (7)	43.10	4.22	31.90	ND	0.43
7 (1)	11.50	ND	0.95	6.20	ND
7 (2)	4.92	ND	1.51	5.22	0.17

Note: Data represent individual determinations

ND = Not detected

* No other PCB mixtures were detected

** No other pesticides or derivatives detected

TABLE A-9
HYDROCARBON ANALYSES OF MARINE SEDIMENT SAMPLES (EPA/IEC SURVEY, APRIL 1980)

Station	Cast	Wet Wt. (g)	Dry Wt. (g)	Liquid Wt. (μg/g)	Total f_1 GRAV (μg/g)	Resolved f_1 GC (μg/g)	CPI	ALK/ISO	f_1/TOC ($\bar{x}$ 10^4)	Total f_2 GRAV (μg/g)	Resolved f_2 GC (μg/g)	Source Classification*
1	6	5.2	25.4	3,190	382	7.6	3.95	0.65	196	315	17	5/4/3/1
1	7	109.5	50.2	3,910	417	6.9	5.14	0.36	430	390	29	5/4/3/1
7	1	102.3	47.8	1,090	34	1.7	4.94	2.04	24	9	2.1	3/1/4
7	2	41.7	17.2	1,460	41	2.2	4.92	4.71	28	62	2.6	3/1/4

f_1 = Aliphatic hydrocarbons
f_2 = Aromatic hydrocarbons
GRAV = Gravimetric analysis
GC = Gas chromatograph
ALK/ISO = Alkanes/isoprenoids
CPI = Carbon preference index (C_{26}-C_{30})
TOC = Total organic carbon

*Source Classifications

1 = Terrigenous biogenic materials
3 = Chronic petroleum contamination
4 = Pyrogenic polynuclear aromatic hydrocarbons
5 = Fuel oil

present in the sediments (ERCO, 1980). Other indicated sources of hydrocarbon inputs into Existing Site sediments included: (1) chronic petroleum contamination, (2) pyrogenic combustion contamination (compounds from fossil fuel combustion entering the system via direct fallout over the ocean or fallout over land, with subsequent riverine transport), and (3) terrigenous biogenic materials (mainly plant waxes probably introduced into coastal sediments through riverine runoff).

Tissues

Only two samples (both at Station 1) were successfully collected for tissue analysis (Table A-10). Both lobster and crab showed low levels of metals. No CHC's were identified. Historical data were unavailable for comparison.

BIOLOGY

The Existing Site and vicinity were surveyed by IEC using box cores to collect infauna (1979/1980), and underwater video and still camera photography to identify epifauna (1980). Remote photography is an invaluable sampling method for surveying epibenthic organisms on deep, rocky habitats, but information gained by this method is limited because specimens are not collected for positive identification, and highly mobile species rarely are observed. Results from the photographic survey are reported in Appendix B.

TABLE A-10
LEVELS OF TRACE METALS IN CRUSTACEAN TISSUES COLLECTED FROM THE EXISTING SITE
(μg/g)

Tissue	Date	Trace Metals		
		Hg	Cd	Pb
Lobster (*Homarus americanus*)	June 1979	0.055	0.71	0.46
Crab (*Cancer* sp.), juvenile	April 1980	0.035	0.39	2.84

The laboratory analysis for infauna, considered the 5 to 7 dominant species within each replicate sample, comprises a total of 20 and 15 species in the 1979 and 1980 IEC Surveys, respectively (Tables A-11 and A-12).

Polychaetes were the major group (14 and 10 spp., respectively). No molluscs were dominant in the first survey, and only three species were dominant during the second. Crustaceans were represented by four amphipod and one isopod species in the first survey, but only by a single barnacle in the second.

Species composition of the infauna samples reflected the temporal heterogeneity of the substrate within the Existing Site, as the sample-to-sample variability was very high. Only three dominant species (all polychaetes) were common to both surveys: Prionospio malmgreni, Aricidea quadrilobata, and Cossura longocirrata.

During the 1979 survey there was little overlap in dominant species between casts at Station 7, possibly because of differences in sediment characteristics (Table A-5). All replicates were separated by nearly 0.5 nmi. Casts 2 and 5 were from areas characterized by fine silts and clays; casts 7 and 11 were from sandy areas (Table A-5). Only 10% of the dominants occurred in both areas. In contrast, casts from Station 7 during 1980 were within 0.02 nmi of each other, and all had similar sediment characteristics (Table A-6). Consequently, 67% of the dominant species were present in at least 3 of the 5 casts.

Earlier surveys by NUSC and Normandeau gave a different indication of dominant organisms and community structure than the IEC surveys. The differences between the NUSC and IEC surveys may have resulted from different sampling methodologies. The NUSC survey collected benthic samples by dragging an anchor dredge for 200 to 400m, whereas the IEC studies used 0.06-m^2 box cores. A dredge samples a much larger area than a box core which, perhaps, could account for the greater number of molluscs collected.

TABLE A-11
ABUNDANCES OF THE DOMINANT INFAUNA WITHIN
EACH STATION, COLLECTED AT THE EXISTING SITE IN JUNE 1979
(individual/0.06 m^2)

	Station 4	Station 7			
Cast	2	2	5	7	11
Annelida					
Polychaeta					
Ampharete artica	--	41	122	--	112
Aricidea quadrilobata	--	--	--	19	--
Cossura longocirrata	--	3	12	--	--
Drilonereis longa	--	1	--	--	--
Exogone verugera	19	--	--	--	--
Euclymene collaris	24	--	--	--	--
Maldane cristata	--	--	--	--	44
Melinna cristata	--	2	--	--	--
Polydora ligni	--	--	--	71	--
Potamethus singularis	--	--	--	61	11
Prionospio malmgreni	--	--	11	42	--
Spio filicornis	25	--	23	--	--
Spiophanes kroyeri	--	--	--	--	35
Streblosoma spiralis	--	--	--	31	17
Arthropoda					
Amphipoda					
Harpinia propinqua	--	1	--	--	--
Paradulichia typica	28	--	--	--	--
Photis reinhardi	--	1	--	--	--
Unciola serrata	113	--	--	--	--
Isopoda					
Cyathura polita	--	--	--	42	--
Sipuncula					
Phascolion strombi	--	--	--	237	--

Note: A dash (-) indicates that the organism was not one of the 5 to 7 dominants within the replicate or station, but may or may not be present.

TABLE A-12
ABUNDANCES OF THE DOMINANT INFAUNA SPECIES WITHIN EACH STATION, COLLECTED AT THE EXISTING SITE IN APRIL 1980
(individual/0.06 m^2)

Cast	Station 1							Station 7						
	1	2	3	4	5	$\bar{X}$	SD	1	2	3	4	5	$\bar{X}$	SD
Annelida														
Oligochaeta	3	20	10	12	24	13.8	8.3	--	--	--	--	--	--	--
Polychaeta														
Anobothrus gracilis	13	7	0	16	7	8.6	6.2	534	29	37	37	7	128.8	226.8
Aricidea quadrilobata	--	--	--	--	--	--	--	206	68	8	8	11	60.2	85.4
Chaetozone setosa	--	--	--	--	--	--	--	115	1	19	20	1	31.2	47.8
Cossura longocirrata	16	6	0	16	16	10.8	7.4	41	12	26	48	32	31.8	13.9
Heteromastus filiformis	--	--	--	--	--	--	--	123	20	27	6	6	36.4	49.2
Ninoe nigripes	--	--	--	--	--	--	--	122	31	44	35	5	47.4	44.2
Paraonis gracilis	23	25	26	24	38	27.2	6.1	234	154	42	98	43	114.2	81.4
Prionospio malmgreni	154	72	12	342	186	153.2	125.7	126	10	14	12	12	34.8	51.0
Tharyx acutus	--	--	--	--	--	--	--	12	17	19	20	5	14.6	6.2
Tharyx annulosus	56	59	33	29	63	48.0	15.8	--	--	--	--	--	--	--
Arthropoda														
Cirripedia														
Cytherois zostericola	48	24	0	0	0	14.4	21.5	--	--	--	--	--	--	--
Mollusca														
Bivalvia														
Astarte undata	35	37	1	12	12	19.4	15.8	--	--	--	--	--	--	--
Crenella glandula	5	5	0	9	33	10.4	13.0	--	--	--	--	--	--	--
Nucula delphindonta	1	5	4	9	28	9.4	10.7	--	--	--	--	--	--	--

Note: A dash (-) indicates that the species was not one of the 5 to 7 dominants within the replicate, but may or may not be present.

SD = Standard deviation
$\bar{X}$ = Mean

The Van Veen grabs used in the Normandeau (1974) investigations collected samples twice as large (0.14 m^2) as the IEC samples. In the first Normandeau survey, one station (GM3) was within 0.5 nmi of the IEC and NUSC survey locations, and two stations (GM7, GM8) were within 8 to 10 nmi. All stations in the second survey were within 3 nmi of the IEC and NUSC sites.

A comparison of the 10 dominant species collected in the Normandeau I and II surveys (1974a,b), with the dominant species in the IEC surveys, again revealed very few overlaps. Of all the dominant species collected during the 1979 IEC survey, 15% and 35% were present in Normandeau I and II, respectively. IEC (1979) dominants Harpinia propinqua (amphipod) and Phascolion strombi (sipunculid) were dominant in Normandeau I and II, respectively. Of the dominant species found in the 1980 IEC survey, 33% and 40% were present in Normandeau I and II, respectively. The polychaete Ninoe nigripes was dominant in IEC (1980) and Normandeau I; none of the IEC (1980) dominants were dominant in the Normandeau II study. Most of these differences could be due to changes in sediment characteristics; as noted earlier sediment grain size can change radically over short distances.

Photographic surveys (Appendix B) of the epifauna associated with sandy/silty substrates revealed large numbers of unidentified tubicolous polychaetes in some areas, but few or none in other areas (Table A-13). Cerianthid anemones (Cerianthus borealis) were common and a few asteroids (Henricia, Solaster) were noted. Crabs and fishes were absent but, as noted, this may be due to the method of sampling.

Molluscs were the major group collected by NUSC (1979). The three most abundant and four of the seven dominant species were molluscs. None of these organisms were dominant in the 1979 IEC survey, and only a mollusc (Astarte undata) and a polychaete (Ninoe nigripes) were dominant in the 1980 IEC survey. Five of the 20, and 3 of the 15, dominant species in the 1979 and 1980 IEC surveys, respectively, were present in low numbers in the NUSC (1979) investigations.

TABLE A-13
ABUNDANCES OF THE EPIBENTHIC SPECIES WITHIN EACH HABITAT TYPE AT THE EXISTING SITE

Species	*No Relief (N = 38)		**Low Relief (N = 14)		†Medium Relief (N = 6)		††High Relief (N = 8)	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Porifera								
Aplysilla glacialis	0	0	0	0	0	0	0.2	0.7
Hymedesmia sp.	0	0	0	0	0.2	0.4	0.8	1.2
Myxilla fimbrata	0	0	0.9	1.3	0	0	0.1	0.3
Pellina sitiens	0	0	0.2	0.4	0	0	0.2	0.5
Polymastia infrapilosa	0.7	1.1	1.8	2.3	2.3	1.5	4.0	3.5
Subertechinus hispidus	0.05	0.3	0.9	1.2	1.8	1.3	2.0	2.3
Tentorium semisuberites	0	0	0	0	0	0	0.1	0.3
unid. sponges	0	0	0.07	0.3	0.3	0.5	0.8	1.2
Cnidarians								
Bolocera tuediae	0	0	0.1	0.4	0	0	0	0
Cerianthus borealis	0.3	0.8	0	0	0.2	0.4	0	0
Clavularia modesta	0	0	0.4	1.1	0	0	0	0
Metridium senile	0	0	0.07	0.3	0	0	0	0
Stomphia coccinea	0	0	0	0	0	0	0.4	0.7
Annelida								
Myxicola infundibulum	0	0	0.1	0.5	0	0	0	0
unid. sp. A	16.2	16.6	0	0	21.3	24.1	1.2	3.5
unid. sabellid	0	0	0.3	0.7	0	0	0	0
Arthropoda (Crustacea)								
Balanus balanus	0	0	3.2	3.2	0.7	0.5	0.5	0.8
Hyas coarctatus	0	0	0.07	0.3	0	0	0	0
Pandalus sp	0	0	0	0	0	0	0.2	0.7
unid. caridean shrimp	0.3	0.2	0	0	0	0	0	0
Echinodermata								
Henricia sanguinolenta	0.08	0.3	0.7	0.8	0.8	1.6	0.4	0.5
Solaster endeca	0.03	0.2	0.07	0.3	0	0	0	0
unid. asteroid (juv)	0	0	0	0	0	0	0.2	0.7
Strongylocentrotus droebachiensis	0	0	0	0	0	0	0.2	0.7
Psolus fabricii	0	0	0	0	0	0	0.2	0.7
unid. ophiuroids	0	0	2.6	5.7	0	0	0.5	1.1
Brachiopoda								
Terebratulina septentrionalis	4.0	9.9	27.4	18.9	6.7	3.1	8.1	7.2
Chordata (Ascidians)								
Apylidium sp	0	0	0.07	0.3	0	0	0	0
Ascidia callosa	0.1	0.4	0.1	0.4	0.2	0.4	0.2	0.7
Boltenia ovifera	0	0	0.1	0.4	0	0	0	0
Halocynthia pyriformis	0.5	2.0	0	0	0	0	0	0

Note: Values represent the mean number and standard deviation of individuals/photographic frame (frame = 0.2 m^2). The number of frames at each habitat follows the habitat description. Abundances were determined by benthic photography.

* Silt bottom, no rocks
** Sediments and rock
† Rocks, some sediment
†† Rock outcrops, cobble

$\bar{X}$ = Mean number
SD = Standard deviation

Appendix B

PHOTOGRAPHIC CHARACTERIZATION

Remote photographic techniques (videotape, still photographs) were employed to survey the epifauna around the Point Disposal Location (PDL) of the Existing Site. Eight stations were established within this topographically complex area: two on the tops of the rocky rises or ridges, five on slopes, and one on a basin floor (Figure B-1). Numerous still photographs were taken at each station and representative examples are reproduced herein. Physical and biological descriptions of each station is presented. Table B-1 lists the relative abundances of each species within the stations. Exact values were not possible to ascertain because surface area varied with the amount of relief in the areas photographed.

STATION 5 - TOP OF RIDGE

Station 5 was located southwest of the PDL and on top of a rocky area at a depth of 40m (Figure B-1). Almost all locations within this station were covered by a light to moderate layer of sediment; bare rock was exposed in a few places. The bottom was generally flat, but interrupted in some areas by low rocks or rock outcrops. The overall physical relief was low (< 15 cm). Some areas showed evidence of heavy recent sedimentation.

Brachiopods were by far the most numerically dominant organisms within Station 5, and were more abundant here than in any of the other stations around the PDL. The organisms were attached to rocky substrates, but the point of attachment was often buried beneath a thin layer of sediment. Barnacles were usually present, but in low numbers, within areas of little or no sediment cover; presumably, dead individuals occur in some areas of heavier sediment layers. Sponges, asteroids, polychaetes, and stalked ascidians were present in lower numbers. A few dense aggregations of ophiuroids were evident.

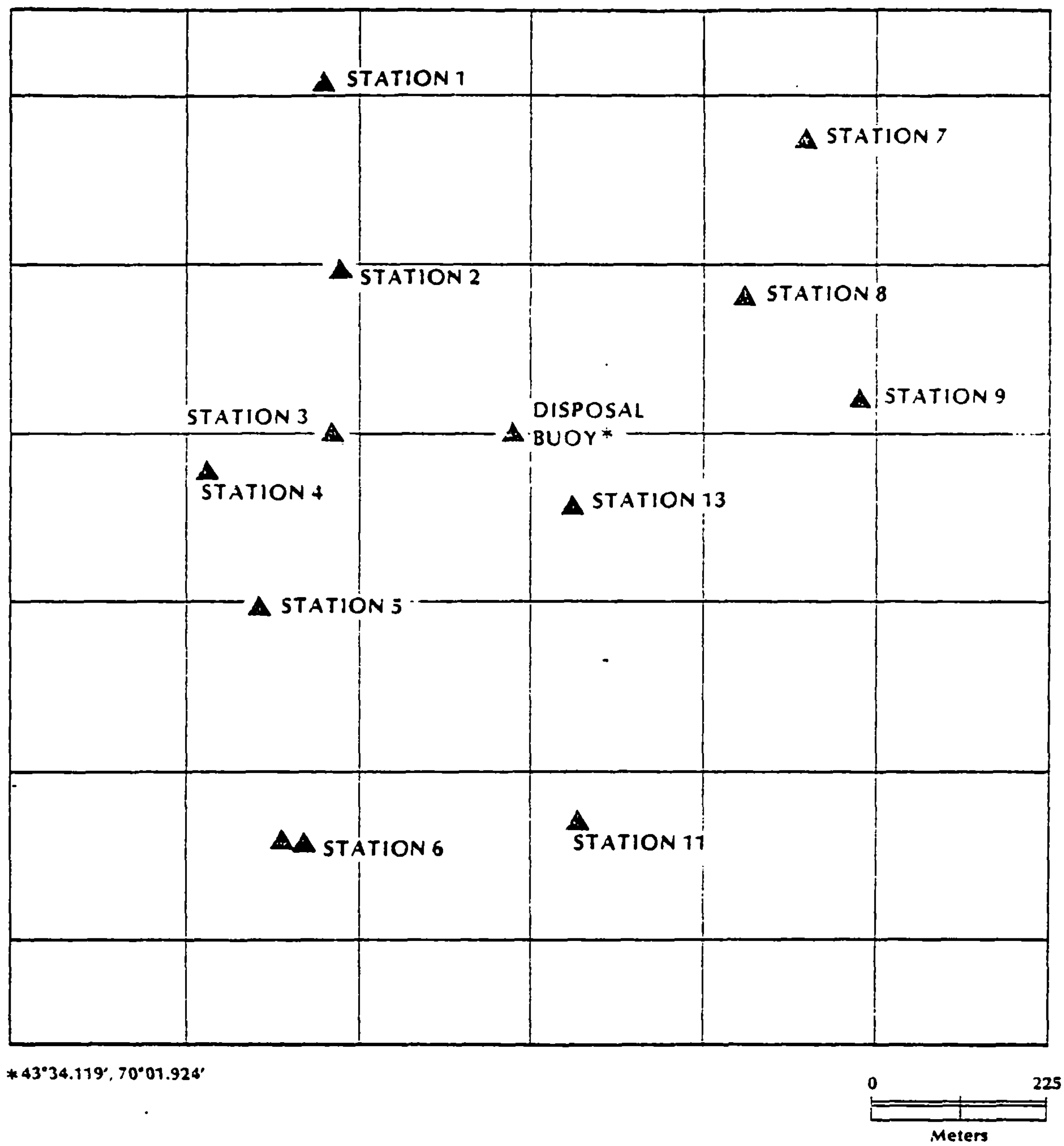

Figure B-1. Location of Stations for Benthic Photography and the Bathymetric Base Chart

TABLE B-1
ABUNDANCES OF THE EPIBENTHIC SPECIES AT EACH STATION

	Station 1 (N = 11)		Station 4 (N = 10)		Station 5 (N = 9)		Station 6 (N = 6)		Station 7 (N = 7)		Station 8 (N = 9)		Station 9 (N = 21)	
	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD	X	SD
Porifera														
Apiysilla glacialis	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Hymedesmia sp.	0	0	0	0	0	0	0	0	0	0	0.1	0.3	0.3	0.8
Myxilla fimbrata	1.2	1.4	0	0	0	0	0	0	0	0	0	0	0.1	0.2
Pellina sitiens	0.3	0.5	0	0	0	0	0	0	0	0	0	0	0.1	0.3
Polymastia infrapilosa	1.8	2.4	1.3	1.0	0.9	1.5	0	0	0	0	1.2	1.6	2.3	2.7
Subertechinus hispidus	0.7	1.1	0	0	0.6	1.1	0	0	0	0	0.1	0.3	1.3	1.8
Tentorium semisuberites	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2
unid. sponges	0.1	0.3	0	0	0	0	0	0	0	0	0.2	0.4	0.3	0.8
Cnidarians														
Bolocera tuediae	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0.1	0.2
Cerianthus borealis	0	0	0	0	0	0	0	0	0	0	1.6	1.2	0.1	0.2
Clavularia modesta	0.4	1.2	0	0	0	0	0	0	0	0	0	0	0	0
Metridium senile	0.1	0.3	0	0	0.1	0.3	0	0	0	0	0	0	0	0
Stomphia coccinea	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Annelida														
Myxicola infundibulum	0.2	0.6	0	0	0	0	0	0	0	0	0	0	0	0
unid. sp. A	1.4	4.5	20.3	23.2	0	0	10.2	6.5	15.7	11.2	5.6	9.1	15.7	19.7
unid. sabellid	0	0	0	0	0.7	1.0	0	0	0	0	0	0	1.3	2.6
Arthropoda (Crustacea)														
Balanus balanus	2.5	3.7	0	0	1.9	2.2	0	0	0	0	0.3	0.5	0.2	0.5
Hyas coarctatus	0	0	0	0	0.1	0.3	0	0	0	0	0	0	0	0
Pandalus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2
unid. caridean shrimp	0	0	0.1	0.3	0	0	0	0	0	0	0	0	0	0
Echinodermata														
Henricia sanguinolenta	0.4	0.8	0	0	2.3	2.3	0	0	0	0	0.7	1.3	0.2	0.4
Solaster endeca	0.2	0.4	0	0	0	0	0	0	0	0	0	0	0	0
unid. asteroid (juv)	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.4
Strongylocentrotus droebachiensis	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2
Psolus fabricii	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.2
unid. ophiuroids	0	0	0	0	4.1	6.8	0	0	0	0	0	0	0.2	0.7
Brachiopoda														
Terebratulina septentrionalis	26.0	13.6	2.6	2.7	26.8	25.3	0	0	0	0	2.8	3.9	5.0	5.7
Chordata (Ascidians)														
Apylidium sp.	0.1	0.3	0	0	0	0	0	0	0	0	0	0	0	0
Ascidia callosa	0.5	0.8	0	0	0	0	0	0	0	0	0	0	0.1	0.5
Boltenia ovifera	0	0	0	0	0.2	0.4	0	0	0	0	0	0	0	0
Halocynthia pyriformis	0.7	2.4	1.0	3.2	0	0	0	0	0	0	0	0	0	0

Note: Values represent the mean number and standard deviation of individuals/photographic frame (frame = $0.2m^2$).

X = Mean number
SD = Standard deviation
N = Number of frames at each station

Two subareas within Station 5 were unique among all stations surveyed, in that they appeared to be covered by a thick layer of sediment and were almost completely devoid of visible life. In one of these subareas the sediment consisted of coarse-grained sand with numerous shell fragments and ripple marks (Figure B-2), indicating possible strong water motion and winnowing of fine sediments. A few tracks were visible on the sediment, possibly from the tentacles of a terebellid polychaete. The sediment in the other subarea of Station 5 was much finer and globular in appearance; no shell fragments were observed (Figure B-3). Virtually no signs of life were present.

A thick layer of sediment, per se, does not prohibit the development of biological communities. Indeed, several bottom areas in nearby stations appeared to have a similar sediment cover, yet numerous benthic organisms were present. The combined features of thick sediment and lack of life within the two subareas of Station 5 strongly suggest recent deposition of this sediment and concomitant burial of attached organisms.

This explanation is feasible since Station 5 was located on top of an elevated rocky mound, immediately downcurrent from the small basin designated as the PDL. Beginning in Fall 1979 approximately two barges per day dumped sediment at the PDL. Consequently, the heavy sedimentation evident within the two areas of Station 5 may have resulted from dredged material disposal.

STATION 8 - TOP OF RIDGE

Station 8 was northeast of the PDL, on top of a small bench at a depth of 50m (Figure B-1). All bottoms within this station possessed moderate to heavy layers of sediment. Some bottom areas were characterized by partially buried (15 to 20 cm) cobbles interspersed with small pebbles; whereas other areas appeared to be flat and covered extensively by fine sand, with little evidence of water motion. The overall physical relief of Station 8 ranged from low (<15 cm) to moderate (15 to 60 cm). There was no indication of significant

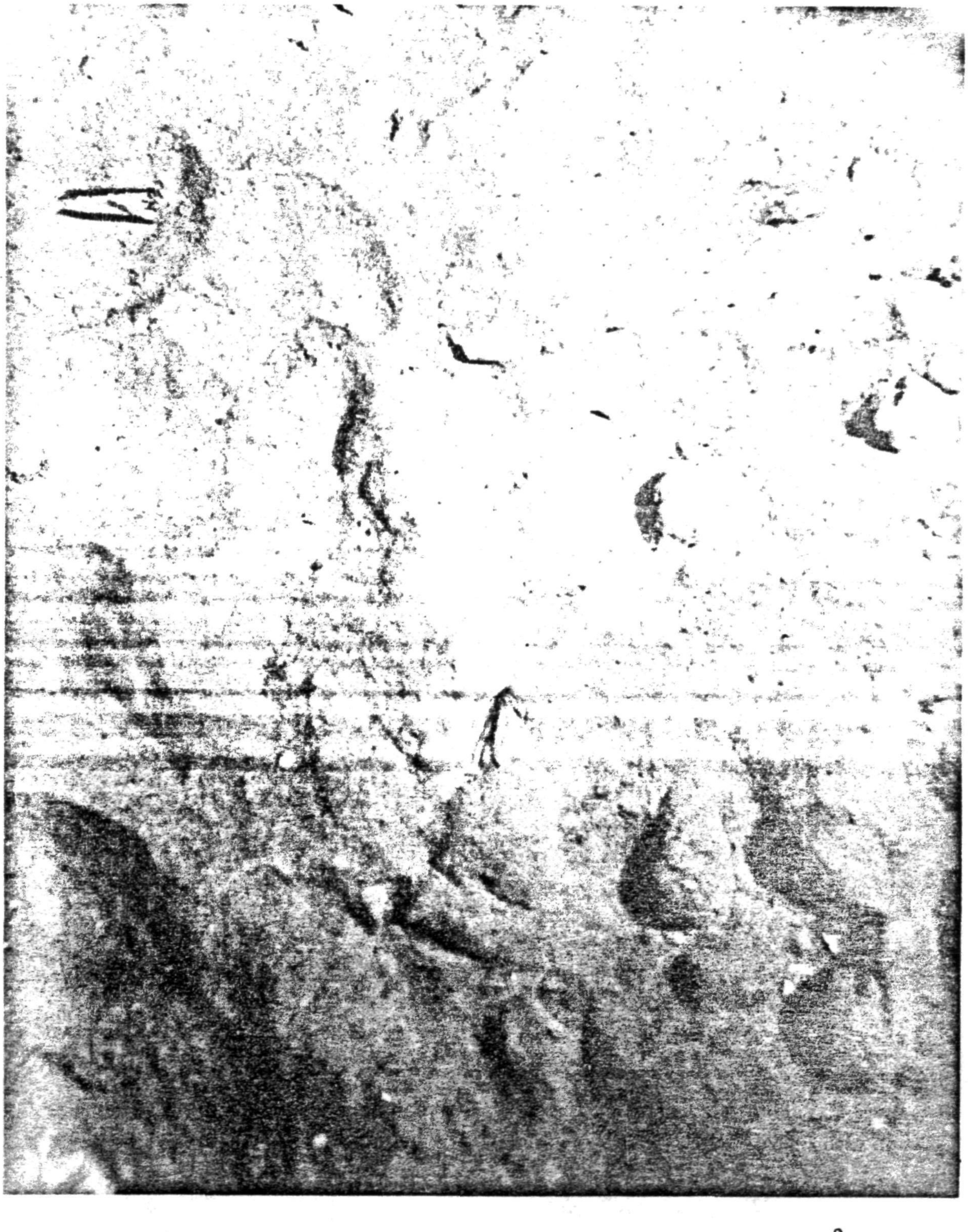

Figure B-2. Evidence of Recent Sedimentation (Area $\simeq 0.2m^2$) at Station 5 (no epibenthic organisms are present)

Figure B-3. Another Subarea ($\simeq 0.2m^2$) at Station 5
With Evidence of Recent Sedimentation

sedimentation occurring within the past few months. The cobble and gravel areas were populated by low numbers of brachiopods, asteroids, barnacles, and sponges. Ophiuroids were not observed.

The sediment surface was characteristic of intensive biological activity by infauna and epifauna. Tubicolous polychaetes were present, as well as cerianthid anemones (Figure B-4). The anemones have greatly elongated bodies and are adapted for living within secreted tubes buried in sand or mud. Many size classes were evident, suggesting a relatively stable habitat--one that was not formed by recent sedimentation. The sediment layer must be fairly deep in these areas because cerianthids were present and brachiopods are absent.

Although both Stations 5 and 8 are on the tops of elevated pinnacles or benches, they were somewhat different. Station 5 was primarily low relief bedrock covered by generally thin layers of sediment (except in two areas); the bottom at Station 8 consisted of semiexposed cobble and areas of relatively thick sediment.

The biological communities reflect the physiographic differences. Brachiopods were ubiquitous at Station 5, but were restricted to areas having cobble bottoms at Station 8. At Station 5 ophiuroids were common within small depressions in the bedrock, but they were absent from Station 8. The relatively deeper sediments in Station 8 were populated by cerianthids and tubicolous polychaetes; these were absent and uncommon, respectively, at Station 5.

STATION 1 - SLOPE

Station 1 was on a slope at a depth of 40 to 60m, northwest of the PDL (Figure B-1). The bottom here consisted of bedrock outcrops which were exposed in some areas, and covered with a light to moderate layer of fine-grained sediment in others. The bottom was generally flat, with low (< 15 cm) physical relief. There was some evidence of recent but light sedimentation.

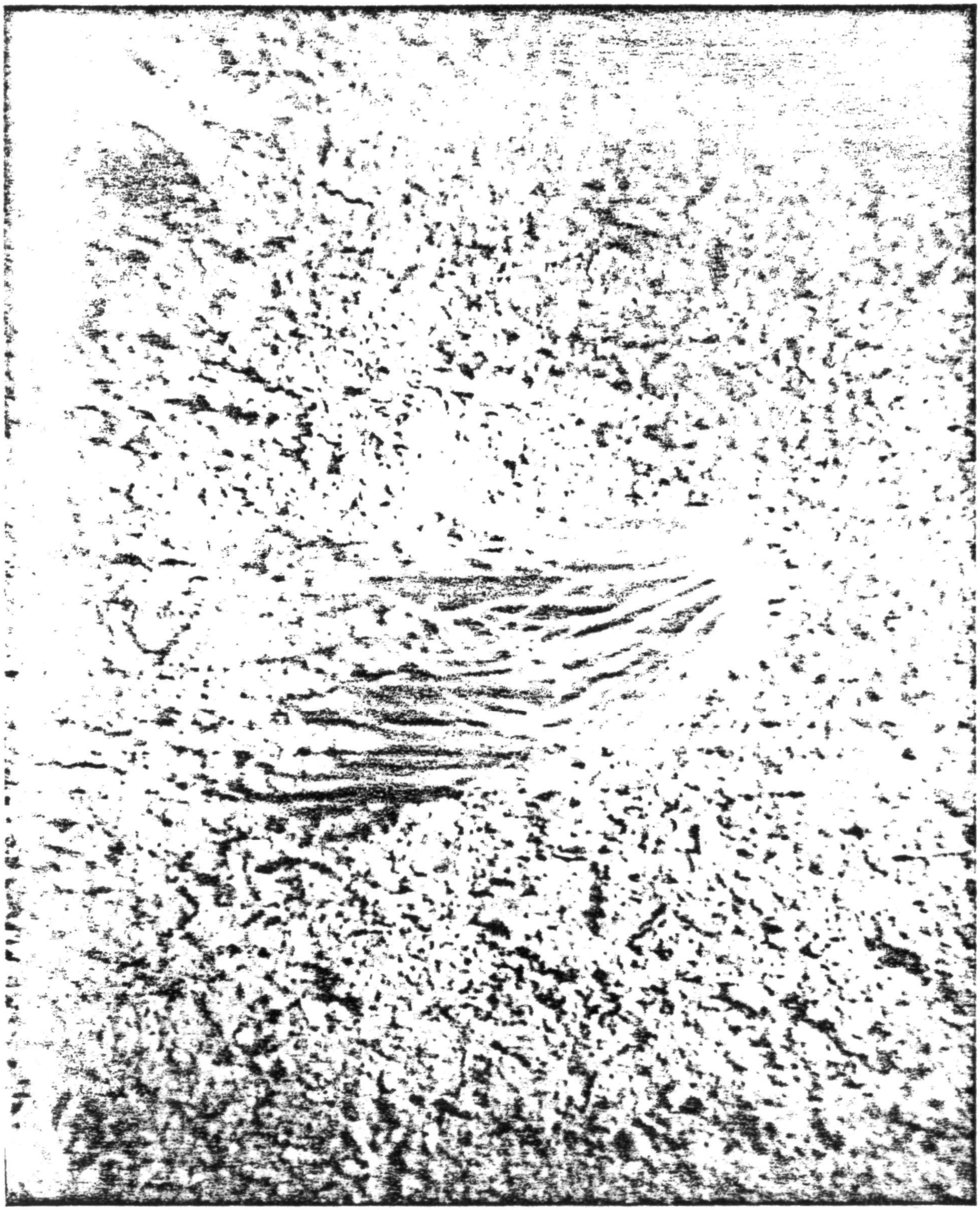

Figure B-4. The Benthos at Station 8 ($\simeq 0.2m^2$)
(Cerianthid anemones are Cerianthus borealis; numerous "twisted" tubes are unidentified polychaetes)

A relatively diverse epifaunal community was present on exposed bedrock with little or no sediments. Brachiopods were dominant and nearly as abundant as at Station 5. Barnacles were much less abundant than brachiopods, but more abundant at this station than at any other station surveyed near the PDL. Numerous types of sponges, both erect and encrusting, were common in low numbers, as were asteroids. Actiniarid and stoloniferid anemones were present, but uncommon on bedrock. Stoloniferids were not observed at other stations.

Bottom areas covered by fine-grained sediment were characterized by a disturbed surface, indicating little water motion and extensive bioturbation by infaunal and epifaunal species. The epibenthic community here was relatively diverse. Polychaete worm tubes and tunicates were present in low numbers. Brachiopods were the dominant organisms in this habitat, suggesting the presence of bedrock below the sediment layer (brachiopods require a hard substrate for attachment). The absence of cerianthid anemones, which require a relatively deep layer of sediment and were common in nearby stations, further supports the presence of a moderate layer of sediment.

Most sediment bottoms within Station 1 may have been formed by natural processes associated with a sloped environment, rather than by disposal activities. The prevailing southwesterly current would direct most of the suspended dredged sediments away from this station. A few brachiopods showed evidence of partial or complete burial.

STATION 4 - SLOPE

Station 4 lay on a slope at a depth of 45 to 55m, due west of the PDL (Figure B-1). This region was flat with low (< 15 cm) physical relief and was covered by a layer of fine-grained sediment. Small rocks (15 to 25 cm) were present in one area, providing the only vertical relief at this station. Water motion apparently was minimal, and there was some evidence of recent sedimentation.

Few organisms were apparent on the semiexposed rocks. Erect sponges and unidentified fouling organisms (hydroids, bryozoans) were present in low numbers. A clump of five brachiopods was observed to be partially buried, and all individuals appeared to be dead.

Extensive biological activity by infauna was suggested by the surface sediment features. Numerous holes, mounds, and tracks created by bivalves, polychaetes, and/or gastropods were present. The epibenthic fauna was dominated by an unidentified tubicolous polychaete, characterized by a twisted tube extending 7 to 10 cm from the bottom. Of all stations surveyed, polychaetes were most abundant within this station (Figure B-5).

Bottom sediments populated by polychaetes at this station may represent sedimentary basins of long standing. However, the absence of cerianthid anemones indicates a relatively shallow thickness of sediment. In other areas, the presence of brachiopods, sponges, and a single live barnacle within a sediment layer suggests relatively recent deposition on a rocky surface. Although brachiopods can settle on polychaete tubes (numerous tubes are present in the area), the sponges and barnacles require a hard substrate. In other areas there was stronger evidence of recent sedimentation. Here, the few sponges and brachiopods were almost completely buried, yet apparently were still alive.

Station 4 was located on the north slope of a rocky elevation, the top of which exhibited evidence of extensive and recent sedimentation (Station 5). Sedimentation patterns observed for Station 4 may have been a result of its location downslope of large sedimentary deposits and/or because of downcurrent transport of materials released at the PDL. Recent sedimentation may be a direct and/or indirect result of disposal activities.

STATIONS 6 AND 7 - SLOPES

Station 6 was southwest of the PDL, at a depth of 55 to 65m (Figure B-1). This station formed the southern slope of the rocky elevation, with Station 4

Figure B-5. The Slope Benthos at Station 4 ($\simeq 0.2m^2$) (numerous "twisted" tubes are unidentified polychaetes; partially buried sponge near the lower left corner may be Polymastia infrapilosa) on the northern slope and Station 5 at the top. Station 7 was located on a slope at 50 to 60m depth, northwest of the PDL. The seafloor at both stations was flat and covered by a layer of fine-grained sediment. No rocky outcrops, cobbles, or pebbles were present. On the basis of sediment characteristics, water motion evidently was minimal. There was no evidence of recent sedimentation at either station.

Unidentified tubicolous polychaetes (see Station 4) are the only sedentary organisms visible at both Stations 6 and 7. However, their abundances in both stations were lower than the densities observed within similar habitats from other stations. Indeed, with the exception of the areas of heavy sedimentation at Station 5, 6, and 7 had the least developed epibenthic communities among all stations investigated. The surface sediments at both stations, however, revealed numerous tracks and holes, indicating the presence of mobile and buried organisms.

The slope location of Stations 6 and 7 is conducive to natural sedimentation by gravitational flow from upslope sediment deposits. Station 6 (usually downcurrent of the PDL) may receive more sediments due to disposal activities than Station 7 (usually upcurrent). Neither area bears evidence of recent sedimentation because polychaetes do not appear to be buried. Sedimentation rates and bottom characteristics evidently were similar at both stations because the epibenthic communities were composed of the same polychaete species in similar densities and sizes.

STATION 9 - SLOPE

Station 9 is a slope at 45 to 55m depth, due west of the PDL (Figure B-1). This area was the most ecologically diverse of all the stations surrounding the PDL. The small-scale physiography ranged from flat bottoms extensively covered by fine-grained sediment to bottoms with high relief (~ 60 cm) consisting of rocky ledges or numerous large rocks (20 to 25 cm), with little or no sediment cover. There was no evidence of bottom currents, but some indication of recent sedimentation.

The rocky surfaces at Station 9 were populated by attached organisms such as brachiopods, numerous types of erect and encrusting sponges, anemones, polychaetes, and barnacles (Figure B-6). Asteroids, ophiuroids, and a sea urchin were observed. All densities were low and no single species was clearly dominant. Sponges were the most abundant group.

All flat bottom areas were covered by a layer of sediment and the surfaces were disturbed by numerous tracks and holes formed by organisms. In some locations the sediment layer must have been relatively thin, because erect sponges, brachiopods, rock-dwelling asteroids, and a few tubicolous polychaetes were present. Other bottom areas were covered by a deeper layer of sediment, as suggested by the presence of cerianthid anemones and the greater abundance of tubicolous polychaetes.

The biological diversity of flat bottom at Station 9 was similar to that at Station 1. Station 1 was also on a slope, but the bottom was primarily bedrock covered by an apparently thin layer of sediment. Station 9 had more tubicolous polychaetes and cerianthids, and fewer brachiopods than Station 1, indicating deeper layers of sediments.

STATION 11 - FLOOR

Station 11 occupied the floor of a small basin south of the PDL at a depth of 60m, and was connected to the PDL via a narrow north-south oriented ravine (Figure B-1). The floor was a flat expanse of mud with obvious signs of bioturbation. Sediments in this basin appeared to have accumulated over a long period of time, with no indication of heavy, recent sedimentation.

Tubicolous polychaetes were the only organism observed, but it was common; its density exceeded values recorded for some slope stations.

DISCUSSION

All eight IEC stations within the Existing Site (Figure B-1) were covered by some sediment. Some of these areas supported populations of large

Figure B-6. A Rocky Rubble Habitat at Station 9 ($\simeq 0.2\ m^2$) (organisms include a large solitary sponge [Polymastia infrapilosa], smaller solitary sponges [Subertechnicus hispidus], brachiopods [Terebratulina septentrionalis], anemones [Stomphia coccinea], colonial sponges [Hymodismia sp.], and the asteroid [Henricia sanguinolenta]) cerianthid anemones and/or tubicolous polychaetes, which commonly are found in areas subjected to natural siltation. Sedimentation is probably an ongoing process in these areas, but occurs at a rate slow enough for the survival of diverse populations of organisms.

Evidence of recent and extensive sediment deposition, however, was found at 4 of the 8 stations within the Existing Site. Station 5 was located on top of a rocky elevation, downcurrent of the PDL (relative to the dominant current). Two areas within Station 5 were characterized by extensive sedimentation and almost complete absence of life. Consequently, there is a high probability that these areas were affected by relatively recent dredged material disposal activities. The remaining three stations (Stations 1, 4, and 9) were on slopes. Gravitational flow of sediments downslope is a common process, thus the partial or complete burial of epibenthic species may or may not have been a result of dredged material disposal. Station 4 was downslope of Station 5, and it is possible that the sediments present were directly or indirectly derived from dredged material disposal. There was no evidence of extensive and recent sedimentation at Station 6, which also was downslope of Station 5.

Four species observed in the IEC photographic survey of the epifauna also were present in NUSC (1979) and the Normandeau (1974) samples. Abundances were different during the recent study, however, because photographic surveys were not restricted to soft substrates, as were the dredges and grabs used previously. Brachiopods require a hard substrate for attachment, thus they were rarely collected by dredges and grabs, but were the dominant species in most photographs of hard substrate areas. Asteroids commonly were observed on hard substrates, but were absent from dredge and grab samples. Dredges, grabs, and photographic surveys of the sediment basins all indicated that cerianthid anemones were generally present, but in low numbers.

This surveyed region, all within a relatively small area, emphasizes the large spatial and temporal variability associated with the biota of the Western Atlantic Boreal Province. The number of species, number of individuals, and species composition differ substantially within similar habitats from different areas.

Appendix C

LAND DISPOSAL COMMENTS AND RESPONSES

Comment [from National Coalition for Marine Conservation, Inc.]: "The summary dismissal of land disposal as an alternative to ocean disposal does not appear to be an attempt in good faith to comply with the requirements of NEPA. For example, mere allusion to "the social impacts of increased trucking in the Portland area" is not dispositive of the question of the feasibility of onshore disposal. Furthermore, Section 6.06 is a travesty of response. To say on the one hand the construction of marshes from dredged materials "would be an ideal use for the material" and then dismiss this possibility on the grounds that "there is insufficient information on the requirements of New England marshes for this to be a feasible alternative" is to admit that the Corps is not discharging its obligations under NEPA and the Marine Protection, Research and Sanctuaries Act."

Response [by the CE]: The Corps does not believe we hastily or arbitrarily dismissed land disposal; we do believe the material presented was a concise statement of the facts. However, to amplify the social impacts of transporting nearly one million cubic yards of sediments through Portland or South Portland, the following is presented:

First, assume that a large earth moving truck can carry 30 cubic yards per trip and that it takes one hour to load, unload and make a round trip to and from the disposal site. Then one truck could transport 240 cubic yards of material a day. If 20 trucks are used to haul the sediments, then it would require 209 days or over 41 weeks to move the material -- forty weeks of 160 round trips per day moving through Portland or South Portland.

Also, before the sediments could be hauled away, the sediments would have to be drained. From past projects, we have determined that it requires about 8 acres of land for each 100,000 cubic yards of material. Consequently, about 80 acres of land would be required for draining and handling the lees. In addition, the Maine Department of Environment Protection has requested that the Corps increase the size of the turning basin in Portland Harbor.

Finally, the Corps believes it is discharging its obligations under NEPA and MPRS Act. The Corps has and continues to research uses for dredged materials -- this includes the building of marshes. No marsh project has been constructed in the New England area, therefore, the feasibility of marsh construction in this area has not been evaluated.

Comment [by the National Coalition for Marine Conservation, Inc.]: It does not appear from the EIS that the Corps has made any real attempt to find an onshore disposal site or to analyze the true economic feasibility of onshore disposal or the biological feasibility of marsh construction. Thus, it appears that there has been a failure to comply with 41 Fed. Reg. 47675 (see Fed. Reg. p. 47678, Oct. 29, 1976).

Response [by the CE]: The Corps is aware of this section of the Federal Register; however, we fail to see why it is stated that the Corps is not in compliance.

As for biological feasibility of marsh construction, we refer you to our previous comments. Concerning economics, land disposal is clearly the more expensive alternative. Ocean disposal requires only single handling of the dredged material; that is, from dredge to scow which is then towed to the disposal area. Land disposal, since there are no areas along the waterfront, would involve trucking thereby requiring triple handling. The operation would include: dredge to scow, scow to drainage area by crane and crane to truck. The additional manpower and equipment requirements are obvious. The following is an example of some of the associated costs:

Cost per truck per day	$150
Cost per front end loader per day	$150
Number of days necessary to just transport the dredged materials	209

Trucks/loader		Cost/day		Days		Cost
20	x	$150	x	209	=	$627,000
2	x	$150	x	209	=	62,700
Cost of materials and construct of dike						525,000
Estimated total cost for land disposal						$1,214,700

APPENDIX D

REPORT OF BIOASSAY AND BIOACCUMULATION TESTING - SOUTH REACH PORTLAND - HARBOR, MAINE

Prepared for:

New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
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Prepared by:

Environmental Sciences Division
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One Alewife Place
Cambridge, Massachusetts 02140

June 1982

TABLE OF CONTENTS

1. INTRODUCTION

This assessment was performed for the New England Division of the Corps of Engineers under Work Order No. 0007, Contract No. DACW-33-81-D-0002.

The New England Division is considering dredging material from the south reach of Portland Harbor, Maine (Figure 1 and Appendix A). This assessment was conducted with material collected from this area on March 9, 1982 (Appendix A). Tests with the material were initiated on March 20, 1982 (Appendix B.1), 11 days after it was collected. This report was delivered to the Waltham facility of the New England Division on June 4, 1982.

The report contains three appendices. Sampling information for dredged material and reference sediment is presented in Appendix A. ERCO's quality-control program for the receipt of samples, preparing, and testing of dredged material and associated sediments is detailed in Appendix B. All raw bioassay-related data are contained in Appendix C. Only bioassay data directly relevant to the assessment are presented in the main body of the report.

Figure 1. Locations of Proposed Dredging and Disposal Sites. Sampling Stations for Sediment are Depected in Maps. (Information Supplied By J. Bajek, U.S. Army, COE).

2. OBJECTIVES

The objective of this assessment is to evaluate the ecological acceptability of the proposed oceanic discharge of dredged material from the south reach of Portland Harbor to the disposal site located approximately 6 nmi east of Cape Elizabeth, Maine (Figure 1). If the proposed discharge operation is judged to be ecologically acceptable according to the bioassay- and bioaccumulation-related criteria employed in the assessment, the disposal practice is considered to be in partial compliance with Subpart B (Environmental Impact) of the ocean dumping regulations (U.S. EPA, 1977).

Subpart B (Environmental Impact) of the ocean dumping regulations consists of the following basic sections: §227.5 (Prohibited Materials); §227.6 (Constituents Prohibited as Other than Trace Contaminants); §227.7 (Limits Established for Specific Wastes or Waste Constituents); §227.8 (Limitations on the Disposal Rates of Toxic Wastes); §227.9 (Limitations on Quantities of Waste Materials); §227.10 (Hazards to Fishing, Navigation, Shorelines or Beaches); §227.11 (Containerized Wastes); §227.12 (Insoluble Wastes); and §227.13 (Dredged Materials). Disposal of dredged material must comply with restrictions and limitations imposed by §227.5, §227.6, §227.9, §227.10, and §227.13 of the regulations (U.S. EPA, 1977).

Dredged material from the south reach of Portland Harbor complies with §227.5 (Prohibited Materials) of the ocean dumping regulations since it does not contain high-level radioactive wastes; materials used for warfare; insufficiently described materials; or persistent, inert substances that may interfere materially with legitimate uses of the ocean. Compliance of the material with toxicological (bioassay-based) and bioaccumulation-related criteria identified in §227.6 (Constituents Prohibited as Other than Trace Contaminants) and §227.13 (Dredged Material) of the regulations is addressed in this report.

3. METHODS AND MATERIALS[a]

Proposed dredged material from the south reach of Portland Harbor was collected (March 9, 1982) by a sampling crew supervised by J. Bajek, NED, U.S. Army Corps of Engineers, who supplied all information concerning sample collection. Nine sampling sites (Sites A through I) were occupied in Portland Harbor (Figure 1). At each site, samples were collected with a gravity corer or grab sampler. The samples were placed in polyethylene bags, which were iced immediately and transported to ERCO's facility in Cambridge, Massachusetts. The samples were delivered to ERCO by Mr. Robert Morton, SAI, at 1400 on March 11 and were immediately placed in cold storage (2-4°C).

Dredged material was composited into the following four samples: sample 1 - sites G, H, and I; sample 2 - sites A, E, and F; sample 3 - sites C and D; and sample 4 - site B. Material was prepared for biological testing according to procedures described in Appendix B of the manual entitled Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters (U.S. EPA and U.S. Army COE, 1977). Artificial seawater (30 ppt salinity) was employed in the bioassay tests.

Bioassays with dredged material were conducted according to guidelines presented in Appendix F of the EPA and COE manual for dredged material (U.S. EPA and U.S. Army COE, 1977). Species tested in the solid phase bioassays were the

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[a]Procedures used to sample, prepare, and test dredged material are described in detail in Appendix B.1 and B.2 of this report.

grass shrimp (Palaemonetes pugio), hard clam (Mercenaria mercenaria), and sandworm (Nereis virens). Grass shrimp were obtained from a commercial supplier in Massachusetts. Hard clams and sandworms were acquired from commercial suppliers in, respectively, Long Island, New York, and Boston, Massachusetts. Animals were acclimated in artificial seawater for at least 3 days prior to initiation of testing. All species were tested in the same aquaria. Testing temperature was 20±1°C. Water exchange (artificial seawater) was by the replacement, as compared to the flow-through, method. Control (culture) sediment employed in the tests was collected on March 11, 1982, from the subtidal zone off Manchester, Massachusetts. The sediment consisted primarily of sand. Reference (disposal-site) sediment used in the tests was collected on March 10, 1982, from a single sampling site located approximately 13 nmi east of Portland Head, Maine (Figure 1). The sediment was collected with a grab sampler operated by the sampling crew directed by J. Bajek. Depth of water at the sampling site was approximately 58 m. The sediment was placed in polyethylene bags, which were immediately iced and transported to ERCO's Cambridge facility. The sediment arrived at ERCO at 1400 on March 11 and was immediately placed in cold storage (2-4°C).

At the conclusion of the solid phase bioassays with grass shrimp, hard clams, and sandworms, all surviving organisms from each aquarium (replicate) were placed in an aquarium containing clean, sediment-free water and allowed to void their digestive systems (sand worms were confined in Nitex containers to prevent predation by grass shrimp). Organisms were maintained in uncontaminated media for a period of 2 days. During this time, fecal material was removed from aquaria. At the end of the 2-day period, all samples of organisms were split into approximately equal amounts. One of these subsamples was placed in a polyethylene clean bag and frozen for later analyses for metals. The second subsample was put in solvent-rinsed aluminum foil and frozen for analyses for organics. Prior to being chemically analyzed, biological samples were thawed and exoskeletons of grass shrimp and hard clams were removed with acid-rinsed plastic utensils (metal analyses) or solvent-rinsed metal utensils (organic analyses).

Biological samples (tissue samples) were analyzed for two metals - Cd and Hg - according to procedures described by Goldberg (1976) and the U.S. EPA (1979). In the analyses for Cd, an aliquot of wet, homogenized tissue (approximately 5 g for hard clams and sandworms and 0.3-0.6 g for grass shrimp) was placed in a 100-ml tall-form Pyrex beaker with 5 ml of concentrated, Instra-analyzed (J.T. Baker Co.) nitric acid and refluxed without boiling until the tissue was completely digested (6-24 hr). Following digestion, the sample was evaporated to dryness. Then, additional nitric acid (1-2 ml) and 30% Ultrex (J.T. Baker Co.) hydrogen peroxide (1-2 ml) were added to the beaker, and the sample was heated until oxidative frothing subsided. At this time, the sample was cooled, diluted to volume with deionized, distilled water, and analyzed by graphite-furnace atomic absorption spectrophotometry (AAS). For the analyses for Hg, a separate aliquot of wet, homogenized tissue (about 5 g for hard clams and sandworms and 0.3-0.6 g for grass shrimp) was placed in a 300-ml glass BOD bottle. Approximately 15-20 ml of concentrated, Instra-analyzed sulfuric acid was placed in the bottle, and the sample was heated at 55°C in a water bath until the tissue was completely digested (2 hr). After cooling of the sample, 100 ml of deionized, distilled water and 1-2 g of Instra-analyzed potassium permanganate were added to the bottle. The resulting solution was analyzed by cold-vapor AAS after addition of reducing agents (10% hydroxylamine hydrochloride and 10% stannous sulfate).

Tissue samples were analyzed for three types of organics - PCBs, the DDT family, and petroleum hydrocarbons - according to procedures described by the U.S. EPA (1971), Crump-Wiesner et al. (1974), the U.S. Food and Drug Administration (1977), and Warner (1976). Tissue samples (5-20 g wet wt.) were placed in 50-ml centrifuge tubes, to which were added 10-ml aliquots of 10 N potassium hydroxide and high-purity methanol, and 5 µg of an internal standard (androstane). After sealing with nitrogen gas, the tubes were placed in a water bath at 80°C for 4 hr (tubes were shaken every 30 min). This saponification process, described above, digests the tissue, thereby releasing PCBs, DDTs, and petroleum hydrocarbons. Three 20-ml portions of high-purity hexane were used to extract the original compounds of interest from the methanol/potassium hydroxide digestate. The water soluble fraction was then discarded. The three extracts were combined, dried over a small volume (10 g) of sodium sulfate, and concentrated to 1 ml by flash evaporation. The extracts were then fractionated using column chromatography (1 g sodium sulfate, 6.5 g of 7.5% deactivated alumina, and 1 g sodium sulfate) as follows. The 1-ml concentrate was charged to the top of the column and the column was eluted with 25 ml of hexane. The hexane was concentrated to 2 ml by flash evaporation, and further concentrated to 0.5 ml under a stream of purified nitrogen. The hexane fraction was analyzed for PCBs and the DDT family by packed-column gas chromatography and electron-capture detection, employing a Hewlett-Packard Model 5840A instrument equipped with a Ni^{63} detector. The column, a 6-ft x 2-mm I.D. glass instrument packed with 5% SP2401 or 1.95% SP2401 and 1.5% SP2250, was held isothermally at 188°C. The peaks in the hexane fraction were identified and quantified by comparing retention times and peak areas to those of standards. An aliquot of the column-chromatographic fraction was analyzed for petroleum hydrocarbons by glass capillary gas chromatography and flame ionization detection, employing a Hewlett-Packard Model 5840A instrument. The column, a 0.25-mm I.D. x 30-m SE30 glass capillary fused silica column (J&W Scientific), was temperature-programmed from 60°C to 275°C at 10°/min. The areas of the resolved and unresolved components were measured by electronic integration and planimetry, respectively, and compared to the areas of an internal standard (androstane) to determine the concentration of petroleum hydrocarbons.

Results of the bioassay and bioaccumulation studies were interpreted by statistical techniques recommended by the U.S. EPA and U.S. Army COE (1977). When warranted, each data set generated in the studies was evaluated by Cochran's test to determine if variances of the data were homogeneous. If variances were homogeneous, a parametric one-way analysis of variance (ANOVA) and, if necessary, Student-Newman-Keuls' multiple-range test was used to determine if significant differences exist between control or reference organisms and organisms exposed to dredged material. If variances were not homogeneous as judged by Cochran's test, the data were transformed (natural logarithm of X + 1), and the transformed data were evaluated for homogeneity of variances by Cochran's technique. Transformed data exhibiting homogeneous variances were analyzed for significant differences by a parametric one-way ANOVA and, if appropriate, Student-Newman-Keuls' test. In all statistical tests, the symbols "*" and "ns" are used to denote significant and nonsignificant differences, respectively.

4. RESULTS

Results of the bioassay and bioaccumulation studies conducted during the ecological assessment of proposed dredged material from the south reach of Portland Harbor are presented in this section of the report.

4.1 Bioassay Studies

Data produced by solid phase bioassays with grass shrimp, hard clams, and sandworms are presented in Table C1 (Appendix C). Mean survival of organisms exposed for 10 days to dredged material was 88.0 to 98.0% (grass shrimp), 99.0 to 100.0% (hard clams), and 94.0 to 99.0% (sandworms).

Analysis of total (combined) survival data for the three species exposed for 10 days to control (culture) sediment, reference (disposal-site) sediment, and the solid phase of dredged material is presented in Table 1. Mean survival of control organisms was greater than 90%, thus allowing evaluation of data from tests with reference sediment and dredged material. Survival of organisms exposed to the solid phase of dredged material was not significantly different ($\alpha = 0.05$) than survival of reference organisms. Thus, it is concluded that, with regard to its toxicological effects, the solid phase of dredged material from the south reach of Portland Harbor is ecologically acceptable for discharge at the proposed disposal site.[a]

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[a]Paragraph 37, page F17, Appendix F of the EPA and COE manual for dredged material (U.S. EPA and U.S. Army COE, 1977) states that a solid phase has "real potential for causing environmentally unacceptable impacts on benthic organisms [only if] difference in mean survival between animals in the control and test sediments is statistically significant <u>and</u> [emphasis added] greater than 10 percent."

Table 1.—Analysis of total (combined) survival data for grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*) exposed for 10 days to control (culture) sediment, reference (disposal-site) sediment, and solid phase of dredged material

Step 1. Survival Data (From Table C1)

Treatment (t): / Replicate (r)	Number of Survivors: Control (Culture) Sediment	Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	60	55	59	53	60	58
2	59	59	59	56	59	56
3	59	58	56	60	60	57
4	58	59	58	59	54	60
5	57	58	60	58	56	60
Mean ($\bar{x}$):	58.60	57.80	58.40	57.20	57.80	58.20
	(97.7%)	(96.3%)	(97.3%)	(95.3%)	(96.3%)	(97.0%)

Step 2. Cochran's Test for Homogeneity of Variances of Survival Data

Treatment (t)	Number of Survivors: Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	57.80	2.70
Dredged Material - Sites G, H, I	58.40	2.30
Dredged Material - Sites A, E, F	57.20	7.70
Dredged Material - Sites C, D	57.80	7.20
Dredged Material - Site B	58.20	3.20

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{7.70}{23.10} = 0.33 \text{ ns},$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Total Survival Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	4.24	1.06	0.23 ns,
Error	t(r-1)=20	92.40	4.62	
Total	tr-1=24	96.64		

as compared to: $F_{(tab.)}$ = 2.87 for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

4.2 Bioaccumulation Studies

Concentrations of the DDT family in tissues in grass shrimp, hard clams, and sandworms that survived 10-day exposure to the solid phase of dredged material were always less than the analytical detection limit of 0.01 μg/g wet weight. Concentrations of Cd (Table 2), Hg (Table 3), PCBs (Table 4), and petroleum hydrocarbons (Table 5) in organisms exposed to dredged material usually were not significantly elevated ($\alpha = 0.05$) above concentrations observed in reference organisms. However, significant ($\alpha = 0.05$) bioaccumulation did occur in the cases of mercury in sandworms exposed to the composite of dredged material from Sites G, H, and I and PCB's in grass shrimp exposed to the composites of material from Sites A, E, and F.

Table 5.—Petroleum hydrocarbons (Continued)

Organism	Analysis
Sandworms	Step 1. Concentration of Chemicals in Tissues

Treatment (t): / Replicate (r)	Concentration (µg/g wet wt.): Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	1.3	8.4	13.0	4.2	7.1
2	2.2	4.3	1.8	4.2	5.1
3	3.8	6.8	1.3	3.8	5.1
4	3.6	4.2	5.0	14	6.2
5	2.0	5.7	2.4	3.8	4.7
Mean ($\bar{x}$):	2.6	6.1	4.7	6.0	5.6

Step 2. Cochran's Test for Homogeneity of Variances of Chemical Data

Treatment (t)	Data (µg/g wet wt.): Mean ($\bar{x}$)	Variance (s^2)
Reference (Disposal-Site) Sediment	2.6	1.16
Dredged Material - Sites G, H, I	6.1	3.25
Dredged Material - Sites A, E, F	4.7	23.56
Dredged Material - Sites C, D	6.0	20.04
Dredged Material - Site B	5.6	0.98

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$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{23.56}{48.99} = 0.48 \text{ ns,}$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Chemical Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	42.6	10.6	1.08 ns,
Error	t(r-1)=20	196.0	9.8	
Total	tr-1=24	238.6		

as compared to: $F_{(tab.)} = 2.87$ for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 5.—Petroleum hydrocarbons (Continued)

Organism	Analysis
Hard Clams	Step 1. Concentration of Chemicals in Tissues

Treatment (t): Replicate (r)	Concentration (ug/g wet wt.) Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	2.8	5.9	6.0	6.3	7.3
2	4.7	8.1	4.6	11.0	11.0
3	5.5	8.8	5.5	3.4	6.6
4	7.5	9.7	12.0	14	4.8
5	4.4	4.2	8.9	10	15
Mean ($\bar{x}$):	5.0	7.3	7.4	8.9	8.9

Step 2. Cochran's Test for Homogeneity of Variances of Chemical Data

Treatment (t)	Data (ug/g wet wt.) Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	5.0	2.95
Dredged Material - Sites G, H, I	7.3	5.05
Dredged Material - Sites A, E, F	7.4	9.20
Dredged Material - Sites C, D	8.9	17.16
Dredged Material - Site B	8.9	16.57

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{17.16}{50.93} = 0.34 \text{ ns,}$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Chemical Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	52.7	13.18	1.29 ns,
Error	t(r-1)=20	203.7	10.19	
Total	tr-1=24	256.4		

as compared to: $F_{(tab.)}$ = 2.87 for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 5.—Analyses of petroleum hydrocarbons in tissues of grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*) that survived 10-day exposure to reference (disposal-site) sediment and solid phase of dredged material

Organism	Analysis
Grass Shrimp	Step 1. Concentration of Chemicals in Tissues

Treatment (t): / Replicate (r)	Concentration (ug/g wet wt.) Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	<0.1	<0.1	1.0	1.2	<0.1
2	<0.1	<0.1	<0.1	6.0	<0.1
3	5.0	<0.1	<0.1	26	40
4	<0.1	12	23.0	3.3	7.0
5	2.8	2.4	6.5	<0.1	<0.1
Mean ($\bar{x}$):	1.6	2.9	6.1	7.3	9.5

Step 2. Cochran's Test for Homogeneity of Variances of Chemical Data

Treatment (t)	Data (ug/g wet wt.) Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	1.6	4.9
Dredged Material - Sites G, H, I	2.9	26.6
Dredged Material - Sites A, E, F	6.1	95.9
Dredged Material - Sites C, D	7.3	114.1
Dredged Material - Site B	9.5	300.4

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{300.4}{541.90} = 0.55 *,$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Chemical Data (Transformed Data)

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	2.39	0.60	0.38 ns,
Error	t(r-1)=20	31.44	1.57	
Total	tr-1=24	33.83		

as compared to: $F_{(tab.)}$ = 2.87 for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 4.—Polychlorinated biphenyls (Continued)

Organism	Analysis
Hard Clams	Step 1. Concentration of Chemicals in Tissues

Concentration (ug/g wet wt.)

Treatment (t): Replicate (r)	Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	<0.01	<0.01	<0.01	<0.01	<0.01
2	<0.01	<0.01	<0.01	0.01	<0.01
3	<0.01	<0.01	<0.01	0.01	<0.01
4	<0.01	<0.01	<0.01	<0.01	0.01
5	<0.01	<0.01	<0.01	0.01	0.01
Mean ($\bar{x}$):	0.01	0.01	0.01	0.01	0.01

- - - - Further Analysis Not Warranted - - - -
($\bar{x}$ for dredged material equal to $\bar{x}$ for reference sediment)

Organism	Analysis
Sandworms	Step 1. Concentration of Chemicals in Tissues

Concentration (ug/g wet wt.)

Treatment (t): Replicate (r)	Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	<0.01	0.02	<0.01	0.01	0.01
2	<0.01	<0.01	0.01	<0.01	0.01
3	<0.01	0.01	<0.01	0.01	<0.01
4	<0.01	<0.01	<0.01	0.01	0.01
5	<0.01	0.01	<0.01	0.01	0.01
Mean ($\bar{x}$):	0.01	0.01	0.01	0.01	0.01

- - - - Further Analysis Not Warranted - - - -
($\bar{x}$ for dredged material equal to $\bar{x}$ for reference sediment)

Table 4.—Polychlorinated Biphenyls (Continued)

Organism	Analysis
Grass shrimp (continued)	Step 4. Student-Newman-Keuls' Multiple-Range Test for Identifying Cause of Significant Difference in Chemical Data

A. Ranking of Treatment Means ($\bar{x}$) From Lowest to Highest

(1)	(2)	(3)	(4)	(5)
Reference Sediment - 0.02	Dredged Material, Site B - 0.03	Dredged Material, Sites G, H, I - 0.04	Dredged Material, Sites C, D - 0.05	Dredged Material, Sites A, E, F - 0.07

- -

B. Comparison of Mean for Reference Sediment with Greater Means for Dredged Material

Comparison of Means	Difference Between Means	
(5) vs. (1)	0.07 - 0.02 = 0.05 *,	as compared to LSD (least significant difference) = 0.0326 for α = 0.05, $s_{\bar{x}}$ = 0.0077, and K = 5
(4) vs. (1)	0.05 - 0.02 = 0.03 ns,	as compared to LSD = 0.0305 for α = 0.05, $s_{\bar{x}}$ = 0.0077, and K = 4
(3) vs. (1)	0.04 - 0.02 = 0.02 ns,	as compared to LSD = 0.0276 for α = 0.01, $s_{\bar{x}}$ = 0.0077, and K = 3
(2) vs. (1)	0.03 - 0.02 = 0.01 ns,	as compared to LSD = 0.0227 for α = 0.05, $s_{\bar{x}}$ = 0.0077, and K = 2

Table 4.—Analyses of polychlorinated biphenyls (PCBs) in tissues of grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*) that survived 10-day exposure to reference (disposal-site) sediment and solid phase of dredged material

Organism	Analysis
Grass Shrimp	Step 1. Concentration of Chemicals in Tissues

Treatment (t): Replicate (r)	Concentration (ug/g wet wt.): Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.02	0.03	0.07	0.05	0.04
2	0.05	0.04	0.05	0.05	0.05
3	<0.01	0.07	0.09	0.08	0.02
4	<0.01	0.02	0.08	0.03	0.01
5	0.02	0.05	0.05	0.03	0.05
Mean ($\bar{x}$):	0.02	0.04	0.07	0.05	0.03

Step 2. Cochran's Test for Homogeneity of Variances of Chemical Data

Treatment (t)	Data (µg/g wet wt.): Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	0.02	0.00027
Dredged Material - Sites G, H, I	0.04	0.00037
Dredged Material - Sites A, E, F	0.07	0.00032
Dredged Material - Sites C, D	0.05	0.00042
Dredged Material - Site B	0.03	0.00033

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{0.00042}{0.00171} = 0.25 \text{ ns},$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Chemical Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	0.00586	0.0015	5.00 *,
Error	t(r-1)=20	0.00684	0.0003	
Total	tr-1=24	0.01270		

as compared to: $F_{(tab.)} = 2.87$ for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 3.—Mercury (Continued)

Organism	Analysis
Sandworms (continued)	Step 4. Student-Newman-Keuls' Multiple-Range Test for Identifying Cause of Significant Difference in Metal Data

A. Ranking of Treatment Means ($\bar{x}$) From Lowest to Highest

(1)	(2)	(3)	(4)	(5)
Reference Sediment –	Dredged Material, Sites C, D –	Dredged Material, Sites A, E, F –	Dredged Material, Site B –	Dredged Material, Sites G, H, I –
0.003	0.006	0.008	0.008	0.013

B. Comparison of Mean for Reference Sediment with Greater Means for Dredged Material

Comparison of Means	Difference Between Means	
(5) vs. (1)	0.013 – 0.003 = 0.010 *,	as compared to LSD (least significant difference) = 0.008 for α = 0.05, $s_{\bar{x}}$ = 0.002, and K = 5
(4) vs. (1)	0.008 – 0.003 = 0.005 ns,	as compared to LSD = 0.008 for α = 0.05, $s_{\bar{x}}$ = 0.002, and K = 4
(3) vs. (1)	0.008 – 0.003 = 0.005 ns,	as compared to LSD = 0.007 for α = 0.05, $s_{\bar{x}}$ = 0.002, and K = 3
(2) vs. (1)	0.006 – 0.003 = 0.003 ns,	as compared to LSD = 0.006 for α = 0.05, $s_{\bar{x}}$ = 0.002, and K = 2

Table 3.—Mercury (Continued)

Organism	Analysis
Sandworms	Step 1. Concentration of Metal in Tissues

Treatment (t): Replicate (r)	Concentration (ug/g wet wt.) Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.002	0.017	0.008	0.004	0.017
2	0.004	0.005	0.006	0.009	0.010
3	0.002	0.019	0.002	0.005	0.003
4	0.004	0.016	0.013	0.007	0.002
5	<0.001	0.007	0.009	0.005	0.009
Mean ($\bar{x}$):	0.003	0.013	0.008	0.006	0.008

Step 2. Cochran's Test for Homogeneity of Variances of Metal Data

Treatment (t)	Data (ug/g wet wt.) Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	0.003	0.0000018
Dredged Material - Sites G, H, I	0.013	0.0000402
Dredged Material - Sites A, E, F	0.008	0.0000163
Dredged Material - Sites C, D	0.006	0.0000040
Dredged Material - Site B	0.008	0.0000367

- -

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{0.0000402}{0.0000990} = 0.41 \text{ ns},$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Metal Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	0.000274	0.000068	3.40 *,
Error	t(r-1)=20	0.000396	0.000020	
Total	tr-1=24	0.000670		

as compared to: $F_{(tab.)}$ = 2.87 for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 3.—Mercury (Continued)

Organism	Analysis
Hard Clams	Step 1. Concentration of Metal in Tissues

Treatment (t): / Replicate (r)	Concentration (ug/g wet wt.)				
	Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.016	0.017	0.019	0.010	0.015
2	0.012	0.021	0.010	0.013	0.010
3	0.016	0.017	0.012	0.012	0.020
4	0.014	0.012	0.020	0.012	0.016
5	0.015	0.016	0.013	0.010	0.010
Mean ($\bar{x}$):	0.015	0.017	0.015	0.011	0.014

Step 2. Cochran's Test for Homogeneity of Variances of Metal Data

Treatment (t)	Data (ug/g wet wt.)	
	Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	0.015	0.000003
Dredged Material - Sites G, H, I	0.017	0.000010
Dredged Material - Sites A, E, F	0.015	0.000020
Dredged Material - Sites C, D	0.011	0.000002
Dredged Material - Site B	0.014	0.000021

- -

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{0.000021}{0.000056} = 0.43 \text{ ns},$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Metal Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	0.000070	0.000018	1.64 ns,
Error	t(r-1)=20	0.000224	0.000011	
Total	tr-1=24	0.000294		

as compared to: $F_{(tab.)}$ = 2.87 for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 3.—Analyses of mercury (Hg) in tissues of grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*) that survived 10-day exposure to reference (disposal-site) sediment and solid phase of dredged material

Organism	Analysis
Grass Shrimp	Step 1. Concentration of Metal in Tissues

Treatment (t): Replicate (r)	Concentration (ug/g wet wt.): Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.084	0.10	0.34	0.050	0.35
2	0.15	0.40	0.13	0.14	0.22
3	0.19	0.30	0.23	0.18	0.19
4	0.39	0.058	0.19	0.16	0.27
5	0.26	0.094	0.093	0.16	0.23
Mean ($\bar{x}$):	0.21	0.19	0.20	0.14	0.25

Step 2. Cochran's Test for Homogeneity of Variances of Metal Data

Treatment (t)	Data (ug/g wet wt.): Mean ($\bar{x}$)	Variance(s^2)
Reference (Disposal-Site) Sediment	0.21	0.014
Dredged Material - Sites G, H, I	0.19	0.023
Dredged Material - Sites A, E, F	0.20	0.009
Dredged Material - Sites C, D	0.14	0.003
Dredged Material - Site B	0.25	0.004

- -

$$C_{(cal.)} = \frac{s^2(max.)}{\Sigma s^2} = \frac{0.023}{0.053} = 0.43 \text{ ns},$$

as compared to:

$C_{(tab.)} = 0.54$ for $\alpha = 0.05$, $k = 5$, and $v = 4$

Step 3. Parametric One-Way Analysis of Variance (ANOVA) of Metal Data

Source of Variation	df	Sum of Squares	Mean Square	$F_{(cal.)}$
Treatment (Reference Sediment, Dredged Material From Four Sites)	t-1=4	0.034	0.009	0.90 ns,
Error	t(r-1)=20	0.208	0.010	
Total	tr-1=24	0.242		

as compared to: $F_{(tab.)} = 2.87$ for $\alpha = 0.05$, numerator df = 4, and denominator df = 20

Table 2.—Cadmium (Continued)

Organism	Analysis
Sandworms	Step 1. Concentration of Metal in Tissues

Treatment (t): / Replicate (r)	Concentration (ug/g wet wt.) Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.058	0.038	0.047	0.027	0.031
2	0.034	0.055	0.036	0.050	0.038
3	0.044	0.044	0.052	0.039	0.035
4	0.063	0.046	0.050	0.042	0.048
5	0.047	0.052	0.042	0.049	0.051
Mean ($\bar{x}$):	0.049	0.047	0.045	0.041	0.041

- - - - Further Analysis Not Warranted - - - -
($\bar{x}$ for dredged material
less than $\bar{x}$ for reference sediment)

Table 2.—Analyses of cadmium (Cd) in tissues of grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*) that survived 10-day exposure to reference (disposal-site) sediment and solid phase of dredged material

Organism	Analysis
Grass Shrimp	Step 1. Concentration of Metal in Tissues

Treatment (t): / Replicate (r)	Concentration (ug/g wet wt.): Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	<0.10	<0.11	<0.10	<0.13	<0.11
2	<0.18	<0.10	<0.05	<0.10	<0.10
3	<0.21	<0.08	<0.21	<0.07	<0.17
4	<0.21	<0.10	<0.18	<0.10	<0.12
5	<0.09	<0.07	<0.09	<0.08	<0.11
Mean ($\bar{x}$):	<0.15	<0.09	<0.13	<0.10	<0.12

- - - - Further Analysis Not Warranted - - - -
($\bar{x}$ for dredged material less than
$\bar{x}$ for reference sediment)

Organism	Analysis
Hard Clams	Step 1. Concentration of Metal in Tissues

Treatment (t): / Replicate (r)	Concentration (ug/g wet wt.): Reference (Disposal-Site) Sediment	Dredged Material - Sites G, H, I	Dredged Material - Sites A, E, F	Dredged Material - Sites C, D	Dredged Material - Site B
1	0.16	0.11	0.13	0.15	0.13
2	0.17	0.07	0.10	0.10	0.13
3	0.19	0.08	0.08	0.09	0.13
4	0.16	0.11	0.16	0.14	0.10
5	0.15	0.11	0.14	0.08	0.11
Mean ($\bar{x}$):	0.16	0.10	0.12	0.11	0.12

- - - - Further Analysis Not Warranted - - - -
($\bar{x}$ for dredged material less than
$\bar{x}$ for reference sediment)

5. DISCUSSION

The test organisms employed in the ecological assessment of proposed dredged material from the south reach of Portland Harbor are considered (U.S. EPA and U.S. Army COE, 1977) to be sensitive to dredged material and appropriate for testing with the material. To be considered appropriate for testing with dredged material, organisms, in addition to being sensitive to the material, must be reliable test organisms (commonly used in bioassays) and representative of broad taxonomic or trophic (feeding) groups (U.S. EPA, 1977). In the case of organisms used in solid phase tests, representation is according to feeding characteristics, i.e., a filter-feeder, deposit feeder, and burrowing species must be evaluated (U.S. EPA, 1977). Consequently, the results of this ecological assessment are applicable to a wide variety of sensitive benthic organisms indigenous to the proposed disposal site.

The bioassay (toxicity-related) studies performed in this assessment indicate that the proposed discharge of dredged material from the south reach of Portland Harbor would be ecologically acceptable according to the criteria established in the ocean dumping regulations (U.S. EPA, 1977). In addition, most of the bioaccumulation tests performed during the assessment indicate no potential for xenobiotic constituents of the material to accumulate in the human food chain.[a] There was

[a]Paragraph 25, page G11, Appendix G of the EPA and COE manual for dredged material (U.S. EPA and U.S. Army COE, 1977) states that there is "no indication of potential bioaccumulation from [the solid phase of] the dredged material [if there are] no statistical differences between tissue concentration in the reference substrate controls and the dredged material."

some indication of accumulation potential for PCB's in animals exposed to composited samples of sediment from Sites A, E, and F, and, to a lesser degree, for mercury in animals exposed to the composite of samples G, H, and I. The likelihood of harmful accumulation in human consumers is remote. Mercury has not been demonstrated to biomagnify in the ecological food web. PCB's do have the potential to reach high concentration in upper levels of the ecological food chain via the mechanism of biomagnification. However, the organisms employed in the bioaccumulation tests are characterized by body burdens of PCB's that are approximately two orders-of-magnitude less than the FDA action levels of 5 µg/g for fish and shellfish (U.S. FDA, 1979), and are likely to represent only a small percentage of the food supply utilized by upper-trophic-level predators in the vicinity of the disposal site.

6. CONCLUSIONS (SUMMARY)

The proposed oceanic discharge of dredged material from the south reach of Portland Harbor, Maine to the disposal site located approximately 6 nmi east of Cape Elizabeth, Maine, is ecologically acceptable as judged by the toxicity-related criteria employed in this assessment. Total (combined) survival of grass shrimp (Palaemonetes pugio), hard clams (Mercenaria mercenaria), and sandworms (Nereis virens) exposed for 10 days to the solid phase of the four samples of dredged material and reference (disposal-site) sediment was not significantly different.

Tissues of organisms that survived exposure to the solid phase of dredged material from the four sampling sites usually did not contain significantly elevated concentrations of xenobiotic constituents (cadmium, mercury, polychlorinated biphenyls, the dichloro-diphenyl-trichloroethane family, and petroleum hydrocarbons) as compared to tissues of reference organisms. Only 3% of the bioaccumulation tests (2 of 60 tests) performed during the assessment - 1 of 12 tests for PCB's and 1 of 12 tests for mercury - indicate a statistical potential for bioaccumulation.

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All information in this appendix was provided by Mr. J. Bajek of the New England Division, U.S. Army Corps of Engineers.

Appendix A. Locations of Proposed Dredging and Disposal Sites. Sampling Stations for Sediment are Depicted in Maps

PORTLAND HARBOR - SOUTH REACH

[illegible]SS	TYPE OF SAMPLE	LOCATION	DEPTH OF WATER AT TIME OF SAMPLING (Approx. High Ti[illegible]
A	- Gravity Cores to 2'7" depth	Approx. halfway between white "D" buoy and Commercial Marine Dock	8-9'
B	- Grabs (Smith-MacIntyre)	Approx. halfway between red buoy and rubble wall	32'
C	- Cores to 4'11" depth	Mid-point along outer pier arm (seaward), approx. 30m away	32'-34'
D	- Cores to 4'0" depth	Approx. halfway out along west side of pier, approx. 20m away	35'
E	- Cores to 3'3" depth	Approx. 50m north of Port. Harbor Marine Building	12'
F	- Cores to 4'4"	Approx. 75m from shore (boatyard)	8'-9'
G	- Grabs	Halfway between red buoy #4 and mooring dolphin	18'
H	- Grabs	Approx. 30m east of marker #1	14'
I	- Cores to 3'0" depth	Approx. 100m north of red marker #4	9'-10'

All harbor sediments were collected on 9 March 1982 between 10:45 am and 5:30 pm. At [illegible]ch station, one 1-gallon bag of material was tagged, filled, sealed and placed in cold [illegible]orage (iced in coolers) for shipment to ERCO.

Reference sediment was collected on 10 March 1982 between 3:05 pm and 4:15 pm [illegible]the coordinates 43° 38'N, 69° 59'W at a water depth of approx. 190'.

x 13200.0
y 25965.6
z 44557.7

Portland Harbor Sampling Party Crews

Vessel - Edgarton

9 March 1982			10 March 1982
Gene Crouch	-	NMFS	Gene Crouch
Mike Bartlett	-	FWS	Dick Semonian
Ralph Abele	-	FWS	Jim Bajek
Mike Conneilly	-	CE	Don Phipps
Ray Francisco	-	CE	Dan Barry
Dick Semonian	-	CE	Bob Morton
Jim Bajek	-	CE	Gary Paquette
Don Phipps	-	Capt.	Lance Stewart - SAI
Dan Barry	-	Deckhand	Mark Silvia - SAI
Bob Morton	-	SAI	
Gary Paquette	-	SAI	

The quality-control program described in this appendix consists of a chain-of-custody statement for sediment samples, laboratory procedures for preparing sediment for bioassays and conducting bioassays, and quality-control information for bioaccumulation studies.

B.1 Chain of Custody Statement for Sediment Samples

APPENDIX B.1

ENVIRONMENTAL SCIENCES DIVISION
ENERGY RESOURCES CO. INC.
205 ALEWIFE BROOK PARKWAY
CAMBRIDGE, MA 02138

CHAIN-OF-CUSTODY STATEMENT FOR SEDIMENT SAMPLES

Sediment samples[1] were delivered to ERCO's Aquatic Toxicology Laboratory, 205 Alewife Brook Parkway, Cambridge, Massachusetts at 1400 on March 11, 1982. Samples were delivered by Mr. Robert Morton, SAI, and were received by Mr. T.J. Ward, ERCO. At ERCO, the samples were maintained in a secured laboratory until they were used for bioassay testing.

Timothy J Ward

T.J. Ward, Director,
Aquatic Toxicology Laboratory
Energy Resources Co. Inc.

C D Rose

C.D. Rose, Project Officer
Energy Resources Co. Inc.

[1] Samples consisted of 12 bags of sediment.

B.2 Laboratory Procedures for Preparing Sediment for Bioassays and Conducting Bioassays

APPENDIX B.2

LABORATORY PROCEDURES FOR PREPARING DREDGED MATERIAL AND CONDUCTING BIOASSAYS[a]

Procedure	Date of Implemen-tation of Procedure	Certifications of Performance of Procedure		
		Aquatic Toxicologist	Laboratory Director	Division Director
1. Store control sediment (CS), reference sediment (RS), and 9 samples of dredged sediment (DS) at 2-4°C in separate containers. Mix sediment in each container as thoroughly as possible.	CS 3-11-82	[signature]	[signature]	[signature]
	RS 3-11-82	"	"	"
	DS 3-11-82	"	"	"

Solid Phase Bioassays

Bioassays should be initiated by March 25, 1982 (2 weeks after March 11, 1982, date of sediment delivery).
Do not be concerned with sophisticated photoperiod.
Maintain dissolved oxygen in aquaria at >4 ppm.
Cover aquaria to prevent salinity changes.

Procedure	Date of Implementation of Procedure	Aquatic Toxicologist	Laboratory Director	Division Director
2. Remove CS and RS from storage and wet sieve through 1-mm mesh into separate containers. Use minimum volume of artificial sea water [ASW] of salinity 30 ppt for sieving purposes. Place nonliving material remaining on sieve in appropriate containers.	3/18/82	"	"	"
3. Mix CS and RS in respective containers and allow to settle for 6 hr.	3/18/82	"	"	"
4. Decant ASW and mix CS and RS as thoroughly as possible.	3/18/82	"	"	"
5. Assign treatments (CS, RS, 4 samples of DS) and replicates (5 r per treatment) to aquaria.	3/18/82	"	"	"
6. Randomly position aquaria in environmental chamber maintained at 20±1°C.	3/18/82	"	"	"

[a]This document is a copy of the work sheet that was used during the evaluation. The document differs from the work sheet in that dates appear in typed form and certifications were added at a single time after the dates were typed.

Procedure	Date of Implementation of Procedure	Certifications of Performance of Procedure		
		Aquatic Toxicologist	Laboratory Director	Division Director
7. Partially fill aquaria with ASW.	3/18/82	*	*	*
8. Place 30 mm of CS in 5 control aquaria. Place 30 mm of RS in each remaining aquarium. Fill 1st aquarium to ~10 mm, then 2nd aquarium to ~10 mm, ..., and finally last aquarium to ~10 mm. Repeat sequence until aquaria are filled to ~20 mm. Repeat sequence again until aquaria are filled to ~30 mm. This procedure will help to ensure that CS and RS in all aquaria are homogeneous. Store remaining CS and RS at 2-4°C for later use.	3/18/82	*	*	*
9. Replace ASW 1 hr after CS and RS have been added to aquaria. Do not disturb sediment during replacement.	3/18/82	*	*	*
10. Select 600 hard clams from holding tanks and randomly distribute into 30 culture dishes. Follow same procedure for sandworms.	3/18/82	*	*	*
11. Randomly distribute contents of culture dishes into aquaria.	3/18/82	*	*	*
12. If necessary, replace 75% of ASW 24 hr after animals are introduced into aquaria.	Not necessary	*	*	*
13. Acclimate animals for 48 hr. During this time period, remove dead animals and replace with live animals.	3/18-20/82	*	*	*

Laboratory Procedures (Continued)

Procedure	Date of Implementation of Procedure	Certifications of Performance of Procedure		
		Aquatic Toxicologist	Laboratory Director	Division Director
14. During acclimation period, remove appropriate volumes of 9 samples of DS from storage and wet-sieve each sample through 1-mm mesh into separate containers. Use minimum volume of ASW for sieving purposes. Place nonliving material remaining on sieves in containers.	3/20/82	*	*	*
15. Mix 9 samples of DS in respective containers and allow to settle for 6 hr.	3/20/82	*	*	*
16. Decant ASW and mix 9 samples of DS as thoroughly as possible.	3/20/82	*	*	*
17. Composite 9 samples of DS into following samples: Sample 1 - G, H, I; Sample 2 - A, E, F; Sample 3 - C, D; Sample 4 - B.	3/20/82	*	*	*
18. Place 15 mm of appropriate sample of DS in all but control and reference aquaria. Employ basic strategy identified in Step 8.	3/20/82	*	*	*
19. Remove remaining CS and RS from storage. Warm to test temperature (20 ± 1°C). Add 15 mm of CS to each control aquarium and 15 mm of RS to each reference aquarium. Employ basic strategy identified in Step 8.	3/20/82	*	*	*

Procedure	Date of Implementation of Procedure	Certifications of Performance of Procedure		
		Aquatic Toxicologist	Laboratory Director	Division Director
20. Replace 75% of ASW 1 hr after addition of 4 samples of DS and final addition of CS and RS.	3/20/82	*	*	*
21. Select 600 grass shrimp from holding tank and randomly distribute into 30 culture dishes.	3/20/82	*	*	*
22. Randomly distribute contents of culture dishes into aquaria.	3/20/82	*	*	*
23. Perform the following activities:				
Every day after introduction of grass shrimp into aquaria				
• Record salinity, temperature, dissolved oxygen, and pH in each aquarium (record in log book)	Day 0 3/20/82	*	*	*
	Day 1 3/21/82	*	*	*
	Day 2 3/22/82	*	*	*
	Day 3 3/23/82	*	*	*
• Record obvious mortality, formation of tubes or burrows, and unusual behavior patterns of animals (record in log book)	Day 4 3/24/82	*	*	*
	Day 5 3/25/82	*	*	*
	Day 6 3/26/82	*	*	*
	Day 7 3/27/82	*	*	*
	Day 8 3/28/82	*	*	*
	Day 9 3/29/82	*	*	*
	Day 10 3/30/82	*	*	*

Laboratory Procedures (Continued)

Procedure	Date of Implementation of Procedure	Certifications of Performance of Procedure		
		Aquatic Toxicologist	Laboratory Director	Division Director
Every 2 days after introduction of grass shrimp into aquaria				
• Replace 75% of ASW	Day 2 3/22/82	"	"	"
	Day 4 3/24/82	"	"	"
	Day 6 3/26/82	"	"	"
	Day 8 3/28/82	"	"	"
24. At end of 10-day testing period, sieve sediment in each aquarium through 0.5-mm screen. Count live animals. Note sublethal responses. Depurate surviving organisms in ASW for 48 hr and preserve for bioaccumulation study.	3/30/82	"	"	"

B.3 Quality-control Information for Bioaccumulation Studies

Appendix B.3.—Quality-control information pertaining to bioaccumulation studies

Type of Quality-Control Information (unit of measurement)	Chemical Constituent	Organism Analyzed		
		Grass Shrimp (*Palaemonetes pugio*)	Hard Clams (*Mercenaria mercenaria*)	Sandworms (*Nereis virens*)
1. Pretesting data (concentrations of chemical constituents in organisms prior to testing - µg/g wet wt.)[a]	Cadmium (Cd)	0.11, 0.14, 0.12	0.13, 0.17, 0.16	0.027, 0.033, 0.035
	Mercury (Hg)	0.069, 0.12, 0.12	0.025, 0.033, 0.027	0.020, 0.022, <0.001
	Polychlorinated biphenyls (PCBs)	0.01, 0.01, 0.03	<0.01, <0.01, <0.01	0.03, 0.03, 0.03
	Dichloro-diphenyl-trichloroethane (DDT) family	<0.01, <0.01, <0.01	<0.01, <0.01, <0.01	<0.01, <0.01, <0.01
	Petroleum hydrocarbons	24, 31, 21	3.6, 3.5, 3.0	7.9, 11, 7.0

[a]Pretesting data represent three subsamples of 20 composited individuals of typical organisms employed in bioaccumulation studies conducted at ERCO during February 1982. Pretesting data are not derived from stocks of organisms used in bioaccumulation studies for the south reach of Portland Harbor.

[b]Precision data are derived from organisms exposed to Replicate 1 of dredged material from Site B (metals in hard clams and sandworms), Replicate 4 of material from Site B (metals in grass shrimp), and Replicate 1 of material from the composite of Sites A, E, and F (organics in hard clams and sandworms). Data for organics in shrimp are pretesting data.

[c]Standard oyster tissue (NBS-SRM 1566) was obtained from the National Bureau of Standards. All measured values are derived from triplicate analyses.

Quality-control information (continued)

Type of Quality-Control Information (unit of measurement)	Chemical Constituent	Organism Analyzed		
		Grass Shrimp (*Palaemonetes pugio*)	Hard Clams (*Mercenaria mercenaria*)	Sandworms (*Nereis virens*)
2. Precision data (concentrations of chemical constituents in triplicate subsamples of one set of organisms exposed to dredged material - μg/g wet wt.)[b]	Cadmium (Cd)	<0.10, <0.07, <0.19	0.16, 0.13, 0.092	0.028, 0.037, 0.029
	Mercury (Hg)	0.069, 0.60, 0.13	0.015, 0.016, 0.013	0.024, 0.025, 0.003
	Polychlorinated biphenyls (PCBs)	0.01, 0.02, <0.01	<0.01, <0.01, <0.01	<0.01, <0.01, <0.01
	Dichloro-diphenyl-trichloroethane (DDT) family	<0.01, <0.01, <0.01	<0.01, <0.01, <0.01	<0.01, <0.01, <0.01
	Petroleum hydro-carbons	<0.1, <0.1, <0.1	6.0, 5.5, 6.4	25, 6.1, 7.9

Quality-control information (continued)

Type of Quality-Control Information (unit of measurement)	Chemical Constituent	Organism Analyzed		
		Grass Shrimp (*Palaemonetes pugio*)	Hard Clams (*Mercenaria mercenaria*)	Sandworms (*Nereis virens*)
3. Accuracy data				
• Organics (concentrations of chemical constituents in above-identified triplicate subsamples attributable to reextraction - μg/g wet wt.)	Polychlorinated biphenyls (PCBs)	<0.01, <0.01, <0.01 (original recovery = 100%)	<0.01, <0.01, <0.01 (original recovery = 100%)	<0.01, <0.01, <0.01 (original recovery = 100%)
	Dichloro-diphenyl-trichloroethane (DDT) family	<0.01, <0.01, <0.01 (original recovery = 100%)	<0.01, <0.01, <0.01 (original recovery = 100%)	<0.01, <0.01, <0.01 (original recovery = 100%)
	Petroleum hydrocarbons	<0.1, <0.1, <0.1 (original recovery = 100%)	0.2, 0.6, 0.4 (original recovery = 94%)	0.4, 0.5, 0.4 (original recovery = 97%)
• Metals (concentrations of metals in standard oyster tissue - μg/g dry wt.)[c]		Oyster tissue - measured value	Oyster tissue - certified value	
	Cadmium (Cd)	3.7 ± 0.2	3.5 ± 0.4	
	Mercury (Hg)	0.034 ± 0.024	0.057 ± 0.015	

Table C1. Results of solid phase bioassays with grass shrimp (*Palaemonetes pugio*), hard clams (*Mercenaria mercenaria*), and sandworms (*Nereis virens*)[a]

Treatment (t)	Replicate (r)	Number of Survivors[b,c]			
		Grass Shrimp	Hard Clams	Sandworms	Total
Control (Culture) Sediment	1	20	20	20	60
	2	19	20	20	59
	3	20	20	19	59
	4	18	20	20	58
	5	18	20	19	57
	Mean ($\bar{x}$):	19.00	20.00	19.60	58.60
	(%):	(95.0)	(100.0)	(98.0)	(97.7)
Reference (Disposal-Site) Sediment	1	17	20	18	55
	2	20	20	19	59
	3	20	20	18	58
	4	20	20	19	59
	5	20	18	20	58
	Mean ($\bar{x}$):	19.40	19.60	18.80	57.80
	(%):	(97.0)	(98.0)	(94.0)	(96.3)
Dredged Material - Sites G, H, I	1	20	19	20	59
	2	19	20	20	59
	3	19	20	17	56
	4	20	20	18	58
	5	20	20	20	60
	Mean ($\bar{x}$):	19.60	19.80	19.00	58.40
	(%):	(98.0)	(99.0)	(95.0)	(97.3)
Dredged Material - Sites A, E, F	1	15	19	19	53
	2	16	20	20	56
	3	20	20	20	60
	4	19	20	20	59
	5	18	20	20	58
	Mean ($\bar{x}$):	17.60	19.80	19.80	57.20
	(%):	(88.0)	(99.0)	(99.0)	(95.3)

Table C1. Continued

Treatment (t)	Replicate (r)	Number of Survivors[b,c]			
		Grass Shrimp	Hard Clams	Sandworms	Total
Dredged Material - Site C, D	1	20	20	20	60
	2	19	20	20	59
	3	20	20	20	60
	4	19	19	16	54
	5	18	20	18	56
	Mean ($\bar{x}$):	19.20	19.80	18.80	57.80
	(%):	(96.0)	(99.0)	(94.0)	(96.3)
Dredged Material - Site B	1	18	20	20	58
	2	19	20	17	56
	3	20	20	17	57
	4	20	20	20	60
	5	20	20	20	60
	Mean ($\bar{x}$):	19.40	20.00	18.80	58.20
	(%):	(97.0)	(100.0)	(94.0)	(97.0)

[a]Bioassays (10-day tests) were conducted at 20 ± 1°C in 38-liter aquaria. Organisms were exposed to each replicate of a treatment in a single aquarium. Water in aquaria was exchanged by the replacement, as compared to the flow-through, method and was aerated. A 14-hour light and 10-hr dark photoperiod was maintained with cool-white fluorescent bulbs. Minimum values of dissolved oxygen and pH recorded during the bioassays were 5.5 mg/l and 7.5, respectively. Salinity was maintained at 30 ppt.

[b]Twenty (20) individuals of each species were initially exposed to each replicate of a treatment. Thus, a total of 60 animals was employed in each aquarium.

[c]In addition to monitoring survival of all species, burrowing behavior of sandworms was noted at 2-day intervals. No differences were observed among aquaria.

APPENDIX E

COMMENTS AND RESPONSES TO COMMENTS ON THE DRAFT EIS

The Draft EIS (DEIS) was issued on October 14, 1982. 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:

- o Comments correcting facts presented in the EIS, or providing additional information, were incorporated into the text and the changes were noted.

- o Specific comments which were not appropriately treated as text changes where numbered in the margins of the letters, and responses prepared for each numbered item.

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.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

October 18, 1982

OFFICE OF THE
ASSISTANT DIRECTOR
FOR ASTRONOMICAL,
ATMOSPHERIC, EARTH
AND OCEAN SCIENCES

Environmental Protection Agnecy
Office of Water (Acct. #072)
Criteria and Standards Division
Washington, DC 20480

Dear Sir:

1-1 The National Science Foundation has no comments on the DEIS for the Portland, Maine Dredged Material Disposal Site Designation.

Sincerely,

Barbara E. Onestak
Acting Chairman
Committee on Environmental Matters

DEPARTMENT OF THE ARMY
WATER RESOURCES SUPPORT CENTER, CORPS OF ENGINEERS
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

REPLY TO
ATTENTION OF:

WRSC-D

24 NOV 1982

Mr. Frank G. Csulak
Criteria and Standards Division (WH-585)
U. S. Environmental Protection Agency
401 M Street, S. W.
Washington, D. C. 20460

Dear Mr. Csulak:

2-1 Inclosed are the U. S. Army Corps of Engineers comments on the Draft Environmental Impact Statement (DEIS) for the Portland, Maine Ocean Dredged Material Disposal Site Designation dated October, 1982. Our technical review comments on the Preliminary DEIS were provided your office by Colonel Maximilian Imhoff's letter of March 30, 1982.

As discussed in the DEIS, the Corps concluded in its final EIS for maintenance dredging for the Portland Harbor dated June 1979, that the existing site is the most environmentally and economically feasible ocean disposal site for this Federal project. In addition, the site has been used, with EPA approval, and under authority of 40 CFR 228.4(e) for the disposal of other dredged materials from Portland Harbor and vicinity. Therefore, we ask that, for consistency and to reflect existing as well as projected future use of the site, that the proposed action be clearly stated throughout the document as final designation for the disposal of those materials dredged from Portland Harbor and vicinity that are in compliance with EPA criteria and requirements and Corps regulations.

Sincerely,

W. R. MURDEN, P. E.
Chief, Dredging Division

1 Incl
As stated

SUBJECT: Corps Comments on the Draft EIS for the Portland, Maine Ocean Dredged Material Disposal Site Designation

General

2-2 The present assessment appears to adequately describe Portland Harbor and the existing dumpsite area with the exception that no mention is made of recent Corps testing performed on Portland Harbor sediments in areas outside the Federal Channel. A copy of these data are attached for EPA's consideration and use in final EIS preparation. These data are the result of a testing program to characterize sediments in areas east of the Portland Bridge where private interests may be expected to maintenance dredge with disposal at the existing site. This testing has substantially increased our data base for private berthing and channel areas in the harbor. Additionally, it provides useful information for assessing the potential for acute and chronic toxocological effects of the harbor sediments if dumped at the existing site. Our analysis of this data is that no significantly adverse impacts are expected to occur.

Specific

2-3 Pages V para. 2 and XIII - The proposed action should be revised to state that the site is required for ocean disposal of materials dredged from Portland harbor and vacinity or Portland Harbor area as stated on page IX, para 2.

2-4 Page 1-2; last para. - Discussion on site designation is vague and may be misconstrued as for maintenance dredged material only. The statement should be revised as previously agreed between the Corps and EPA to read as follows: The Portland, Maine site would be designated for the disposal of dredged material. The site may be used for the disposal of dredged material only after evaluation of each Federal project or permit application has established that the disposal is within site capacity and in compliance with the criteria and requirements of EPA and the CE regulations.

2-5 Page 2-9; 1st para. - The last sentence should be changed to indicate that the Federal Channel maintenance dredging project occurred during 1979-1981 and that various private dredging projects in the area have been occurring from that time and is still in progress. The presently active private dredging is expected to result in an additional 800,000 c.y. deposited at the existing site.

2-6 Page 2-10;1st para. - It should be explained which "favorable disposal areas" Pequegnat et al identified and their relationship to the area being considered for designation.

2-7 Page 2-11; 3rd para. - There is an apparent discrepancy in the distance from the alternative site to Portland Harbor. This section of the report states the distance as 55 nmi while other sections in the assessment indicate that it may be approximately half that distance.

2-8 Page 2-14; 1st para. - It should be explicit that future dredging/ocean disposal projects may involve sediments outside the Federal Channel limits (i.e. Portland Harbor and Vicinity).

2-9 3rd para. - It should be noted that the existing site will continue to be monitored under NED's DAMOS program.

2-10 Page 2-25; last para. - The sentence should be changed to indicate that although a major portion of material dredged from the Portland Harbor area is fine sand, silt and clay in a low-energy environment and is generally not excluded from further testing under the specified exclusion criteria, on a case by case basis, material from the area could qualify for an exclusion depending on particular circumstances (e.g. glacial clays and tills from deep improvement projects).

2-11 Pages 4-4; 4-5 and 4-9 - These sections should include the most recent testing information (attached).

2-12 Page 4-15; 4th para. - The recent testing in Portland Harbor includes chlorinated hydrocarbon analyses.

2-13 Page 4-16; para's 1 and 2 - The inclosed bioassay/bioaccumulation test information and Mussel Watch Study data should be utilized here to aid in predicting any body burden uptake potential from dredged material disposed at the existing site.

United States Department of the Interior

OFFICE OF THE SECRETARY

Office of Environmental Project Review
15 State Street
Boston, Massachusetts 02109

IN REPLY REFER TO

November 26, 1982

Mr. Frank G. Csulak
Criteria and Standards Division (WH-585)
U.S. Environmental Protection Agency
Washington, DC 20460

Dear Mr. Csulak:

3-1 We have reviewed the draft environmental impact statement (DEIS) for the Portland, Maine, Ocean Dredged Material Disposal Site Designation and offer the following comment.

We have no objection to the final designation of the proposed site for the ocean disposal of dredged material that is in compliance with the criteria and requirements established by the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (CE) in accordance with the Marine Protection, Research, and Sanctuaries Act. However, we continue to experience problems with the nature of some of the material that has been disposed of at this site. We have not been in agreement with EPA and CE in their interpretation of the ocean dumping criteria. Since this DEIS is predicated upon compliance with ocean dumping criteria, we feel that the alternative section is inadequate
3-2 because it does not cover a worst case scenario. There may be times when dredged material does not comply with the ocean dumping criteria. This DEIS should be expanded to analytically investigate alternatives to ocean disposal of dredged material that fails to comply with the ocean dumping criteria. The alternative analysis should include a thorough discussion of land based and shallow water containment of contaminated material.

Thank you for the opportunity to provide comments on this DEIS.

Sincerely,

William P. Patterson

William P. Patterson
Regional Environmental Officer

NATIONAL WILDLIFE FEDERATION

1412 Sixteenth Street, N.W., Washington, D.C. 20036 202—797-6800

November 29, 1982

Frank G. Csulak
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Re: Comments on Draft Environmental Impact Statement for the Portland, Maine Ocean Dredged Material Disposal Site Designation

Dear Mr. Csulak:

4-1 Following are the comments of the National Wildlife Federation on the referenced Draft EIS:

1. Consideration of alternative sites

4-2 As we have pointed out many times in the past,* the analyses contained in the draft EIS are deficient with respect to the consideration of alternative disposal sites. The draft EIS states that "the potential adverse effects of dredged sediment on indigenous organisms and resources are presently unknown" at the Wilkinson Basin (deepwater) site. DEIS at xiii. In addition, with respect to water quality and ecology, "baseline surveys have not been conducted at the Alternative Site" to compare with data accumulated at the existing interim site. DEIS at 2-18. How can the effects of dredged material disposal at different alternative disposal sites be compared when no data has been collected at one of the alternative sites?

4-3 There has been no attempt to select a disposal site alternative at or beyond the continental shelf break. The ocean dumping regulations make it clear that EPA should "wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used." 40 C.F.R. § 228.5, emphasis added. The draft EIS has tried to brush this off by noting, among other things, that "great water depth (>200m) would result in the deposition of dredged materials over a larger area than projected for the Existing Site." DEIS

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*(See: National Wildlife Federation comments on: Hawaii ODMDS, January 15, 1980; San Francisco Channel Bar ODMDS, January 8, 1981; New York ODMDS, April 5, 1982; Sabine-Neches ODMDS, October 4, 1982; and Savannah, Charleston, and Wilmington ODMDSs, November 22, 1982.)

at xiii. Why is this so bad? Are decision makers to infer that the dredged materials are environmentally degrading and therefore deposition at a shelf-break site would have a greater environmental impact?

2. Feasibility of marsh construction

4-4 In 1979 the Corps of Engineers stated that the construction of marshes "would be an ideal use" for dredged materials from the Portland Harbor. DEIS at 2-6. In response to comments from the National Coalition for Marine Conservation, the Corps of Engineers explained that: "no marsh project has been constructed in the New England area, therefore, the feasibility of marsh construction in this area has not been evaluated." Feasibility assessment should not and cannot appropriately be deferred to a future site-specific proposal. The purpose of this EIS is to assess the suitability of and need for the proposed ocean dumpsite. The need for an ocean site clearly depends, at least in part, on the availability and sufficiency of suitable land-based alternatives.

3. Toxicity of dredged materials

4-5 We are concerned that the toxicity of dredged material from the Portland Harbor has been inadequately considered. Interstate Electronics Corporation's (IEC) field survey has found that "sediments from the center of the Existing Site contained levels of mercury, cadmium, and lead 3 to 12 times higher than sediments from control station 7, just outside the site." DEIS at A-11. IEC attributes these differences to "contaminants present in dredged material dumped at the ODMDS." DEIS at A-11.

4-6 IEC has also found that chlorohydrocarbon concentrations in Existing Site sediments exceed control concentrations. DEIS at A-14. Moreover, sediments at the Existing Site "contained high levels (>300ppm) of both saturated and aromatic hydrocarbons." DEIS at A-14. IEC has concluded that these are most probably a result of spilled No. 2 fuel oil from the Portland Harbor. No bioassay or bioaccumulation tests were conducted on these sediments; however, tissue samples from one lobster and one crab showed low levels of metals. DEIS at A-16. More comprehensive tests must be conducted and the results incorporated into the final EIS to permit meaningful evaluation of the proposed site designation action.

4-7 The existing interim disposal site may be inappropriate because of the toxicity of the disposed material and because of its proximity to important fishing grounds. Although the existing interim site is described as being a low-energy environment, the draft EIS warns that "the possibility of contaminating finfish and shellfish exists." DEIS at 4-5. Moreover, "potential adverse effects of dredged sediments on the biota include . . . changes in physical and chemical characteristics of sediments and water, and introduction of pollutants to surrounding sediments." DEIS at 4-2. These statements are disconcerting since the "Edge-of-the-

Bottom," the primary dragging-ground for Portland-based fishermen, is 1.5 nmi from the existing interim site. DEIS at 3-30. Also, local currents are variable, but predominantly northeast in the summer and northwest or southwest in the winter. DEIS at 3-6. This would appear to position the "Ordnance Tow" and the gill nets depicted in figure 3-7 directly downcurrent from the existing interim site. DEIS at 3-31.

4-8 We recommend that appropriate bioassay and bioaccumulation tests be conducted on materials dredged from the Portland Harbor to determine their toxicity. Onshore containment of toxic materials should be given serious consideration. The selection of any offshore disposal site should be made by considering proximity to nearby fishing grounds and trends of currents that pass over the site (not solely on the basis of its previous use from 1943 to 1946).

We appreciate the opportunity to communicate these comments and trust that the final EIS will adequately address the need for testing dredged materials from Portland Harbor and selecting a safe, environmentally acceptable dredged material disposal site.

Sincerely,

Porter Hoagland
Conservation Intern
Pollution and Toxic Substances Division

Kenneth S. Kamlet
Director
Pollution and Toxic Substances Division

cc: Col. Carl B. Sciple, New England Division COE
Lester Sutton, EPA Region I
Steve Schatzow, EPA Headquarters
Christopher M. Weld, National Coalition for Marine Conservation

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20235
OFFICE OF THE ADMINISTRATOR

November 30, 1982

Mr. Frank G. Csulak
Criteria and Standards Division (WH-585)
Environmental Protection Agency
401 M St., S.W., Room 2824
Washington, D.C. 20460

Dear Mr. Csulak:

5-1 This is in reference to your draft environmental impact statement entitled "Portland, Maine, Dredged Material Disposal Site Designation." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide comments. We would appreciate receiving four copies of the final environmental impact statement.

Sincerely,

Joyce M. Wood
Director
Office of Ecology and Conservation

Enclosure - Letter from:

Ruth Rehfus, National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Services Division
Habitat Protection Branch
7 Pleasant Street
Gloucester, MA 01930

November 30, 1982

Mr. Frank G. Csulak
Criteria and Standards Division (WH-585)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Csulak:

We have reviewed the Draft Environmental Impact Statement (DEIS) for the Portland, Maine, Dredged Material Disposal Site Designation and have the following comments:

General Comments

5-2 We concur with the final designation of the existing site for the ocean disposal of dredged material. The site has been used since 1946. We believe that it generally meets the site selection criteria listed on page xvi of the Summary Sheet, and that it is the preferred site in comparison with the various available alternatives. However, we are concerned about the rationale used to evaluate the various alternatives to ocean disposal and to select this site over other possible sites.

The DEIS seems to take the position that ocean disposal of dredged material is preferable to other alternatives. Before a position is taken on preferable alternatives for disposal of dredged material, each project should be evaluated on its own merits, and all feasible alternatives to ocean disposal (upland disposal, wetland creation, etc.) should be fully investigated and evaluated.

5-3 Further, the DEIS appears to emphasize conditions and contaminant levels of dredge spoils from Portland Harbor, rather than potential effects at the designated site as a result of disposing of dredge spoils.

5-4 The information presented in the document to justify the designation of the existing site is based primarily on site specific data developed for the Disposal Area Monitoring System (DAMOS) program and on the bioassay/bioaccumulation test conducted for the Portland Harbor maintenance dredging project of 1979. Since that time the National Marine Fisheries Service has raised concerns relative to the conclusiveness of this information. (See attached letter of September 29, 1981, to the Assistant Secretary of the Army (Civil Works) from the Administrator of National Oceanic and Atmospheric Administration.

We believe that the data from DAMOS and other studies conducted for the Federal navigational project dredging were too limited, because they provide little indication of how toxic the sediments are, to what extent the pollutants will be transported to other areas, and to what degree they will be taken up and accumulated by marine organisms. The final EIS should place emphasis on disposal site characterisitics (hydrological, chemical, biological) and how those characteristics affect the disposal of dredged material and its subsequent fate in the marine environment.

Specific Comments

Chapter 2 - ALTERNATIVES INCLUDING THE PROPOSED ACTION LAND-BASED

DISPOSAL

5-5 Page 2-6, paragraph 2. It is stated that the Corps of Engineers "... does not consider land disposal of Portland Harbor channel dredged material to be a viable alternative at this time (CE, 1979); therefore, further evaluation will not be a part of EPA's site designation process."

We do not believe that a project conducted in 1979 should be used as the basis for excluding from consideration in all future projects the various available alternatives to ocean disposal. Those alternatives should be fully considered before final decisions are made to dispose of dredged materials in the ocean. Alternatives include, but are not limited to, habitat creation, fill for upland construction projects, beach nourishment, and cover for sanitary landfill areas; they should be fully evaluated in the final EIS.

DETAILED CONSIDERATION OF THE ALTERNATIVE SITES

(6) DISPERSAL, HORIZONTAL TRANSPORT, AND VERTICAL MIXING CHARACTERISTICS OF THE AREA INCLUDING PREVAILING CURRENT DIRECTION AND VELOCITY, IF ANY

5-6 Page 2-15, second paragraph. It is stated that "Previous studies have demonstrated the relative immobility of dredged sediments dumped at the Existing Site (DAMOS), suggesting that a major portion of dredged sediment dumped at the site will remain within site boundaries...." This statement should be substantiated by appropriate data and documentation. We also recommend that monitoring studies be conducted to determine the short-term and long-term chemical, biological, and hydrological characteristics of the area, to confirm the validity of the conclusion regarding the relative immobility of the sediments in this area.

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

5-7 Page 2-16, third paragraph, last sentence. It is stated that "Trace metal concentrations in tissues of crustaceans and other benthic organisms collected at the Existing Site were below FDA Action Levels (DAMOS)." Although this may be true, reference should be made to trace metal concentrations in tissues of marine organisms and the effects on those organisms themselves (e.g., inhibition of reproductive cycles, susceptibility to diseases etc.), as well as on the people who may eat them.

RECOMMENDED USE OF THE SITE

GUIDELINES FOR THE MONITORING PLAN

PROGRESSIVE, NONSEASONAL, CHANGES IN WATER QUALITY OR SEDIMENT COMPOSITION AT THE DISPOSAL SITE, ATTRIBUTABLE TO DREDGED MATERIAL

Page 2-26, first paragraph.

5-8 It is stated that "Measurable changes in water quality due to dredged material disposal are unlikely to occur or be detectable because of: Limited release of contaminants...." However, a recent study supports the contention that sediment concentration alone does not reflect bioavailability of contaminants to marine organisms.[2] The final EIS should discuss this possibility. (Same comment applies to Chapter 4, pages 4-9, and 4-13.)

5-9 In conclusion, although we agree that the existing disposal site seems to be the best choice, we believe that the data contained in the DEIS are too limited to allow a thorough evaluation of the biological, chemical and hydrological conditions at the dumpsite. The limited amount of research and monitoring done in conjunction with the DAMOS program and the information generated with respect to dredging of the Federal navigational channel in 1979 are not, in our opinion, adequate to support a conclusion that there will be no long-term effects from continued use of the existing site. Therefore, we urge that a more thorough monitoring program be designed and conducted to insure that no undesirable environmental changes occur as a result of dredged material disposal at the site.

Sincerely,

Ruth Rehfus

Ruth Rehfus
Branch Chief

---

2 "Accumulation of PCBs, mercury and cadium by Nereis Virens, Mercenaria mercenaria and Palaemonetes Pubio from contaminated harbor sediments," by N.I. Rubinstein, E. Lores, and N.R. Gregory. EPA/ERL Gulf Breeze prepublication, Contribution No. 452.

RESPONSES TO WRITTEN COMMENTS

1-1 EPA appreciates the National Science Foundation's Review of the Portland, Maine Draft EIS.

2-1 EPA thanks the Corps of Engineers for their review of the Portland, Maine Draft EIS.

2-2 EPA appreciates the Corps of Engineers for providing the recent bioaccumulation/bioassay reports. A summary of this information has been incorporated into the Final EIS.

2-3 The suggested revision has been made in the Final EIS.

2-4 EPA does not agree that the designation statement in the DEIS is vague and could be miscon strued as only for for maintenance dredging material. However, the CE correctly points out that it is not the statement previously agreed upon. The statement has been changed in the FEIS.

2-5 The updated information has been included in the FEIS.

2-6 The "Favorable Disposal Areas" that Pequegnat et al., identified is the entire continental shelf-slope Region beyond the 300-M isobath. The four most important fishery species from their dollar value are the American Lobster, Caribbean Shrimp, Soft-Shell Clam, and Ocean Perch. The major amounts of these species are taken at or above the 300-M isobath. As elsewhere, the benthic biomass decreases rapidly near and beyond the shelf-break.

For clarification, a parenthetic statement relating to the 300-M isobath has been included in the FEIS.

2-7 The distances have been corrected in the FEIS.

2-8 The statement only refers to present dredging projects. However, for clarification and consistency with the proposed site designation the statement has been revised in the FEIS.

2-9 the continued monitoring under NES's DAMOS program has been noted in the FEIS.

2-10 The suggested clarification has been made in the FEIS.

2-11 The additional recent data has been added to the FEIS.

2-12 See response 2-11.

2-13 See response 2-11.

3-1 EPA thanks the U.S. Department of the Interior for their comments on the FEIS.

3-2 The Department of the Interior is correct in saying that there may be times when dredged material does not satisfy EPA's criteria and regulations. At that time the availability of other feasible alternatives must be assessed. As is stated on page 2-5, the need for dumping in the ocean must be demonstrated with each application. Also, with each project there is a review to ensure that the dredged material is in compliance with the regulations (page 1-9).

4-1 EPA appreciates the National Wildlife Federation's review of the Draft EIS.

4-2 *See EPA's responses to those comments in the corresponding Final EIS's.

As correctly stated in the DEIS and in your comment, no baseline surveys have been made of the alternative site. The lack of baseline surveys plus the sparity of historical data and information on the alternative site makes it evaluation difficult. The evaluations leading to the DEIS indicated the existing historically used site is environmentally acceptable. The alternative site may also be environmentally acceptable site with known characteristics to a possibably environmentally acceptable site with many unknowns would be wise.

4-3 EPA disagrees with the comment. While the ocean dumping regulations are correctly quoted in the comment, the underlining trends to place undue emphasis on beyond the Continental Shelf. Both "beyond the Continental Shelf" and "Historically Used" sites were considered. Paragraph two, page xiii presents four problems with sites on the Continental Shelf, not just one. The reason for rejecting an alternative site off the continental shelf is stated on page 2-7. "---An alternative site off the continental shelf was rejected because the cost of transporting the material would be excessive and no significant environmental benefits would be derived."

4-4 The evaluations leading to the DEIS addressed the selection of an environmentally acceptable Ocean Dredged Material Disposal Site (ODMDS). The CE has expressed a need for an ODMDS in the area (page 1-5). As stated on page 1-6, the EIS only addresses those issues germane to the selection, evaluation, and final designation of an environmentally acceptable ODMDS. In planning disposals from future Federal projects and permitted dredging, both the ODMDS and non-ocean alternatives will be considered. The LAND-BASED DISPOSAL section (page 2-5) was included in the DEIS as background information on previous evaluations. The CE's full responses to the referenced comment is included in Appendix C.

4-5 As stated in the comment, the field survey found "sediments from the center of the Existing Site contained levels of mercury, cadium, and lead 3 to 12 times higher than sediments from control station 7, just outside the site." This does not indicate the levels found were unacceptable. It does indicate the levels were higher inside the site than outside the site, with these levels" probably" resulting from contaminants in the dredged materials dumped at the site. It should be noted the reported results for bulk analysis of the sediments and are relatively low (micrograms per gram).

4-6 Much of response 4-5 applies to chlorinate hydrocarbons which also were found to be higher within the site than at the control station. Again, bulk analysis was used and the levels are relatively low (nangrams per gram).

4-7 The statements quoted in the comment are from a general resume in the DEIS of possible effects of dredged material disposal in the ocean. The degree of any of the possible effects varies with the individual site. The evaluations leading to the DEIS indicated the fisheries in the area had not been adversely affected by past disposals of dredged materials at the existing site. However, because of the general possibility of movements of the sediments in the site in the direction of the fisheries, it was recommended CHC's and metals be measured in the monitoring program (page 2-25).

4-8 Bioassay and bioaccumulations tests are being performed. As an example, a recently received "Report of Bioassay and Bioaccumulation Testing - South Reach Portland - Harbor, Maine" is being included in the Final EIS as Appendix D. For remainder of comment, see response 4-4.

5-1 EPA appreciates the Department of Commerce's review of the DEIS.

5-2 EPA acknowledges the National Marine Fisheries Service's concurrence with the proposed action. The DEIS does not take the position that ocean disposal is preferable to other alternatives. It presents the information and evaluations relating to the selection of an environmentally acceptable ocean disposal site. See response 4-4.

5-3 EPA does not agree with the comment. While information on the conditions and contaminate levels of the dredged spoils, other aspects also are presented in chapters 2, 3 and 4.

5-4 The information presented in the DEIS was based on not only the DAMOS reports but also on a number of other reports (see references). Additional information on bioassays/bioaccumulation is being included in the Final EIS (see response 4-4). The letter to the Assistant Secretary of the Army is self-explanatory.

5-5 It is apparent that the statement on page 2-6 was misleading. It has been changed in the Final EIS to reflect the relationship between the site selection and use of the site. See aslo response 4-4.

5-6 The DAMOS project indicates that alter disposal, dredged material sediments ramain relatively immobile and ramain at the site. The area's topography is extremely rugged and consists of bedrock outcrops. The unconsolidated sediments in the basin indicates a low-energy environment with accumulation of fine materials. The rugged topography of the area inhibits the movement of dredged material sediments.

5-7 The possible effects stated in the comment are under continuing study (see new Appendix D).

5-8 It is agreed that sediment concentration (bulk analysis) does not reflect bioavailability of contaminants to marine organisms. However, for the three reasons stated on page 2-26, it is not believed monitoring of the water will be usefull in evaluating long-term changes. The Existing Site quite small in respect to the overall area and its water masses. It is believed that monitoring the sediments, possibably including elutraite tests, and the movement of the sediments will be more usefull in predicting long-term effects.

5-9 EPA believes the data presented in the DEIS adequately supports the proposed actions. The suggestion for the monitoring program are appreciated.