United States
Environmental Protection
Agency

Water

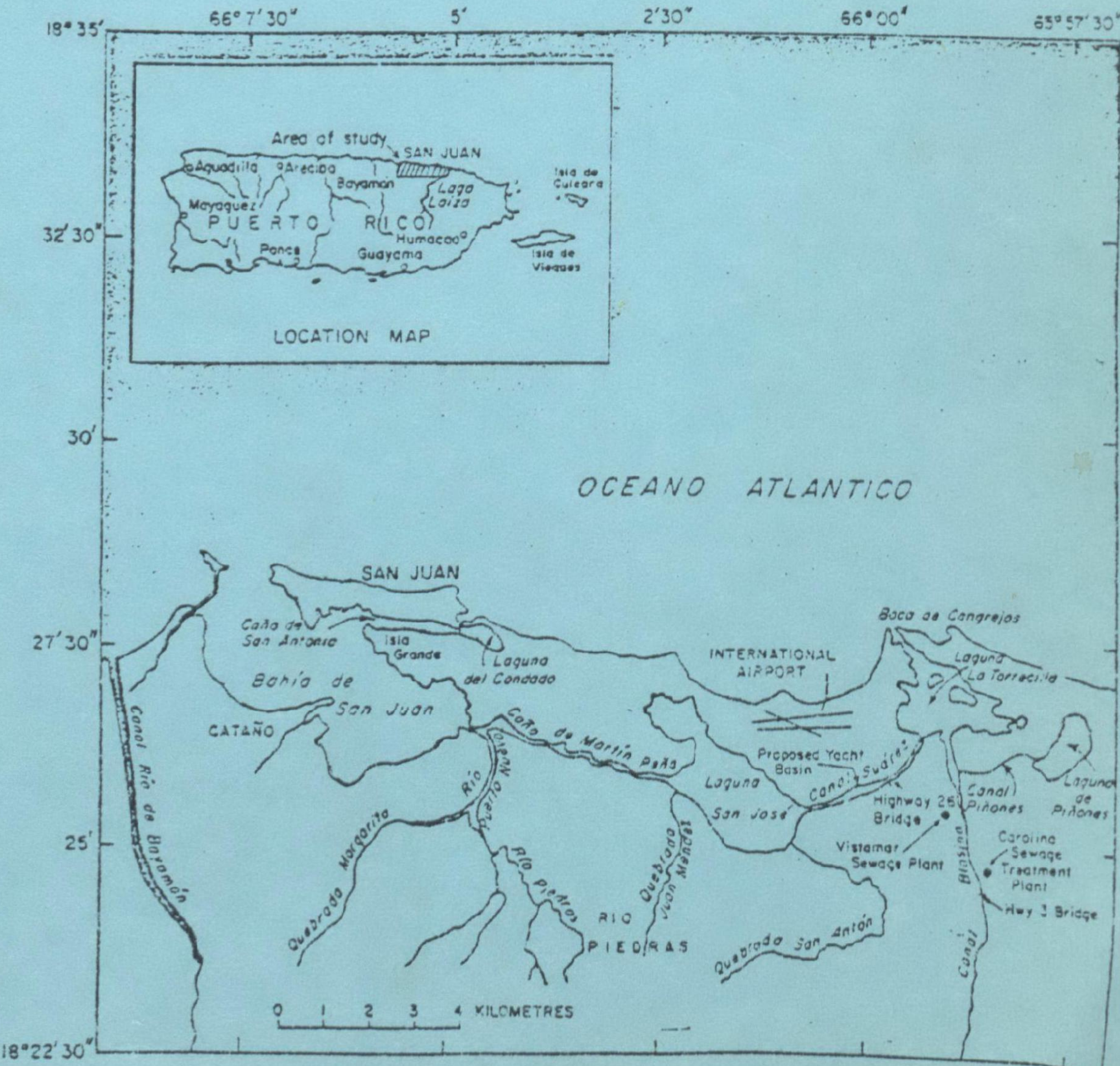
Office of Water
Criteria and Standards Division
Washington, DC 20460

December 1982

EPA

Environmental Impact Statement (EIS) for the San Juan Harbor, Puerto Rico Dredged Material Disposal Site Designation

FINAL



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

FINAL
ENVIRONMENTAL IMPACT STATEMENT (EIS)
FOR
SAN JUAN HARBOR, PUERTO RICO, OCEAN
DREDGED MATERIAL DISPOSAL SITE DESIGNATION

December 1982

Prepared by: U.S. Environmental Protection Agency
Criteria and Standards Division (WH-585)
Washington, D.C. 20460

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT (EIS)
FOR
SAN JUAN HARBOR, PUERTO RICO
OCEAN DREDGED MATERIAL DISPOSAL SITE DESIGNATION

( ) Draft
(x) Final
( ) Supplement to Draft

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER REGULATIONS AND STANDARDS
CRITERIA AND STANDARDS DIVISION

1. Type of Action

(x) Administrative/Regulatory action
( ) Legislative action

2. Description of the Proposed Action

The proposed action is the final designation of a San Juan Harbor (SJH), Puerto Rico, Ocean Dredged Material Disposal Site (ODMDS). The Interim Site at San Juan is square shaped, centered at 18°30'40"N, 66°09'00"W, covers 0.98 nmi^2, and is approximately 2.2 nmi north of the San Juan coast. The Interim Site is proposed to receive final designation for the disposal of dredged material.

Alternative ocean disposal sites were considered in a Site Evaluation Study (Appendix B) and included both a shallow water and deep water area.

Department of State
Department of Transportation
Coast Guard
EPA, Region II, Carribean Field Office
National Science Foundation

States and Municipalities

Autoridad Puertos de Puerto Rico
Commonwealth Department of Natural Resources
Commonwealth Environmental Quality Board
Puerto Rico Aqueduct and Sewer Authority
Puerto Rico State Historic Preservation Office

Private Organizations

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

6. Comments on the Final EIS are due 30 days from the date of EPA's publication of Notice of Availability in the Federal Register which is expected to be MAR 07 1983

Comments should be addressed to:

Michael S. Moyer
Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, S.W.
Washington, DC 20460
(202) 245-3036

Copies of the EIS may be obtained from:

Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, S.W.
Washington, D.C. 20460

The Final EIS may be reviewed at the following locations:

Environmental Protection Agency
Public Information Reference Unit, Room 2404 (Rear)
401 M Street, S.W.
Washington, DC 20460

Environmental Protection Agency
Region II, Carribean Field Office
Post Office Box 792
San Juan, Puerto Rico 00902

U.S. Army Corps of Engineers
Library
400 W. Bay Street
Jacksonville, FL 32201

SUMMARY

ORGANIZATION OF THE ENVIRONMENTAL IMPACT STATEMENT

This summary highlights succeeding chapters and explains the major points of the document. The main body of the text contains reduced technical information, with an abstract and summary at the beginning of each chapter.

Chapter 1 specifies the purpose of and need for action, presents background material relevant to dredged material disposal, and provides an overview of the legal framework by which the Environmental Protection Agency (EPA) selects, designates, and manages ocean disposal sites. Chapter 2 presents the alternatives including the proposed action and an evaluation of the proposed site based on the 11 specific site selection criteria listed in the Ocean Dumping Regulations and Criteria (40 CFR §228.6). The reasons for proposing designation of the existing San Juan Harbor Site (Interim Site) are summarized.

Chapters 3 and 4 contain the essential site information: Chapter 3 describes the environment of the interim site, emphasizing the dominant physical, geological, and biological features, and discusses other activities at the site. Chapter 4 discusses the environmental consequences of dredged material disposal at the proposed site in terms of the effects on public health and safety and on the ecosystem of the site. Unavoidable consequences are discussed in terms of adverse effects, productivity, and commitment of resources.

Chapter 5 identifies the principal and contributing authors of this EIS. Chapter 6 contains the glossary of terms used herein and a list of references.

Appendix A is a summary of the equipment used, survey methods, and the results. Reference citations and approximate center coordinates of the sampling sites are included. Appendix B is a Site Evaluation Study performed to examine the desirability of using alternative ocean disposal sites. Appendix C presents the bioassay procedures and results. Appendix D contains comments received and EPA's responses.

PURPOSE OF AND NEED FOR ACTION

The Proposed Action discussed in this Environmental Impact Statement (EIS) is the final designation of the San Juan Harbor Ocean Dredged Material Disposal Site, corner coordinates 18°30'10"N, 66°09'31"W; 18°30'10"N, 66°08'29"W; 18°31'10"N, 66°08'29"W; 18°31'10"N, 66°09'31"W (Figure S-1). The Proposed Action amends the 1977 interim designation of the EPA Ocean Dumping Regulations and Criteria by making final designation of the site.

The Port of San Juan is the center of commerce and industry for Puerto Rico, handling about 80 percent of all cargo entering or leaving Puerto Rico. To accomodate these deep-draft vessels, the harbor must be periodically dredged by the Army Corps of Engineers (CE).

The action, as proposed, fulfills the need for an ocean location which will provide for expedient disposal of dredged material. The proposed site has received an annual average of nearly 465,000 yd^3 of dredged material during the dredging cycle. In addition, the CE has proposed a project within San Juan Harbor to deepen, widen, and possibly realign and extend channels and turning basins (CE, 1975). The Proposed Action does not exempt the use of this site from additional environmental review nor does it exempt the dredged material from compliance with the Ocean Dumping Regulations and Criteria prior to disposal at a designated site.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Alternatives to the Proposed Action include (1) No Action, and (2) selection of Alternative Ocean Sites. This EIS does not consider land disposal alternatives. The CE evaluated land disposal in its Maintenance Dredging EIS (CE, 1975b) and determined that the few potential land sites presented considerable environmental hazards and technical difficulties.

The No-Action Alternative to final designation is not considered acceptable. The interim designation of the San Juan Harbor ODMDS will expire in February 1983 without the permanent designation of that site or an alternate ocean disposal site for continuing use.

In a site Evaluation Study (Appendix B), three alternative disposal areas, including the interim site, (hereinafter termed "sites") off the north coast of Puerto Rico were compared on the basis of the 11 specific site selection criteria listed at 40 CFR §228.6:

- Interim site: The interimly - designated San Juan Harbor ODMDS is located 1.4 nmi from the coast in water up to 400m (see Figure S-1).

- Inshore site: An area 1 nmi offshore in water averaging 100m deep (see Figure 2-1).

- Offshore site: An area 2.4 - 3.4 nmi offshore (1-2 nm north of the interim site) in water averaging 400 - 600m deep (see Figure 2-1).

The Interim Site is recommended for designation because:

- Impacts resulting from dumping at the site have been temporary and restricted to site boundaries.

- The past dredged materials are similar to disposal site sediments at the interim site.

- The site has been previously used.

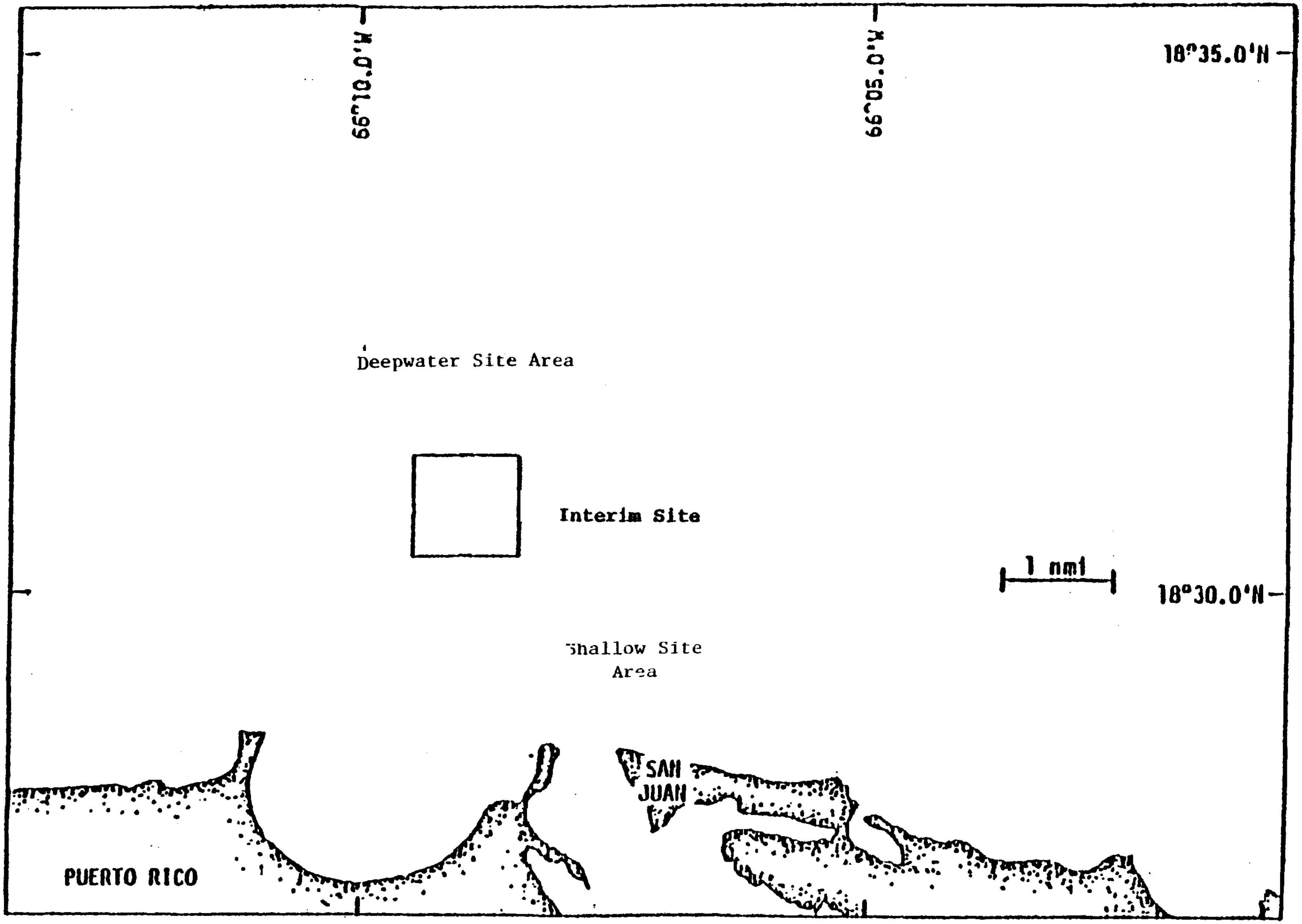


Figure S-1

Interim Ocean Dredged Material Disposal Site

AFFECTED ENVIRONMENT

Three distinct topographic features—the Insular Shelf, the escarpment, and the Insular Slope—reflect the geology of the region. The Insular Shelf, composed of biogenic limestones and granitic instrusions, is a continuation of terrestrial geological formations. The depth of sandy sediments in this region ranges from a few centimeters to over two meters in local depressions. The interim site is located over the slope. Sediments at the site are predominantly silt and clay. The Shelf region is separated from the Insular Slope by a steep submarine escarpment which is generally devoid of sediments.

Easterly trade winds dominate the climate of Puerto Rico providing a climate that is distinctly tropical throughout the year. Trade winds generate sea and swell which are highest in August and minimal in February, and also create a westerly flowing current of surface water which flows around Puerto Rico. Infrequent tropical hurricanes and tropical storms are sometimes severe, occur any time from August to October, and generally produce considerable rainfall.

Three distinct water masses, defined by temperature and salinity, occur in the deeper waters. These water masses, found throughout the Carribbean Sea, include Tropical Surface Water (0m to 75m), Subtropical Underwater (200m to 600m), and Antarctic Intermediate Water (600m to the bottom). A large permanent density gradient (pycnocline) from 50m to

240m separates the two upper water masses, inhibiting vertical mixing. The layer of Tropical Surface Water extends over the Insular Shelf. The surface water shows little seasonal variation in temperature or salinity, reflecting the relatively constant weather conditions of Puerto Rico.

Surface waters in the Caribbean Sea generally flow westward due to the constant easterly trade winds. The current regime off the north coast of Puerto Rico is composed of tidal and non-tidal components of similar magnitude. Semi-durinal tidal currents rotate in a clockwise direction, whereas wind-driven, non-tidal currents are predominantly along shore. The reported net flow off San Juan is westward.

The waters of the region are similar to those occurring elsewhere in the Caribbean Sea, and are typical of tropical waters. Surface water are low in nutrients (nitrate-N, nitrite-N, orthophosphate-P), low in suspended solids, and well oxygenated. Subsurface waters are relatively higher in nutrients and lower in dissolved oxygen, as a result of the decomposition of detrital material.

Commercial fisheries in coastal waters around Puerto Rico are not very productive. Some of the reasons for this lact of productivity are speculated to be:

- Puerto Rico's insular shelf is limited in areal extent;
- There is little or no upwelling nearshore to bring nutrients from the bottom into coastal circulation;
- Rivers emptying into coastal waters are relatively small, and therefore, no great quantities of nutrients from the land are carried out into the sea.

The latter two items may be reflected in the relatively small phytoplankton and zooplankton populations in Puerto Rican coastal waters (Department of Natural Resources, 1979).

All dredged material must meet EPA criteria [40 CFR 227], before permit for ocean disposal is granted. None of the material is to be packaged in any way.

The CE has and will continue to perform dredging using Corps - owned hopper dredges. Future dredging will also be performed by private contract using hopper, dragline, clamshell, and dipper dredged (CE, 1975).

A total of 4.3 million yd^3 from San Juan Harbor has been dumped at the interim site since 1974. Maintenance dredging would be biennial, removing a total of 465,000 yd^3 of silaceous and other sedimentary materials from San Juan Bay to be disposed at the chosen site. If the proposed deepening project is implemented, its completion would result in the need for an increase of 185,000 yd^3 in the average annual estimated operation and maintenance dredging.

Both surveillance and monitoring are feasible at the Interim Site because it is relatively close to shore. Surveillance of disposal operations at the interim could easily be achieved by shipriders and/or helicopter. Monitoring costs would be considerably higher at a site further offshore due to both increased distance from shore and increased water depth.

Although heavy shipping and cruise ship traffic passes through or in the vicinity of all three ocean sites, disposal activities will not cause any interference with these activites. The small volume of dredged material makes operation and maintenance disposal activities necessary only every two years.

ENVIRONMENTAL CONSEQUENCES

Previous disposal of dredged material at the interim site has had no significant adverse impacts on human health, economics, safety, or aesthetics. Mounding has not resulted in sufficient shoaling to create a navigational hazard. Minor, short-term adverse effects from dumping has likely occurred at the interim site, including a temporary reduction in abundances of bottom-dwelling animals resulting from burial.

Disposal of dredged material would be expected to have a minimal effect at the offshore site. Mounds are less likely to form because of greater depths and because dredged material would likely be dispersed over a large area by currents.

Disposal of dredged sediment at an inshore site over the insular shelf would increase the turbidity of the near shore waters which could adversely impact coral reef communities and waterfront recreational facilities.

Disposal operations do not interfere with any long-term use of resources.

CONCLUSION

Considering both environmental and economic factors, the Interim Site is an acceptable location to receive material dredged from San Juan Harbor. The site is recommended as the preferred site for continuing disposal activities.

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CONTENTS (continued)

CONTENTS (continued)

ILLUSTRATIONS

CONTENTS (continued)

TABLES

CHAPTER 1

PURPOSE OF AND NEED FOR ACTION

The Port of San Juan is the center of commerce and industry for Puerto Rico, handling about 80 percent of all cargo entering or leaving Puerto Rico. Access of ships to the harbor depends on dredging of the channels to maintain the authorized depths. The action proposed in this EIS is the final designation of the interim-designated San Juan Harbor Ocean Dredged Material Disposal Site (ODMDS). Guidelines for site management are provided by the Ocean Dumping Regulations.

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 San Juan Harbor (SJH) area (see Figure 1-1). The purpose of the proposed action is to provide an environmentally acceptable ocean location for the disposal of materials dredged from San Juan Harbor. 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.

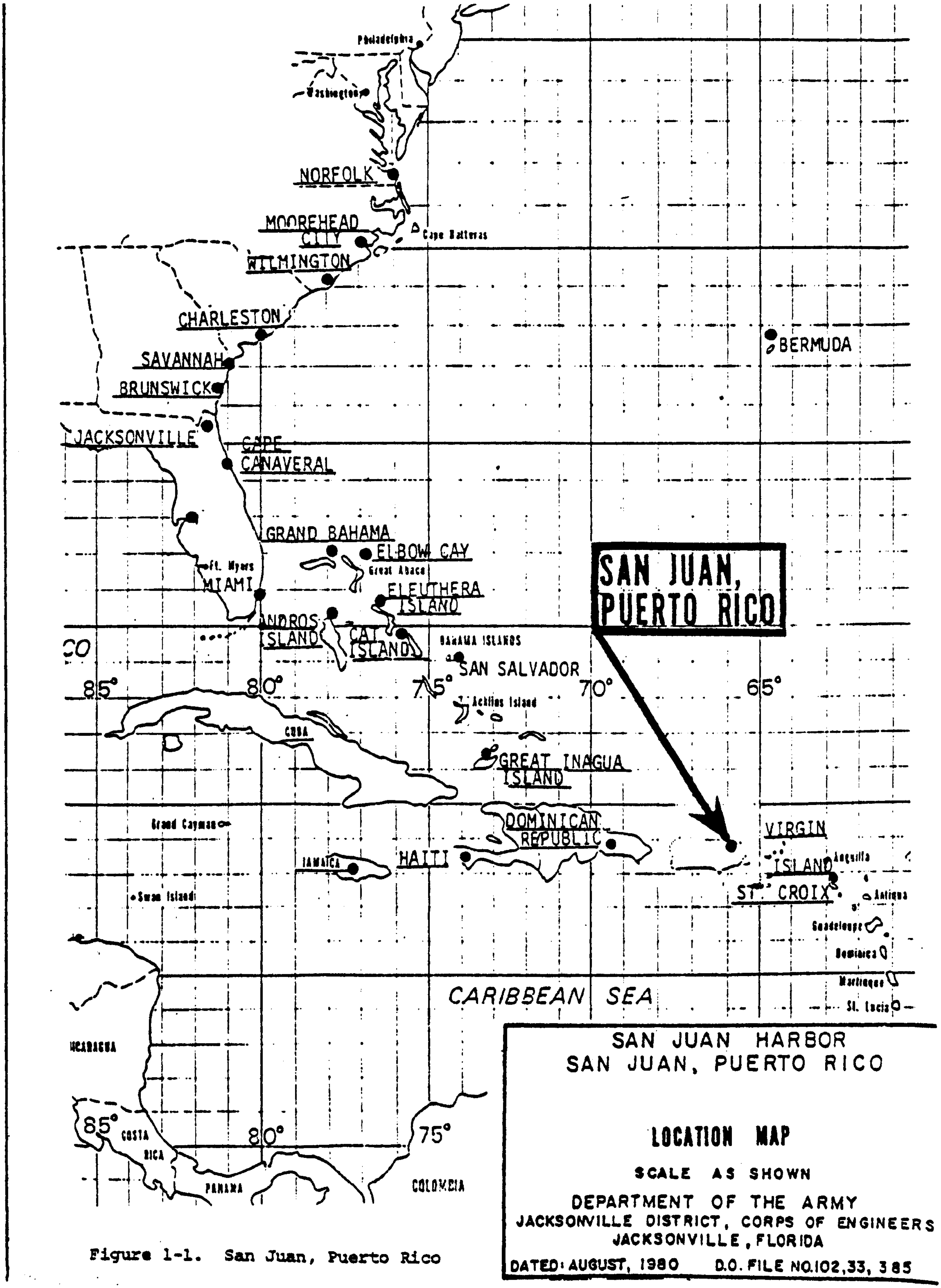


Figure 1-1. San Juan, Puerto Rico

Based on an evaluation of all reasonable alternatives, the proposed action in this EIS is to permanently designate the existing interim-designated San Juan Harbor ODMDS. The boundary coordinates of the site are: 18°30'10"N, 66°08'29"W; 18°30'10"N, 66°08'29"W; 18°31'10"N, 66°08'29"W; 18°31'10"N, 66°09'31"W. The site is centered approximately 2.2 nautical miles (nmi) offshore, has an averaged depth of 292m and a rectangular area of 0.98 square nautical miles.

The SJH-ODMDS, as delineated above, would be designated for the disposal of dredged material. The site may be used for disposal of the 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 U.S. Army Corps of Engineers (CE) regulations.

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 sea or 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 103 permit application the effects of ocean disposal of dredged material on human health, welfare, or amenities, or the marine environment, ecological systems, or 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 in the CE's 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 and improve the nation'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

Annually approximately 465,000 cubic yards of silaceous and other sedimentary materials enter the San Juan, Puerto Rico Harbor mainly from two rivers, Rio de Bayamon and Rio Piedras, and one Canal, Cano de Martin Pena. For the CE's Jacksonville District to maintain the San Juan Harbor to its authorized depth, this material must be removed on a biennial basis. The CE has requested the EPA to permanently designate an ocean disposal site suitable for continued disposal of dredged material from the San Juan Harbor and for materials derived from any future approved Deepening Project.

EPA's 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, performed 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. 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.

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 the disposal site evaluation study and EIS 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 a site(s) 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; e.g., 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 one or more selected areas are deemed suitable for final designation, it is EPA's position that the site designation process, including the disposal site(s) 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 an alternative site(s) 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 Part 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 one 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 Parts 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 Part 227 Subpart C), and (2) compliance with the environmental impact criteria (40 CFR Part 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**

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 Army Corps of Engineers	Issuance of permits for transportation of dredged material for disposal.
	Recommendation of disposal site locations.
U.S. Department 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

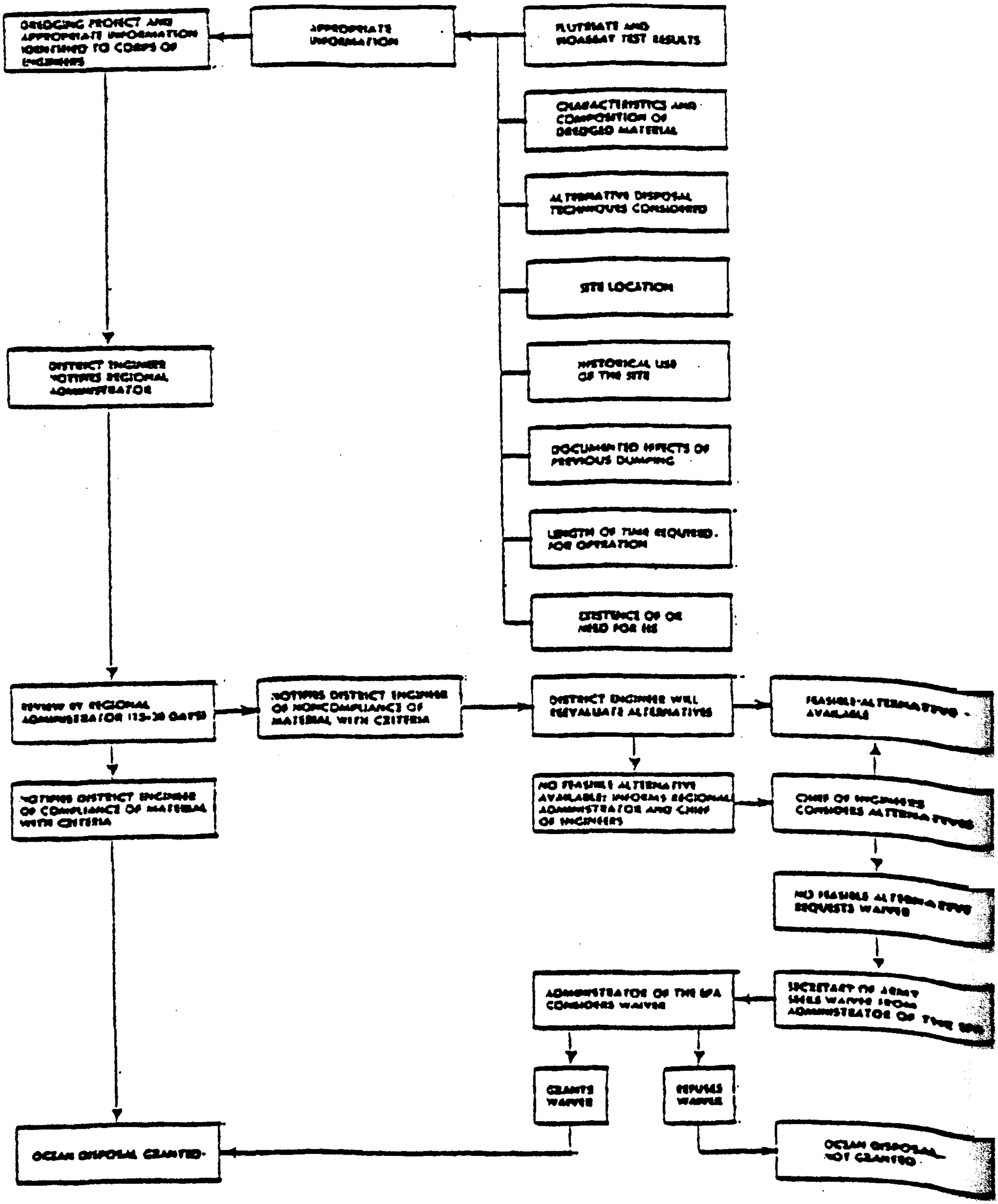


Figure 1-2 Dredged-Material Evaluation Cycle

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 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, ecological systems, 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 Part 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..." (40 CFR §227.6) and that the dredged material "can be discharged so as not to exceed the limiting permissible concentration..." (40 CFR §227.13). The bioassays ensure that "no significant undesirable effects will occur due either to chronic toxicity or to bioaccumulation..." (40 CFR §227.6). 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 to conduct 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 Title I 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 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 with 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 which float or remain in suspension) are also prohibited as other than trace contaminants. Other materials (e.g., arsenic, lead, copper, zinc, cyanides, fluorides, organosilicon, 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

Alternate locations for a San Juan Harbor (SJH), Puerto Rico ODMDS were evaluated in a Site Evaluation Study (Appendix B). Based on this evaluation it was determined that the interim-designated SJH-ODMDS should receive final designation. Evaluation of this site based on the 11 specific site selection criteria [40 CFR §228.6(a)] are presented in this Chapter.

EPA proposes that the interim-designated SJH-ODMDS receive final designation for continuing use as a disposal site for dredged material. Alternatives considered were:

- o No Action
- o Alternative Ocean Sites
- o Proposed Action

Various ocean alternatives, including the Interim Site, were considered in detail in a Site Evaluation Study (see Appendix B). The results of this study are summarized below. The "No-Action" and "Proposed Action" alternatives are considered in detail in this chapter. In addition, although not a requirement for this study, use of land disposal as an alternative is discussed.

NON-OCEAN DISPOSAL ALTERNATIVES

All alternative disposal methods must be evaluated during the consideration of permit applications for non-Federal dredging projects and in the preparation of the project EIS for Federal projects. The selection and permanent designation of an environmentally acceptable ocean disposal site for use in these evaluations is independent of these individual project requirements. Consequently, the non-ocean disposal alternatives are not considered in this EIS. However, as information, a brief resume of the availability of land-based disposal sites is presented below.

Land use in the San Juan area is almost exclusively urban and semi-urban in character. San Juan Harbor is surrounded by urban and industrial development. The metropolitan area of Greater San Juan borders the bay on the north, east, and southeast while Catano and satellite cities are filling in the formerly less-urbanized areas to the south and west of the bay. Flood control improvements have alleviated periodic flooding which occurred in the area south and west of the bay. This has resulted in the development of the marshy lowlands in this area for urban and industrial use. The little remaining agricultural land in the vicinity of the bay, lying near its southwest side, is rapidly being urbanized, primarily because of the protection afforded by the flood control improvements (CE, 1975).

The Corps of Engineers studied the availability of upland disposal sites (CE, 1975). This study found that the extent of development is such that no suitable upland disposal site is available within a feasible distance. The only land available near the harbor consists of small scattered parcels of doubtful practicability for both economic and environmental reasons.

The nearest inland sites of suitable size are about seven to eleven miles west of the harbor. Preliminary cost estimates for these sites showed that the costs would be considerably higher than for the nearshore sites. In addition, the effects of dike construction, support facilities construction, hauling of dredged material to the site, and loss of land for other purposes would be more severe than disposal at an ocean site. Use of the dredged material as fill was considered. This use was considered to be inadvisable because of the high silt and fines content of the dredged material. It was determined that the dredged material would be unsuitable as a supporting base for facilities and would require expensive diking for its retention (CE, 1975).

Prior to 1974, all operation and maintenance dredged material (with the exception of Bar Channel material) was placed in upland disposal areas. In 1974, these areas were finally exhausted, and no new upland site could be obtained even in small parcels adequate for one-time maintenance dredging operations. Consequently, from 1975 on, all material resulting from operation and maintenance dredging of San Juan Harbor has been disposed offshore.

NO-ACTION ALTERNATIVE

Under the EPA Ocean Dumping Regulations and Criteria (ODR), issued January 11, 1977, in accordance with the requirements of Section 102(c) of the MPRSA, various sites were approved for ocean dumping "...on an interim basis pending completion of baseline for continuing use of termination of use [40 CFR §228.12(a)]. The SJH-ODMDS was included in the interim designations. Ammendments to the ODR on December 9, 1980, stipulates that "---this list of interim sites will remain in force according to the following schedule:---(4) until such time as formal rulemaking is completed or until February, 1983, whichever is sooner, the following sites for disposal of dredged material under Corps of Engineers permits under Section 103 of the Act:---(iv) San Juan Harbor."

One alternative to the proposed action is that of taking no-action. This would result in the termination of the use of the SJH-ODMDS in February, 1983 when its interim designation expires without the permanent designation of an alternate ocean disposal site.

The net result of the No-Action Alternative would be that the CE would not have an EPA-approved, finally designated ocean site for disposal of the dredged material from San Juan Harbor. Therefore, the CE would be required to either: (1) justify an acceptable alternate disposal method (e.g., land based), (2) develop information sufficient to select an acceptable ocean site for disposal, or (3) modify or cancel dredging projects that depend on ocean disposal as the only feasible method for disposal of the dredged material.

It was determined in the Site Evaluation Study (Appendix B) that the interim-designated SJH-ODMDS should receive final designation for continuing use for disposal of dredged material. Consequently, the No-Action Alternative, effectively terminating the EPA designation of this site, is not considered to be acceptable.

ALTERNATIVE OCEAN SITES

After an initial appraisal of various alternative ocean locations, areas inshore and offshore of the interim-designated site were selected for evaluation (see Figure 2-1). These evaluations did not demonstrate significant environmental advantages to designation of these sites in lieu of the interim-designated site.

Inshore Area

An inshore site could be designated in a representative area located 1.0 nmi offshore in water averaging 100 m deep. The dominant sediment type for this insular shelf area is calcareous skeletal sand (coral, mollusks, calcareous algae, and foraminifera predominate). Relict skeletal components are common sediment constituents (Schneidermann, et al. 1975).

Disposal of dredged sediment at a nearshore site over the insular shelf increase turbidity in nearshore waters which could adversely impact coral reef communities and waterfront recreational facilities. Anticipated savings associated with using a site closer to shore than the Interim Site are estimated at $70,000 per 500,000 yd^3 of sediment. However, the potential adverse environmental effects associated with the insular shelf ecosystem could not justify use of ths area based solely on economic savings. Thus this inshore area was eliminated from further consideration as an alternative ocean disposal site.

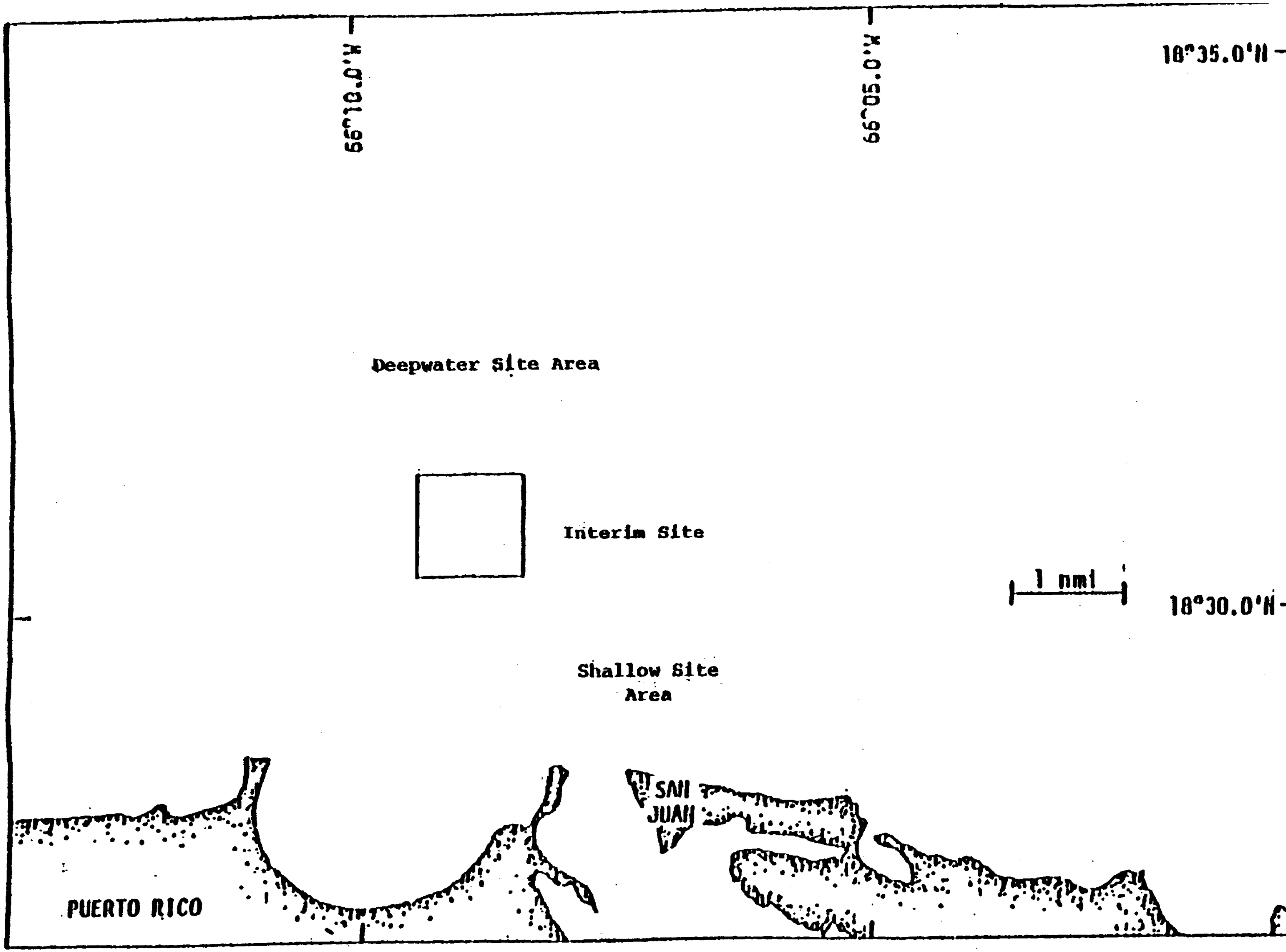

66°10.0'W
66°05.0'W
18°35.0'N
18°30.0'N
Deepwater Site Area
Interim Site
1 nmi
Shallow Site
Area
SAN
JUAN
PUERTO RICO

Figure 2-1

Offshore Area

Use of an offshore area, located 2.4 - 3.4 nmi from shore (1-2 nmi north of the interim site) in 400 - 600 m of water would move the effects of dumping even further offshore than the Interim Site. Although excess turbidity and nutrient release associated with sediment disposal would be less likely to be detected in coastal waters, other environmental effects would be similar to those at the interim site. In light of the fact that there is no evidence to indicate that the Interim Site is currently creating adverse water quality effects in coastal waters, the added cost of transporting the material the greater distance cannot be justified. The cost of monitoring would also be higher at an offshore site because of both higher travel costs and increased costs of sampling in the deeper waters. For these reasons, a site located further offshore than the existing Interim Site cannot be justified.

PROPOSED ACTION

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

The above general criteria were used in the initial process of selecting three alternative ocean sites off the northern coast of Puerto Rico. The Site Evaluation Study eliminated two of the alternative ocean sites (see above) and recommended the Interim Site for final designation.

The location of the site, sampling stations, and depths are shown in Figure 2-2. The interim-designated SJH-ODMDS was evaluated using the 11 specific site selection criteria [(40 CFR 228.6(a))] of the ODR. The results of these evaluations are presented below.

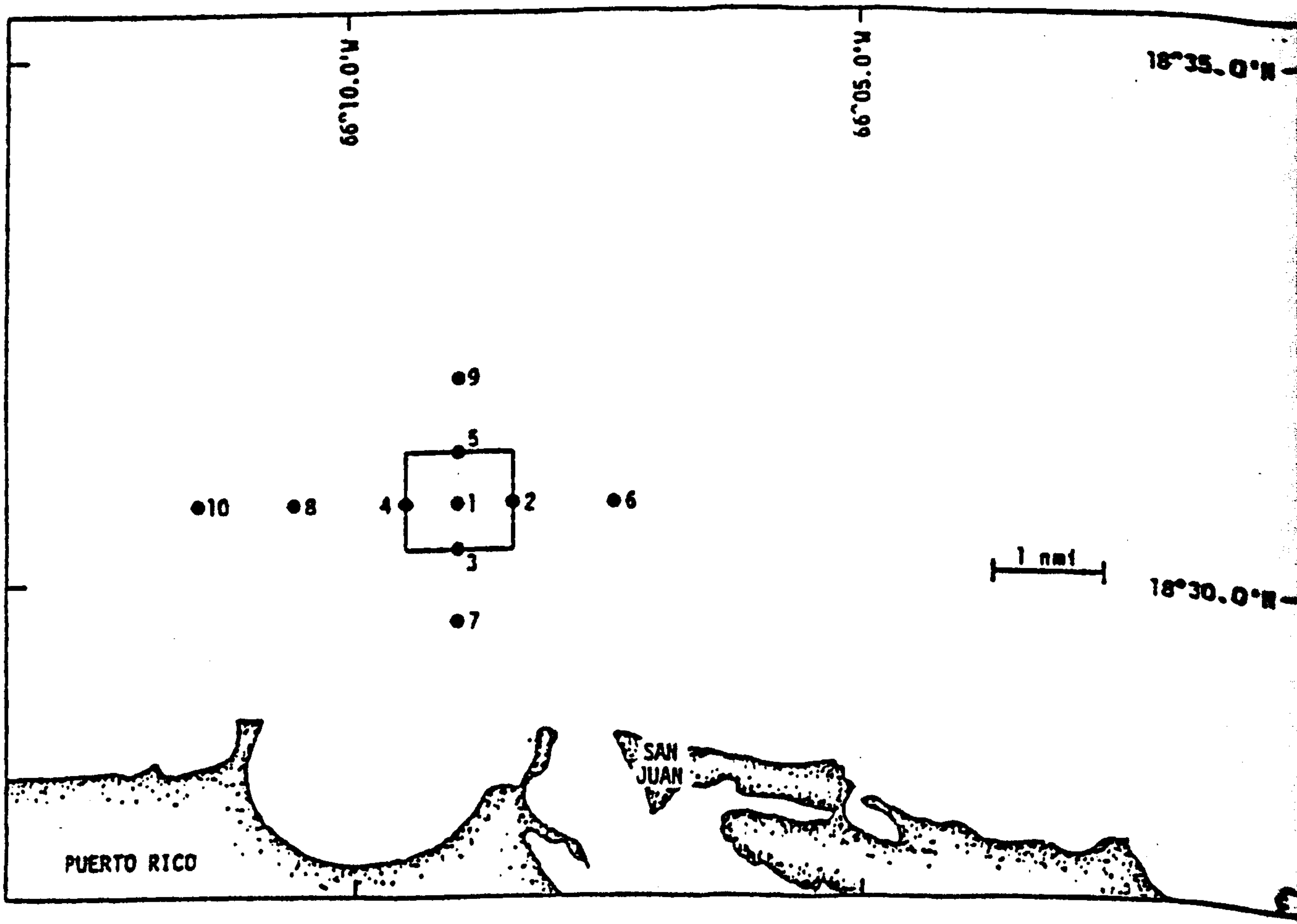
1. Geographical position, depth of water, bottom topography, and distance from the coast [40 CFR 228.6(a)(1)]

The center coordinates of the interim SJH-ODMDS are presented in Figure 2-2 (Site 1).

The site is centered 2.2 nmi from the nearest coastal land, the Isle de Cabras, and has an average depth of 292 m. The bottom drops off steeply to the north. The Insular Slope in this area to the north is characterized by numerous submarine ridges and swales. The bottom sediments within the 0.98 nmi area of the site averages 48% silt and 45% clay, the remainder being sand and gravel.

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)]

The Interim Site does not encompass any known unique breeding, spawning, nursery, or passage areas of nekton, marine mammals, or birds. The open water of the site may be feeding grounds for some wide ranging pelagic fish (i.e., tuna, jacks, mackeral). Deep waters at the site are feeding grounds for various snappers (blackfin, silk, and vermillion), but the site is not unique in this regard.



NUMBER	1	2	3	4	5	6	7	8	9	10
LATITUDE	18° 30.7'N	18° 30.7'N	18°30.2'N	18°30.7'N	18°31.2'N	18°30.7'N	18°29.2'N	18°30.7'N	18°31.[illegible]'N	18°30.7'N
LONGITUDE	66° [illegible] W	66° [illegible].5 W	66°09.[illegible] W	66°[illegible]W	66°09.0'W	66°07.8'W	66°09.0'W	66°10.0'W	66°09.0'W	66°11.0'W
DEPTH	2[illegible]m	2[illegible] m	213m	273m	4[illegible]m	436m	4[illegible]m	383m	4[illegible]m	223m

Figure 2-2
Station Locations, Coordinates, and Depths in the Area of the San Juan ODMDS

3. Location in relation to beaches and amenity areas [40 CFR 228.6(a)(2)]

Palo Seco and Punta Salinas, on the coast immediately west of San Juan, are both approximately 2.5 nmi from the center of the Interim Site. Both are developed beaches which serve metropolitan San Juan.

El Morro Castle, a National Historical Site, attracts thousands of visitors every year. The castle is located on a prominance on the western tip of Isle San Juan overlooking the Atlantic Ocean. Disposal activities at the site are 2.5 nmi to the north in the Atlantic Ocean and can be seen from the castle.

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)]

Only dredged material will be disposed of at the site. All dredged materials must meet EPA criteria (40 CFR 227) before permit for ocean dumping is granted. None of the material will be packaged in any way.

The CE has and will continue to perform dredging using Corps-owned hopper dredges. Further dredging will also be performed by private contract using hopper, dragline, clamshell, and dipper dredges (CE, 1975).

The total amount of dredged material dumped at the site since 1974 has been 4.3 million yd^3. Maintenance dredging of 173,000 and 1.3 million yd^3 has been conducted in 1974 and 1980, respectively. From 1974-76, 2.8 million yd^3 of dredged material from harbor improvements were dumped at the site.

A deepening project has been proposed by the CE for San Juan Harbor. The proposal under consideration consists of a plan for deepening, widening, and possibly realigning and extending channels; deepening of turning basins, and easing of channel connecting angles within the authorized existing project. Additionally, consideration is being given to incorporation of Sabana approach channel, a Puerto Rico Ports Authority project, into the authorized Federal harbor project. Excavation volume is estimated at 12,795,000 cubic yards of soft material and rock with work to be accomplished by barge-mounted clamshell or dragline and dredged material barged to the offshore disposal area. Accomplishment of the project would require an estimated 41 months from the letting of the initial contract. Maintenance would be scheduled at 2-year intervals and would involve an incrase of an estimated 185,000 cubic yards per year over previous maintenance (CE, 1975).

5. <u>Feasibility of surveillance and monitoring</u> [40 CFR 228.6(a)(5)]

Surveillance of disposal operations at the Interim Site could easily be achieved by helicopters or shipriders.

Environmental surveys (Appendix A) were conducted at the Interim Site in February and June, 1980 and encountered minor difficulties or delays. Similar surveys could be conducted in the future to determine whether or not disposal at a site is significantly affecting adjacent areas.

6. <u>Dispersal, horizontal transport and vertical mixing characteristics of the area including prevailing current direction and velocity</u> [40 CFR 228.6(a)(6)]

Dredged materials characteristically exhibit dispersion of fine material and subsequent elevated levels of suspended sediment and turbidity upon being dumped at the surface, during descent through the water column, and on impact with the ocean floor. The material dredged from San Juan Harbor is mainly silty clay which would cause turbidity during all phases of disposal.

The current regime off the north coast of Puerto Rico is composed of tidal and non-tidal components of similar magnitude. Semi-diurnal tidal currents rotate in a clockwise direction, whereas wind-driven non-tidal currents are predominantly along shore. The resulting net surface drift has not been established with any certainty, but the reported net flow off San Juan is westward, with frequent reversals. Current velocities at the Interim Site are unknown, but at Barceloneta, 23 nmi to the west, average approximately 0.5 kn. Generally, subsurface currents off the north coast are also along shore but weaker than surface currents.

There is no known upwelling of subsurface water at the Interim Site. A well-mixed layer of surface water extends to approximately 20 m in May, to 75-100 m in January. A strong permanent thermocline inhibits mixing.

The frequent reversals of currents at the Interim Site indicate that elevated levels of suspended sediments associated with dumping would be dispersed parallel to the coast, but not in a specific direction. Surface turbidity would be dispersed rapidly in the mixed layer. Elevated levels of suspended sediments in mid and bottom waters will remain below the thermocline and also be dispersed parallel to the coast, until particles settle to the bottom.

The strength of bottom currents at the Interim Site is unknown, but sedimentary information indicates that the area is a depositional environment. Thus, horizontal movement of dredged material on the sea floor is not expected.

7. Existence and effects of current and previous discharges and dumping in the area (including cumulative effects)
40 CFR 228.6(a)(7)]

Chemical and biological data suggest that previous dumping has created only minor modifications at the site (Appendix A). Oil and grease levels are higher in site sediments; however, levels of other trace contaminants show no consistent trends. Benthic infaunal communities at the Interim Site show low abundances and diversity similar to the surrounding area (Appendix A). Low levels of infauna in the region are the result of the general fine grain size, high water content, and unconsolidated nature of the sediments, and appear to be unrelated to disposal activities at the site.

Values for water quality parameters measured at the Interim Site (see Appendix A) are similar to those found in surrounding waters.

8. Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of specific scientific importance and other uses of the ocean
[40 CFR 228.6(a)(8)]

Heavy shipping and cruise ship traffic passes through or in the vicinity of the Interim Site. However, pass disposal activities have not interfered with the ship traffic.

A modest commercial fishery exists out of San Juan, but most fishing activity is centered in shallow water, inshore of the Interim Site. Commercial fishing near San Juan is hampered by rough seas and strong winds, conditions which occur throughout most of the year.

The Bureau of Land Management does not plan to lease any part of the north coast for oil or gas extraction. No other mineral extraction occurs at or near the site. (Federal Register, April 17, 1981

Disposal at the Interim Site would not interfere with the other activities listed above.

9. 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)]

An environmental survey of the Interim Site was conducted in 1980 (Appendix A). The study revealed oceanic water similar in water quality and thermalhaline structure to other areas of the tropical Atlantic.

Benthic infaunal populations at the site and surrounding regions of similar depth are extremely low in density and dominated by polychaete and sipunculid worms (see Tables A-12 to A-16, Appendix A).

Fish fauna at the site are expected to be sparse and composed of wide-ranging pelagic fish, such as tunas, jacks, and mackerals. Deep-waters at the site may be inhabited by various species having wide depth ranges (snappers, spiny dogfish, conger eels, and batfishes) as well as others representative of the abyssal slope, such as grenadiers.

10. Potentiality for the development or recruitment of nuisance species in the disposal site [40 CFR 228.6(a)(10)]

Survey work at the Interim Site has not indicated the development or recruitment of any nuisance species. There are no components in the dredged material, or consequences of its disposal, which would attract such fauna to the site.

11. Existence at or in close proximity to the site of any significant natural or cultural features of historical importance 40 CFR(a)(11)]

The National Register of Historic Places and its supplements list no sites within or near the Interim Site.

USE OF THE SITE

Permissible Material Loadings

To date, approximately 4.3 million yd^3 of dredged material has been dumped at the site with no obvious adverse impacts and no noticeable effects on the surrounding sea bottom. It is anticipated that the continuation of historic dumping volumes will have little effect. Further monitoring at the site is not recommended unless dredging volumes significantly exceed present volumes as would occur upon approval of the proposed deepening project.

Conclusion

Considerations for final site designation of the San Juan Harbor, P.R. ODMDS are based on EPA Ocean Dumping Regulations 11 site-specific criteria. The recommendation is made for the following reasons:

- Dredged material disposal has occurred at the Interim Site since 1974. Recent surveys (Appendix A) have detected no persistent or cumulative changes in the water quality or ecology at the disposal site.

- Impacts resulting from dumping have been temporary and restricted to site boundaries.

  Dredged materials are similar to disposal site sediments, thus changes in sediment texture and/or chemistry are unlikely.

- Surveillance and monitoring are facilitated due to the size and location of the site.

- Dredged material disposal at the SJH-ODMDS is cost effective.

- Interference with fisheries, shipping, or other beneficial uses of the ocean are insignificant.

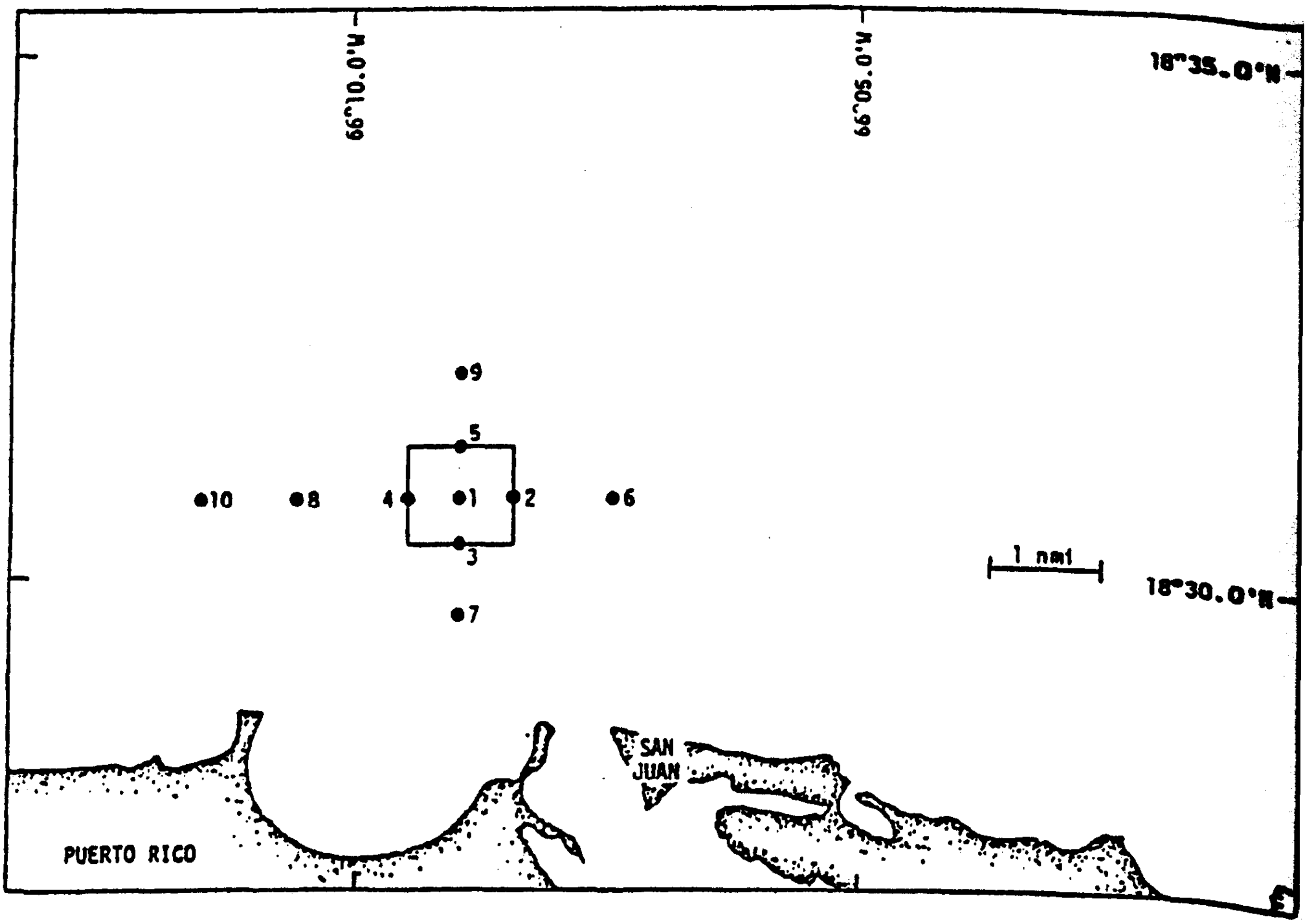
CHAPTER 3

AFFECTED ENVIRONMENT

Chapter 3 describes the environmental characteristics of the San Juan, Puerto Rico ODMDS. This Interim Site has been used for disposal of dredged material since 1974. Turbidity and suspended solids levels measured at the site were low. Sediments at the San Juan ODMDS are primarily (90%) silt and clay. The macrofaunal assemblage was dominated by small-bodied, deposit feeding polychaetes and sipunculans typical of muddy habitats. No differences were detected in the densities of these species between the disposal site and adjacent area.

Environmental characteristics which either will affect or be affected by the proposed dredged material disposal operations are described below. Oceanographic characteristics potentially affected by dumping are generally characterized as geological, chemical, or biological. Meteorlogical and ancillary oceanographic information is also presented in this chapter because natural physical processes influence the fate of released dredged material and the impacts of subsequent disposal. A history of the dredging operation, and commercial and recreational resources which may be affected by dredged material are also presented.

Site-specific surveys of the Interim Site were conducted for the Environmental Protection Agency by Interstate Electronics Corporation (IEC). Station locations, coordinates, and water depths are given in Figure 3-1. Ten stations were located in the study area: five (1-5) were within the ODMDS, and five (6-10), outside the site, were used as controls. Stations were oriented with the long axis in an upcurrent-downcurrent direction.



NUMBER	1	2	3	4	5	6	7	8	9	10
LATITUDE	18° 30.7'N	18° 30.7'N	18°30.2'N	18°30.7'N	18°31.2'N	18°30.7'N	18°29.2'N	18°30.7'N	18°31.7'N	18°30.7'N
LONGITUDE	66° 08.8'W	66° 08.5'W	66°08.8'W	66°08.8'W	66°08.8'W	66°07.5'W	66°08.8'W	66°10.0'W	66°08.8'W	66°11.5'W
DEPTH	226m	290 m	213m	273m	400m	438m	40m	383m	466m	273m

Figure 3-1
Station Locations, Coordinates, and Depths
in the Area of the San Juan ODMDS

Methods of data collection and detailed survey results are presented in Appendix A.

In addition to the field data collected by IEC, data has been compiled from numerous other sources to assist in characterizing the interim site. One of the oceanographic surveys was performed near San Juan Harbor (EPA, 1971); two additional surveys were performed off the north coast of Puerto Rico approximately 50-60 km west of San Juan Harbor (Black and Veatch, 1975; Puerto Rico Nuclear Center, 1975); a deepwater (6000 m) study was conducted at the Puerto Rico chemical waste dump site located approximately 80 km northwest of San Juan (Raytheon, 1978). Table 3-1 summarizes the major environmental studies previously conducted off the northern coast of Puerto Rico.

ENVIRONMENTAL CHARACTERISTICS OF THE PROPOSED SITE

For each of the major headings discussed in this section, i.e., geological conditions, meteorology, and physical, chemical and biological characteristics, a general overview of conditions in the area is presented followed, where appropriate, by a discussion of site-specific conditions. The physical and chemical characteristics of the dredged material are given at the end of this section.

GEOLOGICAL CONDITIONS

Geological information relevant to a ODMDS includes bathymetry and bottom character. Bathymetric data can provide information on bottom stability, persistence of sediment mounds and shoaling. The character of the bottom sediments strongly determines the composition of the resident benthic biota. Differences in sediment size distribution between natural ODMDS sediments and dredged material may be used as a tracer to determine the area of bottom influence of the dredged material. Changes in ODMDS sediment size induced by disposal can produce significant changes in chemical characteristics and the composition of the benthic biota.

Year	Sponsor	Studies Performed	Reference
1971	U.S. Environmental Protection Agency	Coastal Water Quality	U.S. EPA, 1971
1973-75	Puerto Rico Water Resources Authority	Biological, Chemical, Physical and Geological Survey of Ocean Environment	Puerto Rico Nuclear Center, 1975
1974	Puerto Rico Aqueduct and Sewer Authority	Biological, Chemical, Physical, and Geological Survey of Ocean Environment	Black and Veatch, 1975
1978	National Oceanographic and Atmospheric Administration	Physical and Chemical Study of Dumpsite	Raytheon, 1978

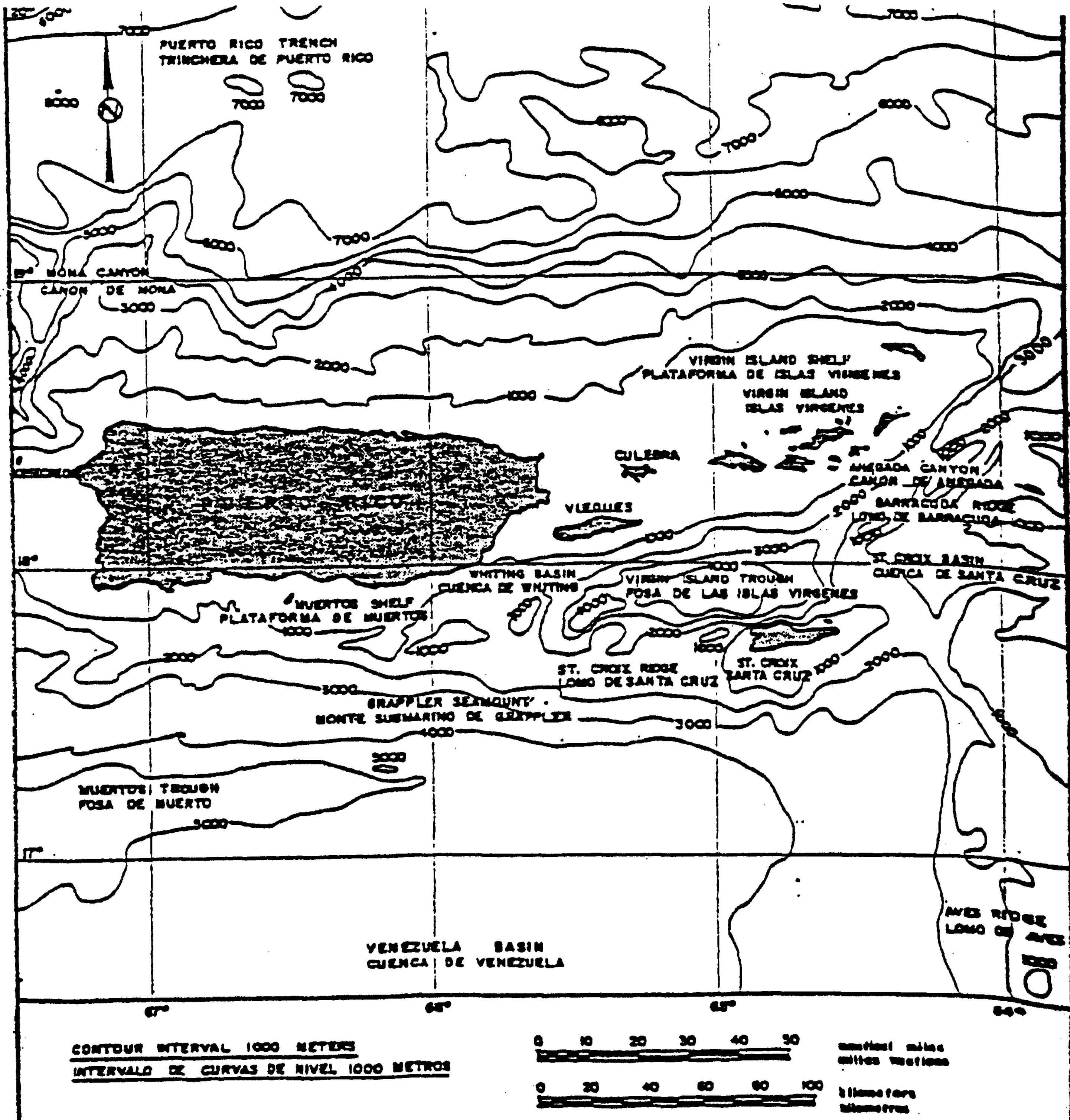
Table 3-1
Environmental Surveys Off the North Coast of Puerto Rico

Puerto Rico, the easternmost and smallest of the four major islands of the Greater Antilles, is about 160 km long and 50 to 60 km wide. Together with the Virgin Islands and the Leeward and Windward Islands of the Lesser Antilles, this chain of islands form a broad, southward-stretching arc to eastern Venezuela and provide the boundary between the Atlantic Ocean and the Carribean Sea (Department of Natural Resources, 1979).

The north coast of Puerto Rico is characterized by sand beaches and rock ledges superimposed upon a sequence of generally continuous Tertiary sedimentary deposits. Rock outcrops are common along the coast but are less prominent seaward as outcrops become increasingly covered by present-day sediments. A major portion of the stratigraphic section here is composed of a thick sequence of carbonate units (Monroe, 1973).

Structurally, the north coast stratigraphic section is dominated by gentle folding, low amplitude flexures and a few faults. All stratas dip gently northward (seaward) and are essentially unbroken until terminated by the southernmost bounding faults of the Puerto Rico Trench (about 35 to 45 km from shore) (Department of Natural Resources, 1979). See Figure 3-2. Normal weathering of predominantly limestone outcrops coupled with a complex history of tectonisms and various periods of sea-level fluctuation have resulted in a karst topography along a major portion of the north coast (Black and Veatch, 1975).

The dominant sediment type for the insular shelf (defined by the 200 m contour) is calcareous skeletal sand (coral, molluscs, calcareous algae and foraminifera predominant). Relict skeletal components are common sediment constituents (Schneidermann et al., 1975). The principle sand size non-carbonate component of shelf sediments is quartz (Schneidermann et al., 1975). Non-carbonated grains are generally concentrated in areas influenced by river run-offs. On the northern shelf the relative proportion of quartz to skeletal grains decrease from a high at the beach to a low at the shelf edge (Schneidermann et al., 1975).



BATHYMETRY AND PHYSIOGRAPHIC FEATURES IN THE VICINITY OF PUERTO RICO
BATIMETRIA Y FISIOGRAFIA EN AREAS CERCANAS A PUERTO RICO

Source: GARRISON et al., 1972
Origen: GARRISON et al., 1972

Figure 3-2

Sediments within the interim site, with a depth variance from 213-400 m, were predominantly (90%) silt and clay. There were no significant temporal or spatial trends in the distribution of silt and clay over the deeper portion of the survey area. (Percent sand, silt, and clay and station depth data is summarized in Table 3-2.).

From depths taken during sediment sampling (a separate bathymetric study was not performed), it is apparent that the bottom drops off steeply to the north. The entire site is located over the insular slope and is characterized by numerous submarine ridges and swales.

CLIMATE*

Climatic parameters of interest at a ODMDS are air temperature, rainfall, wind statistics, storm occurrences, and fog. Air temperature interacts with surface waters and, particularly during warm periods, influences the vertical stability of the water. Winds and storms can generate waves and currents which stir up and transport dredged material. A high incidence of fog during particular seasons might affect navigational safety and limit disposal operations.

Regional Climatology

Puerto Rico has a tropical maritime climate dominated by easterly trade winds and modified considerably by local effects such as sea and land breezes.

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*Source: Department of Natural Resources and Mineral Resources Development Corporation, 1979

Station	Mean Depth among Casts(m)	% Composition ($\bar{X} \pm SD$)[1]			
		Gravel	Sand	Silt	Clay
1	260	4.81 ± 7.71	8.99 ± 3.74	37.30 ± 9.61	48.89 ± 5.50
2	283	0.00 ± 0.00	7.56 ± 146	49.72 ± 5.09	42.72 ± 4.91
3	194	0.10 ± 0.13	15.44 ± 4.50	44.73 ± 3.21	39.73 ± 3.85
4	265	0.00 ± 0.00	9.75 ± 1.07	44.54 ± 2.29	45.72 ± 2.82
5	420	1.43 ± 3.78	8.55 ± 3.16	47.13 ± 5.67	42.89 ± 3.88
6	407	0.01 ± 0.03	8.25 ± 10.53	44.17 ± 6.65	47.59 ± 4.58
7	36	23.93 ± 8.31	73.84 ± 10.30	2.23 ± 2.40	0.00 ± 0.00
8	311	0.99 ± 2.61	5.09 ± 3.24	43.57 ± 5.55	50.35 ± 5.80
9	466	0.00 ± 0.00	3.78 ± 1.25	45.46 ± 4.51	50.75 ± 4.02
10	260	0.00 ± 0.00	1.66 ± 0.21	41.77 ± 4.20	56.57 ± 4.33

(1) n = 7 except at Station 7 (n=3).

Table 3-2. Sediment Composition in the Area of the San Juan DMDS During February, 1980

Temperature

Temperatures exhibit seasonal uniformity with monthly temperatures varying only slightly from the mean annual temperature of 25.8°C. Daily temperature ranges in coastal areas are small due to the moderating effects of nearby marine waters. The normal range at Isla Verde Airport in San Juan between the warmest month, August (27.4°C) and the coolest month, January (24.1°C), is 3.3°C (U.S. Department of Commerce, 1976). In tropical areas exhibiting small seasonal temperature variations, temperature conditions are almost entirely dominated by diurnal variations. The mean diurnal range in San Juan is 7.4°C, a value which is the difference between the mean daily maximum (29.6°C) and minimum (22.2°C) temperatures. On an average, there are only 37 days a year when the maximum daily temperature exceeds 32.2°C. The maximum and minimum temperatures on record in the area are 36°C (October, 1963) and 16°C (March, 1957), respectively.

Precipitation

Atmospheric precipitation in the tropics consists almost entirely of rainfall. The mean annual rainfall of 152cm along the northern coast is the result of two rainfall producing mechanisms: easterly waves and cold fronts. The former are migratory wave-like disturbances superimposed on the predominating trade winds that occur in the Caribbean most often between April and November. During this period, there is a marked increase in the number of cloudy days and precipitation; monthly rainfall averages 15 to 18cm compared to the lower values (5 to 8cm) experienced during the rest of the year. Thunderstorms occur on an average of 40 days per year, most commonly during the night and early morning hours. Hail, a phenomenon associated with thunderstorms, rarely occurs. None has been recorded in San Juan since 1926. The remainder of the rainfall is associated with trailing edges of cold fronts that have moved across the U.S. mainland and occasionally penetrated far enough south to affect

Puerto Rico. The extent to which Puerto Rico is affected depends upon the intensity of the front. Weak cold fronts may result in only cloudier-than-normal conditions, while strong fronts can produce heavy and continuous rainfalls which may last for several days. Extreme precipitation conditions have been recorded: maximum monthly rainfall---42.86cm, minimum monthly rainfall---0.13cm, and maximum 24-hour rainfall---26.8cm.

Wind

Easterly trade winds predominate in Puerto Rico throughout the entire year. Because of the proximity of the Atlantic Ocean, these trade winds are significantly modified by land and sea breezes. Table 3-3 presents the mean annual percent frequency of wind direction at San Juan. The frequency distribution is bimodal showing two peaks: one from the ENE, and the other from the ESE. Wind passes through the east during the transition between the two peaks, which occurs when land and sea breezes initiate during the course of the day. The diurnal variation of wind direction in the vicinity of San Juan is shown on Table 3-4.

The ENE direction is most frequent thoughout the year, and is a result of the sea breeze; an opposite, more southerly, circulation prevails during the morning hours as a result of the land breeze effect.

Wind speeds in the area are moderate. The mean annual wind speed is 14.2 km/hr but shows considerable daily and monthly variation. Table 3-4 illustrates this variation.

Maximum wind speeds occur in July, which has the highest monthly mean speed (16.1 km/hr) and average peak wind speeds in excess of 29 km/hr in downtown San Juan. October exhibits the lowest mean monthly wind speed (11.3 km/hr). Nocturnal wind speeds are significantly lower than those in late morning or early afternoon.

Table 3-3

Mean Annual Percentage Frequencies of Wind Direction at San Juan, PR

N	0.9
NNE	1.7
NE	6.4
ENE	28.5
E	9.7
ESE	13.4
SE	9.8
SSE	6.0
S	4.2
SSW	1.8
SW	1.5
WSW	0.8
W	0.3
WNW	0.3
NW	0.5
NNW	0.7
Calm	13.5

Table 3-4

Prevailing Wind Direction and Speed
at San Juan, PR

Annual Prevailing Wind Direction
(Local Time)

2AM	8AM	2PM	8PM	Annual
SE	ESE	ENE	ENE	ENE

Mean Maximum Wind Speed (km/hr) and Local Time

Station and Period Record	Strongest Month (July)		Weakest Month (October)	
San Juan (1931-42)	29.7	2 PM	22.3	2 PM
San Juan (1957-60)	23.9	2-3 PM	18.5	2-3 PM

Mean Minimum Wind Speed (km/hr) and local Time

Station and Period of Record	Strongest Month (July)		Weakest Month (October)	
San Juan (1931-42)	15.0	5 AM	8.9	8 AM
San Juan (1957-60)	8.5	7 AM	5.6	6 AM

The maximum wind speed recorded in San Juan was 258 km/hr during the San Felipe hurricane in September 1928.

Extreme Weather (Storms)

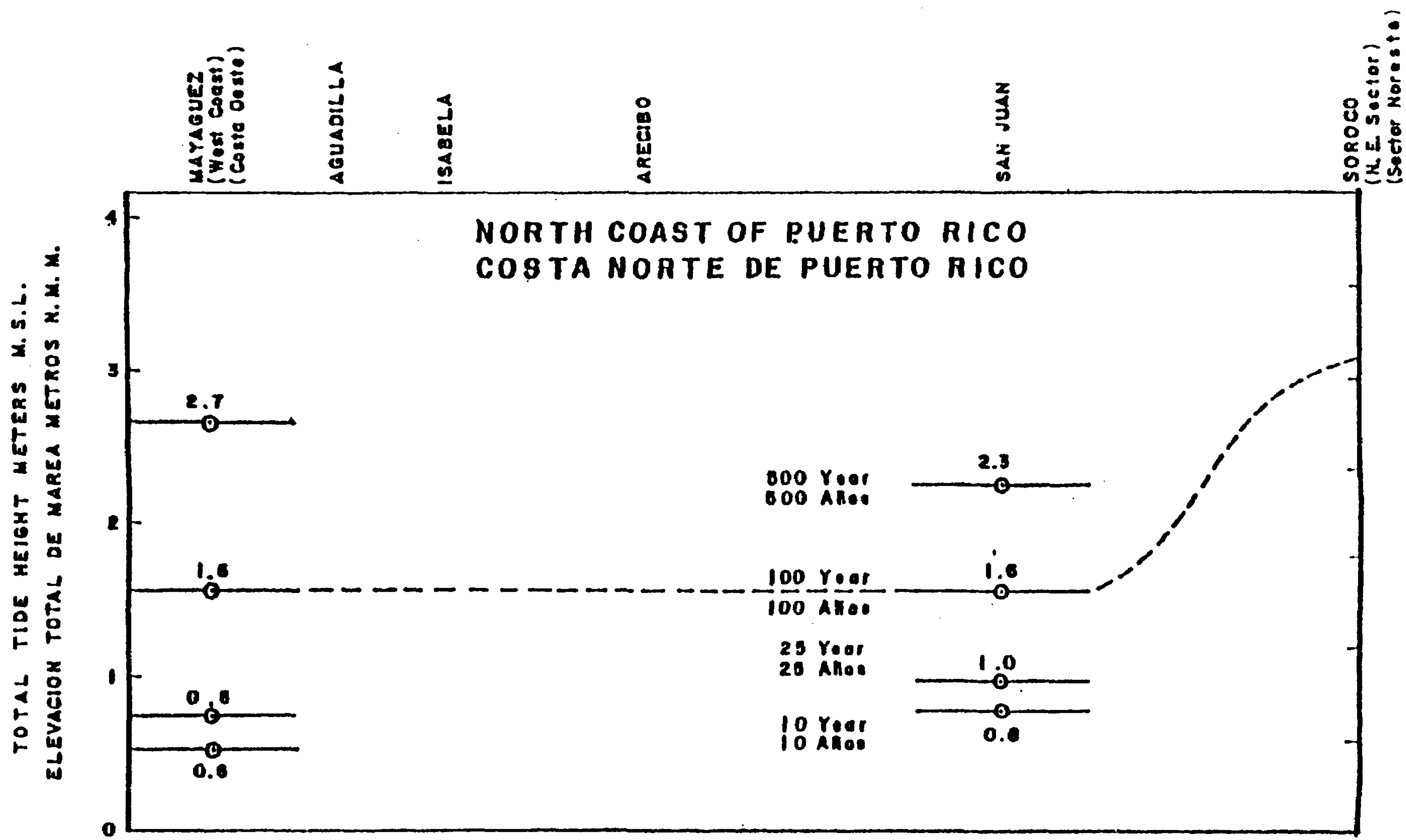
Hurricanes and tropical storms are important features of the climate of Puerto Rico, particularly during the summer and early autumn. Although Puerto Rico lies in the tropical hurricane region of the eastern Caribbean, there have been only six storms of hurricane intensity to strike the Island during the past 60 years.

Property damage and loss of lives results from high wind speeds and flooding. Figure 3-3 provides interpolated total tide levels for 10-, 25-, 100-, and 500-year return periods for the north coast derived from a NOAA storm tide frequency analysis based on hurricane data from 1871.

PHYSICAL CHARACTERISTICS

Physical oceanography parameters determine the nature and extent of the mixing zone, thereby influencing sediment transport and the chemical environment at a 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 in and out of the ODMDS. Tidal currents might contribute to the transport of dumped material, but usually do not add net directional effects.

Interpolated Total Tide Levels For The 10-, 25-, 100-, And 500 Year Return Period For The North Coast Of Puerto Rico
Niveles Totales De La Marea, En La Costa Norte De Puerto Rico, Interpolados Para Periodos de Repeticion de 10, 25, 100 Y 500 Años



Source: U.S. Department of Commerce; 1975
Origen: Departamento De Comercio De Los Estados Unidos; 1975

Figure 3-3

Interpolated Total Tide Levels for the 10-, 25-, 100-, and 500 year return period for the

Water Masses

Salinity and temperature data reveal the existence of a well-mixed layer of surface water, the Tropical Atlantic Water (TAW), off the north coast of Puerto Rico. The depth of the well-mixed, constant density water varies with the season and may extend to more than 100 m in January to less than 30 m from April through December (Raytheon, 1978; Schwab et al., in press). The TAW is characterized by an average annual salinity of 35.5 to 36.2% and temperature of 26 to 28°C. The nearshore waters occupying the Interim Site can be relatively less saline during the rainy season, due to the freshwater runoff from the Island (Appendix A, Table A-3). Surface waters at the site show little variation throughout the year reflecting the relatively constant tropical weather conditions in Puerto Rico and the tropical Atlantic.

Below the TAW, at a depth greater than 200 m, lies the Subtropical Underwater with higher salinity 36.5% and lower temperature 12-18°C (Atwood et al., 1976; Schwab et al., in press). A pronounced density gradient (pycnocline) separates the two water masses and inhibits intermixing.

Figure 3-4 presents salinity/temperature profiles taken in 1978 at the Puerto Rico Chemical Waste Dump Site, approximately 50 nmi to the north. The values are in good agreement with those at the Interim Site.

Circulation

Currents in the San Juan area are greatly influenced by the direction and strength of the tradewinds. The tradewinds blow primarily from the northeast. This, in conjunction with the east-west alignment of the coastline, results in a westerly, alongshore current. Short reaches along the coast may show a reversal of the general westerly drift due to local conditions.

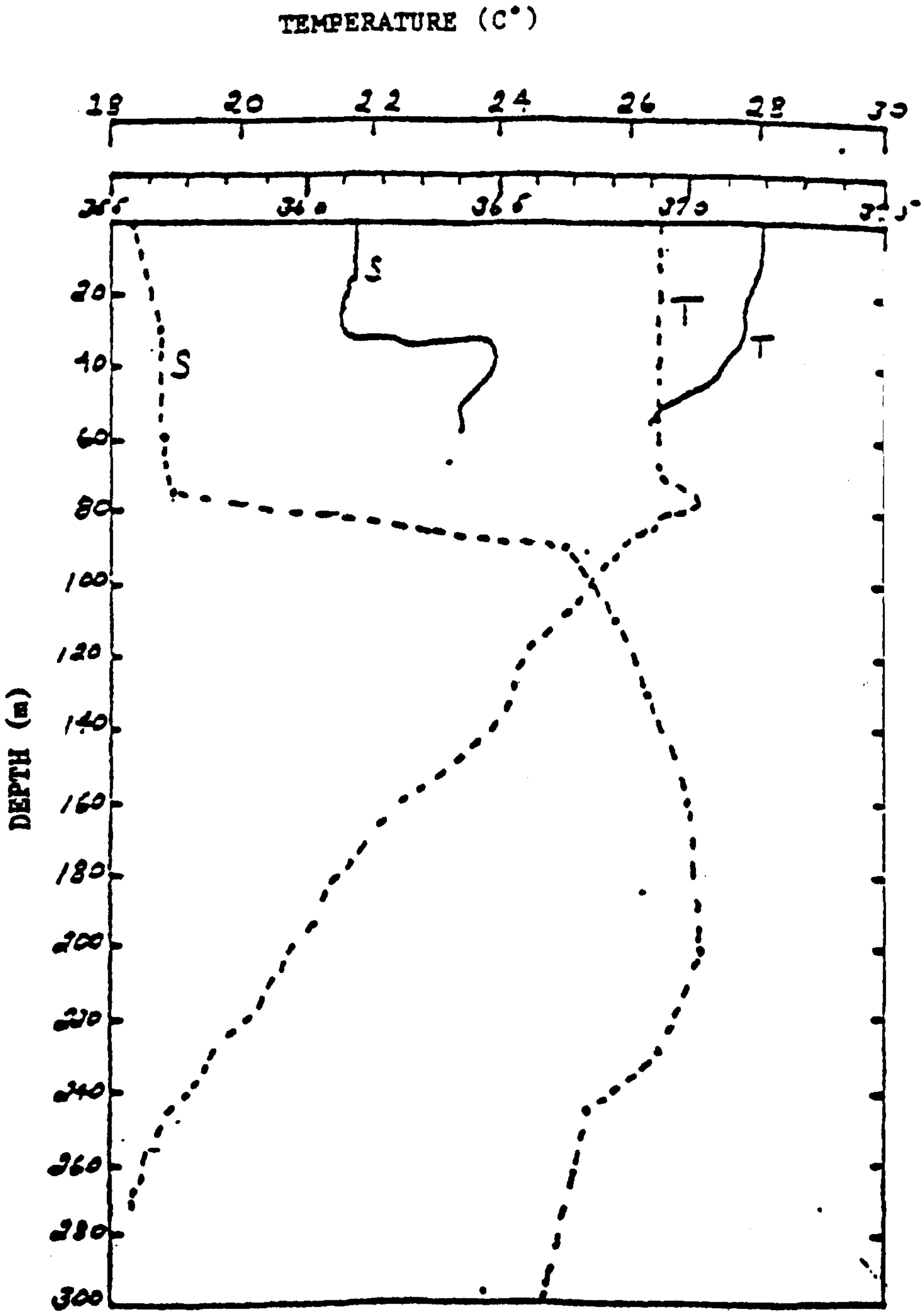


Figure 3-4

Temperature vs. Salinity Profiles
(Source: O'Conner, 1979)

Surface currents at the Interim Site show the general westward drift (mean speed 0.6 km). Superimposed on the longshore drift is a weak rotary tidal current (semidiurnal) which is seldom felt except during rare periods of calm (Calvesbert, 1970; Black and Veatch, 1975).

Subsurface currents at the Interim Site are not well defined, but open ocean data northeast of the site indicates that they will be weak and variable (U.S. Navy Oceanographic Office, 1972). The sediments present at the site and surrounding area are indicative of a relatively undisturbed depositional environment and reinforce the belief that subsurface currents are weak.

CHEMICAL CHARACTERISTICS

The chemical parameters most pertinent to evaluation of a ODMDS include suspended solids, nutrients important to phytoplankton growth (e.g., nitrate and phosphate), dissolved and particulate trace elements (e.g., Cd, Hg, and Pb), and hydrocarbons (e.g., PCB, DDT, and phenol).

Potential impacts are dependent upon 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.

High levels of suspended solids can reduce light penetration through the water column, thereby inhibiting phytoplankton productivity, or clog respiratory structure of fishes and other organisms.

Nutrients are essential for growth and reproduction of phytoplankton. However, under certain conditions and at elevated levels, these nutrients can promote eutrophication and subsequent depletion of dissolved oxygen.

Several trace elements are necessary micronutrients for life processes of organisms. However, many can be toxic, such as mercury and cadmium, when present in relatively high levels in water or in food sources such as suspended particulates. Many chlorinated and petroleum hydrocarbons are also toxic and can be bioaccumulated in some forms if ingested in sufficient quantity by marine organisms.

Water Column Parameters

Values for pH obtained at the site were normal for sea water and ranged from 8.0 to 8.2 in February and 8.2 to 8.4 in June (Appendix A, Table A-4). pH measurements decreased slightly with depth for both surveys. Dissolved oxygen concentrations also decreased with increasing depth (Appendix A, Table A-3). Surface and bottom dissolved oxygen values ranged from about 5.4 to 7.3 mg/l, similar to dissolved oxygen concentrations in other marine waters along Puerto Rico's north coast (PRASA, 1975).

As expected for these waters, turbidity levels and concentrations of total suspended solids at the site were low (Appendix A, Table A-4). Turbidity ranged from 0.15 to 0.59 NTU, with a mean of 0.30 NTU. Total suspended solids averaged 0.3 mg/l, and ranged from below detectable limits to about 1.8 mg/l.

Site values for dissolved and particulate trace metals (Appendix A, Table A-5) were well below EPA water quality criteria for Hg and Cd (EPA, 1976). Dissolved lead values varied widely and were relatively high during the February survey. Overall, concentrations ranged from a low of 0.38 ug/l in June to a maximum of 5.53 ug/l in February.

Deeper waters off the coast are typical of the Caribbean Sea - optically clear and containing little suspended material. Concentrations of suspended material are 0.2 to 5.7 mg/l above the pycnocline, 0.1 to 2.5 mg/l just below the pycnocline, and 0 to 4.8 mg/l in near-bottom waters (EG&G, 1978).

Four pesticides or derivatives were detected in the water column during the surveys (Appendix A, Table A-5). Heptachlor, heptachlor epoxide, and op'DDE were detected, but concentrations were below EPA water quality criteria (EPA, 1976). Dieldrin concentrations were near or above EPA guidelines during the June survey. Dieldrin, however, was below detectable levels in the survey site sediments. Therefore, it is not likely that the elevated dieldrin levels in the water column originated from dredged material. Runoff from land is the most likely source of this compound. No PCB's were found in measurable concentrations in the water column.

Nutrient levels in surface waters show litle seasonality reflecting the relatively constant tropical climate in Puerto Rico. Nitrate, nitrite, and phosphate levels, in general are extremely low off the north coast, typical of nutrient-poor tropical waters (Sverdrup, et al., 1942).

Sediment Characteristics

A variety of trace contaminants, 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 waste, urban and agricultural runoff, atmospheric fallout from urban centers, and accidental spillage. Silty and clayey sediments have a greater absorptive capacity for trace contaminants and typically have higher TOC levels than coarser material because of their large surface area to volume ratio and charge density.

Accumulation of trace elements and chlorinated and petroleum hydrocarbons in sediments can have short-term or long-term negative effects on marine organisms. Many benthic organisms are nonselective deposit feeders which ingest substantial quantities of suspended and bottom sediments. The potential for bioaccumulation of mercury, cadmium, and lead, and some chlorinated hydrocarbons, by these organisms is of particular environmental concern.

High concentrations of organic materials in sediments can lead to anoxic conditions resulting in the production of hydrogen sulfide and metal sulfides. The oxidation of these sulfides is responsible for much of the initial consumption of oxygen immediately following dredged-material disposal or disruption of fine-grained organically rich bottom sediments. Significantly lowered oxygen levels in sediments or near-bottom waters can adversely affect marine organisms.

Heavy metal concentrations in the sediments (Table 3-5 and 3-6) did not follow any spatial or temporal patterns. Concentrations of metals were not significantly different between the disposal site and the adjacent area or between surveys. Sediment cadmium concentrations in the study area ranged from 0.01 to 0.26 mg/kg; mercury from 0.01 to 0.28 mg/kg; and lead from below the detection limit to 25.5 mg/kg. The above values generally are comparable to trace metal concentrations in clay and silt from other sites in Puerto Rico (PRASA) and the Gulf of Mexico (CE, 1975a; Wheeler et al., 1980).

The shallow station (7) had the lowest concentration of cadmium and lead, probably because of the low proportions of silt and clay in this area.

At some of the interim-site stations, values for lead from separate casts differed by three to four orders of magnitude. For stations 5 and 6 in February and Station 1 in June, this variation can be partially accounted for by differences in grain size between casts. At other stations there is no apparent reason for these fluctuations in lead concentrations. Sediment concentrations of lead were weakly but significantly correlated with total organic carbon, oil and grease, and

Station	Hg (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Oil and Grease (mg/g)	TOC (mg/g)
1	0.03, 0.11	0.10, 0.11	2.63, 1.69	1.190, 1.270	8.92, 14.79
2	0.25, 0.07	0.05, 0.06	14.30, 9.46	2.360, 1.440	20.43, 15.71
3	0.11, 0.15	0.13, 0.26	23.60, 25.50	4.210, 6.080	15.39, 19.97
4	0.01, 0.19	0.15, 0.15	23.40, 24.20	2.170, 4.480	19.66, 16.59
5	0.01, 0.06	0.05, 0.02	4.40, 0.05	0.820, 0.910	14.32, 13.41
6	0.16, 0.18	0.13, 0.07	13.50, 0.04	1.750, 1.830	20.98, 13.06
7	0.12, 0.01	0.01, 0.01	<0.01, <0.01	0.670, 0.380	2.18, 2.56
8	0.14, 0.08	0.08, 0.05	9.82, 15.06	1.600, 1.180	16.14, 13.95
9	0.16, 0.13	0.15, 0.14	19.70, 22.30	2.150, 2.130	15.66, 15.06
10	0.14, 0.11	0.06, 0.04	19.30, 21.20	1.210, 1.560	14.71, 15.13

Table 3-5. Values of Trace Metals, Oil and Grease, and Total Organic Carbon (TOC) in the Sediments in the Area of the San Juan DMDS, February 1980. (Two values were measured at each station (IEC, 1980).

Station	Hg (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Oil and Grease (mg/g)	TOC (mg/g)
1	0.28, 0.12	0.11, 0.03	14.95, 0.13	3.730, 1.460	13.25, 13.59
2	0.07, 0.09	0.03, 0.04	0.07, 1.22	1.590, 3.550	11.79, 12.84
3	0.15, 0.19	0.08, 0.09	15.17, 18.70	1.830, 3.300	11.54, 15.36
4	0.19, 0.13	0.07, 0.10	1.88, 12.50	1.890, 2.160	13.26, 12.90
5	0.11, 0.16	0.06, 0.03	0.17, 0.18	1.510, 0.900	6.28, 13.15
6	0.12, 0.14	0.04, 0.16	0.07, 17.50	1.380, 2.270	11.63, 11,69
7	0.07	0.03	0.05	5.090	16.58
8	0.09, 0.04	0.05, 0.05	17.90, 0,20	1.430, 1.530	12.43, 11.47
9	0.08, 0.10	0.08, 0.07	16.20, 15.20	1,040, 0.670	11.53, 11.25
10	0.10, 0.15	0.04, 0.04	13.10, 0.10	0.860, 0.500	11.87, 11.84

Table 3-6. Values of Trace Metals, Oil and Grease, and Total Organic Carbon (TOC) in the Sediments in the Area of the San Juan DMDS, June 1980. (Two values were measured at each station) (IEC, 1980)

cadmium Table 3-7). However, at most stations where lead concentration widely varied between casts, these other parameters did not vary in a similar pattern. This suggests that the large differences in the values of lead between casts may be an artifact introducted by sampling or errors in the analysis.

Concentrations of TOC, (Tables 3-5 and 3-6) ranged from 2.18 mg/g at Station 7 in June to 20.98 mg/g at station 6 in February. These values generally are higher than are normally present in pelagic sediments (Horne, 1969), but are normal when compared with other coastal marine sediments (PRASA, 1975; CE, 1975a). At the shallow site, values in February were significantly lower, with values of 2.18 and 2.56 mg/g.

Oil and grease content (Tables 3-5 and 3-6) at the interim site ranged from 0.50 to 6.08 mg/g, and was significantly higher for sediments inside the disposal area (Stations 1-5) than in the surrounding area (Mann-Whitney U-test, $p < 0.05$). Values of oil and grease in the original dredged material are not available, however, the CE reports that channel sediments in San Juan Harbor are predominantly clay and "appear to have an oil or grease residue intermixed" (CE, 1975b). Consequently, it is likely that the higher oil and grease content in the sediments at the disposal site is a function of the disposal of dredged material.

Station 7 sediments contained high proportions of oil and grease (5.09 mg/g) and TOC (16.6 mg/g) during the June survey. The sea bottom in this area is overlain by coral rubble, gravel, and sand. More data is required to determine whether these high values represent an actual trend or if they are merely artifact.

Levels of organohalogens (CHC's) in the sediments (Table 3-7) were generally low. Concentrations for pesticides and pesticide derivatives were all below 5 mg/kg; those for total PCB (1254 plus 1242) were as high as 55 ug/kg. The 20 to 30-fold increase observed for sediment PCB levels at Station 1 between February and June may suggest that PCB levels

Organohalogen (mg/kg)	Station 1		Station 6	
	Feb	June	Feb	June
Arochlor 1254	1.091	21.962	-	-
Arochlor 1260	-(1)	33.130	7.995	-
Heptachlor	0.128	-	-	-
Heptachlor epoxide	0.059	-	-	-
pp'DDE	1.049	2.184	4.234	-
pp'DDD	0.110	0.803	0.917	-
pp'DDT	1.040	-	0.838	-
op'DDE	-	-	4.931	-

(1) A dash (-) indicates that the value was below the detection limits

Table 3-7. Values of Organohalogens Measured in Sediments in the Area of the San Juan ODMDS in February and June, 1980 changed with time. However, the February and June casts were more than 0.5 nmi apart, and the variability may be spatial rather than temporal. The sediment sampled at this station during June may have been dredged material from San Juan Harbor because it is unlikely that these PCB levels would occur naturally in sediments of this area. Bioassay tests for dredged material previously disposed at the site (see Appendix C) did not show unacceptable toxicity or bioaccumulation of PCB's.

BIOLOGICAL CHARACTERISTICS

The following groups of organisms present at the Interim Site are discussed: phytoplankton, zooplankton, nekton, benthic organisms, microorganisms, and rare and endangered species.

Phytoplankton

In general, waters off the northern Puerto Rico coast contain spacial and temporally patchy populations of phytoplankton of considerable species diversity. Diatoms are the dominant group but become less abundant offshore where coccolithophrids predominate. Prominent diatom components are of the genera Nitzschia, Thalassiosira and Navicula (Puerto Rico Nuclear Center, 1975). Dinoflagellates, although less common than diatoms, are also important components of the phytoplankton population.

Standing crops of algae for the year 1974 demonstrated a broad range. Counts varied from 730 to 18,602 cells per liter, with a mean value of 4,356 (Puerto Rico Nuclear Center, 1975). It has been suggested that periods of increased standing crops may be due to increases in nutrient concentrations during periods of rainfall and subsequent river discharge (Puerto Rico Aqueduct and Sewer Authority, 1975). A slight seasonality is present in the population where a small increase in numbers has been correlated with periods of greater rainfall (Puerto Rico Nuclear Center, 1975).

Zooplankton

Copepods are invariably the most abundant organisms along the north coast, followed by fish eggs, chaetognaths and larvaceans (Puerto Rico Nuclear Center, 1975). Many of the copepod species are typical oceanic species similar to those found in the open waters of the Caribbean and Sargasso Sea. Prominent copepod components are of the genera Acartia and Temora. Ostracods, pteropods, salps and gastropods are occasionally numerous.

Zooplankton population is spatial and temporally patchy in character. During the period November - July, biomass is slightly higher offshore (at times exceeding 40 ml/100 M^3) whereas the situation is reversed during the remainder of the year (less than 30 ml/100 M^3 in inshore areas) (Puerto Rico Nuclear Center, 1975). Vertical distribution patterns are directly influenced by the daily migration of the phytoplankton population up and down the water column. Zooplankton populations are active throughout the year and are expected to exhibit minimal seasonal variations as a result of small climatic fluctuations.

Nekton

The chief component of the nekton for the northern Puerto Rico coast is the fishes, including species from the famalies Caragidae (jacks), Scombridae (tunas and mackerels) and Lutjanidae (snappers) (Puerto Rico Nunclear Center, 1975). Fish faunas may be categorized into three principle habitats--algal mats, rock outcrops and sand-covered bottoms. Algal mats harbor the most abundant and diverse fish fauna. The most numerous group of fishes was the wrasses (exp. Halichoeres s.p. and Thalassoma bifasciatum). Rock outcrops support a fauna generally dominated by species of the Labridae and Holocentridae families. Sand covered bottoms support the least diverse and fewest fishes where the most common species is the razorfish (Hemipteronotus nartinicensis). Large jelly fishes (Aurelia aurita) and cephalopods (squid) can be found in all three habitats and are also prominent components of the nekton (Puerto Rico Aqueduct and Sewer Authority, 1975).

Most marine tropical fishes spawn throughout the year, or at least have prolonged spawning seasons. Physical parameters which trigger spawning remain relatively constant yearly, allowing spawning periods to be extended or continuous (Puerto Rico Nuclear Center, 1975).

No migratory trends have been reported for the northern Puerto Rico coast. Seasonality exists but is not related to salinity and temperature changes. Annual salinity and temperature ranges are generally narrow. It is believed that during winter months high seas and storms are generated which cause the fishes to stray less from their normal habitats (Puerto Rico Nuclear Center, 1975).

Marine mammals are infrequent vistors to the waters off the north coast of Puerto Rico. Those sited include humpback whales, roquals, sperm whales, Cuvier's beaked whales, pilot whales, and dolphins. West Indian manatees have been sighted both east and west of the entrance to San Juan Bay during a special manatee survey conducted by the Department of Natural Resources, Commonwealth of Puerto Rico (1979).

Benthic Organisms

Forty-five species of macrofauna were common in the area of the existing San Juan DMDS during the February and June, 1980 surveys. Polychaete worms dominated the fauna and were best represented by species of Spionidae and Nephtyidae. Spinculans were numberically abundant due to the occurrence of a single species, Golfingia sp. D. All other groups, such as crustaceans and molluscs, were sparsely represented.

Numerical data for the common species (Table 3-8) were used to examine the trophic composition of the macrofauna. Species were assigned to the following feeding categories based on Barnes (1968), Bloom et al., (1972), Santos and Simon (1974), Fauchald and Jumars (1979), and Dauer (1980):

- deposit feeders which injest sediment and detritus;
- suspension feeders which filter food particles from the water column;

Table 3-8. Common Macrofaunal Species Captured in the Area of the San Juan DMDS during February and June, 1980

Species	Trophic Position[1]	Survey Feb	Survey June
Nemertea:			
Nemertean sp. A	C		X
Nemertean sp. I	C	X	X
Cerebratulus lacteus	C	X	
Annelida:			
Polychaeta:			
Leanira alba	C	X	
Pisione sp. A	O	X	
Sigambra tentaculata	C	X	X
Exogone lourei	D	X	X
Haplosyllis spongicola	C		X
Sphaerosyllis sp. A	D	X	
Aglaophamus verrilli	C	X	X
Aglaophamus sp. B	C	X	
Lumbrineris sp.	O	X	
Paraprionospio pinnata	D	X	
Prionospio ehlersi	D	X	X
P. longibranchiata	D	X	X
Prionospio sp.	D	X	
Spionidae gn. B	D		X
Spionidae	D	X	
Spiophanes sp. A	D	X	X
Cirrophorus sp. C	D	X	
Tauberia sp. B	D		X
Cossura delta	D	X	X
C. soyeri	D		X
Cossurella sp. A	D	X	X
Capitellidae gn. L	D	X	X

Species	Trophic Position[1]	Survey Feb	Survey June
Capitellidae	D	X	X
Mediomastus sp.	D	X	
Mediomastus sp. B	D		X
Notomastus sp.	D	X	
Maldanidae gn. A	D	D	
Ampharetidae gn. A		X	
Ampharetidae	D	X	
Terebellidae	D	X	
Archiaellida:			
Polygordius sp. A	O	X	
Oligochaeta:			
Oligochaeta spp.	D	X	
Arthropoda:			
Isopoda:			
Apseudes sp. B	D		X
Astacilla sp. A	O	X	X
Stenetrium occidentale	O		X
Amphidoda:			
Gammaropsis sp. A	D		X
Gammaropsis sp.	D	X	
Leucothae sp. A	?		X
Protohadzia sp. A	?	X	X
Decapoda:			
Callianassa minima	S	X	
Mollusca:			
Aplacophora:			
Chaetoderma sp. A	O	X	
Sipuncula:			
Golfingia sp. D	D	X	X

[1]D = Deposit feeders; S = Suspension feeders
O = Omnivores; C = Carnivores

- o omnivores which can feed on a wide range of plant, animal, detrital, or sediment particles; and
- o carnivores which feed on living animal tissue.

Mean abundance of common species where totalled for each trophic category for each station, and percentages were calculated and results presented in Table 3-9.

The majority of species were deposit feeding organisms which are characteristic of muddy habitats (Gray, 1974) found throughout the study area. Abendant deposit feeders included the sipinculan, Golfingia sp. D, and polychaetes such as Prionospio longibranchiata, Spiophanes sp. A, and Cossura delta.

Nemertean and polychaete carnivores were also common throughout the area; the most numerous representatives were the polychaetes Sigambra tentaculata and species of Aglaophamus. This trophic group was particularly common in June at Station 7 when the syllid polychaete Haplosyllis spongicola became abundant.

Suspension feeders were poorly represented among the common species. The lack of this trophic group probably was due to the high mud content of the substratum. The feeding structures of these organisms can become clogged by silt and clay particles, and burrows of tubes are often difficult to maintain in muddy sediments which are not cohesive (Gray, 1974).

Omnivores were also scarce, and represented by a few polychaete, isopod, and a single molluscan species (Table 3-9).

Figure 3-5 presents a diagrammatic representation of several of the abundant macrofauna which occurred along an inshore to offshore gradient. Changes in sediment composition and depth are also indicated in this figure. Station 7, the shallowest, had a much greater proportion of sand than did the other stations, and consequently a different assemblage of organisms. Stations 3, 1, and 5 shared similar assemblages of macrofauna, but the deepest station (9) was dominated by species of spionid polychaetes.

	February					June, 1980				
Station	D	S	C	O	?	D	S	C	O	?
1	.70	.04	.26	.00	.00	.76	.00	.24	.00	.00
2	.71	.00	.29	.00	.00	.53	.00	.47	.00	.00
3	.61	.00	.39	.00	.00	.60	.00	.40	.00	.00
4	.80	.00	.10	.10	.00	.79	.00	.21	.00	.00
5	.87	.00	.13	.00	.00	.73	.00	.27	.00	.00
6	.88	.00	.12	.00	.00	.71	.00	.29	.00	.00
7	.74	.00	.00	.16	.10	.28	.00	.52	.12	.07
8	.92	.00	.08	.00	.00	.69	.00	.31	.00	.00
9	.76	.00	.02	.10	.13	.81	.00	.01	.08	.11
10	.65	.00	.21	.15	.00	.81	.00	.19	.00	.00

Table 3-9. Percent Trophic Composition of the Common Macrofaunal Species Collected in the Area of the San Juan DMDS. (D=deposit feeder, S=suspension feeder, C=carnivore, O=omnivore, and ?=unknown.)

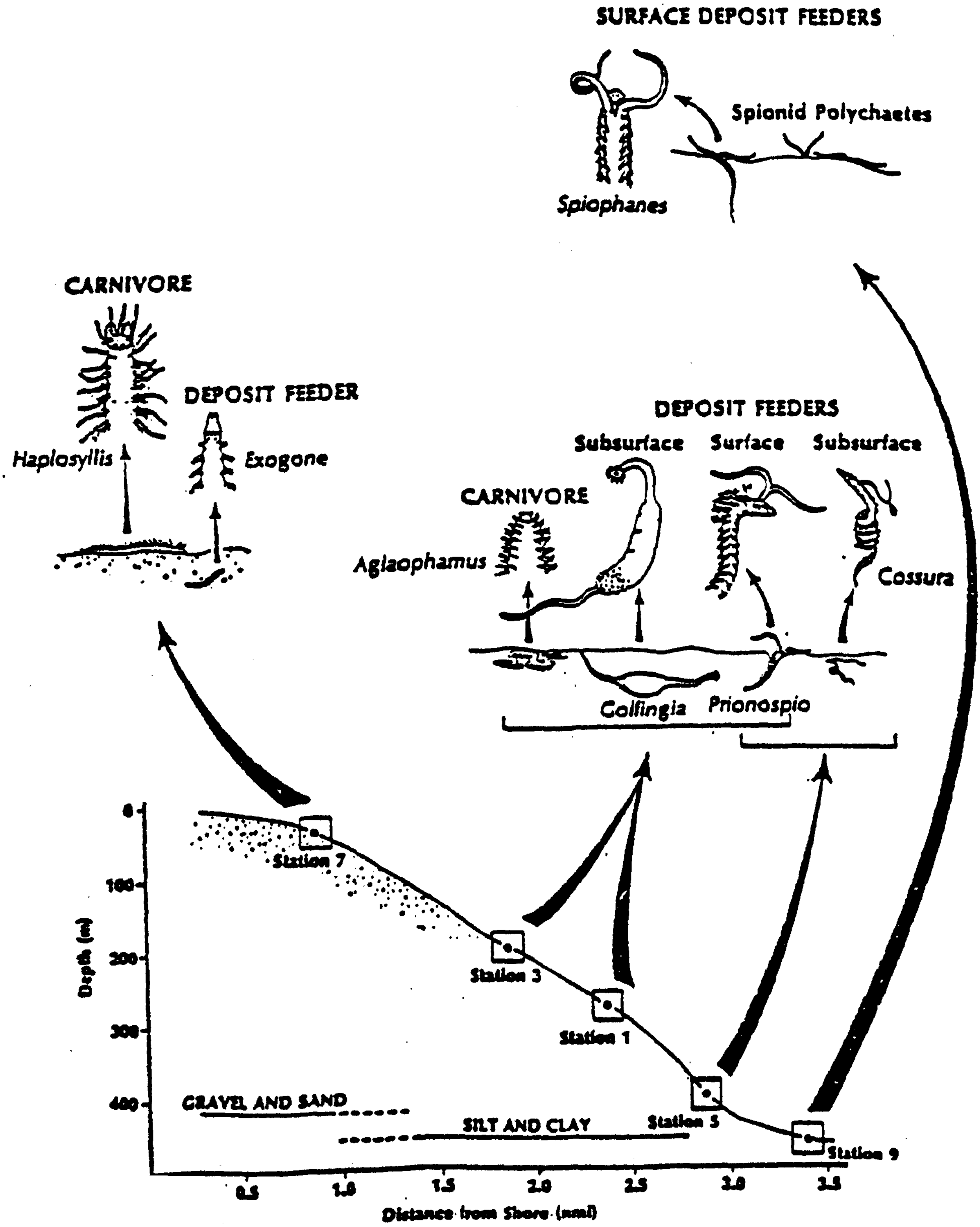


Figure 3-5

Common Macrofauna Collected at DMDS

Six species were selected for further analysis based on their abundance during both surveys. Species included the polychaetes Sigambra tentaculata, Aglaophamus verrilli, Prionospio longibranchiata, Spiophanes sp. A, and Cossura delta, and the sipunculan peanut worm Golfingia sp. D. These species are small bodied organisms ($\leq$ 4 cm in length) which represent a variety of trophic levels (Table 3-8 and Figure 3-5). Numerical data for these species are presented in Table 3-10 and 3-11.

Abundance of all six dominant species was significally different between stations (Table 3-12). Although densities of Golfingia sp. A were not different significantly between stations when tested using parametric methods, densities became significantly different when the non-parametric Kruskal-Wallis test (Sokal and Rohlf, 1969) was applied to the data (February survey, $H=23.78$, $p<0.05$; June survey $H=20.40$, $p<0.05$).

These dominant species were most prevalent at the mid-depth stations (Appendix A, Figures A-3 to A-7), except for Spiophanes sp. A which occurred in great abundance at the deepest station (Appendix A, Figure A-8).

Differences in the densities of dominant species between the ODMDS and control stations were examined for each survey as follows. Stations along a similar isobath which ran through the ODMDS were separated into two groups; a control group (Stations 10, 8, and 6) and a ODMDS groups (Stations 1, 2, and 4). For each dominant species, all density information from the replicates was polled for each group of stations to form two samples. Differences between these samples were tested using a Mann-Whitney U-test (Sokal and Rohlf, 1969). For all but one case, no difference was found between control and ODMDS stations. The exception occurred in February when significantly greater number of Golfingia sp. A were found in the ODMDS site. If differences in densities of the other macrofaunal species did occur between the ODMDS and control sites, then they probably were masked by the natural variations in the abundances of these organisms.

Station	Sigambra tentaculata	Aglaophamus verrilli	Prionospio longibranchiata	Spiophanes sp.A	Cossura delta	Golfingia sp.D
1	1.4 ± 1.1	3.0 ± 2.4	2.4 ± 2.9	0.8 ± 0.8	0.0 ± 0.0	5.6 ± 4.6
2	0.8 ± 0.8	2.6 ± 2.3	1.4 ± 3.1	0.8 ± 0.8	0.0 ± 0.0	4.6 ± 3.9
3	1.0 ± 0.7	8.2 ± 1.9	2.0 ± 2.5	1.2 ± 0.8	0.0 ± 0.0	2.8 ± 2.5
4	0.4 ± 0.9	1.6 ± 2.3	2.8 ± 3.3	1.8 ± 1.1	0.4 ± 0.5	3.2 ± 3.5
5	0.2 ± 0.4	1.0 ± 1.4	0.2 ± 0.4	1.2 ± 1.3	1.6 ± 1.7	0.4 ± 0.5
6	1.6 ± 1.3	0.2 ± 0.4	0.0 ± 0.0	0.8 ± 0.8	1.8 ± 1.3	0.2 ± 0.4
7 (1)	0.0	0.0	0.0	0.0	0.0	0.0
8	0.4 ± 0.9	0.8 ± 1.8	0.0 ± 0.0	2.2 ± 2.3	0.0 ± 0.0	1.4 ± 2.2
9	0.4 ± 0.9	0.0 ± 0.0	0.0 ± 0.0	5.8 ± 3.0	0.4 ± 0.5	0.0 ± 0.0
10	0.6 ± 0.5	2.8 ± 1.3	0.0 ± 0.0	0.8 ± 0.8	0.2 ± 0.4	1.8 ± 1.6

(1) Only one cast was taken at Station 7.

Table 3-10. Numerical Data for the Dominant Species Collected in the Area of the San Juan DMDS, February, 1980. (Values are mean ∓ one Standard Deviation; n=5.)

Station	*Sigambra tentaculata*	*Aglaophamus verrilli*	*Prionospio longibranchiata*	*Spiophanes* sp.A	*Cossura delta*	*Golfingia* sp.D
1	1.0 ± 0.7	1.8 ± 3.5	3.2 ± 5.5	0.2 ± 0.4	0.6 ± 0.9	1.6 ± 1.5
2	1.4 ± 1.1	0.4 ± 0.9	0.0 ± 0.0	0.0 ± 0.0	0.2 ± 0.4	1.8 ± 2.2
3	1.5 ± 1.3	7.0 ± 3.7	3.0 ± 1.4	1.8 ± 1.5	0.5 ± 1.0	8.3 ± 3.0
4	0.4 ± 0.5	3.8 ± 1.6	3.4 ± 4.3	0.0 ± 0.0	0.0 ± 0.0	6.0 ± 4.9
5	0.4 ± 0.5	1.0 ± 0.7	0.0 ± 0.0	0.2 ± 0.4	2.0 ± 1.0	0.4 ± 0.9
6	0.6 ± 0.5	0.0 ± 0.0	0.2 ± 0.4	0.0 ± 0.0	1.6 ± 0.9	0.2 ± 0.4
7 (1)	0.0	0.0	0.0	0.0	0.0	0.0
8	0.8 ± 0.8	2.4 ± 3.8	2.2 ± 2.3	1.4 ± 2.2	0.4 ± 0.5	1.6 ± 2.1
9	0.2 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	5.4 ± 5.9	0.2 ± 0.4	0.2 ± 0.4
10	0.0 ± 0.0	2.4 ± 2.8	0.8 ± 1.3	3.6 ± 4.2	0.4 ± 0.5	3.2 ± 3.5

(1) Only one cast was taken at Station 7

Table 3-11 Numerical Data for the Dominant Species Collected in the Area of the San Juan DMDS, June, 1980. (Values are mean ± one Standard Deviation; n=5.)

Species	Source of Variation	d.f.	Mean Square	F
Aglaophamus verrilli	Survey	1	2.1	0.4
	Station	9	38.7	7.0*
	Survey x Station	9	5.5	1.2
	Residual	72	4.5	
	Total	91		
Golfingia sp.D	Survey	1	0.7	0.5
	Station	9	31.3	2.4
	Survey x Station	9	13.3	1.8
	Residual	72	7.3	
	Total	91		
Spiophanes sp. A	Survey	1	2.8	0.7
	Station	9	23.8	6.3*
	Survey x Station	9	3.8	0.8
	Residual	72	4.6	
	Total	91		
Prionospio longibranchiata	Survey	1	2.4	1.1
	Station	9	12.9	6.1*
	Survey x Station	9	2.1	0.4
	Residual	72	5.4	
	Total	91		
Sigambra tentaculata	Survey	1	0.3	0.6
	Station	9	1.6	3.2*
	Survey x Station	9	0.5	0.8
	Residual	72	0.7	
	Total	91		
Cossura delta	Survey	1	0.5	1.7
	Station	9	4.1	13.7*
	Survey x Station	9	0.3	0.5
	Residual	72	0.6	
	Total	91		

* = $p \leq 0.05$

Table 3-12. Analysis of Variance (Model II) of Densities of the Dominant Species Collected in the Area of the San Juan DMDS During February and June, 19

Microbiology

All ten stations from the February survey were analyzed for total and fecal coliforms in the sediments collected.

Table 3-13 lists the sediment coliform counts from the February survey. Total and fecal coliforms were detected at three stations: two stations on the perimeter of the site (Station 3 and 4) and one control station to the east (Station 6). The data showed no visible pattern or explanation for the presence of the coliforms and could not be related to the other parameters (e.g., trace metal or grain size distribution).

Rare and Endangered Species

Endangered species which inhabit the region include the brown pelican, hawksbill turtle, manatee and leatherback turtle. Threatened species include green sea turtle and the loggerhead turtle.

CHARACTERISTICS OF DREDGED MATERIAL*

San Juan Harbor

The entrance channel (Bar Channel), which lies roughly in the center of the 3,600-foot reach between Cabras Island and Las Cabritas islands on the west and Moro Point on the east, has an overall width of 1,000 feet and is 3.8 feeet deep (Figure 3-6). However, an interior channel is maintained at a depth of 45 feet and width of 500 feet within the 1,000-foot-wide entrance channel.

The entrance channel extends from its northerly project limit in the Atlantic Ocean south for 1,700 feet to the southeasterly bend which marks the junction with Anegado Channel. The bend is 1,200 feet wide and 42 feet deep and the channel shallows in steps to 36 feet deep as it becomes Anegado Channel which varies in width from 1,000 to 1,200 feet. At a distances of about 4,000 feet from the entrance channel bend, an inner

*Source: CE, 1975a

Station No.	Total Coliforms (MPN/100 g)	Fecal Coliforms (MPN/100 g)
1	<133	<133
2	<118	<118
3	167	167
4	167	167
5	<111	<111
6	346	346
7	<133	<133
8	<143	<143
9	<167	<167
10	<154	<154

TABLE 3-13
TOTAL AND FECAL COLIFORM LEVELS
IN SEDIMENTS
February 1980

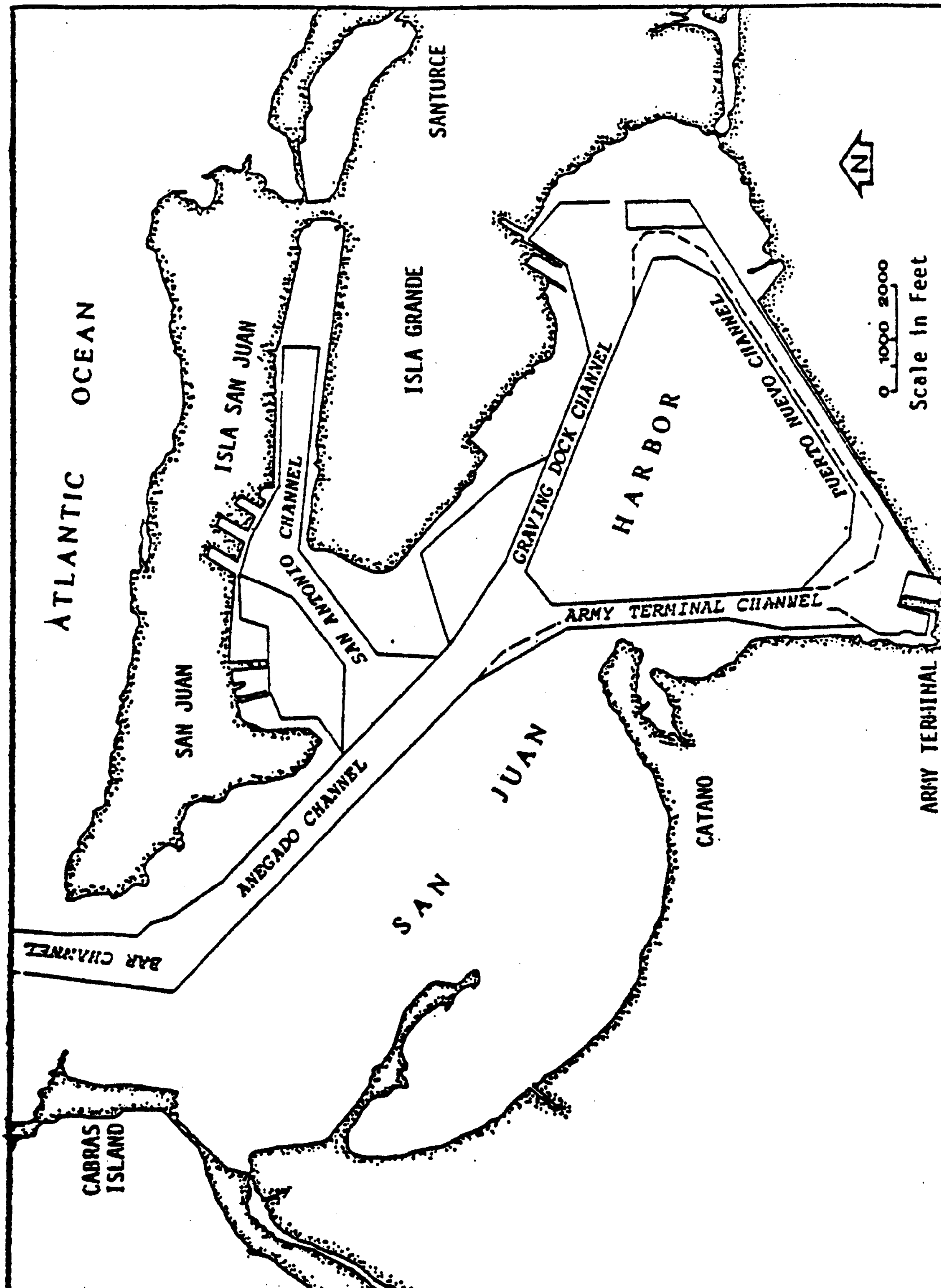


Figure 3-6
San Juan Harbor

harbor area has been dredged on either side of Anegado Channel to a depth of 30 feet. This area, which covers about 329 acres, serves as anchorage area on the western side of Anegado Channel and extends about 400 feet into San Antonio Channel which serves the waterfront area on the south shore of San Juan Island.

An approach channel 35 feet deep and 600 feet wide connects Anegado Channel with San Antonio Channel and a maneuver area about 35 feet deep, 300 to 1,100 feet wide and 2,800 feet long in San Antonio Channel. San Antonio Channel, which varies from 1,100 feet to 300 feet in width, is dredged to 30 feet to the easterly limit of the project area at the east end of San Juan Island waterfront, a distance of about 3,400 feet from Anegado Channel. Anegado Channel continues southeasterly to the junction of Army Terminal and Graving Dock Channels about two miles from the entrance channel bend.

Adjoining the junction of the two channels on the northeast and extending to just off the southwestern shore of Isla Grande is an anchorage area 36 feet deep, 1,550 feet wide, and 3,200 feet long. Army Terminal Channel extends south approximately one mile to the Army Terminal which is the southern limit of the project. The channel is 36 feet deep and 300 feet wide. A turning basin 36 feet deep, 2,000 feet wide, and 2,100 feet long is in front of the terminal.

From the Army Terminal basin, Puerto Nuevo Channel, which is 32 feet deep and 300 feet wide, runs northeast off the Puerto Nuevo waterfront and central market area of San Juan about 1-1/2 miles to Graving Dock Turning Basin which is 30 feet deep, 1,000 feet wide and 2,200 feet long in front of the dock. Graving Dock Channel which is 30 feet deep and 400 feet wide runs northwest about 1-1/2 miles to the junction with Army Terminal Channel.

Physical Characteristics of Dredged Material

Core borings showed a series of clay beds, each with distinct coloration. The uppermost layer is black, very slimy, with a high water content. In places, it appears to have an oil and grease residue intermixed. The layer varies in thickness from several inches to about four feet (CE, 1975a).

Chemical Characteristics of Dredged Material

Bioassay evaluation of sediments from San Juan Harbor were performed by Jones Edmunds and Associates in 1979. Procedures and detailed results are given in Appendix C. Sediments from five locations (Figure 3-7) were subjected to bioassay and bioaccumulation tests and to liquid phase chemical analyses.

No limiting permissible concentration (LPC)* based on suspended particulate phase (SPP) or liquid phase (LP) bioassays would be approached during ocean disposal of any of the five sediments analyzed in this evaluation.

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*The term "limiting permissible concentration (LPC)" is defined in Section 227.27 of EPA's "Ocean Dumping - Final Revisions of Regulations and Criteria"; see Appendix C.

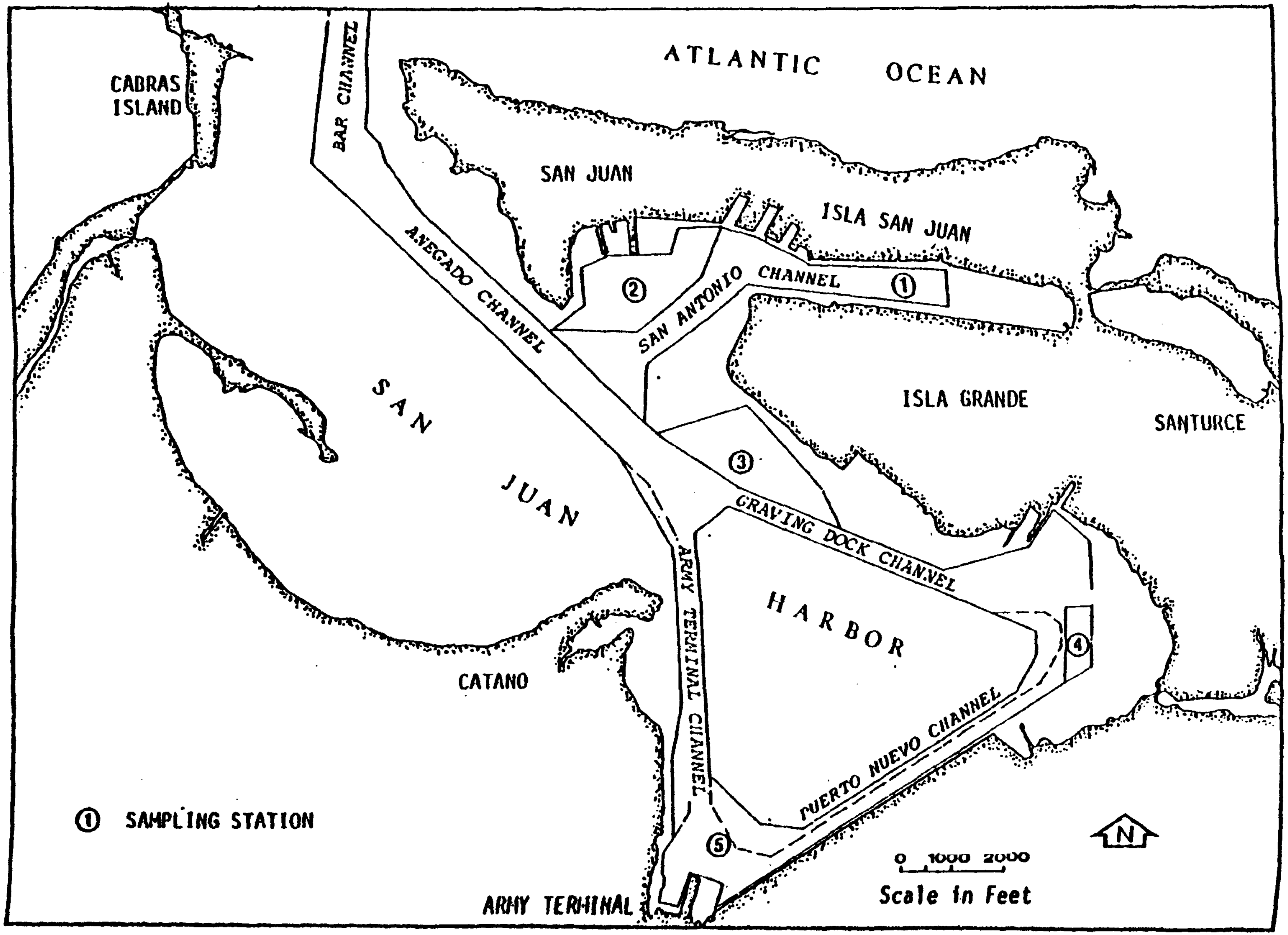

Figure 3-7
Sampling Locations of Sediments Used in Bioassy Tests

None of the five solid phase samples was toxic to clams, grass shrimp or polychaetes. There were no significant differences in survival between the controls (clean sand) and the test sediments for any of the test species, and the LPC would not be approached during ocean disposal of any of the five solid phases.

Generally, the liquid phase chemical analyses revealed few significant differences from the control seawater. The control seawater had a cadmium (Cd) content 13.2 times the LPC (5 ppb); but the liquid phase Cd concentrations were not significantly different from this. Seawater from the east coast of Florida rountinely has a cadmium content higher than the LPC. The mercury content of the control seawater was below the LPC (0.1 ppb) and the limits of detection for the analysis (0.1 ppb). Only two of the five sediment elutriates (SJ1 and SJ2) has concentrations of mercury exceeding the LPC. Assuming that the concentration of mercury in the seawater at the disposal site is less than 99% of the LPC (0.1 ppb), the liquid phase of SJI and SJ2 will not exceed the LPC.

None of the clam tissues analyzed for bioaccumulation showed any significant accumulation of either cadmium or mercury. PCB's and petroleum hydrocarbons were below detection in all of the tissue samples analyzed.

SOCIOECONOMIC CONSIDERATIONS

Puerto Rico is in the midst of an economic turnabout that began in the 1940's with the decision to shift the island's economy from one based largely on agriculture to one based largely on industry (CE, 1975a). A series of government planning and development agencies was created and long-range goals set. The success of the program has been marked to date. Puerto Rico's annual economic growth rate is put at 10 percent, one of the world's higest. Today manufacturing contributes about 44 percent of the islands net income. Once dominant, agriculture now provides only 4.5 percent of island income. Trade and commerce provide about 27 percent (U.S. Department of Commerce, 1979).

COMMERCIAL FISHING

Due to the deep waters which surround the island, large commercially exploitable schools of fish are not attracted to the area. As a result, most commercial fishing is restricted to small boats in the coastal waters. Statistics compiled by the Puerto Rico Department of Agriculture show that landings for the San Juan area (San Juan and Catano) for the period July 1968 - June 1969 amounted to 76,200 pounds valued at $25,500. Most commercial fishing is done at the mouths of rivers and along beaches.

San Juan is part of the north coast (Puerto Rico) statistical district established by the Puerto Rico Department of Agriculture for commercial fisheries statistics. In 1974, the last year records were taken, the north coast ranked fourth out of four statistical districts in total landings in Puerto Rico. In 1974, 214,000 pounds of fish and shellfish were taken on the north coast. Fish commonly caught include mackerel, snappper (land; yellowtail, silk, and mutton), sardine, and snook (Rolon, 1975).

Numerous private and three charter fishing operations centered at San Juan are available for deepsea fishing off the north coast. Billfish and other species caught include blue and white marlin, sailfish, wahoo. Allison tuna, dolphin, mackerel, tarpan, and snook.

COMMERCIAL SHIPPING*

The immense importance of the port facilities at San Juan to the island's economy is pointed up by the fact that about 80 percent of all cargo entering or leaving Puerto Rico is handled by the port. It is estimated that 43 of Puerto Rico's 76 municipios are in the ports tributary area for general cargo. Growth of the port has been remarkable. In 1940, the port handled a little less than 1.3 million tons of cargo; in 1950, the figure was 2.4 million tons; and in 1960, 4.7 million tons. By 1970, the port was handling about 9 million tons annually. The Puerto Rico Ports Authority reported that, in 1972, the port's cargo tonnage was 9,578,000 short tons, a 900 percent increase in the 30-year period from 1940. The Ports Authority figures for gross vessel tonnage also reflect this rapid growth. In 1966, gross tonnage of vessels entering San Juan was 17.3 millon tons. By 1972, the port's gross vessel tonnage was 26.1 million. Although the Commonwealth government has embarked on plans to decentralize industry and commerce, all indications point to continued growth of the San Juan facilities. In 1973, the volume trade was 10.7 million gross tons of cargo.

In addition, cruise-ship traffic places a sizable demand on the port. In 1972, a total of 443 cruise ships and 219,000 cruise passengers visited the port. The total number of vessels using the Port of San Juan in 1973 was 5337.

RECREATION

Marine recreation on the north coast near San Juan consists mainly of swimming and bathing at nearby beaches. Palo Seco and Punta Salinas, two beaches nearest the Interim Site, are 2.5 nmi removed from dumping activities.

Snorkeling, diving and sailing activities are generally curtailed throughout much of the year due to the exposed topography and sea conditions off the north coast.

* Source: Corps of Engineers, 1975a

Oil and Gas Exploration and Development

The occurrence of natural petroleum in economically attractive quantities has not been demonstrated in Puerto Rico. Exploratory drilling on the northcentral coast has failed to discover hydrocarbons. Consequently, Puerto Rico Outer Continental Shelf (OCS) lands have produced little interest by industry and Puerto Rico OCS lands are not included in the present offshore leasing schedule or on the proposed leasing schedule (Federal Register, April 17, 1981).

MARINE DISPOSAL ACTIVITIES IN THE AREA

Only dredged material will be disposed of at the site. All dredged materials must meet EPA criteria (40 CFR 227), before permit for ocean disposal is granted. None of the material will be packaged in any way.

All dredged materials previously dumped at the interim site originated from San Juan Harbor. The toal amount of dredged material dumped at the site since 1974 is 4.3 million yd^3. Maintenance dredging of 173,000 and 1.3 million yd^3 has been conducted in 1974 and 1980, respectively. From 1974-76, 2.8 million yd^3 of dredged material from harbor improvements were dumped at the site.

The nearest active ODMDS in the ocean is the Arecibo interim site 33 nmi to the west. The site has an interim designation for the disposal of dredged material only.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Implementation of the proposed action will not significantly degrade or endanger the marine environment or public health. Both the water depth and the low biological productivity of the site preclude many effects that would be expected at a shallower site. Potential adverse effects at the site are mitigated by the rapid dilution and dispersion of the dredged material. In all, the potential environmental consequences of continuing to use the Puerto Rico ODMDS for disposal purposes are judged to be of minimal environmental consequence.

This chapter examines available scientific and analytical data to determine the environmental consequences of dredged material disposal at the interim site described in Chapter 3. The environmental effects include:

- o Effects of the environmental changes directly affecting public health, safety, aesthetic values, and socioeconomics;
- o Environmental consequences of dredged-material disposal at the interim site including the assessment of the effects on water quality, biota, and sediments of the site;
- o A description of unavoidable adverse effects and mitigating measures;
- o Relationships between short-term uses of the environment and the maintenance and enhancement of long-term productivity;
- o Irreversible or irretrievable commitments of resources which would occur if the proposed action is implemented.

EFFECTS ON PUBLIC HEALTH AND SAFETY, AESTHETIC VALUES, AND SOCIOECONOMICS

Possible adverse effects on man are of primary concern in the ocean disposal of dredged material. Disposal activities may directly affect health, economics, safety, and aesthetics. Indirectly, the human environment could be affected by significant adverse effects on the ocean ecosystem.

COMMERCIAL AND RECREATIONAL FISH AND SHELLFISH

The most direct link to man of contaminants released into the marine environment is via consumption of contaminated seafood. Harmful effects - caused by eating fish or shellfish containing high levels of mercury, lead, or persistent organohalogen pesticides - have been documented (Phillips and Russo, 1978). Dredged materials dumped in the ocean must be carefully evaluated with respect to possible contamination of commercially or recreationally exploitable marine animals.

There are no active commercial fisheries at the site. All fisheries are near shore and their contamination from disposal activities is highly unlikely. Sport fisheries exist in the broad region of the site. However, pelagic fish commonly caught are all wide-ranging and possible impacts are minimal. Disposal of dredged material does not directly affect fishes which are mobile and can swim away from temporarily unfavorable conditions, such as during disposal operations. Turbidity plumes resulting from disposal are short-lived and can be avoided by fish (Sterne and Stickle, 1978).

The interim site does not encompass any known unique breeding, spawning, nursery, or passage areas of marine mammals or birds.

CONTAMINANTS

Many marine organisms, especially shellfish, are capable of concentrating contaminants such as heavy metals, chlorinated hydrocarbons, petroleum hydrocarbons, and coliform bacteria. Uptake of contaminants may be from the water, diet, or sediments. The contaminants may be derived from a variety of sources including dredged material.

The ability of different species to take up contaminants from sediments (or from dredged material) varies between species and with the chemical form of the contaminant. Uptake is usually lower from sediments because the contaminant is tightly bound.

Although no bioaccumulation tests were performed on organisms found at the ODMDS, a solid-phase bioassay test for bioaccumulation of metals and organic residues was performed on tissues of clams exposed to the sediments from San Juan Harbor. (See Appendix C). The concentrations of cadmium in the tissue of clams exposed to the five test sediments were less than the Cd concentration of the control (clean sand) clam tissue. The concentrations of Hg in the same tissue samples showed no significant differences from the control concentration. PCB and petroleum hydrocarbons were below detection for all clams from all treatments. Dumping and subsequent dispersion/dilution of the dredged material at the ODMDS would tend to mitigate the effects of contaminants on those organisms most likely to be affected the benthic organisms. In addition, the dispersed distribution and wide-ranging horizontal migrations of the epipelagic nekton tend to retard the accumulation of contaminants in the nektonic population. Thus, no adverse effects on public health would be expected to be caused by contaminants present in the dredged material.

NAVIGATIONAL HAZARDS

Infrequent dredging and the short periods when dredge vessels operate at a disposal site ensure that disposal activities will not affect commercial or recreational navigation at the proposed site. Past disposal activities have not interfered with ship traffic.

COMMERCIAL SHIPPING

Heavy shipping and cruise ship traffic passes through or in the vicinity of the Interim Site. However, infrequent disposal activities have not interfered with shipping traffic in the past, and future problems are not expected.

ENERGY RESOURCES

The occurrence of natural petroleum in economically attractive quantities has not been demonstrated in Puerto Rico. Exploratory drilling on the northcentral coast has failed to encounter hydrocarbons. Consequently, Puerto Rico Outer Continental Shelf (OCS) lands have produced little interest by industry and Puerto Rico OCS lands are not included in the present offshore leasing schedule or on the proposed leasing schedule (Fed. Reg., April 17, 1981).

GENERAL MARINE RECREATION

Rough seas and strong winds, which occur throughout most of the year, hamper both recreational fishing and sport diving off the north coast of Puerto Rico. These activities do take place in the shallower waters over the insular shelf, and no interference is anticipated from disposal activities at the interim site.

TOURISM/AESTHETIC VALUES

The use of the proposed site for ocean dredged material disposal will not jeopardize coastal water attractiveness to tourists for several reasons. The site is far from tourist recreational areas. Dredging and disposal are infrequent, and past volumes of dredged material for disposal have been minor inputs to the water. Ocean currents prevent the material from washing towards the beaches of Puerto Rico. In addition, hopper-dredge operations are unobtrusive to ship traffic and not likely to attract the attention of tourists.

EFFECTS ON THE ECOSYSTEM

This section discusses possible effects of the dredged material on water quality and on the biota of the water and sediments. Certain factors may reduce adverse effects associated with dredged-material disposal, such as benthic fauna which can withstand burial, and species which are able to recolonize the site.

Adverse effects on the ecosystem, resulting from ocean disposal of dredged material can be subtle and may not exhibit obvious direct effects on the quality of the human environment. Sublethal and chronic effects can combine to cause long-term consequences which are as serious as any readily observed direct impacts. For example, an organism may accumulate in its tissues contaminants from various sources (including dredged material) at concentrations which do not cause its immediate death, but could reduce reproduction, reduce health of eggs and larvae, or adversely affect other facets of the life cycles of individual organisms.

EFFECTS ON WATER QUALITY

Turbidity

The duration of the tubid plume resulting from sediment disposal depends on particle size, currents, and turbulent mixing (Wright, 1978). A turbid plume composed of fine particles will persist longer than one made up of coarser particles. Water density is also a factor. A plume which has disappeared from the surface may persist near a pycnocline at intermediate depths or near the bottom because of sediment resuspension. As the turbid plume moves, planktonic organisms may be carried with it and may be exposed longer than mobile animals which temporarily avoid the area.

Material obtained from the maintenance dredging of San Juan Harbor is mainly silty clay which could cause turbidity during all phases of disposal. According to tank tests and field operations (JBF Scientific Corp., 1975), the following behavior for silts and clays with up to 100% moisture content would exhibit the following predicted behavior (Figure 4-1):

- Most material will fall as solid blocks and entrain little water.

- The descent will be rapid, with no deceleration before impact on the bottom.

- A small density current of lighter particulate material will lag behind the heavier blocks. The current will be affected by passage through the thermocline region, and a significant portion of lighter unconsolidated materials may be lost in the region because of horizontal diffusion.

- There will be little horizontal spreading of material on the bottom after impact. The actual amount of spreading will vary in proportion with the cohesiveness of the material.

- There generally will be some mounding on the bottom, even in deep water.

Mounding should not be an environmentally significant issue due to great depths encountered at the disposal site and the general absence of navigable useage within the area.

The predicted behavior would permit most of the silt and clay (in the form of cohesive clods) to reach the bottom almost directly below the dump point. The clods would fall at varying rates depending upon size and would form the leading edge of a downward-flowing jet which contains the loose silt and clay. The jet would entrain considerable amounts of ambient water and

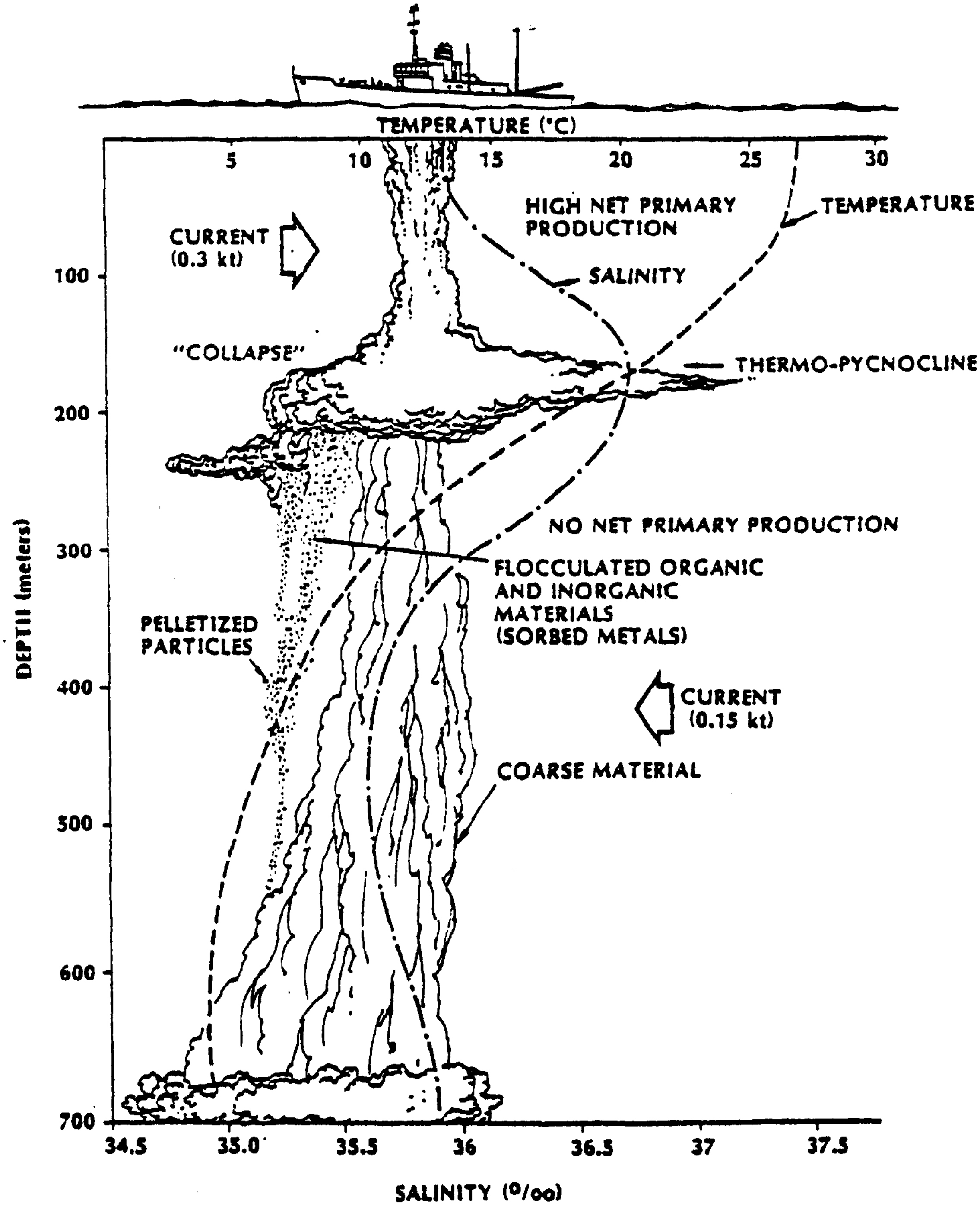

Figure 4-1. Schematic Representation of the Disposal of Harbor-Dredged Material into a Two-Layered Deepwater System with Strong Thermo-Pycnocline
Source: Adapted from Pequegnat et al., 1978

become less dense; at the pycnocline it may become neutrally buoyant and unstable and suffer dynamic and physical collapse (Figure 4-1).

Silt and clay lost from rapidly falling clods and the trawling density currents are affected by two processes. First, the material begins to settle as individual particles. Sizes present in harbor-dredged silts and clays (90%) would have settling velocities slower than 0.07 cm/s, whereas 50% will settle slower than 0.005 cm/s (Table 4-1). At the given rates, even slow ocean currents could carry sediment long distances before settling on the bottom. However, physiochemical and biological flocculation takes place, substantially increasing grain size (Krone, 1962; Mannheim et al., 1970; Pequegnat et al., 1978). Flocculation increases the settling velocities, but it is neither possible to predict accurately how much will take place nor precisely by how much the settling velocities will be increased. Generally, any silts and clays lost from the rapidly settling phase would remain in the water column for a number of days or longer, depending upon flocculation rates. During such times materials would be carried considerable distances and will spread out thinly over the surrounding sea floor. Along-shore currents will tend to disperse this material in an east-west direction.

TABLE 4-1

SETTLING VELOCITIES OF QUARTZ SPHERES IN DISTILLED WATER (20°C)

Diameter (U)		Settling Velocity (m/day)*
62.5		301.0
31.2		75.2
15.6	silt	18.8
7.8		4.7
3.9		1.2
1.95		0.3
0.98		0.074
0.49	clay	0.018
0.25		0.004
0.12		0.001

*Based on Stoke's Law
Source: Sverdrup et al., 1942

High suspended sediment concentrations associated with dredged-material disposal are unavoidable but short-term. Most organisms are not seriously affected by the suspended sediments in the water (Hirsch et al., 1978). Generally, only concentrations of suspended sediments well above those created during most disposal operations cause mortality. Organims normally associated with mud environments are highly tolerant of suspended sediments; organisms not closely associated with muddy habitats are more sensitive. Turbidity created by disposal is probably not of major environmental concern. It will have limited, short-term adverse environmental effects on both planktonic and nektonic communities. Most fish and other free-swimming organisms can escape from falling material and high turbidity areas and return when turbidity levels return to ambient conditions.

Nutrient Releases

Nutrient levels of tropical seawater are generally lower than found in most oceanic waters (Sverdrup et al., 1942). Phytoplankton require nitrogen and phosphorous to photosynthesize and grow. Nutrient releases from dredged material disposal can stimulate biological activity and, under certain conditions, lead to rapid growth of undesirable organisms or toxic concentrations (Pequegnat et al., 1978b). Ocean disposal of dredged materials will release nutrients and temporarily elevate nutrient levels and stimulate planktonic growth. However, such growth will be quickly curtailed as the nutrient levels are reduced to background levels by dilution with ocean water. Nutrients which do escape from the sediments after disposal and enter the water column would be diluted below toxic levels within 10m of the disposal point (Conner et al., 1979).

Oxygen Demand

Great volumes of particulate matter with potentially high oxygen demands may be present in dredged material and are released into the water upon disposal. Reduced inorganic matter includes sulfur compounds, reduced iron, and reduced manganese which are readily oxidized by free oxygen in the water and impose chemical oxygen demand (COD) on the system. Organic substances, which are rapidly oxidized by bacteria in the presence of oxygen, impose biochemical oxygen demand (BOD) on the water column.

Effects of adding oxygen-demanding material to the water column are functions of the length of time the material resides in the water and of the amount of water avialable for dilution. Studies show that only a small fraction of oxidizable components of dredged material is reactive on the timescale relative to its residence time (Schubel et al., 1978). Reduced dissolved species in interstitial water appear to be the most reactive and are the only components which place an immediate oxygen demand on the water column after disposal. The oxidizable particulates simply settle on the ocean floor before imposing demands on oxygen (Schubel et. al., 1978). The study shows that the oxygen-demand of fine-grained estuarine sediments with water contents of 80% (e.g., the proposed harbor-dredged material) is approximately 0.4 mg O_2/g of drv sediment--which means that the dissolved oxygen demand of 1.0 m^3 of dredged material designated for ocean disposal would require 31 m^3 of water, and an oxygen concentration of 6 mg/liter to satisfy the demand.

The disposal of harbor-dredged material at the Interim Site would cause temporary decreases in dissolved oxygen levels near the affected area. Considering the calculated volume of initial mixing for a deepwater site off the east coast of Puerto Rico of 1.5×10^6 M^3 (EPA, 1981), reduction of background dissolved oxygen would be reduced minimally (0.4 to 0.8 mg/l at the east coast deepwater site). The expected reduction of dissolved oxygen in the descent jet and bottom surge would be higher, but both are short-lived phenomena, and further dilution in all cases will act to reduce adverse impacts.

The long-term impacts on dissolved oxygen levels of materials remaining at the pycnocline at the site would be negligible due to further dilution of materials after initial mixing. Levels of suspended sediments attributable to dredged material will be rapidly reduced to background concentrations. The COD and BOD of the material should be similar to existing suspended sediments. Thus, the oxygen demand in deep waters should not exceed already-existing levels.

Trace Metal and Organohalogen Accumulation

Toxic levels of trace metals for most marine organisms have not been established, partially due to extreme variabilities in the sensitivities exhibited by organisms during their different life stages. The form of chemical contaminants is difficult to determine in the natural environment, but is important in determining toxicity. Trace metals present in dredged material may follow many pathways when introduced to the site environment. For instance, the trace metals can: (1) be released into the water while the dredged material is settling or after deposition on the sea floor; (2) remain adsorbed to site sediments; and/or (3) be ingested, primarily by benthic organisms.

Laboratory and field tests on dredged material indicate that, under certain conditions (e.g., oxidizing or reducing environments), some trace metals are released from dredged material into seawater in concentrations well above background levels (Lee et al., 1975). Manganese was released in the greatest quantities under both oxidizing and reducing conditions. Under reducing conditions, such substantial amounts of iron and lead were released. Zinc was taken up from water under both oxidizing and reducing conditions, while copper, and lead, and cadmium were neither releaed nor taken up under oxidizing conditions. Actual increases over background values which did occur were insignificant (parts per billion or less) so that considerable analytical difficulties are encountered in even detecting the contaminants. Furthermore, there is little evidence to indicate that such low levels would cause adverse effects on marine organisms during the extremely short time before the concentrations were diluted to the original background levels (Pequegnat et al., 1978b).

EFFECTS ON BIOTA

Plankton

As mentioned previously increased nutrient levels expected immediately following disposal will only temporarily stimulate planktonic growth due to the rapid reduction of elevated concentrations by dilution with ocean water.

Microscopic marine life such as phyto- and zooplankton in the path of denser dredged material may be trapped, carried to the bottom, and smothered. Available studies on biota trapping are minimal, but it can be expected that the ability of an organism to withstand being carried to the bottom is directly related to its ability to swim and the size of each plankton. Most of the organisms move with the currents, and the water will be replenished between each dump. Thus there will be no significant adverse impact on the local planktonic community due to trapping of organisms by the descending dredged materials.

Nekton

The transient turbidity plume associated with the disposal of dredged material poses no significant threat to fishes. Suspended particles can cause gill damage, reducing fish respiratory surface area (Ritchie, 1970), but this type of gill damage has not been positively identified as harmful to fish in terms of overall survival. The functional decrease in gill surface area may be offset by using reserve surface area (not all of the gill surface is used for respiration) or a compensatory increase in the gas-exchange capacity of the blood (O'Connor et al., 1977). Turbidity plumes associated with dredged material disposal are so brief that there is no significant threat to fish.

During periods of high turbidity, pelagic fish probably swim to favorable areas. Sedentary fish (e.g., toadfish) usually have a higher tolerance of suspended particles, thereby minimizing the effects of suspended solids on their respiration (O'Connor et al., 1977).

After dumping, fish are often attracted to disposal sites by the exposure of food items in the dredged material and by the mound formed by dumping (Oliver et al., 1977). Adverse effects are not expected because (1) disposal has only short-term, transient effects on water-column parameters, (2) foraging activity by the fish is not restricted to the disposal site, and (3) fish have not been shown to accumulate contaminants associated with dredged material.

Benthos

Benthic animals live on (epifauna) and in (infauna) the sediments. Epifauna are usually dominated by echinoderms and crustacea, whereas the infauna primarily consist of small, segmented worms (polychaetes) and mollusks. Sedentary benthic organisms are important indicators of disposal-related effects because they are directly exposed to a stressed environment. They are also important because many are commercially valuable (e.g., shellfish) or are food sources (e.g., polychaetes or amphipods) for demersal finfish.

Wright (1978) concluded that dredged material may physically bury sessile and possibly some mobile organisms. Some organisms survive by borrowing through the overburden material, but others cannot and die as a result. The intensity of this effect varies with type of dredged material, thickness of the overburden, frequency of dumping, and species of benthic organisms involved. The factors discussed below are the bases for comparing the effects of disposal on the benthos at the site.

The small volumes of dredged material and the similarity of this material and the bottom sediments at the disposal site (silty clay) should cause minimal harmful effects on the benthic biota. Benthic infaunal communities at the Interim Site show low abundance and diversity which is expected at this depth and distance from shore (IEC, 1980). Pequegnat et al., (1978) reported that, on a worldwide basis, the average deep-ocean biomass is about 0.01% of life on the continental shelf.

Since 1974, 4.3 million yd^3 of dredged material has been dumped at the site. When comparing benthic biota data from stations within the site boundaries (1-5) with those outside the site (6-10), differences expected from natural variations in the abundance of these organisms was observed (the exception occurring in February when significantly greater numbers of Golfingia sp.A were found within the ODMDS site). Such data shows that while some benthic organisms likely succumb to burial by smothering, the area is not affected irreparably and organisms are able to recolonize the sediment at the disposal site.

Contaminant uptake is of considerable importance in the benthic community because the organisms are exposed to potentially toxic substances. Many benthic organisms are deposit feeders. Seventy-two percent of the macroinfauna found at the site were deposit feeders. While sediments are passing through their digestive tracts, changes in pH, digestive enzymes and other factors may increase the mobility of some substances (especially metals) and cause them to be absorbed into the tissues or excreted in a form available to other organisms (EPA, 1976).

Concentrations of heavy metals were not significantly different between the sediments of the disposal site and the adjacent areas and are generally comparable to trace metal concentrations in clay and silt from other sites in Puerto Rico (PRASA, 1975) and the Gulf of Mexico (CE, 1975a; Wheeler et al., 1980). Benthic organisms should not be affected by these low concentration of contaminants.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

Few unavoidable adverse environmental effects will be created by the disposal of dredged material in the ocean at the existing site. The only potentially unavoidable adverse effects which may occur at the site under consideration are:

- o Generation of turbidity in site waters which will temporarily lower water quality;
- o Possible avoidance of the site by fish during or immediately following disposal operations;
- o Smothering of some of the less mobile benthic organisms by burial under dredged material; and
- o Alteration of the sediment composition which will affect species composition of the benthos at the sites. (The proposed harbor-dredged material is similar to sediments existing at the Interim Site and effects on the species composition should be minimal.)

The expected adverse effects on water quality as a result of the dredged material disposal operation will be short-lived, and mostly an aesthetic problem rather than an environmental one. The residual turbidity at the site will be rapidly diluted and will be of little consequence to the general water quality or biology of the surrounding area. Adverse effects on the benthic community will be confined to the selected site which is 1815 m x 1815 m (5955 ft x 5955 ft). The area represents a minor portion of ocean bottom available in the region, and the perturbation of the total benthic community will be insignificant.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Several resources will be irrevesibly or irretrievably committed by the use of the site:

- Loss of energy in the form of fuel required to transport hopper dredges and/or barges to and from site;
- Loss of economic resources due to costs associated with disposal in the ocean;
- Loss of some benthic organisms at the site which are buried by dredged material during disposal operations.

RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

Disposal operations will not interfere with the long-term use of any resources at the Interim Site. The site is an oceanic area of limited productivity, and important species of finfish and shellfish are not affected. The site constitutes only a small portion of the much larger areas of the Insular Slope used by wide-ranging species, and actual disposal operations will be limited. The principal adverse effect on the biota is the temporary reduction in the abundances of benthic animals after disposal.

CHAPTER 5

COORDINATION
PREPARERS OF THE DRAFT EIS

This Final EIS was prepared by the Environmental Protection Agency's Ocean Dumping EIS Task Force.

The principle author of the Final EIS is Michael S. Moyer. Reviews were provided by the members of the Task Force:

William C. Shilling, Project Officer
Frank G. Csulak
Edith R. Young
Christopher S. Zarba

During the preparation of the Final EIS, reviews were provided by:

Department of the Army
Waterways Experiment Station
Corps of Engineers
P.O. Box 631
Vicksburg, Mississippi 39180

Marine and Wetlands Protection Branch
U.S. Environmental Protection Agency
Region II
26 Federal Plaza
New York, New York 10278

The marine environment in the area of the San Juan ODMDS was studied during sruveys conducted in February and June, 1980, by Interstate Electronics Corporation (IEC) under contract to EPA (Contract Number 68-01-4610). The "Survey Methods, Results, and Interpretations" were provided by IEC (Appendix A).

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.
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.

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.

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.
COMPENSATION DEPTH	The depth at which photosynthetic oxygen production equals oxygen consumed by plant respiration; the lower part of the photic zone.
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.
COST/BENEFIT RATIO	A comparison of the price, disadvantages and liabilities of any project versus profit and advantages.
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 (1 g 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 concept 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.

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).

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.
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 (mlt); the average height of all low tides measured over an 18.6-year period at a specific site.

MLW — Mean Low Water (mlw); 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.
OXYGEN MINIMUM LAYER	A subsurface layer in the water column in which the concentration of dissolved oxygen is lower than in the layers above or below.
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 which 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).
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.
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.
TKN	Total Kjeldahl Nitrogen; the sum of organic nitrogen (in the trinegative state) and ammonia nitrogen analytically determined by the Kjeldahl digestion procedure. This procedure is particularly applicable to sediment and sludge samples.
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.
ZOOPLANKTON	Weakly swimming animals whose distribution in the ocean is ultimately determined by current movements.

ABBREVIATIONS

C	Centigrade
CE	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
yd^3	cubic yard(s)
DA	District Administrator (CE)
DMRP	Dredged Material Research Program
DMDS	Dredged Material Disposal Site
DOC	U.S. Department of Commerce
DOI	U.S. Department of the Interior
EHA	Espey, Huston and Associates, Inc.
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
g	gram(s)
IMCO	Inter-Governmental Maritime Consultative Organization
km	kilometer(s)
kn	knot(s)
m	meter(s)
mg	milligram(s)
mlt	mean low tide
mlw	mean low water
mm	millimeter(s)
MPRSA	Marine Protection, Research, and Sanctuaries Act
N	north
NEPA	National Environmental Policy Act
nmi	nautical mile(s)
NMFS	National Marine Fisheries Service
NOO	Naval Oceanographic Office
PL	Public Law
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand = $^{o}/oo$
RA	Regional Administrator (EPA)

TDWR	Texas Department of Water Resources
TOC	total organic carbon
W	west
yr	year(s)

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Appendix A

SURVEY METHODS, RESULTS, AND INTERPRETATION

1. INTRODUCTION

The marine environment in the area of the San Juan Harbor Ocean Dredged Material Disposal Site (SJH-ODMDS) was studied during surveys conducted in February and June, 1980, by Interstate Electronics Corporation (IEC) under contract to the EPA (Contract Number (68-01-4610). The purpose of the surveys was to provide baseline biological, chemical, geological, and physical data to characterize the environment of the disposal sites, and to evaluate the effects of dredged-material disposal on the marine environment. Methods of data collection, survey results, and interpretations of the survey data are presented in the following sections.

2. METHODS

Surveys were conducted using the Ocean Survey Vessel (OSV) ANTELOPE. Radar range and bearing positioning were used for navigation.

Ten stations were located in the study area; five were within the ODMDS, and five were used as controls (Figure A-1). Stations were oriented with the long axis in an upcurrent-downcurrent direction. The parameters measured, coordinates, and water depths for all stations are presented in Table A-1

Microbiological analyses of sediments and tissues, and physical oceanographic measurements were performed aboard the ANTELOPE; 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.

2.1 WATER COLUMN MEASUREMENTS

Shipboard Procedures: Conductivity and temperature profiles were measured with Plessey CTD, and data were stored on 9-trace computer disks. A rosette sampler equipped with 30-liter Go-Flo bottles was used to collect surface and near-bottom samples for suspended solids, dissolved oxygen, and salinity and temperature CTD calibration samples; mid-depth samples were collected for analysis of dissolved and particulate trace metals and chlorinated hydrocarbons. 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 using the modified Winkler technique (Strickland and Parsons, 1972); and pH with a Beckman pH meter. Water samples for total suspended solids and trace metal (particulate and dissolved) analyses were transferred from Go-Flo bottles to 2-liter pressure filtration bottles, followed by filtration 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 as Amberlite XAD resin column for extraction of chlorinated (CHC's) hydrocarbons (Osterroht, 1977). Both the filters and resin column were processed in a positive pressure clean hood and frozen until extraction and analysis.

Laboratory Methods: Total suspended solids were determined gravimetrically on an electrobalance, according to the procedure of Meade et al. (1975). Particulate trace metal samples collected on Nucleopore filters were leached with 1N Ultrex nitric acid and filtered. Samples were analyzed for Cd and Pb by graphite furnace atomic absorption spectrophotometry (AAS). Particulate Hg samples were analyzed with cold-vapor AAS (EPA, 1979).

Analysis of dissolved Hg required an acid-permanganate digestion, reduction with hydroxylamine sulfate, and analysis with cold-vapor AAS following EPA (1979). Dissolved Cd and Pb were extracted using a chelation-solvent extraction method described by Sturgeon et al. (1980), and analyzed by graphite furnace AAS.

Organohalogens were eluted from adsorption column with acetonitrile, extracted three times with hexane, dried, fractionated in florisil columns, and analyzed with an electron capture gas chromatograph according to Osterroht (1977).

2.2 GEOCHEMISTRY AND GRAIN SIZE ANALYSIS

Shipboard Procedures: Sediment samples for geochemical analyses (trace metals, oil and grease, TOC, and CHCs) were collected from the surface

2-cm of two replicate 0.06 m^2 box cores per station. Samples were frozen in precleaned Teflon bottles. An additional 50 g of sediment were removed from each core and frozen for grain size analyses. Five other samples for grain size determinations were taken from biological sediment samples collected as described later.

Laboratory Methods: Trace metals (Cd and Pb) were leached from 5 to 10 g of sediments with 1N nitric acid, and analyzed by graphite furnace AAS. Hg was leached from 5 to 10 g of sediments with aqua regia and $KMnO_4$ at 95°C for 30 minutes. The digest was reduced using hydroxylamine sulfate and stannous sulfate, and analyzed by cold-vapor AAS according to EPA (1979).

CHCs were extracted into a 1:1 acetone-hexane solvent by soxhlet extraction, evaporated, cleaned on a florisil column followed by a silicic acid column fractionation, and quantified using electron capture gas chromatography according to EPA (1974). An additional acid cleanup step was required for analysis of polychlorinated biphenyls (PCB). Petroleum hydrocarbons were extracted from sediments with a methylene dichloride-methanol azeotropic mixture, and analyzed with column and glass capillary gas chromatography as described by Brown et al. (1979).

Oil and grease were extracted from 100 g sediment samples with an acetone-hexane mixture, dried and quantified gravimetrically according to the method of APHA (1975). Total organic carbon in sediments was measured with a Perkin-Elmer Model 240 Elemental Analyzer, using a procedure described by Gibbs (1977).

Sediment grain size was determined by washing sediment samples through 2,000 and 62 u 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 (ϕ) interval sieves, dried, and weighed. The silt-clay fractions were analyzed using the pipette method (Rittenhouse, 1933); a dispersant was used to prevent flocculation.

2.3 BIOLOGICAL MEASUREMENTS

Shipboard Procedures: Five macrofaunal samples were collected at each station with 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. In addition, two trawls, one inside and one outside of the site, were performed using a 7-6 m Otter trawl to collect epifauna from the area, and to examine tissue concentrations of total and fecal coliforms. Epifauna were sorted in stainless steel trays, identified, and counted.

2.4 MICROBIOLOGICAL MEASUREMENTS

Shipboard Procedures: Approximately 30 g of sediments from the (1 cm) of each of the two geochemical box cores were collectd with a sterile spoon, placed into a sterile container, and refrigerated. Ten grams of the pooled sample were analyzed for total and fecal coliforms using a modified Most Probable Number (MPN) method (APHA, 1975); the analysis was completed within 6 hours after collection.

3. RESULTS AND DISCUSSION

3.1 WATER COLUMN PARAMETERS

3.1.1 Hydrography and Related Constituents

Salinity and temperature during the surveys were typical of tropical ocean waters and followed no strong temporal or spatial patterns. The largest changes for these parameters occurred with depth. Surface temperatures ranged between 25 and 26°C in February and were slightly higher in June, ranging from 27 to 29°C (Table A-3). The mean bottom temperatures at the deep stations (1, 6, 8, 9) were 15.7°C in February and 17.7°C in June.

Temperature-depth profiles were not available for either survey, thus the seasonal variation of the thermocline is not known. However, the similarities of surface and bottom (60 m) temperatures at Station 7 indicated that the mixed layer extended to at least 60 m during February.

Salinity ranged from 36 to 37°/oo with a mean for both surveys of 36.55°/oo (Table A-3). These measurements were slightly higher than average values (35.92 to 36.47°/oo) reported for the Atlantic Ocean between 15° and 20°N latitude (Sverdrup et al., 1942).

Values for pH were normal for sea water, and ranged from 8.0 to 8.2 in February and 8.2 to 8.4 in June (Table A-4). pH measurements decreased slightly with depth for both surveys. Dissolved oxygen concentrations also decreased with increasing depth (Table A-3). Surface and bottom dissolved oxygen values ranged from about 7.3 to 5.4 mg/l, similar to dissolved oxygen concentrations in other marine waters along Puerto Rico's north coast (PRASA, 1975).

As expected for these waters, turbidity levels and concentrations of total suspended solids were low (Table A-4). Turbidity ranged from 0.15 to 0.59 NTU, with a mean of 0.30 NTU. Total suspended solids averaged 0.3 mg/l, and ranged from below detectable limits to about 1.8 mg/l.

3.1.2 Trace Metals and Halogenated Hydrocarbons

Values for dissolved and particulate trace metals (Table A-5) were well below EPA water quality criteria for Hg (0.01 ug/l) and (5.0 ug/l) Cd (EPA, 1976). Dissolved lead values varies widely and were relatively high during the February survey. Overall, concentrations ranged from a low of 0.38 mg/l in June to a maximum of 5.53 mg/l in February for Station 6. The maximum value was considerably higher than dissolved lead values reported for seawater near the mouth of the Manati River, about 25 km west of San Juan Harbor (PRASA, 1975). The large range of lead concentrations in the survey area may be a function of runoff from San Juan Harbor combined with local tides and variations in water currents.

Four pesticides or derivatives were detected in the water column during the surveys. Heptachlor, heptachlor epoxide, and op'DD were detected, but concentrations were below EPA water quality criteria (EPA, 1976). Dieldrin concentrations were near or above EPA guidelines (0.003 ug/l) during the June survey. Dieldrin, however, was below detectable levels in the survey site sediments, therefore, it is not likely that the elevated dieldrin levels in the water column originated from dredged material. Runoff from land is the most likely source of this compound. No PCB's were found in measurable concentrations in the water column.

3.2 SEDIMENT CHARACTERISTICS

3.2.1 Physical

Water depths over the survey area varied widely and increased with distance from San Juan Harbor (Table A-6). Nearshore Station 7 was 35 to 60 m deep; depths at the other stations ranged from 200 to 450 m. Sediments in the deeper stations (1-6, 8-10) were predominantly (ca. 90%) silt and clay, whereas sediments at Station 7 were nearly 100% sand and gravel (Tables A-6 and A-7). There were no significant temporal or spatial trends in the distribution of silt and clay over the deeper portion of the survey area.

3.2.2 Chemical

With the exception of Station 7, concentrations of heavy metals in sediments (Tables A-8, A-9) followed no spatial or temporal patterns. Concentrations of metals were not significantly different between the disposal site and the adjacent area, or between surveys. Sediment cadmium concentrations in the study area ranged from 0.01 to 0.26 mg/kg; mercury from 0.01 to 0.28 mg/kg; and lead from below the detection limit to 25.5 mg/kg (Table A-8, A-9). The above values generally are comparable to trace metal concentrations in clay and silt from other sites in Puerto Rico (PRASA, 1975) and the Gulf of Mexico (CE, 1975a; Wheeler, et al., 1980). Station 7 had the lowest concentrations of cadmium and lead, probably because of the low proportions of silt and clay in this area.

At some stations, values of lead from separate casts differed by three to four orders of magnitude. For Stations 5 and 6 in February and Station 1 in June, this variation can be partially accounted for by differences in grain sizes between casts. At other stations there is no apparent reason for these fluctuations in lead concentrations. Sediment concentrations of lead were weakly but significantly correlated with total organic carbon (TOC), oil and grease, and cadmium (Table A-11); however, at most stations where lead concentrations widely varied between casts, these other parameters did not vary in a similar pattern. This suggests that the large differences in lead between casts may be an artifact introduced by sampling or errors in the analysis.

Concentrations of TOC (Tables A-8, A-9) ranged from 2.18 mg/g at Station 7 in May to 20.98 mg/g at Station 2 in February. These values generally are higher than are normally present in pelagic sediments (Horne, 1969), but are normal when compared with other coastal marine sediments (PRASA, 1975; CE, 1975a). Except at Station 7 in May, no seasonal or spatial trends existed in the TOC distribution.

Oil and grease content ranged from 0.38 to 6.08 mg/g in June, and was significantly higher for sediments inside the disposal site than in the surrounding area (Mann-Whitney U-test, $p<0.05$). Values of oil and grease in the original dredged material are not available; however the CE reports that channel sediments in San Juan Harbor are predominantly clay and "appear to have an oil or grease residue intermixed" (CE, 1975b). Consequently, it is likely that the higher oil and grease content in sediments at the disposal site is a function of the disposal of dredged material. There was no significant seasonal variation in oil and grease content with the exception, again, of Station 7.

Station 7 sediments contained high proportions of oil and grease (5.09 mg/g) and TOC (16.6 mg/g) during the June survey (Table A-9). The sea bottom in this area is overlain by coral rubble, gravel, and sand. The high oil and grease and TOC concentrations could indicate disposal of dredged material from the bar channel which is predominantly sand (CE, 1975b). Unfortunately, only one sample from Station 7 was available for laboratory analysis; more data are required to determine whether these high values represent an actual trend or if they are merely artifact.

Levels of organohalogens (CHCs) in the sediments were generally low; values were higher outside the disposal site (Station 6) than inside (Station 1) during the February survey (Table A-9). Organohalogens were only analyzed within the site for the June survey. Concentrations for pesticides and pesticide derivates were all below 5 ug/kg; those for total PCBs (1254 plus 1242) were as high as 55 ug/kg. The 20 to 30-fold increase observed for sediment PCB levels at Station 1 between February and June may suggest that PCB levels changed with time; however, the February and June casts were more than 0.5 nmi apart, and the variability may be spatial rather than temporal. The sediment sampled at this station during June may have been dredged material from San Juan Harbor because it is unlikely that these PCB levels would occur naturally in sediments of this offshore area.

3.3 MACROFAUNA

Forty-five species of macrofauna were common in the area of the existing San Juan ODMDS during the February and June, 1980 surveys (Table A-12). Polychaete worms dominated the fauna, and were best represented by species of Spionidae and Nephtyidae. Sipunculans were numerically abundant due to the occurrence of a single species, Golfingia sp.D. All other groups, such as crustaceans and molluscs, were represented poorly.

Numerical data for the common species in Table A-12 (available upon request) were used to examine the trophic composition of the macrofauna. Species were assigned to the following feeding categories based on Barnes (1968), Bloom et al., (1972), Santos and Simon (1974), Fauchald and Jumars (1979), and Dauer (1980):

- deposit feeders which injest sediment and detritus;
- suspension feeders which filter food particles from the water column;
- omnivores which can feed on a wide range of plant, animal, detrital, or sediment particles, and
- carnivores which feed on living animal tissue.

Mean abundance of common species were summed for each trophic category for each station, and percentages were calculated and are presented in Table A-13.

The majority of species were deposit feeding organisms which are characteristic of muddy habitats (Gray, 1974) found throughout the study area. Abundant deposit feeders included the spinculan, Golfingia sp. D, and polychaetes such as Prionospiolongibranchiata,Spiophanes sp. A, and Cossuradelta.

Nemertean and polychaete carnivores were also common throughout the area; the most numerous representatives were the polychaetes Sigambra tentaculata and species of Aglaophamus. This trophic group was particularly common in June at Station 7 when the syllid polychaete Haplosyllis spongicola became abundant.

Suspension feeders were poorly represented among the common species. The lack of this trophic group probably was due to the high mud content of the substratum. The feeding structures of these organisms can become clogged by silt and clay particles, and burrows or tubes are often difficult to maintain in muddy sediments which are not cohesive (Gray, 1974).

Omnivores were also scarce, and represented by a few polychaete, isopod, and a single molluscan species (Table A-12).

Figure A-2 presents a diagrammatic representation of several of the abundant macrofauna which occurred along an inshore to offshore gradient. Changes in sediment composition and depth are also indicated in this figure. Station 7, the shallowest, had a much greater proportion of sand than did the other stations, and consequently a different assemblage of organisms was found at this site. Stations 3, 1, and 5 shared similar assemblages of macrofauna, but the deepest station (9) was dominated by species of spionid polychaetes.

Six species were selected for further analysis based on their abundance during both surveys. Species included the polychaetes Sigambra tentaculata, Aglaophamus verrili, Prionospio longibranchiata, Spiophanes sp. A, and Cossura delta, and the sipunculan peanut worm Golfingia sp. D. These species are small bodied organisms ($\leq$ 4 cm in length) which represent a variety of trophic levels (Table A-12 and Figure A-2). Numerical data for these species are presented in Tables A-14 and A-15)

Abundance of all six dominant species was significantly different between stations (Table A-16). Although densities of Golfingia sp. A were not different significantly between stations when tested using parametric methods (Table A-16), densities became significantly different when the non-parametric Kruskal-Wallis test (Sokal and Rohlf, 1969) was applied to the data (February survey, $H=23.78$, $p<0.05$; June survey $H=20.40$, $p<0.05$).

These dominant species were most prevalent at the mid-depth stations (Figures A-3 to A-7), except for Spiophanes sp. A which occurred in great abundance at the deepest station (Figure 8).

Differences in the densities of dominant species between the ODMDS and control stations were examined for each survey as follows. Stations along a similar isobath which ran through the ODMDS were separated into two groups; a control group (Stations 10, 8, and 6) and an ODMDS group (Stations 1, 2 and 4). For each dominant species, al density information from the replicates was pooled for each group of stations to form two samples. Differences between these samples were tested using a Mann-Whitney U-test (Sokal and Rohlf, 1969). For all but one case, no difference was found between control and ODMDS stations. The exception occurred in February when significantly greater numbers of Golfingia sp. A were found in the ODMDS. If differences in densities of the other macrofauna species did occur between the ODMDS and control sites, then they probably were masked by the natural variations in the abundance of these organisms.

3.4 EPIFAUNA

Information on the epifauna and demersal fish living in the area of the San Juan ODMDS is very sparse due to problems or trawling at this deep area. During the first survey, the net was lost and no organisms were collected. Trawls were attempted at Station 1 during the second survey, but due to partial fishing by the net, only a few animals were collected. These organisms included two species of sponge, the shrimps *Solenocera* cf. *vioscai* and an unidentified Aristeinae, and a hermit crab, *Pagurus* sp. Because of this limited data, no attempt will be made to discuss the epifaunal community of the area.

3.5 MICROBIOLOGY

All ten stations from the February survey were analyzed for total and fecal coliforms in the sediments; no shellfish were collected. Only tissue samples were scheduled to be analyzed in the June survey; however, none were collected.

Table A-17 lists the sediment coliform counts from the February survey. Total and fecal coliforms were detected at three stations: two stations on the perimeter of the site (Stations 3 and 4) and one control station to the east (Station 6). The data showed no visible pattern or explanation for the presence of the coliforms and could not be related to the other parameters (e.g., trace metal or grain size distribution as discussed in Sections 3.2.1 and 3.2.2., respectively) measured at the site.

4. CONCLUSIONS

Water column and sediment parameters were generally within normal ranges for coastal areas. There were a few indications of contaminant inputs, possibly in runoff, from the island of Puerto Rico. These and dredged material inputs to the survey area were indicated by relatively high levels of pesticides and PCB's in the water column and sediments, increased concentrations of lead in the water column, and higher oil and grease levels in sediments inside the disposal site (relative to background levels). Most physical and chemical parameters were distributed in a patchy manner throughout the area. There were few clear temporal or spatial trends in water column or sediment parameters.

The macrofaunal assemblage was dominated by small-bodied, deposit feeding polychaetes and sipunculans typical of muddy habitats. This assemblage of organisms was present at all stations except the shallowest, Station 7; this shallower site was inhabited by small polychaetes and crustaceans, and a wider range of trophic groups was represented.

Dominant macrofauna were patchily distributed throughout the study area. No differences were detected in the densities of these species between the disposal site and adjacent area.

The total and fecal coliform distribution in the sediments could not be correlated with the other physical and chemical parameters measured at the site. The origin of the coliforms at the site and its vicinity is unknown.

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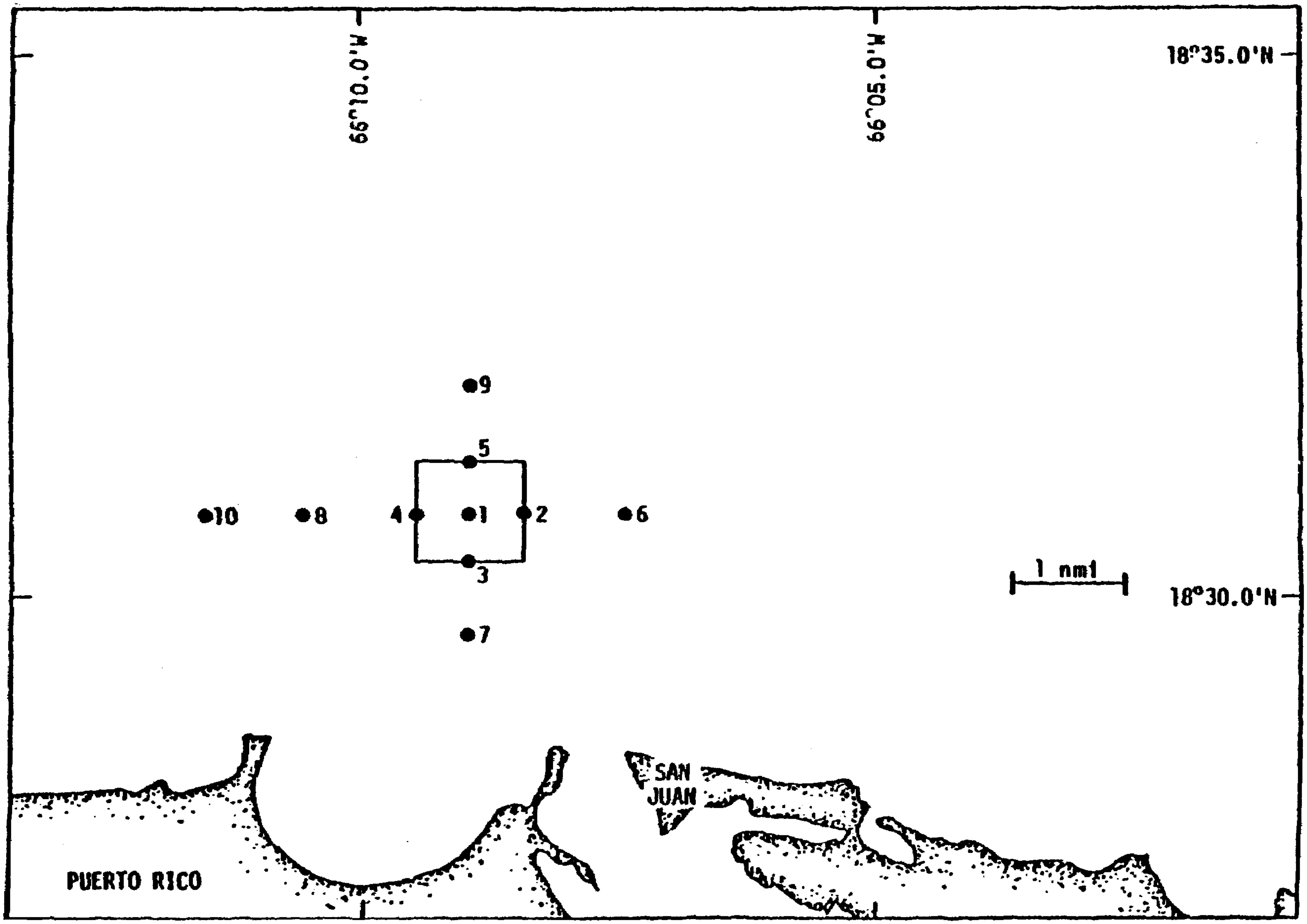


Figure A-1

Station Locations in the Area of the San Juan Harbor DMDS

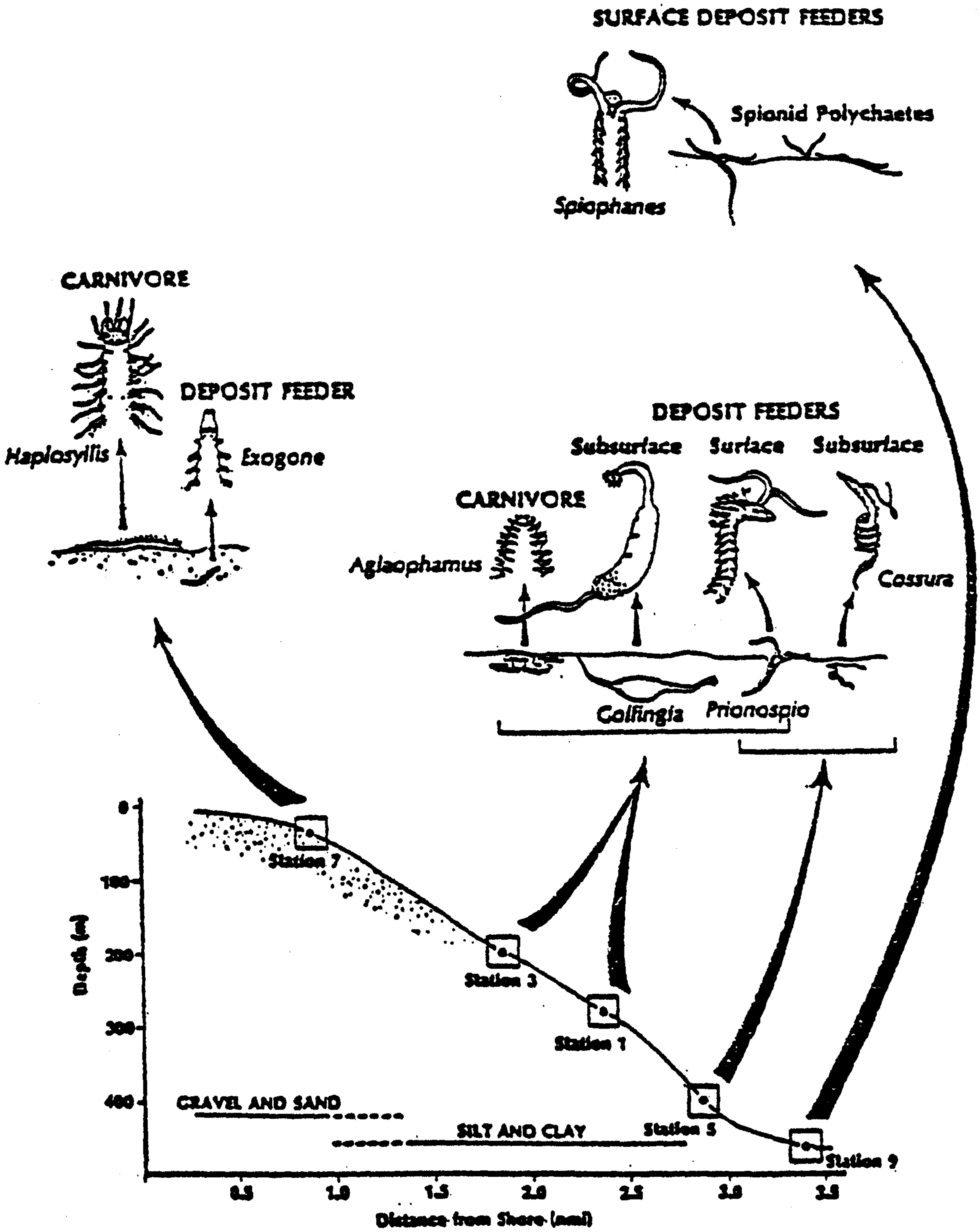
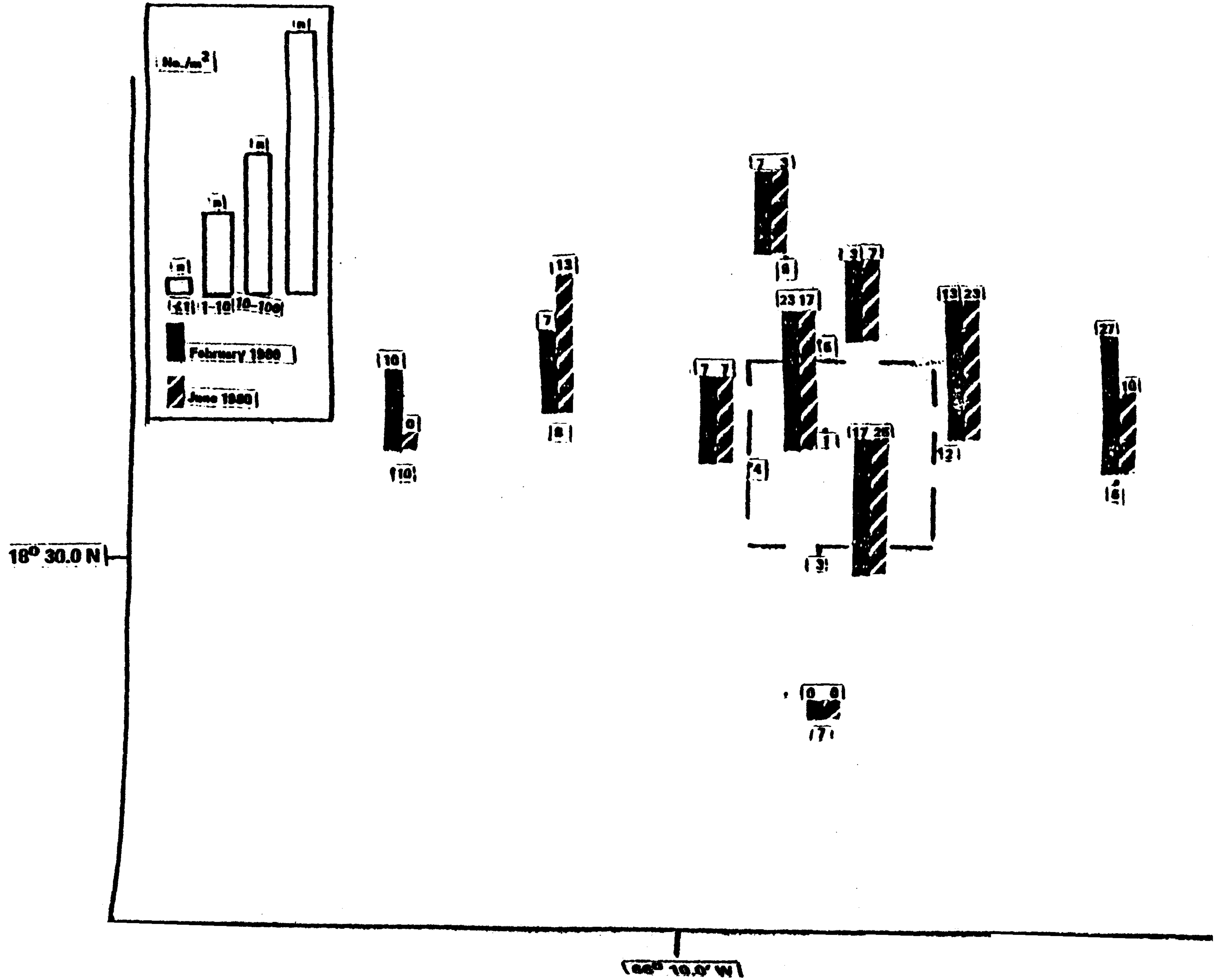


Figure A-2
Common Macrofauna Collected at DMDS



No./m²
1-10
10-100
February 1980
June 1980
18° 30.0 N

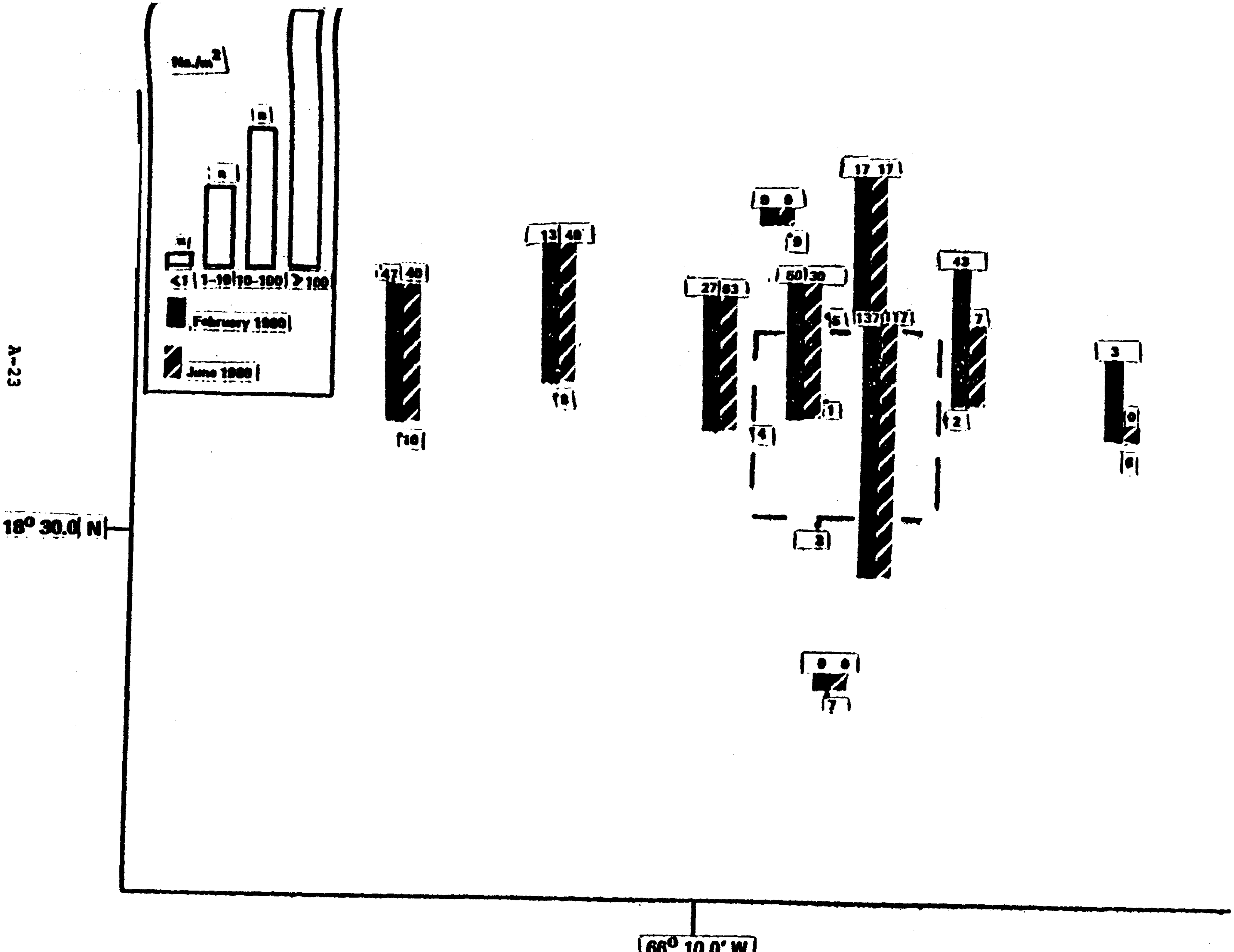


Figure A-4. Distribution (Number of Individuals/m^2) of <u>Aglaophamus verrilli</u> *in the area of the San Juan DMDS.*

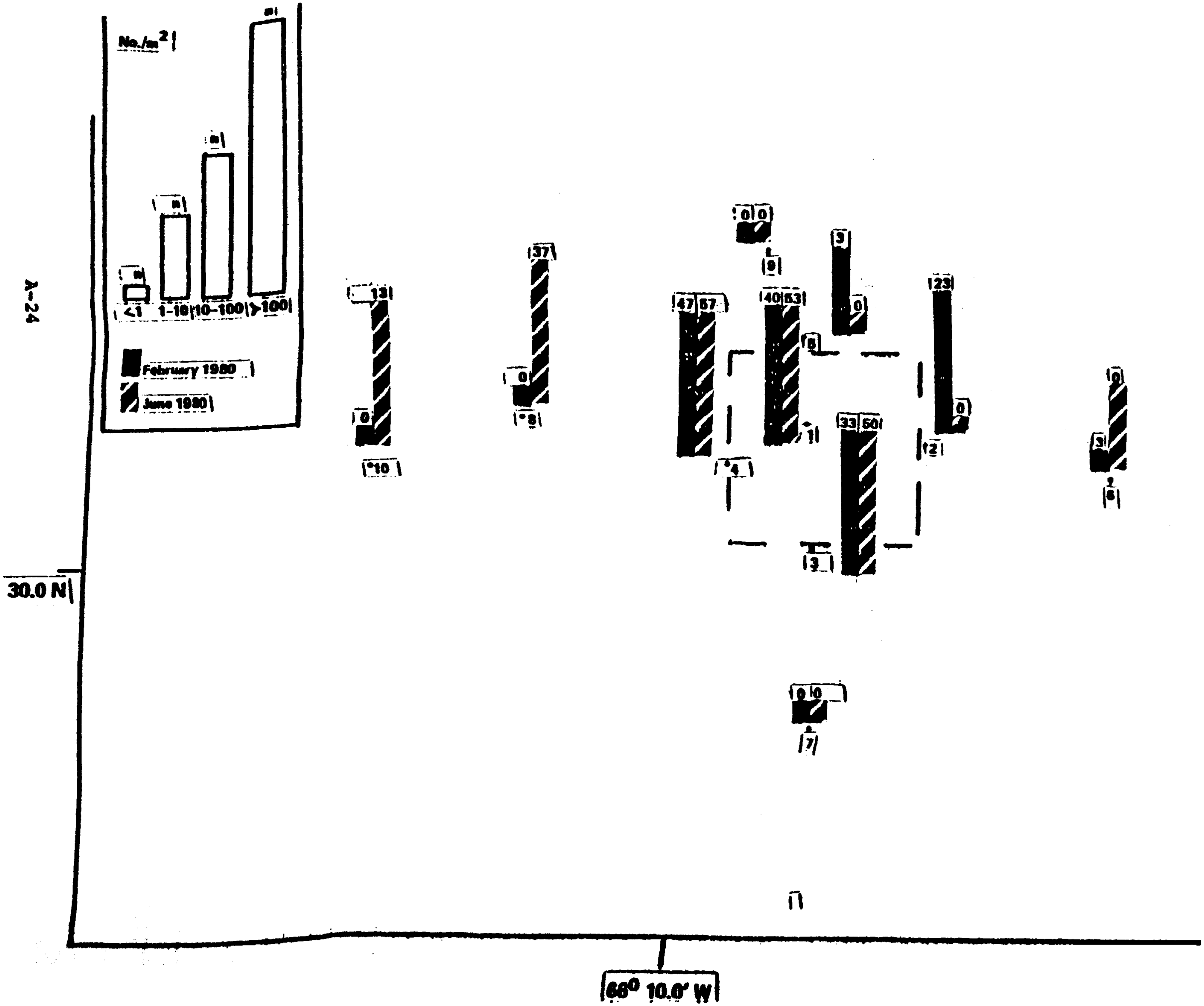


Figure A-5. Distribution (Number of individuals/m^2) of [illegible]

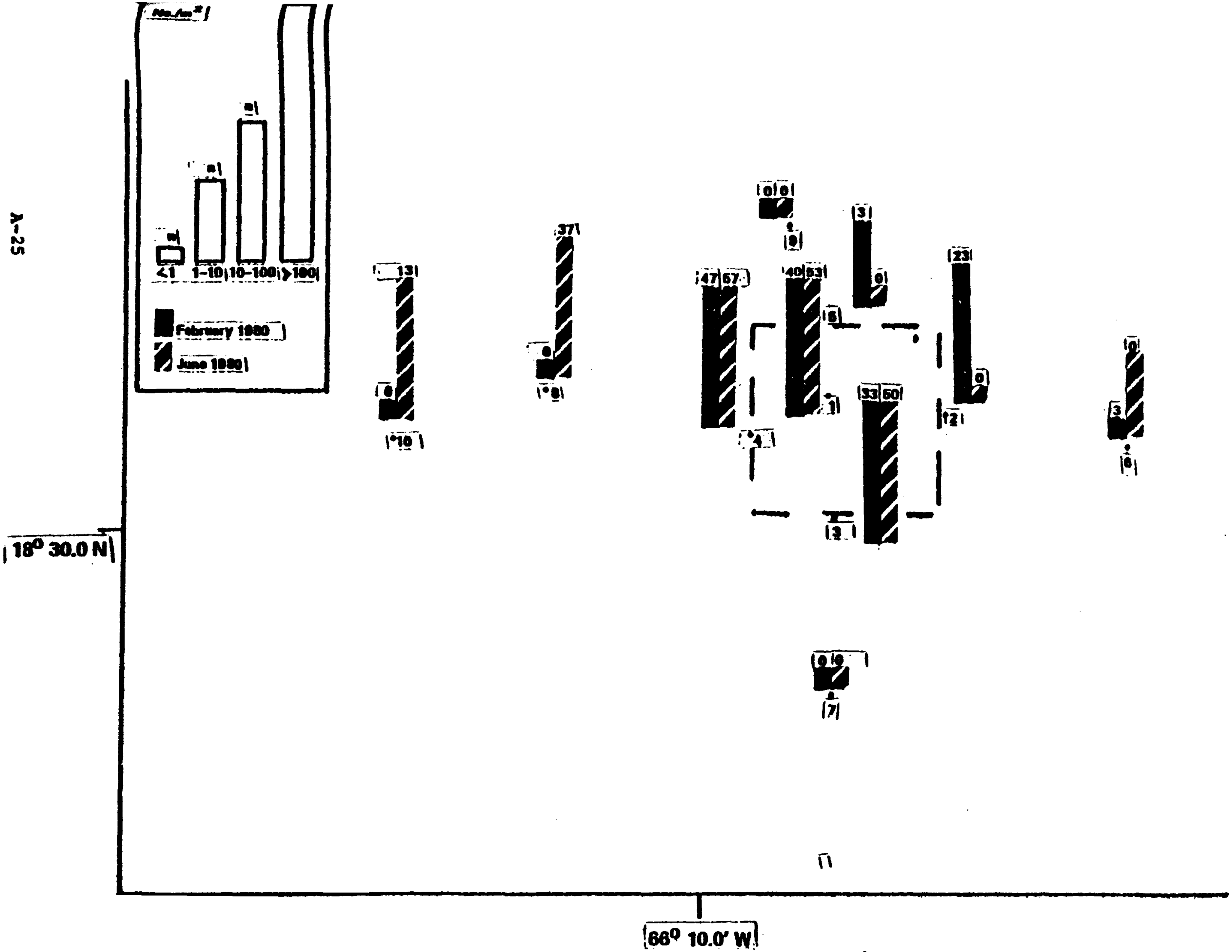
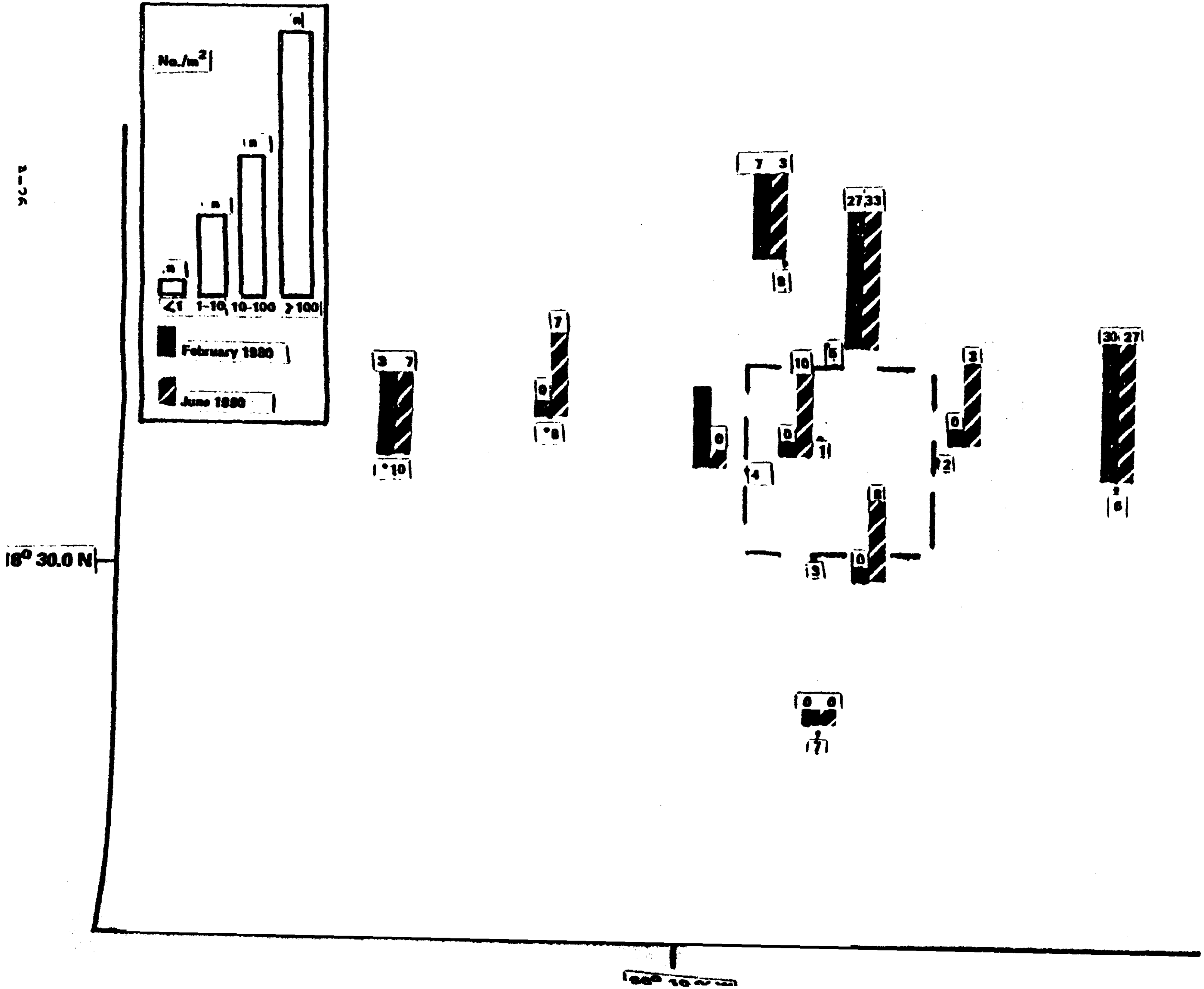


Figure A-6. Distribution (Number of individuals/m^2) of <u>Cossura</u> <u>delta</u> in the area of the San Juan DMDS



No./m²
<1
1-10
10-100
>100
February 1980
June 1980
18° 30.0 N

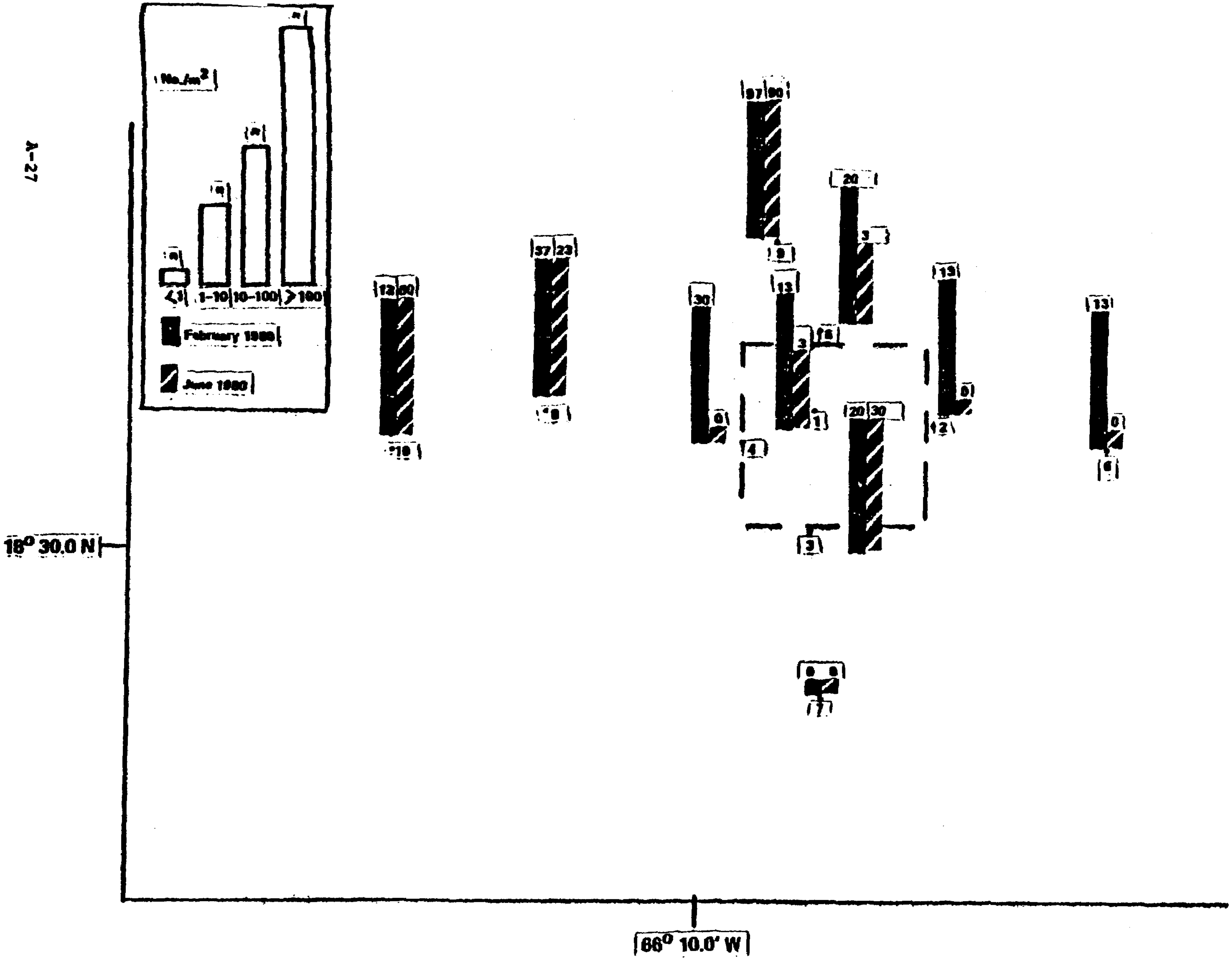


Figure A-8. Distribution (Number of individuals/m²) of <u>Spiohanes</u> sp.A in the area of the San Juan DMDS

	WATER COLUMN								SEDIMENT										BIOTA		
			WATER SAMPLING ROSETTE						BOX CORER, 7 DROPS										DREDGE/TRAWL		
	INSTRUMENT ARRAY		GO-FLO				GO-FLO TEFLON 1 INFO		GEOLOGICAL-CHEMICAL							BIOLOGICAL			EPIFUNA & MACROINFAUNA TISSUES		
	1 PROFILE/ STATION		2 SAMPLES: SURFACE & BOTTOM/STATION				1 MIDWATER SAMPLE/ STATION		2 CORES/STATION							5 CORES/ STATION			2 TRAWLS/SITE		
STATION NUMBER	STATION NUMBER PROFILES OF SALINITY, pH TEMPERATURE	CALIBRATION SAMPLES SALINITY, TURBIDITY pH, & TEMPERATURE	SUSPENDED SOLIDS	DISSOLVED OXYGEN	DISSOLVED TRACE METALS	PARTICULATE TRACE METALS	CHLORINATED HYDROCARBON SCAN	SUSPENDED SOLIDS	GRAINSIZE, ARTIFACTS	TOTAL ORGANIC CARBON	TRACE METALS	CHLORINATED HYDROCARBON SCAN (a)	TOTAL & FECAL COLIFORMS	OIL & GREASE	GRAIN SIZE & ARTIFACTS	MACROINFAUNA, TAXONOMY	MEIOFAUNA (N/M RATIO) (a)	TRACE METALS (c)	CHLORINATED HYDROCARBON SCAN (c)	TOTAL & FECAL COLIFORMS (c)	MACROFAUNA, TAXONOMY
1	●	●	●	●	QC	QC	QC	●	●	QC	QC	QC	●	●	●	●	●	QC	QC	●	●
2									QE	QE	QE		QE	QE	QE	QE	QE				
3									●	●	●		●	●	●	●	●				
4									●	●	●		●	●	●	●	●				
5									●	●	●		●	●	●	●	●				
6	●	●	●	●	QR	QB	●	●	●	●	QC	●	●	●	●	●	●		●	●	●
7	●	●	●	●					●	●	●		●	●	●	●	●				
8	●	●	●	●					●	●	●		●	●	●	●	●				
9	●	●	●	●					●	●	●		●	●	●	●	●				
10									●	●	●		●	●	●	●	●				

NUMBER	1	2	3	4	5	6	7	8	9	10
LATITUDE	18° 30.7'N	18° 30.7'N	18°30.2'N	18°30.7'N	18°31.2'N	18°30.7'N	18°29.2'N	18°30.7'N	18°31.7'N	18°30.7'N
LONGITUDE	66° 09.0'W	66° 09.5'W	66°09.0'W	66°09.5'W	66°09.0'W	66°07.5'W	66°09.0'W	66°10.0'W	66°09.0'W	66°11.0'W
DEPTH	200m	200 m	213m	273m	400m	436m	40m	383m	466m	273m

QC – ONE QUALITY CONTROL SAMPLE WILL BE TAKEN IN ADDITION TO THE SAMPLES BEING COLLECTED AT THE DESIGNATED STATION
QE – ATMOSPHERIC FALLOUT
QR – RINSING EFFICIENCY FOR REMOVAL OF SEAWATER FROM NUCLEOPORE FILTERS
QB – HANDLING BLANKS FOR TRACE METALS
(a) – COMPOSITE SAMPLE FROM BOTH BOX CORES AT EACH DESIGNATED STATION
(b) TWO SUB SAMPLES FROM ONE BOX CORE ONLY
(c) COMPOSITE SAMPLES FROM ALL DREDGES AND TRAWLS, PLUS SAMPLES OF OPPORTUNITY FROM GEOLOGICAL CHEMICAL BOX CORES: SPECIES IDENTIFIED ON BOARD BEFORE ANALYSIS OR PRESERVATION.

Table A-1

Sampling Schedule at the San Juan Harbor DMOS, Puerto Rico

Table A-2. Laboratories performing analyses of samples.

Biology	Chemistry/Geology
Barry A. Vittor & Associates Mobile, Alabama	Science Applications, Inc. La Jolla, California
LaMer* San Pedro, California	LFE Environmental* Richmond, California

* quality control

able A-3. Measurements of temperature, salinity, and dissolved oxygen in the water column in the area of the San Juan DMDS during February and June, 1980.

Station	Depth(m)	Temperature (°C)		Salinity (%)		Dissolved Oxygen (mg/l)	
		Feb.	Jun.	Feb.	Jun.	Feb.	Jun.
1	2	25.9	28.8	36.45	36.53	7.247	6.912
	111	- (1)	-	-	36.79	-	-
	132	-	-	37.22	-	-	-
	265	17.8	-	36.71	-	6.044	-
	320	-	17.5	-	16.19	-	6.075
6	2	25.8	27.6	36.46	36.54	7.328	6.781
	220	-	-	-	36.76	-	-
	280	-	-	37.03	-	-	-
	439	-	17.7	-	36.32	-	6.041
	560	16.4	-	36.51	-	5.681	-
7	2	25.8	28.4	36.66	36.20	7.066	6.880
	15	-	-	-	36.26	-	-
	32	-	27.7	-	36.20	-	6.909
	61	25.7	-	36.56	-	6.504	-

Con't Table A-3

Station	Depth(m)	Temperature (°C)		Salinity (%)		Dissolved Oxygen (mg/l	
		Feb.	Jun.	Feb.	Jun	Feb.	Jun.
8	2	25.2	27.7	36.75	36.19	7.071	7.225
	149	-	-	-	36.83	-	-
	268	12.0	-	36.60	-	5.382	-
	298	-	18.7	-	36.48	-	6.814
9	2	25.8	27.8	36.75	36.18	7.128	7,271
	350	-	-	-	36.62	-	-
	464	16.6	-	36.61	-	5.939	-
	700	-	16.8	-	36.07	-	5.833

(1) A dash (-) indicates that a measurement was not taken at that depth.

Table A-4. Measurements of pH, turbidity, and total suspended solids in the water column in the area of the San Juan DMDS during February and June, 1980.

Station	Depth(m)	pH Feb.	pH Jun.	Turbidity (NTU) Feb.	Turbidity (NTU) Jun.	Total Suspended Solids (mg/l) Feb.	Total Suspended Solids (mg/l) Jun.
1	2	8.2	8.3	0.57	0.27	0.380	1.850
	111	-1	8.3	-	0.23	-	*2
	132	8.1	-	0.19	-	0.509	-
	265	8.0	-	0.41	-	0.847	-
	320	-	8.3	-	0.35	-	*
6	2	8.2	8.3	0.59	0.37	0.966	*
	220	-	8.3	-	0.15	-	*
	280	8.1	-	0.20	0.18	0.292	-
	439	-	8.3	-	-	-	*
	560	8.0	-	0.31	-	0.390	-
7	2	8.2	8.4	0.33	0.38	0.467	0.164
	15	-	8.4	-	0.30	-	0.182
	32	-	8.4	-	0.27	-	0.204
	61	8.2	-	0.45	-	0.456	-
8	2	8.2	8.4	0.21	0.30	0.276	0.185
	149	-	8.3	-	0.20	-	0.203
	268	8.1	-	0.50	-	0.827	-
	298	-	8.3	-	0.25	-	0.118
9	2	8.2	8.4	0.24	0.32	0.287	0.178
	350	-	8.3	-	0.21	-	0.049
	464	8.1	-	0.25	-	0.354	-
	700	-	8.2	-	0.18	-	*

(1) A dask (-) indicates that a measurement was not taken at that depth.
(2) An asterisk (*) indicates that the value was below detection limits.

Table A-5. Measurements of particulate and dissolved trace metals, and organohalogens in the water column in the area of the San Juan DMDS during February and June, 1980. (All measurements were taken at mid-depth).

Measurement	Station 1 Feb.	Station 1 Jun.	Station 6 Feb.	Station 6 Jun.
Particulate Trace Metals (ug/l):				
Hg	0.188×10^{-3}	0.200×10^{-3}	0.236×10^{-3}	0.200×10^{-3}
Cd	0.178×10^{-1}	0.200×10^{-2}	0.559×10^{-2}	0.100×10^{-2}
Pb	0.886×10^{0}	0.300×10^{-2}	0.564×10^{-2}	0.200×10^{-2}
Dissolved Trace Metals (ug/l):				
Hg	0.015	0.003	0.002	0.003
Cd	0.700	0.085	0.310	0.012
Pb	1.130	0.640	5.530	0.380
Organohalogens (ng/l):				
Heptachlor	0.462	0.596	0.419	0.102
Heptachlor epoxide	-(1)	-	-	0.175
op 'DDE	-	0.302	-	0.124
Dieldrin	-	5.653	-	2.659

(1) A dash (-) indicates that a measurement was below analytical detection limits.

Table A-6. Sediment composition in the area of the San Juan DMDS during February, 1980.

Station	Mean Depth among Casts(m)	% Composition ($\bar{X} \pm SD$)[1]			
		Gravel	Sand	Silt	Clay
1	260	4.81 ± 7.71	8.99 ± 3.74	37.30 ± 9.61	48.89 ± 5.50
2	283	0.00 ± 0.00	7.56 ± 146	49.72 ± 5.09	42.72 ± 4.91
3	194	0.10 ± 0.13	15.44 ± 4.50	44.73 ± 3.21	39.73 ± 3.85
4	265	0.00 ± 0.00	9.75 ± 1.07	44.54 ± 2.29	45.72 ± 2.82
5	420	1.43 ± 3.78	8.55 ± 3.16	47.13 ± 5.67	42.89 ± 3.88
6	407	0.01 ± 0.03	8.25 ± 10.53	44.17 ± 6.65	47.59 ± 4.58
7	36	23.93 ± 8.31	73.84 ± 10.30	2.23 ± 2.40	0.00 ± 0.00
8	311	0.99 ± 2.61	5.09 ± 3.24	43.57 ± 5.55	50.35 ± 5.80
9	466	0.00 ± 0.00	3.78 ± 1.25	45.46 ± 4.51	50.75 ± 4.02
10	260	0.00 ± 0.00	1.66 ± 0.21	41.77 ± 4.20	56.57 ± 4.33

(1) n = 7 except at Station 7 (n=3).

Table A-7. Sediment composition in the area of the San Juan DMDS during June, 1980.

Station	Mean Depth among Casts (m)	% Composition ($\bar{X} \pm SD$)[1]			
		Gravel	Sand	Silt	Clay
1	310	3.60 ± 9.04	5.31 ± 7.57	54.25 ± 8.53	45.83 ± 4.83
2	296	2.92 ± 5.71	4.65 ± 8.74	48.64 ± 8.74	43.80 ± 6.09
3	232	1.73 ± 3.44	8.92 ± 9.79	45.90 ± 13.52	43.45 ± 3.76
4	281	0.00 ± 0.00	0.00 ± 0.00	54.75 ± 3.39	45.24 ± 3.39
5	379	0.00 ± 0.00	0.00 ± 0.00	52.43 ± 6.46	47.57 ± 6.46
6	448	0.00 ± 0.00	0.00 ± 0.00	48.43 ± 4.43	51.56 ± 4.43
7	49	61.15	38.85	0.00	0.00
8	300	0.00 ± 0.00	0.00 ± 0.00	48.49 ± 3.65	51.51 ± 3.65
9	464	0.00 ± 0.00	0.00 ± 0.00	45.23 ± 5.07	54.77 ± 5.07
10	287	0.00 ± 0.00	0.00 ± 0.00	46.92 ± 2.47	53.08 ± 2.47

(1) n=7 except at Station 3 (n=6) and Station 7 (n=1).

Station	Hg (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Oil and Grease (mg/g)	TOC (mg/g)
1	0.03, 0.11	0.10, 0.11	2.63, 1.69	1.190, 1.270	8.92, 14.79
2	0.25, 0.07	0.05, 0.06	14.30, 9.46	2.360, 1.440	20.43, 15.71
3	0.11, 0.15	0.13, 0.26	23.60, 25.50	4.210, 6.080	15.39, 19.97
4	0.01, 0.19	0.15, 0.15	23.40, 24.20	2.170, 4.480	19.66, 16.59
5	0.01, 0.06	0.05, 0.02	4.40, 0.05	0.820, 0.910	14.32, 13.41
6	0.16, 0.18	0.13, 0.07	13.50, 0.04	1.750, 1.830	20.98, 13.06
7	0.12, 0.01	0.01, 0.01	<0.01, <0.01	0.670, 0.380	2.18, 2.56
8	0.14, 0.08	0.08, 0.05	9.82, 15.06	1.600, 1.180	16.14, 13.95
9	0.16, 0.13	0.15, 0.14	19.70, 22.30	2.150, 2.130	15.66, 15.06
10	0.14, 0.11	0.06, 0.04	19.30, 21.20	1.210, 1.560	14.71, 15.13

Table A-8. **Values of Trace Metals, Oil and Grease, and Total Organic Carbon (TOC) in the Sediments in the Area of the San Juan DMDS, February, 1980. (Two values were measured at each station)**

Station	Hg (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Oil and Grease (mg/g)	TOC (mg/g)
1	0.28, 0.12	0.11, 0.03	14.95, 0.13	3.730, 1.460	13.25, 13.59
2	0.07, 0.09	0.03, 0.04	0.07, 1.22	1.590, 3.550	11.79, 12.84
3	0.15, 0.19	0.08, 0.09	15.17, 18.70	1.830, 3.300	11.54, 15.36
4	0.19, 0.13	0.07, 0.10	1.88, 12.50	1.890, 2.160	13.26, 12.90
5	0.11, 0.16	0.06, 0.03	0.17, 0.18	1.510, 0.900	6.28, 13.15
6	0.12, 0.14	0.04, 0.16	0.07, 17.50	1.380, 2.270	11.63, 11.69
7	0.07	0.03	0.05	3.090	16.58
8	0.09, 0.04	0.05, 0.05	17.90, 0.20	1.430, 1.530	12.43, 11.47
9	0.08, 0.10	0.08, 0.07	16.20, 15.20	1.040, 0.670	11.53, 11.25
10	0.10, 0.15	0.04, 0.04	13.10, 0.10	0.860, 0.500	11.87, 11.84

0.149 .064 6.487

Table A-9. Values of Trace Metals, Oil and Grease, and Total Organic Carbon (TOC) in the Sediments in the Area of the San Juan DHBS, June, 1980. (Two values were measured at each station)

Organohalogen (mg/kg)	Station 1		Station 6	
	Feb	June	Feb	June
Arochlor 1254	1.091	21.962	-	-
Arochlor 1260	-(1)	33.130	7.995	-
Heptachlor	0.128	-	-	-
Heptachlor epoxide	0.059	-	-	-
pp'DDE	1.049	2.184	4.234	-
pp'DDD	0.110	0.803	0.917	-
pp'DDT	1.040	-	0.838	-
op'DDE	-	-	4.931	-

(1) A dash (-) indicates that the value was below the detection limits

Table A-10. Values of Organohalogens Measured in Sediments in the Area the San Juan DMDS in February and June, 1980

Table A-11. Pearsons Correlation Coefficients (r) between sediment variables measured in the area of the San Juan DMDS, February and June, 1980.

	CD	Pb	Oil & Grease	% Silt	% Clay	TOC
Hg	.2864*	.2561	.3213*	.2292	.1723	.2361
Cd		.6865*	.5608*	.2565	.3271*	.4227*
Pb			.3964*	.4475*	.3625*	.4332*
Oil & Grease				-.0320	-.0705	.5410*
% Silt					.7182*	.3673*
% Clay						.4081*

* = $p \leq 0.05$

Table A-12. Common Macrofaunal Species Captured in the Area of the San Juan DMDS during February and June, 1980

Species	Trophic Position[1]	Survey Feb	Survey June
Nemertea:			
Nemertean sp. A	C		X
Nemertean sp. I	C	X	X
Cerebratulus lacteus	C	X	
Annelida:			
Polychaeta:			
Leanira alba	C	X	
Pisione sp. A	O	X	
Sigambra tentaculata	C	X	X
Exogone lourei	D	X	X
Haplosyllis spongicola	C		X
Sphaerosyllis sp. A	D	X	
Aglaophamus verrilli	C	X	X
Aglaophamus sp. B	C	X	
Lumbrineris sp.	O	X	
Paraprionospio pinnata	D	X	
Prionospio ehlersi	D	X	X
P. longibranchiata	D	X	X
Prionospio sp.	D	X	
Spionidae gn. B	D		X
Spionidae	D	X	
Spiophanes sp. A	D	X	X
Cirrophorus sp. C	D	X	
Tauberia sp. B	D		X
Cossura delta	D	X	X
C. soyeri	D		X
Cossurella sp. A	D	X	X
Capitellidae gn. L	D	X	X

Species	Trophic Position[1]	Survey Feb	Survey June
Capitellidae	D	X	X
Mediomastus sp.	D	X	
Mediomastus sp. B	D		X
Notomastus sp.	D	X	
Maldanidae gn. A	D	D	
Ampharetidae gn. A		X	
Ampharetidae	D	X	
Terebellidae	D	X	
Archiaellida:			
Polygordius sp. A	O	X	
Oligochaeta:			
Oligochaeta spp.	D	X	
Arthropoda:			
Isopoda:			
Apseudes sp. B	D		X
Astacilla sp. A	O	X	X
Stenetrium occidentale	O		X
Amphidoda:			
Gammaropsis sp. A	D		X
Gammaropsis sp.	D	X	
Leucothae sp. A	?		X
Protohadzia sp. A	?	X	X
Decapoda:			
Callianassa minima	S	X	
Mollusca:			
Aplacophora:			
Chaetoderma sp. A	O	X	
Sipuncula:			
Golfingia sp. D	D	X	X

[1]D = Deposit feeders; S = Suspension feeders
O = Omnivores; C = Carnivores

Station	February					June, 1980				
	D	S	C	O	?	D	S	C	O	?
1	.70	.04	.26	.00	.00	.76	.00	.24	.00	.00
2	.71	.00	.29	.00	.00	.53	.00	.47	.00	.00
3	.61	.00	.39	.00	.00	.60	.00	.40	.00	.00
4	.80	.00	.10	.10	.00	.79	.00	.21	.00	.00
5	.87	.00	.13	.00	.00	.73	.00	.27	.00	.00
6	.88	.00	.12	.00	.00	.71	.00	.29	.00	.00
7	.74	.00	.00	.16	.10	.28	.00	.52	.12	.07
8	.92	.00	.08	.00	.00	.69	.00	.31	.00	.00
9	.76	.00	.02	.10	.13	.81	.00	.01	.08	.11
10	.65	.00	.21	.15	.00	.81	.00	.19	.00	.00

Table A-13. Percent Trophic Composition of the Common Macrofaunal Species Collected in the Area of the San Juan DMDS. (D=deposit feeder, S=suspension feeder, C=carnivore, O=omnivore, and ?=unknown.)

Station	*Sigambra tentaculata*	*Aglaophamus verrilli*	*Prionospio longibranchiata*	*Spiophanes* sp.A	*Cossura delta*	*Golfingia* sp.D
1	1.4 ± 1.1	3.0 ± 2.4	2.4 ± 2.9	0.8 ± 0.8	0.0 ± 0.0	5.6 ± 4.6
2	0.8 ± 0.8	2.6 ± 2.3	1.4 ± 3.1	0.8 ± 0.8	0.0 ± 0.0	4.6 ± 3.9
3	1.0 ± 0.7	8.2 ± 1.9	2.0 ± 2.5	1.2 ± 0.8	0.0 ± 0.0	2.8 ± 2.5
4	0.4 ± 0.9	1.6 ± 2.3	2.8 ± 3.3	1.8 ± 1.1	0.4 ± 0.5	3.2 ± 3.5
5	0.2 ± 0.4	1.0 ± 1.4	0.2 ± 0.4	1.2 ± 1.3	1.6 ± 1.7	0.4 ± 0.5
6	1.6 ± 1.3	0.2 ± 0.4	0.0 ± 0.0	0.8 ± 0.8	1.8 ± 1.3	0.2 ± 0.4
7(1)	0.0	0.0	0.0	0.0	0.0	0.0
8	0.4 ± 0.9	0.8 ± 1.8	0.0 ± 0.0	2.2 ± 2.3	0.0 ± 0.0	1.4 ± 2.2
9	0.4 ± 0.9	0.0 ± 0.0	0.0 ± 0.0	5.8 ± 3.0	0.4 ± 0.5	0.0 ± 0.0
10	0.6 ± 0.5	2.8 ± 1.3	0.0 ± 0.0	0.8 ± 0.8	0.2 ± 0.4	1.8 ± 1.6

(1) Only one cast was taken at Station 7.

Table A-14. Numerical Data for the Dominant Species Collected in the Area of the San Juan DMDS, February, 1980. (Values are mean ± one Standard Deviation; n=5.)

Station	Sigambra tentaculata	Aglaophamus verrilli	Prionospio longibranchiata	Spiophanes sp.A	Cossura delta	Golfingia sp.D
1	1.0 ± 0.7	1.8 ± 3.5	3.2 ± 5.5	0.2 ± 0.4	0.6 ± 0.9	1.6 ± 1.5
2	1.4 ± 1.1	0.4 ± 0.9	0.0 ± 0.0	0.0 ± 0.0	0.2 ± 0.4	1.8 ± 2.2
3	1.5 ± 1.3	7.0 ± 3.7	3.0 ± 1.4	1.8 ± 1.5	0.5 ± 1.0	8.3 ± 3.0
4	0.4 ± 0.5	3.8 ± 1.6	3.4 ± 4.3	0.0 ± 0.0	0.0 ± 0.0	6.0 ± 4.9
5	0.4 ± 0.5	1.0 ± 0.7	0.0 ± 0.0	0.2 ± 0.4	2.0 ± 1.0	0.4 ± 0.9
6	0.6 ± 0.5	0.0 ± 0.0	0.2 ± 0.4	0.0 ± 0.0	1.6 ± 0.9	0.2 ± 0.4
7 (1)	0.0	0.0	0.0	0.0	0.0	0.0
8	0.8 ± 0.8	2.4 ± 3.8	2.2 ± 2.3	1.4 ± 2.2	0.4 ± 0.5	1.6 ± 2.1
9	0.2 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	5.4 ± 5.9	0.2 ± 0.4	0.2 ± 0.4
10	0.0 ± 0.0	2.4 ± 2.8	0.8 ± 1.3	3.6 ± 4.2	0.4 ± 0.5	3.2 ± 3.5

(1) *Only one cast was taken at Station 7*

Table A-15. Numerical Data for the Dominant Species Collected in the Area of the San [illegible] (Values [illegible] Standard Deviation; n=5.)

Species	Source of Variation	d.f.	Mean Square	F
Aglaophamus verrilli	Survey	1	2.1	0.4
	Station	9	38.7	7.0*
	Survey x Station	9	5.5	1.2
	Residual	72	4.5	
	Total	91		
Golfingia sp.D	Survey	1	0.7	0.5
	Station	9	31.3	2.4
	Survey x Station	9	13.3	1.8
	Residual	72	7.3	
	Total	91		
Spiophanes sp. A	Survey	1	2.8	0.7
	Station	9	23.8	6.3*
	Survey x Station	9	3.8	0.8
	Residual	72	4.6	
	Total	91		
Prionospio longibranchiata	Survey	1	2.4	1.1
	Station	9	12.9	6.1*
	Survey x Station	9	2.1	0.4
	Residual	72	5.4	
	Total	91		
Sigambra tentaculata	Survey	1	0.3	0.6
	Station	9	1.6	3.2*
	Survey x Station	9	0.5	0.8
	Residual	72	0.7	
	Total	91		
Cossura delta	Survey	1	0.5	1.7
	Station	9	4.1	13.7*
	Survey x Station	9	0.3	0.5
	Residual	72	0.6	
	Total	91		

* = $p \leq 0.05$

Table A-16. Analysis of Variance (Model II) of Densities of the Dominant Species Collected in the Area of the San Juan DMDS During February and June, 1980.

TABLE A-17
TOTAL AND FECAL COLIFORM LEVELS
IN SEDIMENTS
February 1980

Station No.	Total Coliforms (MPN/100 g)	Fecal Coliforms (MPN/100 g)
1	$<$ 133	$<$ 133
2	$<$ 118	$<$ 118
3	167	167
4	167	167
5	$<$ 111	$<$ 111
6	346	346
7	$<$ 133	$<$ 133
8	$<$ 143	$<$ 143
9	$<$ 167	$<$ 167
10	$<$ 154	$<$ 154

Appendix B

SITE EVALUTION STUDY

FOR

SAN JUAN, PUERTO RICO OCEAN DREDGED MATERIAL DISPOSAL

The Corps of Engineers (CE) has indicated a continuing need for EPA designated Ocean Dredged Material Disposal Sites (ODMDS) for the disposal of operation and maintenance dredged material. The CE has also indicated a need for EPA-designated ocean sites for the disposal of dredged material resulting from new Federal projects or new permitted dredging.

An ODMDS was interimly designatd by EPA in January, 1977, for the disposal of material resulting from the operation and maintenance dredging of San Juan Harbor. This interim status expires in February, 1983. This appendix presents the results of a study conducted to determine if the Interim Site or an alternative ocean site should be permanently designated for: (1) disposal of dredged material resulting from the operation and maintenance activities of San Juan Harbor; and (2) as an alternative in the planning for disposal of dredged material resulting from other dredging projects in the San Juan Bay area.

BACKGROUND

The Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended, and the EPA implementing Ocean Dumping Regulation and Criteria (ODR) provide the basis for designation of ocean disposal sites. Each of these has affected the sequence of events in the process of permanently designating ocean disposal sites.

Marine Protection, Research, and Sanctuarie Act (MPRSA)

The MPRSA, passed by the Congress October 23, 1972, provides the basis "---to regulate the transportation for dumping, and the dumping of material into the ocean waters---". Among other things, the MPRSA establishes a permitting system for controlling dumping into the ocean.

The permitting system is adminstrated by the EPA Administrator (non-dredged material) and the Secretary of the Army (dredged material). The designation of appropriate locations for dumping into the oceans is provided for as a part of the permitting system.

Section 102(a) stipulates criteria that EPA shall consider in the review and evaluation of permit applications. Section 102(a) states, "The Administrator may, considering the criteria established pursuant to subsection (a) of this section, designate recommended sites or times for dumping and, when he finds it necessary to protect critical areas, shall, after consultation with the Secretary, also designate sites or times within which certain materials may not be dumped.

Section 103(a) establishes a permitting program to be administered by the Secretary of the Army "---for the transportation of dredged material for the purpose of dumping it into ocean waters---". Section 103(b) states in part "--- The Secretary shall also make an independent determination as to appropriate locations for the dumping. In considering appropriate locations, he shall, to the extent feasible, utilize the recommended sites designated by the Administrator pursuant to section 102(a)---."

Ocean Dumping Regulations and Criteria

The ODR were issued January 11, 1977, to implement the provisions of the MPRSA. Section 228.4 establishes procecures for designation of sites. Section 228.4(e)(1) states "Areas where ocean dumping of dredged material is permitted subject to the specific conditions of dredged material permits issued by the U.S. Army Corps of Engineers will be designated by EPA by promulgation in this Part 228, and such designation will be made based on environmental studies of each site, regions adjacent to the site, and on historical knowledge of the impact of dredged material disposal on areas similar to such sites in physical, chemical, and biological characteristics. All studies for the evaluation and potential selection of dredged material disposal sites will be conducted in accordance with the appropriate requirements of §§228.5 and 228.6---."

Section 228.5 describes the general criteria for selection of sites to be used for ocean dumping. Section 228.6 describes the specific criteria for site selection.

Site Designation

At the time of issuance of the ODR, a number of ocean disposal sites existed for which a continuing need was indicated. However, the necessary studies to fully evaluate these sites had not been completed. Because of this, EPA approved the sites on an interim basis for a period not to exceed three years pending the completion of baseline or trend assessment surveys and designation for continuing use or termination of use. It was stated "the sizes and use specifications are based on historical usage and do not necessarily meet the criteria stated in the Part" (228.12).

The San Juan Harbor, Puerto Rico ODMDS was interimly designated in the ODR (January 11, 1977). By amendment (December 8, 1980), the interim designation of this site was extended until such time as formal rulemaking is completed or until February, 1983.

EVALUATION OF OCEAN ALTERNATIVES

Theoretically, a site anywhere in the ocean could be selected for location of an ocean dredged material disposal site. For various economic, logistic, safety, and/or environmental reasons, many locations would not be suitable. Therefore, potential site locations were restricted to that area off the north coast of Puerto Rico in the vicinity of San Juan Harbor.

General Criteria for Site Selection

Section 228.5 of the Ocean Dumping Regulations describes the general criteria for selection of sites to be used for ocean dumping. In brief, the general criteria state that site locations will be chosen"...to minimize the interference of disposal activities with other activities in the marine environment..." and so chosen that "...temporary perturbations in water quality or other environmental conditions during initial mixing ... can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shorelines, marine sanctuary, or known geographically limited fishery or shellfishery." In addition, ocean disposal site sizes "... will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts." Finally, whenever feasible, EPA will "...designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used."

The above general criteria were used in the initial process of selecting three alternative ocean sites off the northern coast of Puerto Rico. Each of the three areas was considered as a potentially suitable environment in which to locate an ocean disposal site. Alternatives selected for consideration include: (1) an inshore site (depths averaging 100m, approximately 1 nmi offshore; (2) the interim-designated site (depths to 400m, 1.4 nmi offshore and; (3) an offshore (from the interim) site (depths averaging 400-600m, approximately 2.4-3.4 nmi offshore). (See Figure 1.) Both the inshore and offshore site alternatives are generalized areas with no specific boundaries. Available data from these areas is used to characterize existing conditions of the shallow-water and deeper-water environments.

Specific Criteria for Site Selection

The proposed action is the final designation of a San Juan ODMDS for the disposal of material dredged from San Juan Harbor. The final screening of the sites is based on the 11 specific criteria listed at 40 CFR 228.6 of the Ocean Dumping Regulations. EPA established the 11 specific criteria to constitute "...an environmental assessment of the impact of the use of the site for disposal." These criteria will be used to recommend an ODMDS for final designation.

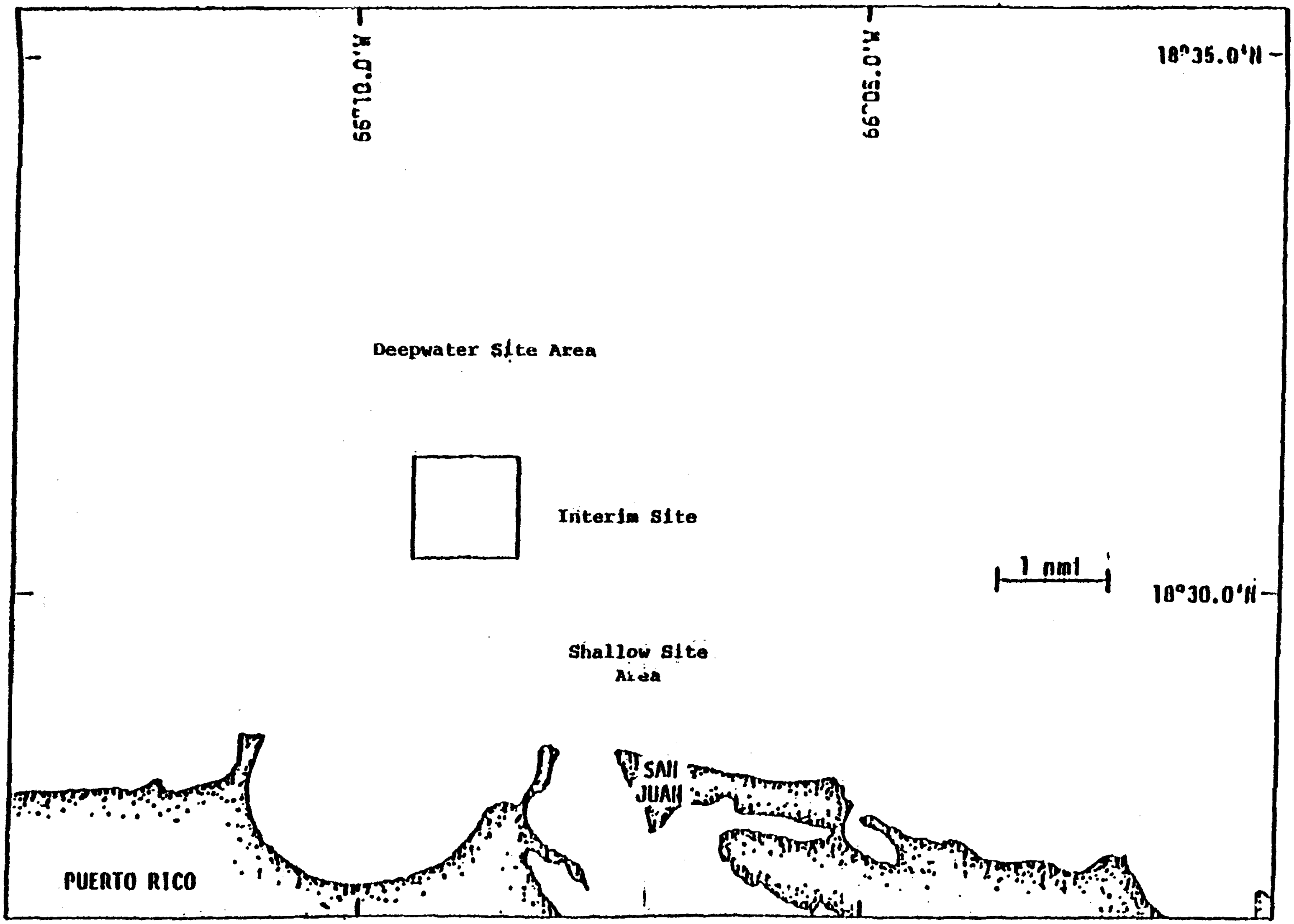


Figure 1

Alternative Ocean Dredged Material Disposal Sites

In the following sections, each of the 11 specific criteria is discussed with reference to the three alternative disposal locations.

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

Each of the three alternatives is located off the coast of Puerto Rico north of San Juan. Puerto Rico rises from a relatively shallow, submerged bank which falls away into the sea in an irregular pattern. The insular shelf in this area is extremely narrow with the 200-m isobath being scarcely more than two or three kilometers from shore. Individual coral heads and coral banks are scattered over the shelf from very near shore to the seaward edge of the shelf. The bottom topography here is irregular, composed mostly of sand inshore and silty clay beyond the shelf.

a. Inshore Site

The inshore site is a representative area located 1.0 nmi offshore in water averaging 100m deep. The dominant sediment type for this insular shelf area is calcareous skeletal sand (coral, mollucks, calcareous algae, and foraminifera predominate). Relict skeletal components are common sediment constituents (Schneidermann, et al. 1975).

b. Interim Site

The interim-designated site is centered at 18°30'40"N, 66°09'00"W approximately 2.2 nmi off the coast of Puerto Rico due north of San Juan (See Figure A-1) and has an average depth of 292m. The bottom sediments within the 0.98 nmi area of the site averages 48% silt and 45% clay, the remainder being sand and gravel. The bottom drops off steeply in the northward direction. The insular slope in this area is characterized by numerous submarine ridges and swales.

c. Offshore (from interim) Site

The area considered as an alternative for offshore disposal is located 2.4-3.4 nmi from shore (1-2 nmi north of the interim site) over the steep upper slope in 400-600m of water.

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)]

Commercial fisheries in coastal waters around Puerto Rico are not very productive. Some of the reasons for this lack of productivity are speculated to be:

- Puerto Rico's insular shelf is limited in areal extent;

- There is little or no upwelling nearshore to bring nutrients from the bottom into coastal circulation;

- Rivers emptying into coastal waters are relatively small, and therefore, no great quantities of nutrients from the land are carried out into the sea.

The latter two items may be reflected in the relatively small phytoplankton and zooplankton populations in Puerto Rican coastal waters (Department of Natural Resources, 1979).

a. Inshore Site

In a commercial fisheries survey (Puerto Rico Department of Agriculture, 1976), significant average catches were obtained in the 38-73m depth range of San Juan. Table A-1 shows that the San Juan catches were dominated by three commercially important snappers: the lane snapper, Lutjanus synagris, the vermillion snapper, Rhomboplites aurorubens, and the silk snapper, Lutjanus vivanus. Additional specific data concerning breeding, spawning, etc. is not available for the shallow water site.

TABLE A-1. CATCH RATES (C/F) OF IMPORTANT SPECIES GROUPS, EXPRESSED AS NUMBERS PER 50 POT-DAYS, BY DEPTH RANGE AND SURVEY AREA. SPECIES GROUPS COMPRISING LESS THAN 4 INDIVIDUALS/50 POT-DAYS EXCLUDED

Depth range									
0-20 fms.		21-40 fms.		41-60 fms.		61-90 fms.		91-125 fms.	
Species group	C/f	Species group	C/f	Species grp.	C/f	Species group	C/f	Species grp.	C/f
Lane snapper	67	Lane snapper	204	Verm. snp.	1269	Silk snp.	202	Silk Snp.	184
Grunts	30	Verm. snp.	62	Silk snapper	423	Verm. snp.	186	Vern. snp.	134
Vermillion snp.	14	Silk snapper	57	Lane snapper	131	Voraz snp.	15	Voraz snp.	16
Nassau grp.	8	Hinds, Coney	14	Blackfin snp.	55	Blackfin snp.	8	Lane snapper	4
Rainbow runn.	4	Grunts	12	Grt. amberjack	12	Lane snp.	6		
		Spiny Lobster	4	Hinds, Coney	12				

Source: Puerto Rico Department of Agriculture, 1976.

b. Interim Site

The Interim Site does not encompass any known unique breeding, spawning, nursery, or passage areas of nekton, marine mammals or birds. The open water of the site may be feeding grounds for some wide-ranging pelagic fish (i.e, tuna, jacks, mackeral). Waters at the site are feeding grounds for various snappers (blackfin, silk, and vermilion), but the site is not unique in this regard.

c. Offshore Site

Same as interim site.

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

San Juan, as one of the oldest cities in the Western Hemisphere, is rich in historical interest. While the city has dozens of churches, buildings, and other historic sites, the two most important are El Morro Castle and La Forteleza. First built in 1533 and reconstructed in 1625, La Forteleza was erected by the Spanish colonials as a defense against raids by French and English pirates and Carib Indians. Located on the southwest corner of San Juan Antiguo, it has been the residence of island governors. By the 1540s, the Spanish also were beginning to fortify the northwest tip of the Island of San Juan to protect the entrance to San Juan Bay and Harbor. But the massive fort which today is know as El Morro Castle or the Fortress of San Felipe del Mororo was not begun until 1591. Work on the fortifications continued over the years until by the end of the 18th century, the defenses included El Canuelo, San Cristobal, and the city walls linking the forts. Today, the National Register of Historic Places lists both La Forteleza and the San Juan National Historic Site, which includes in its 40 acres all of the magnificent El Morro's massive works, as well as lesser fortifications at La Princessa on the north coast of the island and along the linking wall extending to San Cristobal on the old island's east end (CE, 1975). Table A-2 summarizes distances to beaches and El Morro Castle for all three alternatives.

	Developed Beaches (Palo Seco and Punta Salinas)	El Moro Castle National Historical site
Inshore Site	$\leq$ 1.0	$\leq$ 1.0
Interim Site	2.5	2.5
Offshore Site	>3.5	>3.5

Table A-2

Distance of Sites from Amenity Areas (nmi)

Although no survey was conducted at a specific inshore site, the potential for adversely affecting the beaches around San Juan, is greater if disposal takes place in the shallower waters rather than at the Interim Site. Use of the offshore site would further reduce any potential risk.

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)]

Identical types and volumes of dredged material would be released at all three alternative ocean sites. All dredged material must meet EPA criteria [40 CFR 227] before permit for ocean disposal is granted. None of the material is to be packaged in any way.

The CE has and will continue to perform dredging using Corps-owned hopper dredges. Future dredging will also be performed by private contract using hopper dragline, clamshell, and dipper dredges (CE, 1975).

A total of 4.3 million yd^3 from San Juan Harbor has been dumped at the Interim Site since 1974. Maintenance dredging would be biennial, remove a total of 465,000 yd^3 of silaceous and other sedimentary materials from San Juan Bay to be disposed at the chosen site biennially.

A deepening project has been proposed by the CE for San Juan Harbor. The proposal under consideration consists of a plan for deepening, widening, and possibly realigning and extending channels; deepening of turning basins, and easing of channel connecting angles within the authorized existing project. Additionally, consideration is being given to incorporation of Sabana approach channel, a Puerto Rico Ports Authority project, into the authorized Federal harbor project. Excavation volume is estimated at 12,795,000 cubic yards of soft material and rock with work to be accomplished by barge-mounted clamshell or dragline and dredged material barged to the offshore disposal area. Accomplishment of the project would require an estimated 41 months from the letting of the initial contract. Maintenance would be scheduled at 2-year intervals and would involve an increase of an estimated 185,000 cubic yards per year over previous maintenance. (CE, 1975).

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

Both surveillance and monitoring are feasible at each of the alternative sites because they are relatively close to shore. Surveillance of disposal operations at the interim and inshore sites could easily be achieved by shipriders and/or coastal observers. Surveillance (by shipriders or aircraft) and monitoring of the offshore site are feasible but would be more difficult and expensive because of the greater distance offshore.

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)]

No specific current direction or velocity data was gathered for this study in the waters off San Juan. However, previous studies indicate that the coastline of Puerto Rico is generally marked by coastal currents (Shepard and Inman, 1950; Wiegel, 1953) that flow approximately parallel to the shore and one therefore divergent to the trend of oceanic currents farther out. In some instances, coastal currents, which may extend out to sea for many miles, may operate as part of broad eddy circulations created by special hydrographic conditions. Off the north coast of Puerto Rico, the oceanic current is westerly or northwesterly, and the prevailing coastal and longshore currents are westerly. This fact is clearly indicated by the westerly grain of the serrated northern coastline (Kaye, 1959). Such currents would tend to disperse the lighter components of the dredged material parallel to the coast.

There is no known upwelling of water at the interim site and a well-mixed layer of surface water extends to approximately 20m in May to 75-100m in January. A strong permanent thermocline inhibits mixing.

The frequent reversals of currents at the interim site indicate that elevated levels of suspended sediments associated with dumping would be dispersed parallel to the coast. Surface turbidity would be dispersed rapidly in the mixed layer. Elevated levels of suspended sediments in mid and bottom waters will remain below the thermocline and also be dispersed parallel to the coast until particles settle to the bottom.

The strength of bottom currents at the interim site is unknown, but sedimentary information indicates that the area is a depositional environment. This horizontal movement of dredged material on the sea floor is not expected.

7. EXISTENCE AND EFFECTS OF CURRENT AND PREVIOUS DISCHARGES AND DUMPING IN THE AREA (INCLUDING CUMULATIVE EFFECTS) [40 CFR §228.(6)(a)(7)]

a. Inshore Site

An unknown amount of dredged material was placed at a shallow site (centered at 18°00'03"N, 66°08'22"W) in the 1960's. Any immediate and cumulative effects at the site were not documented (Hart, personal correspondence).

b. Interim Site

Chemical and biological data suggest that previous disposal has created only minor modifications at the site (See Appendix A). Oil and grease levels are higher in site sediments, however, levels of other trace contaminants show no consistent trends.

Benthic informal communities at the Interim Site show low abundances and diversity similar to the surrounding area.

Water quality parameters at this site are similar to those found in surrounding waters.

c. Offshore site

Area has never received dredged material.

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)]

Although heavy shipping and cruise ship traffic passes through or in the vicinity of all three alternative sites, disposal activities will not cause any interference with these activities. The small volume of dredged material makes operations and maintenance disposal activities necessary only twice a year.

A modest commercial fishery exists out of San Juan, mainly in the shallow water area. Commercial fishing is hampered by rough seas and strong winds, conditions occurring throughout most of the year.

Disposal activities would not be expected to interfere with fishing activities at the interim or offshore sites. Although no specific data was gathered at the inshore site, use of the region could reasonably be expected to increase turbidity in the area which could have potential adverse impact on the coral reef communities and waterfront recreational facilities.

The Bureau of Land Management does not plan to lease any part of the north coast for oil or gas extraction. No other mineral extraction occurs at or near the Interim Site.

Desalination or fish and shellfish culture activities are not known to exist in the area.

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)]

a. Inshore Site

The water off the north coast of Puerto Rico are typical of tropical seawater in having generally low concentrations of nutrients. Although no specific studies have been performed in the shallow waters off San Juan, the benthic community associated with the hard bottom environment in these waters is very important. It exhibits the highest diversity of organisms and also has a direct influence on other communities. The community serves as a habitat for many demersal fishes which are an intricate part of the icthyofaunal food web, and its lush algae are a primary producer for the populations and organisms that live in it, below it in the honeycombed substrate, and above it in the water column. Its importance cannot be ignored (Puerto Rico Nuclear Center, 1975).

b. Interim Site

An environmental survey of the Interim Site was conducted in 1980. The study revealed oceanic water similar in water quality and thermal-haline structure to other areas of the tropical Atlantic.

Benthic infaunal populations at the site and surrounding regions of similar depth are extremely low in density and dominated by polychaete and sipunculid worms.

Fish fauna at the site are expected to be sparse and composed of wide-ranging pelagic fish, such as tunas, jacks, and mackerals. Deep-waters at the site may be inhabited by various species having wide depth ranges (snappers, spiny dogfish, conger eels, and batfishes) as well as others representative of the abyssal slope, such as grenadiers.

Potential adverse effects at the site are mitigated by the rapid dilution and dispersion of the dredged material. Benthic organisms would be smothered but subsequent resolunitation would occur.

c. Offshore Site

No site-specific water quality or ecological data is available. Since the site is in deep waters, effects of disposal would be similar to but not as pronounced as those at the Interim Site.

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

There are no components in the dredged material or consequences of its disposal which would attract such fuana to the alternative sites. Nuisance species have not been observed as a result of disposal activities at the Interim 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)

The National Register of Historic Places and its supplements list no sites within or near the three alternative sites (see criteria three).

CONCLUSION

In making a recommendation for final site designation, a major factor which must be considered is the cost of transporting the dredged material to the site. The total cost of dredging material from San Juan Bay is the sum of:

- Operating costs of the hopper dredge.
- Monitoring and surveillance costs.
- Income lost from resource development.

Cost components will be used to compare the expense of using the inshore and offshore sites with the historically used interim site. No loss of income from resource development is caused by disposal activities at any of the sites.

A disposal site located in the inshore area would save approximately $70,000 per 500,000 yd^3, the amount to be dredged annually. As previously discussed in the "11 Specific Criteria", use of a shallow, inshore site has the potential to adversely impact the coral reef communities and the recreational facilities of this area.

In light of this potential adverse environmental impact use of an inshore site cannot be justified. The immediate and relatively modest economic benefit is not worth the potential environmental risk. The inshore site is thus eliminated as a disposal alternative.

Use of an offshore site would move the effects of dumping further from the shore. Turbidity and nutrient release would be less likely to be detected in the deeper water. Other environmental effects would be similar to those detected at the interim site. In light of the fact that there is no evidence to indicate that the Interim Site is currently creating adverse water quality effects in coastal waters, the added cost of transporting the material the greater distance cannot be justified. The cost of monitoring would also be higher at an offshore site both because of higher travel costs and increased costs of sampling in deeper waters. For these reasons, a site located further offshore than the existing interim site cannot be justified. Thus, the Interim Site is recommended as the site to receive final designation as the San Juan, Puerto Rico ODMDS.

APPENDIX C

RESULTS OF BIOASSAY EVALUATION OF SEDIMENTS FROM SAN JUAN HARBOR, PUERTO RICO

CONTRACT NO. DACW17-79-C-0074

SEPTEMBER 1979
FINAL REPORT

PREPARED FOR:

Department of the Army
Jacksonville District, Corps of Engineers

JONES, EDMUNDS & ASSOCIATES, INC.
730 North Waldo Road
Gainesville, Florida 32601

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PART I. SUMMARY AND CONCLUSIONS

1. Sediments from five locations in San Juan Harbor, Puerto Rico (Figure 1) were subjected to bioassay and bioaccumulation tests and to liquid phase chemical analyses following Federal guidelines as published in the EPA/COE Manual*.

2. No limiting permissible concentration (LPC) based on suspended particulate phase (SPP) or liquid phase (LP) bioassays would be approached during ocean disposal of any of the five sediments.

3. None of the five solid phase samples was toxic to clams, grass shrimp or polychaetes. There were no significant differences in survival between the controls (clean sand) and the test sediments for any of the test species, and the LPC would not be approached during ocean disposal of any of the five solid phases.

4. Generally, the liquid phase chemical analyses revealed few significant differences from the control seawater. The control seawater had a cadmium (Cd) content 13.2 times the LPC (5 ppb); but the liquid phase Cd concentrations were not significantly different from this. Seawater from the east coast of Florida routinely has a cadmium content higher than the LPC. The mercury content of the control seawater was below the LPC (0.1 ppb) and the limits of detection for the analysis (0.1 ppb). Only two of the five sediment elutriates (SJ1 and SJ2) had concentrations of mercury exceeding the LPC. Assuming that the concentration of mercury in the seawater at the disposal site is less than 99% of the LPC (0.1ppb), the liquid phase of SJ1 and SJ2 will not exceed the LPC.

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*Environmental Protection Agency/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material, "Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters; Implementation Manual for Section 103 of Public Law 92-532 (Marine Protection, Research, and Sanctuaries Act of 1972)," July 1977 (Second Printing April 1978), Environmental Effects Laboratory, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

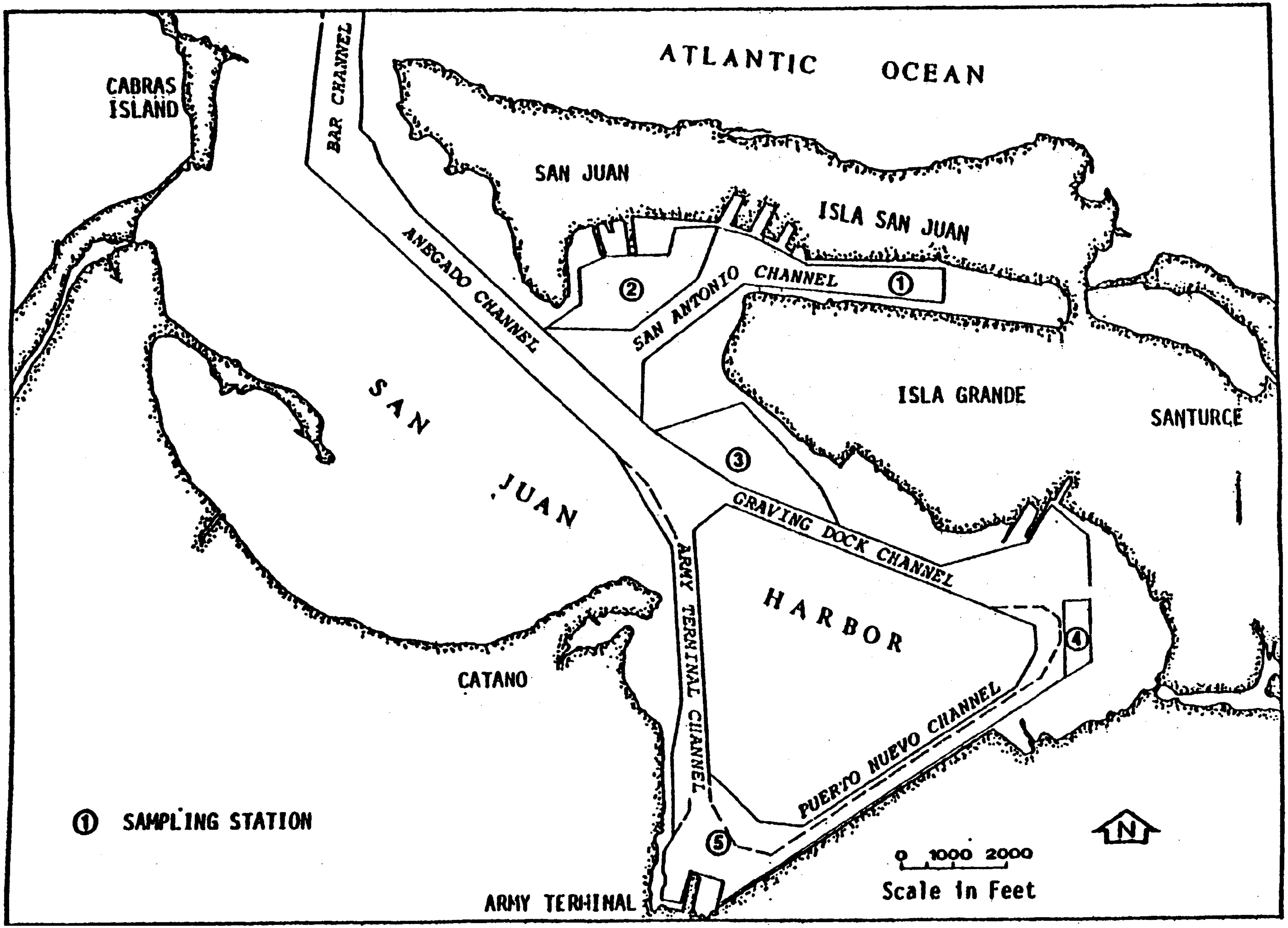

Figure 1. Sampling locations of sediments used in tests.

5. None of the clam tissues assayed for bioaccumulation showed any significant accumulation of either cadmium or mercury. PCB's and petroleum hydrocarbons were below detection in all of the tissue samples analyzed.

6. The disposal vessel, traveling at 2.68 m/sec will require 300 seconds to empty a full capacity load of 9200 m^3. The maximum water depth at the disposal site was assumed to be 20m. These figures yield a calculated dilution factor of 0.00126 or 0.126% after the four-hour initial mixing period.

PART II. METHODS

7. Sediment samples were collected using a Ponar grab sampler. Sediments were placed directly into 6-gallon polyethylene containers, which were filled t the top and tightly sealed. Sediment samples were shipped air express and were used immediately upon receipt in the laboratory. The remaining sediment was stored in a chest freezer specially modified to maintain a temperature of 1-4°C All sediment was used within two weeks.

8. Suspended particulate phase (SPP) for each sediment was prepared in a single 52-gallon linear polyethylene drum. Ten gallons of sediment and 40. gallons of sand-filtered seawater were thoroughly mixed for a half-hour using commercial mixer with stainless steel shaft and blades. The suspension was then allowed to settle for at least 1 hour. The liquid overlying the settled sediment was carefully siphoned off and placed in the appropriate test chambers.

9. Liquid phase (LP) was prepared by Millipore filtering (0.45μm) SPP. A new filter was used for each sediment sample, and the first half litre of filtrate was discarded. In addition to that used in bioassays, two gallons of LP were prepared for chemical analysis. One gallon was placed on ice, and one gallon was acidified (pH $<$ 2) with nitric acid before cooling. Containers were 1-gallon Cubitainers. The samples were packed on ice and sent air sprint to Micro Methods in Pascagoula, Mississippi for chemical analysis. The samples were received within 4 hours.

10. All seawater used in controls, for preparation of all test liquids, and for water changes in solid phase tests was obtained from Marineland, Florida. The seawater is sand filtered at Marineland and subsequently transported in linear polyethylene tanks to our laboratory in Gainesville. Seawater was stored in linear polyethylene tanks upon return to the lab.

Liquid and Suspended Particulate Phase Bioassays

11. Three control vessels with filtered seawater and three replicates each of LP and SPP were set up for each of three test species. All bioassays were illuminated by Sylvania 40 watt cool white fluorescent lights on a 14 hour light/10 hour dark cycle. Laboratory temperature was maintained at 21±2°C.

12. Ten individuals of the sheephead minnow, Cyprinodon variegatus, were placed into 1 1/2 gallon molded glass aquaria containing 4 litres of liquid. Juveniles minnows, 1-1.5 cm in length, that had been cultured in the lab, were used. The aquaria were aerated continuously.

13. Mysid (Mysidopsis bahia) bioassays were performed in 1 1/2 gallon all-glass molded aquaria containing 4 litres of liquid. These assays were also aerated continuously. Mysids were fed Artemia twice daily to prevent cannabalism.

14. Zooplankton tests were performed on Palaemonetes pugio larvae. Larvae were collected from gravid females maintained in our lab and were used within 48 hours after hatching. Tests were run in 300 ml glass crystallizing dishes with 250 ml of liquid. These tests were not aerated.

15. The suspended particulate and liquid phase experiments were continued for 96 hours, as specified in the Register (227.27c), even though results after the first four hours do not enter into the interpretation. However, the register (227.27c) allows a shorter period for zooplankton tests because some of the test species cannot be expected to survive for the full 96 hours.

16. The number of survivors was counted four, eight and 24 hours after set up and every 24 hours thereafter up to 96 hours. Salinity, temperature, dissolved oxygen and pH were measured at the beginning and end of the experiments (see Appendix B).

Solid Phase Bioassay

17. Solid phase bioassays were performed in 10-gallon, all-glass aquaria with continuous aeration. Sieved (500 μm) reference sediment (clean sand) was placed in each aquarium to a 3 centimeter depth, and then 20 clams <u>Mercenaria mercenaria</u> and 20 grass shrimp <u>Palaemonetes pugio</u> were added to each aquarium. The animals were allowed a two day acclimation period. After two days, 1.5 cm of reference sediment (controls) or fresh test sediment was distributed evenly through each aquarium. One hour after adding the sediments and every 48 hours thereafter, water was siphoned off and replaced with fresh filtered seawater. Survivors were counted after 10 days.

18. Solid phase bioassays with polychaetes were performed in the same manner 1 1/2 gallon molded glass aquaria. The polychaetes, <u>Neanthes arenaceodentata</u>, were introduced into the reference sediment 48 hours before the test sediment was applied. All aquaria were aerated continuously. The water was changed precisely as described above. Survivors were counted after 10 days.

Collection and Handling of Animals

19. Clams and polychaetes used in the solid phase bioassays were obtained commercially. The clams were field collected (North Carolina) <u>Mercenaria mercenaria</u> of uniform size (1 1/2 - 2 cm long). Laboratory cultured polychaetes, <u>Neanthes arenaceodentata</u>, were purchased from D.J. Reish at California State University, Long Beach.

20. Grass shrimp and mysids used in the tests were routinely collected from t east coast of Florida. All field collected animals were well acclimated befo use in the bioassays. Great care was always exercised to treat animals gently during collection and subsequent handling. Field collected gravid grass shrimp were separated and held in special containers until the larvae were released. These larvae were then used as the zooplankton species in the liquid and suspended particulate phase tests.

Bioaccumulation

21. Clams surviving the solid phase bioassay tests were prepared for chemical analysis in order to assess the potential for bioaccumulation of metals and organic residues from the sediments assayed. At the end of the solid phase bioassays, clams were kept in filtered seawater for two days in order to void their intestines. The clams were killed by freezing and were briefly thawed for cleaning. The flesh was placed in labeled plastic bags and frozen; shells were discarded. Frozen clam tissue was sent air sprint to Micro Methods in Pascagoula, Mississippi for analysis. The samples were received within 4 hours.

Chemical Analysis

22. Mercury and its compounds were measured by the cold-vapor atomic absorption technique after low-temperature acid digestion. Cadmium and its compounds were measured on the same digest, using atomic absorption spectrophotometry.

23. Organohalogen compounds were extracted and measured using acetonitrile partitioning and columnchromatography followed by quantification by gas chromatography using Ni-63 electron capture detection. Techniques for petroleum hydrocarbons included saponification, ether extraction, fractionation on a silica gel column, and gas chromatography using flame ionization.

III. RESULTS AND DISCUSSION

Sediment SJ1 Bioassays

24. Based on results of the suspended particulate phase (SPP) and liquid phase (LP) bioassays, the limiting permissible concentration (LPC) would not be exceeded during ocean disposal of sediment SJ1. Mysids (SPP, 83%; LP, 90%), sheephead minnows (SPP and LP, 100%) and grass shrimp larvae (SPP and LP, 97%) survived well in the LP and SPP prepared from sediment SJ1.

25. In the solid phase tests of sediment SJ1, clams (100%), grass shrimp (88%) and polychaetes (98%) all survived well. Grass shrimp survival was not significantly different from control survival (93%). The LPC would not be exceeded during ocean disposal of SJ1 based on the results of these solid phase bioassays.

Sediment SJ2 Bioassays

26. Results of the bioassays of the SPP and LP of sediment SJ2 indicate that the LPC would not be exceeded during ocean disposal. Survival among mysids (SPP, 90%; LP, 90%) sheephead minnows (SPP and LP, 100%) and grass shrimp larvae (SPP, 93%; LP, 97%) was excellent.

27. In the solid phase tests of sediment SJ2, clams (99%), grass shrimp (89%) and polychaetes (100%) survived well; and therefore, the LPC would not be exceeded during ocean disposal of sediment SJ2.

Sediment SJ3 Bioassays

28. Based on bioassay results of the SPP and LP of sediment SJ3, the LPC would not be exceeded during ocean disposal. Survival was excellent among all test species: mysids (SPP, 83%; LP 90%); grass shrimp larvae (SPP, 93%, LP, 97%); and sheephead minnows (SPP and LP, 100%).

29. In the solid phase tests of sediment SJ3, clams (99%), grass shrimp (84%) and polychaetes (99%) all survived well. Grass shrimp survival was not significantly different from control survival (93%).

Sediment SJ4 Bioassays

30. Results of the bioassays of the SPP and LP of sediment SJ4 also indicate that the LPC would not be exceeded during ocean disposal. Mysids (SPP, 90%; LP 83%), sheephead minnows (SPP and LP, 100%) and grass shrimp larvae (SPP, 90%; LP, 97%) all survived well.

31. In the solid phase bioassays of sediment SJ4, clams (99%), grass shrimp (84%) and polychaetes (98%) ~~survived well~~; and therefore, the LPC would not be exceeded during ocean disposal of sediment SJ4.

Sediment SJ5 Bioassays

32. Based on bioassay results of the SPP and LP of sediment SJ5, the LPC would not be exceeded during ocean disposal. Survival was excellent among all test species: mysids (SPP 86%; LP 90%); sheephead minnows (SPP and LP, 100%); and grass shrimp larvae (SPP, 97%; LP, 93%).

33. In the solid phase tests of sediment SJ5, clams (100%), grass shrimp (84% and polychaetes (98%) survived well; therefore, the LPC would not be exceeded during ocean disposal of sediment SJ5.

34. In summary, none of the sediment samples taken from San Juan Harbor significantly decreased survival of the test organisms in the SPP, LP or solid phase bioassays. There are no indications that the LPC would be exceeded durin ocean disposal of any of the 5 sediment samples, based on the results of the bioassays.

Liquid Phase Chemical Analyses

35. Results of the metal and nutrient analyses of liquid phase samples for ea of the sediments (see Table A-10) revealed only a few differences from the control seawater values. Only two of the eleven metals (As and Hg) showed elevated levels in the liquid phase samples compared to the control seawater. Sediments SJ3 and SJ5 had arsenic concentrations 28.5 and 8.5 times (respectively) the control seawater concentration (0.002 ppm). Currently, th is no LPC established for arsenic. The concentrations of mercury in the liqu phase of SJ1 and SJ2 were 11 and 6 times (respectively) the control seawater concentration and the LPC. In this case, the LPC is equal to the detection limit of mercury in water (0.1 ppb). Assuming that the concentration of merc in seawater at the disposal site is no greater than 99% of the LPC, the liqui phase of SJ1 and SJ2 will not exceed the LPC for Hg following initial mixing. Although the concentrations of cadmium in all of the 5 liquid phase samples w considerable higher than the suggested LPC (5 ppb), they were not different from the control seawater (66 ppb). The cadmium concentration of seawater from the east coast of Florida was 13.2 times the LPC.

36. As is usual for sediment elutriates, several of the liquid phases showed nitrogen (NH_3 and TKN) and phosphorus (orthophosphate and total phosphate) levels greater than for the seawater. Thusfar,no LPC's have been established for nutrients.

37. The concentration of petroleum hydrocarbons was below the limit of detection (0.1 ppm) for all water samples analyzed.

Bioaccumulation Tests

38. The concentrationsof cadmium in the tissue of clams exposed to the five test sediments were less than the Cd concentration of the control (clean sand) clam tissue. The concentrations of Hg in the same tissue samples showed no significant differences from the control concentration. PCB and petroleum hydrocarbons were below detection for all clams from all treatments.

APPENDIX A: DATA FROM BIOASSAYS AND ANALYSES PERFORMED

Table A-1
Summary of Bioassay Results

Ratios are control/test sediments. Numbers are total numbers of survivors at the end of the test. None of the differences is significant.

Suspended Particulate Phase	SJ1	SJ2	SJ3	SJ4	SJ5
Sheephead minnows	30/30	30/30	30/30	30/30	30/30
Mysids	28/25	28/27	28/25	28/27	28/26
Grass shrimp larvae (48 hrs)	29/29	29/28	29/28	29/27	29/29
Liquid Phase					
Sheephead minnows	30/30	30/30	30/30	30/30	30/30
Mysids	28/27	28/27	28/27	28/25	28/27
Grass shrimp larvae (48 hrs)	29/29	29/29	29/29	29/29	29/28
Solid Phase					
Hard clams	100/100	100/99	100/99	100/99	100/100
Grass shrimp	93/88	93/89	93/84	93/84	93/84
Polychaetes	100/98	100/100	100/99	100/98	100/98

Table A-2

Static Bioassays of Sediment 1

		Hours After Start					
		4	8	24	48	72	96
Cyprinodon variegatus							
Controls	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Palaemonetes pugio (larvae)							
Controls	1	10	10	9	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	29	29		
		Larvae starved to death after 48 hrs.					
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	10		
	2	10	10	10	9		
	3	10	10	10	10		
		30	30	30	29		

Table A-2

Static Bioassays of Sediment I (Continued)

		Hours After Start					
		4	8	24	48	72	96
Liquid Phase (LP)							
100% LP	1	10	10	10	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	30	29		
*Mysidopsis bahia**							
Controls	1	10	10	10	5		
	2	10	10	10	2		
	3	10	10	10	3		
		30	30	30	10		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	4		
	2	9	9	9	4		
	3	10	10	10	3		
		29	29	29	11		
Liquid Phase (LP)	1	10	10	10	2		
100% LP	2	10	10	10	3		
	3	10	10	10	4		
		30	30	30	9		

*Tests discontinued because of apparent contamination of commercially obtained *Artemia* fed to the mysids.

Table A-2

Static Bioassays of Sediment 1 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Mysidopsis bahia - RERUN							
Controls	1	10	10	10	10	9	9
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	28
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	8
	2	10	10	10	10	9	8
	3	10	10	10	10	10	9
		30	30	30	30	29	25
Liquid Phase (LP)							
100% LP	1	10	10	10	10	9	8
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	27

Table A-3

Static Bioassays of Sediment 2

		Hours After Start					
		4	8	24	48	72	96
Cyprinodon variegatus							
Controls	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Palaemonetes pugio (larvae)							
Controls	1	10	10	9	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	29	29		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	10		
	2	10	10	10	9		
	3	10	10	9	9		
		30	30	29	28		

Table A-3

Static Bioassays of Sediment 2 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Liquid Phase (LP)							
100% LP	1	10	10	10	10		
	2	10	10	9	9		
	3	10	10	10	10		
		30	30	29	29		
*Mysidopsis bahia**							
Controls	1	10	10	10	5		
	2	10	10	10	2		
	3	10	10	10	3		
		30	30	30	10		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	9	2		
	2	10	10	10	4		
	3	10	10	10	2		
		30	30	29	8		
Liquid Phase (LP)	1	10	10	9	3		
100% LP	2	10	10	10	3		
	3	10	10	10	2		
		30	30	29	8		

*Tests discontinued because of apparent contamination of commercially obtained *Artemia* fed to the mysids.

Table A-3

Static Bioassays of Sediment 2 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Mysidopsis bahia - RERUN							
Controls	1	10	10	10	10	9	9
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	28
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	9	9
	2	10	10	10	9	9	8
	3	10	10	10	10	10	10
		30	30	30	29	28	27
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	8
	2	10	10	10	10	10	9
	3	10	10	10	10	10	10
		30	30	30	30	30	27

Table A-4

Static Bioassays of Sediment 3

		Hours After Start					
		4	8	24	48	72	96
Cyprinodon variegatus							
Controls	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Palaemonetes pugio (larvae)							
Controls	1	10	10	9	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	29	29		
		Larvae starved to death after 48 hrs.					
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	10		
	2	10	10	9	9		
	3	10	10	10	9		
		30	30	29	28		

Table A-4

Static Bioassays of Sediment 3 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Liquid Phase (LP)							
100% LP	1	10	10	10	10		
	2	10	10	10	10		
	3	10	10	9	9		
		30	30	29	29		
Mysidopis bahia*							
Controls	1	10	10	10	5		
	2	10	10	10	2		
	3	10	10	10	3		
		30	30	30	10		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	9	2		
	2	10	10	10	2		
	3	10	10	9	4		
		30	30	28	8		
Liquid Phase (LP)	1	10	10	9	4		
	2	10	10	10	5		
	3	10	10	10	2		
		30	30	29	11		

*Tests discontinued because of apparent contamination of commercially obtained Artemia fed to the mysids.

Table A-4

Static Bioassays of Sediment 3 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Mysidopsis bahia - RERUN							
Controls	1	10	10	10	10	9	9
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	28
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	9
	2	10	10	10	10	9	9
	3	10	10	10	10	9	7
		30	30	30	30	28	25
Liquid Phase (LP)							
100% LP	1	10	10	10	10	9	8
	2	10	10	10	10	10	9
	3	10	10	10	10	10	10
		30	30	30	30	29	27

Table A-5

Static Bioassays of Sediment 4

		Hours After Start					
		4	8	24	48	72	96
Cyprinodon variegatus							
Controls	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Palaemonetes pugio (larvae)							
Controls	1	10	10	9	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	29	29		
		Larvae starved to death after 48 hrs.					
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	8	8		
	2	10	10	10	9		
	3	10	10	10	10		
		30	30	28	27		

Table A-5

Static Bioassays of Sediment 4 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Liquid Phase (LP)							
100% LP	1	10	10	10	10		
	2	10	10	10	9		
	3	10	10	10	10		
		30	30	30	29		
*Mysidopsis bahia**							
Controls	1	10	10	10	5		
	2	10	10	10	2		
	3	10	10	10	3		
		30	30	30	10		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	1		
	2	9	9	8	3		
	3	10	10	9	3		
		29	29	27	7		
Liquid Phase (LP)	1	10	10	10	4		
100% LP	2	10	10	9	2		
	3	10	10	9	3		
		30	30	28	9		

*Tests discontinued because of apparent contamination of commercially obtained *Artemia* fed to the mysids.

Table A-5

Static Bioassays of Sediment 4 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Mysidopsis bahia - RERUN							
Controls	1	10	10	10	10	9	9
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	28
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	9
	2	10	10	10	10	9	8
	3	10	10	10	10	10	10
		30	30	30	30	29	27
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	9	8
	3	10	10	10	10	8	7
		30	30	30	30	27	25

Table A-6

Static Bioassays of Sediment 5

		Hours After Start					
		4	8	24	48	72	96
Cyprinodon variegatus							
Controls	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	10	10
	3	10	10	10	10	10	10
		30	30	30	30	30	30
Palaemonetes pugio (larvae)							
Controls	1	10	10	9	9		
	2	10	10	10	10		
	3	10	10	10	10		
		30	30	29	29		
		Larvae starved to death after 48 hrs.					
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	10	10		
	2	10	10	10	9		
	3	10	10	10	10		
		30	30	30	29		

Table A-6

Static Bioassays of Sediment 5 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Liquid Phase (LP)							
100% LP	1	10	10	10	9		
	2	10	10	10	9		
	3	10	10	10	10		
		30	30	30	28		
*Mysidopsis bahia**							
Controls	1	10	10	10	5		
	2	10	10	10	2		
	3	10	10	10	3		
		30	30	30	10		
Suspended Particulate Phase(SPP)							
100% SPP	1	10	10	9	5		
	2	10	10	8	2		
	3	10	10	9	3		
		30	30	26	10		
Liquid Phase (LP)	1	10	10	10	6		
100% LP	2	10	10	9	2		
	3	10	10	10	1		
		30	30	29	9		

*Tests discontinued because of apparent contamination of commercially obtained *Artemia* fed to the mysids.

Table A-6

Static Bioassays of Sediment 5 (Continued)

		Hours After Start					
		4	8	24	48	72	96
Mysidopsis bahia - RERUN							
Controls	1	10	10	10	10	9	9
	2	10	10	10	10	10	10
	3	10	10	10	10	10	9
		30	30	30	30	29	28
Suspended Particulate Phase (SPP)							
100% SPP	1	10	10	10	10	10	9
	2	10	10	10	9	9	7
	3	10	10	10	10	10	10
		30	30	30	29	29	26
Liquid Phase (LP)							
100% LP	1	10	10	10	10	10	10
	2	10	10	10	10	9	8
	3	10	10	10	9	9	9
		30	30	30	29	28	27

Table A-7

Results of Solid Phase Bioassays with *Mercenaria mercenaria*

		Control	SJ1	SJ2	SJ3	SJ4	SJ5
Replicate	1	20	20	20	19	20	20
	2	20	20	20	20	19	20
	3	20	20	19	20	20	20
	4	20	20	20	20	20	20
	5	20	20	20	20	20	20
		100	100	99	99	99	100

Table A-8

Results of Solid Phase Bioassays with *Palaemonetes pugio*

		Control	SJ1	SJ2	SJ3	SJ4	SJ5
Replicate	1	18	18	18	19	18	15
	2	20	17	16	16	14	16
	3	19	16	17	17	19	18
	4	17	18	18	17	17	19
	5	19	19	20	15	16	16
		93	88	89	84	84	84
CSS		5.2	5.2	8.8	8.8	14.8	10.8
s^2		1.3	1.3	2.2	2.2	3.7	2.7

$MS_{treatments}$ = 2.72

MS_{error} = 2.23

F = 1.22 (not significant)

$F_{.05}(5,24) = 2.62$

Table A-9

Results of Solid Phase Bioassays with *Neanthes arenaceodentata*

		Control	SJ1	SJ2	SJ3	SJ4	SJ5
Replicate	1	20	20	20	20	20	20
	2	20	20	20	20	20	19
	3	20	19	20	20	19	20
	4	20	19	20	20	20	19
	5	20	20	20	19	19	20
		100	98	100	99	98	98

Table A-10

Metal and Nutrient Analyses of Liquid Phase Samples

(Values are all reported in milligrams per litre (ppm).)

Constituents	Control	SJ1	SJ2	SJ3	SJ4	SJ5
NO_2-N[1]	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
NO_3-N[1]	0.05	0.05	0.05	0.075	0.11	0.05
NH_3-N[1]	<0.02	<0.02	0.21	0.26	0.56	0.33
TKN-N[1]	0.18	0.06	0.25	0.30	0.58	0.66
Orthophosphate-PO_4[1]	0.50	0.22	0.50	1.50	1.20	3.65
Total phosphate-PO_4[1]	0.76	0.76	1.84	2.24	1.84	5.20
TOC-C[1]	9.0	10.0	11.0	11.0	12.0	12.0
As[1]	0.002	<0.001	<0.001	0.057	0.006	0.017
Be[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cd[3]	0.066	0.070	0.070	0.070	0.073	0.077
Cr[1]	0.35	0.39	0.41	0.40	0.43	0.37
Cu[4]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hg[5]	<0.0001	0.0011	0.0006	<0.0001	<0.0001	<0.0001
Ni[6]	0.22	0.24	0.26	0.24	0.25	0.25
Pb[6]	0.04	0.05	0.06	0.05	0.05	0.04
Se[6]	<0.002	<0.002	0.002	0.002	0.002	0.003
Zn[6]	0.01	0.03	0.02	0.01	0.01	0.01
Va[1]	0.005	0.006	0.004	0.004	0.005	0.003
Pet. Hydrocarbons[1]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Marine standards suggested by U.S. EPA 1976 Quality Standard for Water (EPA-440/9/76/023) are: [1]none suggested; [2]0.01 times the 96 hour LC_{50} in flowing water bioassays; [3]5.0 ppb ; [4]0.01 times the 96 hour LC_{50};

Table A-11

Chemical Analyses from Bioaccumulation Tests
(Values in parts per million (µg/g)
test species *Mercenaria mercenaria*)

Mercury

Replicate	Control	SJ1	SJ2	SJ3	SJ4	SJ5
1	0.033	<0.001	0.013	0.003	0.062	0.045
2	0.003	0.003	0.083	0.028	0.003	0.380
3	0.005	0.003	0.038	0.080	0:003	0.043
4	0.013	0.004	0.028	0.018	0.008	0.013
5	0.017	0.011	0.028	0.018	<0.001	0.011
$\bar{x}$ =	0.0142	0.0044	0.0371	0.0294	0.0154	0.0984
CSS =	0.00058	0.00006	0.0028	0.0035	0.0027	0.100
s^2 =	0.000145	0.000015	0.00069	0.00088	0.00068	0.025

(Variances were nonhomogeneous; therefore, we applied the approximate test of the equality of means given by Sokal and Rohlf.)

F_s = 3.13(not significant)
$F_{.05}(5,10)$ = 3.33

Cadmium

Replicate	Control	SJ1	SJ2	SJ3	SJ4	SJ5
1	0.18	0.13	0.14	0.16	0.08	0.12
2	0.18	0.10	0.13	0.13	0.08	0.12
3	0.19	0.17	0.13	0.08	0.12	0.09
4	0.16	0.15	0.14	0.14	0.08	0.07
5	0.20	0.12	0.10	0.12	0.10	0.15
$\bar{x}$	0.182	0.134	0.128	0.126	0.092	0.11

Table A-11
(Continued)

PCB

		Control	SJ1	SJ2	SJ3	SJ4	SJ5
Replicate	1	ND*	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND
	4	ND	ND	ND	ND	ND	ND
	5	ND	ND	ND	ND	ND	ND

Limit of detection for PCB is 0.01 μg/g.

Petroleum Hydrocarbons

		Control	SJ1	SJ2	SJ3	SJ4	SJ5
Replicate	1	ND*	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND
	4	ND	ND	ND	ND	ND	ND
	5	ND	ND	ND	ND	ND	ND

Limit of detection for petroleum hydrocarbons is 1.0μg/g.

*None Detected

APPENDIX B: DATA FROM PHYSICAL PARAMETERS MEASURED ON BIOASSAYS

Physical Parameters of Static Bioassays of
Sediment 1

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Cyprinodon variegatus Controls	1	23/22	30/30	8.0/7.4	7.9/7.9
	2	23/22	30/30	8.0/6.8	7.9/7.8
	3	23/22	30/30	8.0/7.8	7.9/8.0
100% SPP	1	23/22	32/32	7.9/8.0	7.9/7.9
	2	23/22	32/32	7.9/8.1	7.9/8.0
	3	23/22	32/32	7.9/8.0	7.9/8.0
100% LP	1	23/22	32/32	8.1/8.1	8.0/7.9
	2	23/22	32/32	8.1/8.2	8.0/8.0
	3	23/22	32/32	8.1/8.1	8.0/7.9

. . . .

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Palaemonetes pugio (larvae) Controls	1	23/22	29/32	6.8/7.0	7.9/8.0
	2	23/22	29/32	6.8/7.0	7.9/8.0
	3	23/22	29/32	6.8/7.0	7.9/8.0
100% SPP	1	23/22	30/31	6.9/6.3	7.8/7.9
	2	23/22	30/31	6.9/6.3	7.8/7.9
	3	23/22	30/31	6.9/6.4	7.8/7.9
100% LP	1	23/22	30/31	8.0/6.1	7.9/7.9
	2	23/22	30/31	8.0/6.2	7.9/7.9
	3	23/22	30/31	8.0/6.1	7.9/7.9

Table B-1

Physical Parameters of Static Bioassays of
Sediment 1 (Continued)

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Mysidopsis bahia - RERUN					
Controls	1	20/21	31/31	8.3/8.2	8.1/8.2
	2	20/21	31/31	8.4/8.5	8.1/8.1
	3	20/21	31/31	8.2/8.5	8.1/8.1
100% SPP	1	20/21	31/32.5	8.5/8.5	8.1/8.1
	2	20/21	31/32.5	8.5/8.2	8.1/8.2
	3	20/21	31/32	8.6/8.4	8.1/8.2
100% LP	1	20/21	31/32	8.5/8.1	8.1/8.2
	2	20/21	31/33	8.5/8.5	8.1/8.2
	3	20/21	31/33	8.5/8.5	8.1/8.1

Physical Parameters of Static Bioassays of Sediment 2

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Cyprinodon variegatus					
Controls	1	23/22	30/30	8.0/7.4	7.9/7.9
	2	23/22	30/30	8.0/6.8	7.9.7.8
	3	23/22	30/30	8.0/7.8	7.9/8.0
100% SPP	1	23/22	33/33	8.0/7.9	8.0/7.9
	2	23/22	33/33	8.0/8.3	8.0/7.9
	3	23/22	33/33	8.0/8.2	8.0/8.0
100% LP	1	23/22	33/33	7.7/8.0	7.9/7.8
	2	23/22	33/33	7.7/8.0	7.9/7.9
	3	23/22	33/33	7.7/8.1	7.9/7.9
Palaemonetes pugio (larvae)					
Controls	1	23/22.	29/32	6.8/7.0	7.9/8.0
	2	23/22	29/32	6.8/7.0	7.9/8.0
	3	23/22	29/32	6.8/7.0	7.9/8.0
100% SPP	1	23/22	30/32	7.0/6.5	7.7/8.0
	2	23/22	30/32	7.0/6.4	7.7/8.0
	3	23/22	30/32	7.0/6.5	7.7/7.9
100% LP	1	23/22	30/32	8.0/6.1	7.7/7.9
	2	23/22	30/31	8.0/6.3	7.7/7.9
	3	23/22	30/32	8.0/6.1	7.7/7.8

Table B-2

Physical Parameters of Static Bioassays of Sediment 2 (Continued)

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Mysidopsis bahia - RERUN					
Controls	1	20/21	31/31	8.3/8.2	8.1/8.2
	2	20/21	31/31	8.4/8.5	8.1/8.1
	3	20/21	31/31	8.2/8.5	8.1/8.1
100% SPP	1	20/21	31/33	8.4/8.5	8.2/8.1
	2	20/21	31/33	8.5/8.2	8.2/8.1
	3	20/21	31/33	8.4/8.5	8.2/8.2
100% LP	1	20/21	31/31	8.4/8.2	8.2/8.2
	2	20/21	31/31	8.6/8.5	8.2/8.1
	3	20/21	31/33	8.6/8.4	8.2/8.2

Physical Parameters of Static Bioassays of Sediment 3

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Cyprinodon variegatus					
Controls	1	23/22	30/30	8.0/7.4	7.9/7.9
	2	23/22	30/30	8.0/6.8	7.9/7.8
	3	23/22	30/30	8.0/7.8	7.9/8.0
100% SPP	1	23/22	33/33	8.2/8.0	8.0/8.2
	2	23/22	33/33	8.2/8.0	7.9/8.0
	3	23/22	33/33	8.2/8.2	7.9/8.0
100% LP	1	23/22	33/33	8.3/7.9	7.9/7.9
	2	23/22	33/33	8.3/8.0	7.9/8.0
	3	23/22	33/33	8.3/8.0	7.9/8.0
Palaemonetes pugio (larvae)					
Controls	1	23/22	29/32	6.8/7.0	7.9/8.0
	2	23/22	29/32	6.8/7.0	7.9/8.0
	3	23/22	29/32	6.8/7.0	7.9/8.0
100% SPP	1	23/22	30/32	6.0/5.9	7.7/8.0
	2	23/22	30/32	6.0/6.0	7.7/7.9
	3	23/22	30/31	6.0/5.8	7.7/8.0
100% LP	1	23/22	30/32	8.5/6.3	7.8/8.0
	2	23/22	30/32	8.5/6.4	7.8/8.1
	3	23/22	30/31	8.5/6.4	7.8/8.0

Table B-3.

Physical Parameters of Static Bioassays of
Sediment 3 (Continued)

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Mysidopsis bahia - RERUN					
Controls	1	20/21	31/31	8.3/8.2	8.1/8.2
	2	20/21	31/31	8.4/8.5	8.1/8.1
	3	20/21	31/31	8.2/8.5	8.1/8.1
100% SPP	1	20/21	31/33	8.6/8.5	8.1/8.3
	2	20/21	31/33	8.5/8.5	8.1/8.3
	3	20/21	31/33	8.5/8.5	8.1/8.3
100% LP	1	20/21	31/32	8.5/8.2	8.2/8.3
	2	20/21	31/32	8.5/8.5	8.2/8.3
	3	20/21	31/32	8.6/8.4	8.2/8.2

Physical Parameters of Static Bioassays of Sediment 4

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Cyprinodon variegatus					
Controls	1	23/22	30/30	8.0/7.4	7.9/7.9
	2	23/22	30/30	8.0/6.8	7.9/7.8
	3	23/22	30/30	8.0/7.8	7.9/8.0
100% SPP	1	23/22	34/33	8.0/8.0	7.9/8.0
	2	23/22	34/33	8.0/8.1	8.0/8.1
	3	23/22	34/33	8.0/8.1	7.9/8.0
100% LP	1	23/22	33/33	8.2/8.0	8.0/8.2
	2	23/22	33/33	8.2/8.0	7.9/8.0
	3	23/22	33/33	8.2/8.3	8.0/8.0
Palaemonetes pugio (larvae)					
Controls	1	23/22	29/32	6.8/7.0	7.9/8.0
	2	23/22	29/32	6.8/7.0	7.9/8.0
	3	23/22	29/32	6.8/7.0	7.9/8.0
100% SPP	1	23/22	30.5/32	5.7/6.7	7.8/8.1
	2	23/22	30.5/31	5.7/6.5	7.8/8.0
	3	23/22	30.5/32	5.7/6.5	7.8/8.1
100% LP	1	23/22	30.5/32	8.2/6.8	7.8/7.9
	2	23/22	30.5/32	8.2/6.8	7.8/8.0
	3	23/22	30.5/32	8.2/6.9	7.8/8.0

Table B-4

Physical Parameters of Static Bioassays of Sediment 4 (Continued)

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Mysidopsis bahia - RERUN					
Controls	1	20/21	31/31	8.3/8.2	8.1/8.2
	2	20/21	31/31	8.4/8.5	8.1/8.1
	3	20/21	31/31	8.2/8.5	8.1/8.1
100% SPP	1	20/21	31/31	8.5/8.4	8.1/8.2
	2	20/21	30/32	8.4/8.5	8.1/8.2
	3	20/21	30/32	8.4/8.4	8.1/8.2
100% LP	1	20/21	31/32	8.6/8.5	8.1/8.3
	2	20/21	31/32	8.4/8.5	8.1/8.3
	3	20/21	31/32	8.5/8.5	8.1/8.3

Physical Parameters of Static Bioassays of
Sediment 5

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Cyprinodon variegatus					
Controls	1	23/22	30/30	8.0/7.4	7.9/7.9
	2	23/22	30/30	8.0/6.8	7.9/7.8
	3	23/22	30/30	8.0/7.8	7.9/8.0
100% SPP	1	23/22	34/34	8.2/7.9	8.0/8.2
	2	23/22	34/34	8.2/7.9	8.1/8.3
	3	23/22	34/34	8.2/8.0	8.1/8.3
100% LP	1	23/22	34/33	8.0/8.0	7.9/8.1
	2	23/22	34/34	8.0/8.0	7.9/8.3
	3	23/22	34/33	8.0/8.0	7.9/8.3
Palaemonetes pugio (larvae)					
Controls	1	23/22	29/32	6.8/7.0	7.9/8.0
	2	23/22	29/32	6.8/7.0	7.9/8.0
	3	23/22	29/32	6.8/7.0	7.9/8.0
100% SPP	1	23/22	30.5/32	4.8/6.3	7.8/8.0
	2	23/22	30.5/32	4.8/6.5	7.8/8.0
	3	23/22	30.5/32	4.8/6.4	7.8/8.0
100% LP	1	23/22	30.5/32	8.1/6.4	7.8/8.2
	2	23/22	30.5/32	8.1/6.4	7.8/8.2
	3	23/22	30.5/32	8.1/6.5	7.8/8.1

Table B-5

Physical Parameters of Static Bioassays of
Sediment 5 (Continued)

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity (°/00)	D.O.(ppm)	pH
Mysidopsis bahia - RERUN					
Controls	1	20/21	31/31	8.3/8.2	8.1/8.2
	2	20/21	31/31	8.4/8.5	8.1/8.1
	3	20/21	31/31	8.2/8.5	8.1/8.1
100% SPP	1	20/21	31/32.5	8.4/8.5	8.2/8.4
	2	20/21	31/32.5	8.2/8.4	8.2/8.4
	3	20/21	30/32	8.3/8.6	8.2/8.4
100% LP	1	20/21	31/31	8.5/8.4	8.1/8.2
	2	20/21	31/31	8.4/8.3	8.1/8.2
	3	20/21	31/31	8.2/8.4	8.1/8.3

Table B-6

Physical Parameters of Solid Phase Bioassays of

Sediment 1

INITIAL READINGS/FINAL READINGS

		Temp (°C)	Salinity(°/00)	D.O.(ppm)	pH
Palaemonetes pugio and *Mercenaria mercenaria*					
Controls (clean sand)	1	23/22	29/29	8.1/8.1	7.9/8.[illegible]
	2	23/22	29/29	8.1/7.4	8.0/8.[illegible]
	3	23/22	29/29	8.1/7.9	8.0/8.[illegible]
	4	23/22	28/29	7.5/8.0	8.0/8.[illegible]
	5	23/22	28/29	7.7/8.1	7.9/7.[illegible]
Sediment 1	1	23/22	29/29	7.2/7.3	7.8/7.[illegible]
	2	23/22	30/30	4.3/7.3	7.8/8.[illegible]
	3	23/22	30/30	7.2/7.6	7.7/7.[illegible]
	4	23/22	30/30	7.8/7.7	7.7/7.[illegible]
	5	23/22	30/30	7.7/7.7	7.8/7.[illegible]
Neanthes arenaceodentata					
Controls	1	23/22	31/29	7.1/7.2	7.9/8.[illegible]
	2	23/22	31/29	6.8/7.3	7.8/8.[illegible]
	3	23/22	31/29	6.8/7.4	7.9/8.[illegible]
	4	23/22	31/29	6.9/7.4	7.9/8.[illegible]
	5	23/22	31/29	7.0/7.6	7.9/8.[illegible]
Sediment 1	1	23/22	31/30	6.5/7.0	7.9/7.[illegible]
	2	23/22	31/29	6.8/7.4	8.0/8.[illegible]
	3	23/22	30/30	6.7/7.2	8.0/8.[illegible]
	4	23/22	31/30	6.7/7.2	7.9/7.[illegible]
	5	23/22	31/30	6.8/7.4	7.8/8.[illegible]

Temperature and dissolved oxygen were checked daily. Salinity and pH were measured initially and finally only.

Table B-7

Physical Parameters of Solid Phase Bioassays of Sediment 2

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity(°/00)	D.O.(ppm)	pH
Palaemonetes pugio and *Mercenaria mercenaria*					
Controls (clean sand)	1	23/22	29/29	8.1/8.1	7.9/8.0
	2	23/22	29/29	8.1/7.4	8.0/8.0
	3	23/22	29/29	8.1/7.9	8.0/8.0
	4	23/22	28/29	7.5/8.0	8.0/8.0
	5	23/22	28/29	7.7.8.1	7.9/7.9
Sediment 2	1	23/22	30/29	8.0/7.9	7.8/7.9
	2	23/22	30/30	6.8/7.3	7.8/7.9
	3	23/22	30/29	6.5/7.6	7.8/7.9
	4	23/22	29/29	6.9/7.7	7.9/8.0
	5	23/22	29/29	7.6/8.2	7.9/8.0
Neanthes arenaceodentata					
Controls	1	23/22	31/29	7.1/7.2	7.9/8.0
	2	23/22	31/29	6.8/7.3	7.8/8.0
	3	23/22	31/29	6.8/7.4	7.9/8.1
	4	23/22	31/29	6.9/7.4	7.9/8.1
	5	23/22	31/29	7.0/7.6	7.9/8.0
Sediment 2	1	23/22	31/31	6.9/7.4	8.0/8.1
	2	23/22	31/30	6.9/7.2	8.0/8.0
	3	23/22	31/31	7.0/7.4	8.0/8.1
	4	23/22	31/30	6.9/7.8	8.0/8.1
	5	23/22	31/30	6.9/7.0	8.0/8.1

Temperature and dissolved oxygen were checked daily. Salinity and pH were measured initially and finally only.

Table B-8.

Physical Parameters of Solid Phase Bioassays of

Sediment 3

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity(°/OO)	D.O.(ppm)	pH
Palaemonetes pugio and *Mercenaria mercenaria*					
Controls (clean sand)	1	23/22	29/29	8.1/8.1	7.9/8.[illegible]
	2	23/22	29/29	8.1/7.4	8.0/8.[illegible]
	3	23/22	29/29	8.1/7.9	8.0/8.[illegible]
	4	23/22	28/29	7.5/8.0	8.0/8.[illegible]
	5	23/22	28/29	7.7/8.1	7.9/7.[illegible]
Sediment 3	1	23/22	29/30	7.9/8.0	7.9/8.[illegible]
	2	23/22	30/30	7.7/8.1	7.9/7.[illegible]
	3	23/22	30/29	7.9/7.9	8.0/7.[illegible]
	4	23/22	29/29	7.1/7.9	7.9/8.[illegible]
	5	23/22	29/30	7.8/8.0	8.0/8.[illegible]
Neanthes arenaceodentata					
Controls	1	23/22	31/29	7.1/7.2	7.9/8.[illegible]
	2	23/22	31/29	6.8/7.3	7.8/8.[illegible]
	3	23/22	31/29	6.8/7.4	7.9/8.[illegible]
	4	23/22	31/29	6.9/7.4	7.9/8.[illegible]
	5	23/22	31/29	7.0/7.6	7.9/8.[illegible]
Sediment 3	1	23/22	31/31	7.0/7.6	7.9/7.[illegible]
	2	23/22	31/30	7.0/7.4	7.9/8.[illegible]
	3	23/22	31/31	6.9/7.4	7.8/8.[illegible]
	4	23/22	31/31	6.9/7.8	7.9/7.[illegible]
	5	23/22	31/30	6.9/7.5	7.9/8.[illegible]

Temperature and dissolved oxygen were checked daily. Salinity and pH were measured initially and finally only.

Table B-9

Physical Parameters of Solid Phase Bioassays of

Sediment 4

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity(°/00)	D.O.(ppm)	pH
Palaemonetes pugio and *Mercenaria mercenaria*					
Controls (clean sand)	1	23/22	29/29	8.1/8.1	7.9/8.0
	2	23/22	29/29	8.1/7.4	8.0/8.0
	3	23/22	29/29	8.1/7.9	8.0/8.0
	4	23/22	28/29	7.5/8.0	8.0/8.0
	5	23/22	28/29	7.7/8.1	7.9/7.9
Sediment 4	1	23/22	29/29	7.9/7.3	8.0/8.0
	2	23/22	30/29	6.8.7.6	8.0/8.0
	3	23/22	30/29	6.4/7.6	8.0/8.0
	4	23/22	30/29	5.9/7.8	7.9/8.0
	5	23/22	30/29	7.2/7.8	8.0/8.0
Neanthes arenaceodentata					
Controls	1	23/22	31/29	7.1/7.2	7.9/8.0
	2	23/22	31/29	6.8/7.3	7.8/8.0
	3	23/22	31/29	6.8/7.4	7.9/8.1
	4	23/22	31/29	6.9/7.4	7.9/8.1
	5	23/22	31/29	7.0/7.6	7.9/8.0
Sediment 4	1	23/22	31/30	7.0/7.8	8.0/8.2
	2	23/22	31/30	6.8/7.6	8.0/8.2
	3	23/22	31/29	6.8/8.0	8.0/8.2
	4	23/22	31/30	6.9/7.8	7.9/8.2
	5	23/22	31/30	6.9/6.6	7.9/8.2

Temperature and dissolved oxygen were checked daily. Salinity and pH were measured initially and finally only.

Physical Parameters of Solid Phase Bioassays of Sediment 5

INITIAL READINGS/FINAL READINGS

		Temp(°C)	Salinity(°/00)	D.O.(ppm)	pH
Palaemonetes pugio and *Mercenaria mercenaria*.					
Controls (clean sand)	1	23/22	29/29	3.1/8.1	7.9/8.1
	2	23/22	29/29	8.1/7.4	8.0/8.1
	3	23/22	29/29	8.1/7.9	8.0/8.1
	4	23/22	28/29	7.5/8.0	8.0/8.1
	5	23/22	28/29	7.7/8.1	7.9/7.5
Sediment 5	1	23/22	30/29	7.8/7.8	8.0/8.0
	2	23/22	30/30	5.9/7.3	8.0/7.5
	3	23/22	30/30	7.9/7.9	8.0/8.0
	4	23/22	30/30	6.8/7.6	8.0/8.0
	5	23/22	30/30	7.2/7.4	8.0/8.0
Neanthes arenaceodentata					
Controls	1	23/22	31/29	7.1/7.2	7.9/8.0
	2	23/22	31/29	6.8/7.3	7.8/8.0
	3	23/22	31/29	6.8/7.4	7.9/8.1
	4	23/22	31/29	6.9/7.4	7.9/8.1
	5	23/22	31/29	7.0/7.6	7.9/8.0
Sediment 5	1	23/22	31/30	6.8/8.1	7.8/7.6
	2	23/22	31/30	6.7/8.0	7.9/7.7
	3	23/22	31/30	6.7/8.0	7.9/7.6
	4	23/22	30/30	6.8/8.1	7.8/7.7
	5	23/22	30/30	6.8/8.1	7.9/7.8

Temperature and dissolved oxygen were checked daily. Salinity and pH were measured initially and finally only.

APPENDIX D

COMMENTS AND RESPONSES TO COMMENTS ON THE DRAFT EIS

The Draft EIS (DEIS) was issued 13 August 1982. The public was encouraged to submit written comments. This Appendix contains copies of written comments received by EPA on the DEIS.

Comments on the DEIS are numbered in the margins of the letters, and responses presented for each numbered item.

The EPA sincerely thanks all those who commented on the DEIS, especially those who submitted detailed criticism that reflected a thorough analysis of the EIS.

DEPARTMENT OF THE ARMY
JACKSONVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 4970
JACKSONVILLE, FLORIDA 32232

SAJPD-ES

15 October 1982

Mr. Michael S. Moyer
EPA (WH-585)
401 M Street S.W.
Washington, D.C. 20460

Dear Mr. Moyer:

I have reviewed the DEIS for the San Juan Harbor, P.R. Dredged Material Disposal Site Designation and recommend the following additions:

1-1 1. Page 1-4, paragraph 2; insert after the 4th sentence: "In addition to disposal of maintenance materials the usage of interim approved sites is an intergral part of Congressionally authorized navigation improvement projects which require disposal of construction materials associated with harbor deepening."

1-2 2. Page 1-4, paragraph 2; Sentence 5 should read: "To continue to maintain and improve the nation's waterways..."

Sincerely,

A. J. SALEM
Acting Chief
Planning Division

Incl
DEIS

DEPARTMENT OF THE ARMY
WATER RESOURCES SUPPORT CENTER, CORPS OF ENGINEERS
KINGMAN BUILDING
FORT BELVOIR, VIRGINIA 22060

REPLY TO
ATTENTION OF:

28 SEP 1982

WRSC-D

Mr. Patrick Tobin, Acting Director
Criteria and Standards Division (WH-585)
U. S. Environmental Protection Agency
401 M Street, S. W.
Washington, D. C.

Dear Mr. Tobin:

Inclosed are the Corps review comments on the EPA Draft Environmental Impact Statement (DEIS) for the San Juan Harbor, Puerto Rico, Ocean Dredged Material Disposal Site Designation, Incl 1. These comments and concerns are essentially unchanged from those which the Corps provided your office on the Preliminary DEIS, in March 1982.

Our major operational concern with the document involves site designation exclusively for materials derived from operation and maintenance. Our previous understanding was that site designation would be for those materials that are in compliance with the EPA Ocean Dumping Criteria. This would prevent the costly and unnecessary redesignation of a site for each specific project and/or 103 permit action. We are particularly concerned in this instance, in that planning is well advanced for proposed deepening of the San Juan Harbor, with ocean disposal as the most practical alternative, both from an environmental as well as an economic standpoint. A General Design Memorandum, Incl 2, has been prepared for this proposed deepening, which recommends ocean disposal as the preferred alternative. EPA Region II is in general agreement with this approach.

We are continuing to experience problems with the distribution of these site designation documents to the appropriate Corps personnel for review and comment. I request that, for all future document reviews, your staff coordinate directly with Mr. David Mathis of my staff (202) 325-0537, prior to document distribution by your office, to insure that the appropriate Corps personnel receive copies for review.

WRSC-D
Mr. Patrick Tobin, Acting Director

Your cooperation in this effort is greatly appreciated.

Sincerely,

2 Incl
As stated

MAXIMILIAN IMHOFF
Colonel, CE
Commander and Director

DEPARTMENT OF THE ARMY

SOUTH ATLANTIC DIVISION, CORPS OF ENGINEERS
510 TITLE BUILDING, 30 PRYOR STREET, S.W.
ATLANTA, GEORGIA 30303

REPLY TO ATTENTION OF: SADPD-R/SADCO-O

22 September 1982

SUBJECT: Draft Environmental Impact Statement (DEIS) for the San Juan Harbor, Puerto Rico Dredged Material Disposal Site Designation

Commander and Director
Water Resources Support Center
ATTN: WRSC-D
Kingman Building
Fort Belvoir, VA 22060

3-1 Attached comments on subject draft document, which were provided to WRSC-D by SADPD-R/SADCO-O 1st Ind of 19 March 1982, are still valid. A copy of the San Juan Harbor Survey Report is being provided to WRSC-D. We continue to be concerned about the restriction on the final site designation to maintenance dredged material. Jacksonville District comments on the current draft are Inclosure 2.

FOR THE COMMANDER:

for John W. Rushing
DAN M. MAULDIN
Chief, Planning Division

2 Incl
1. SAD Previous Comments
2. Jacksonville District Comments

CF:
SAJPD-E w incl
DAEN-CWP-V w incl

SADPD-R/SADCO-R 19 March 1982

SAD Comments on Draft Environmental Impact Statement (EIS)
For San Juan Harbor, Puerto Rico
Ocean Dredged Material Disposal Site Designation

3-2 1. General. The document states that the proposed action is the final site designation for the dredged material from maintenance dredging of San Juan Harbor (page iii). The maintenance dredging restriction on the site designation causes considerable concern. The Board of Engineers for Rivers and Harbors has recently recommended at a meeting on 3 March 1982 that the dredged material from the proposed deepening project at San Juan Harbor be disposed of in the interim approved EPA ocean disposal site. The ocean disposal plan had been agreed to with Region II EPA, contingent upon testing the dredged material in accordance with the ocean disposal criteria applicable at time of construction. We believe the final site designation should be for all dredged material from San Juan Harbor which meets the ocean dumping criteria. A copy of the San Juan Harbor Survey Report and EIS can be provided to WRSC-D, if needed. The Survey Report will be sent out by OCE for Washington level review in the coming weeks. We believe the dredged material from the deepening project will be undisturbed clean material which meets the ocean dumping criteria.

3-3 2. Page iv, para. 3, line 7. Suggest "significant" be used in lieu of "obvious".

3-4 3. Page ix, last para., 1st sentence. Dredging occurs once every two years (biennial) rather than twice a year (biannual).

3-5 4. Page ix, last para., last sentence. The purpose of the statement that "the proposed action does not exempt the use of this site from additional environmental review..." is unclear. While continued surveillance of the site may be desirable, we believe that current studies should provide adequate environmental review. According to a 1 May 1981 letter from Mr. Joseph Krivak, EPA, Washington to Colonel George R. Robertson, EPA will state in site designation documents that "the report fulfills all legal responsibilities with respect to environmental analysis of the proposed site and that it is not anticipated that the Corps will conduct any further environmental studies with respect to the selection of the site". We believe Mr. Krivak's concept should be included in the DEIS in lieu of the above statement in the existing document.

3-6 5. Page x, para. 1. The discussion of alternatives should be updated to make reference to the San Juan Deepening studies.

3-7 6. Page xi, Figure S-1. Suggest showing alternative ocean disposal sites.

3-8 7. Page xiv, 3rd para. Change CB to CE. Also, the CE has in the past and will in the future perform hopper dredging by contract and Corps owned hopper dredge.

3-9 8. Page xiv, 4th para. Note comment 3. above.

3-10 9. Page xiv, 5th para. Suggest noting that monitoring would be more costly due to deep waters (600').

Incl 1

3-11 10. Page 1-3, 2nd para. While we do not totally agree with the EPA approach as indicated by comment 1. above, we believe the Survey Report with EIS for San Juan Deepening satisfies the requirements stated and that the final site designation should be for all dredged material from San Juan Harbor which meets the ocean dumping criteria (40 CFR 227). We do not know what other EPA regulations would be directly applicable. Is EPA suggesting that the Corps project EIS be the basis of site designation at a later date? Would EPA action be necessary on a project specifically authorized by Congress?

3-12 11. Page 1-5, 1st para., 2nd sentence. Note comment 3. above.

3-13 12. Page 1-12, 2nd para., last sentence. Reference to Figure 1-3 should be Figure 1-2

3-14 13. Page 2-4, 4th para. Suggest that the adverse impact on commerce and the economy of Puerto Rico be noted as a reason for eliminating the no action alternative

3-15 14. Page 2-11, last para. Note comment 7. above.

3-16 15. Page 3-2, Figure 3-1. Suggest duplication with Figure 2-10 be eliminated.

3-17 16. Page 3-25, first para. A statement should be added that notes that the bioassay tests for dredged material previously disposed at the site did not show unacceptable toxicity or bioaccumulation of PCB's. A similar statement may also be desirable for the oil and grease (petroleum hydrocarbons). Also, tissue analysis results from the IEC Survey (page A-28) should be included in the discussion.

3-18 17. Pages 3-44 & 3-45. Statistical data should be updated, if available.

3-19 18. Page 3-46, 3rd para. Note comment 7. above. Also, "dredged" in second sentence should be "dredges".

3-20 19. Page 4-2, 3rd para, 4th sentence. Suggest the use of the term "mobile" in lieu of "motile". Motile has more of a physiological connotation then a spatial movement.

3-21 20. Page 4-3, last para. Substitute "dredge vessels" for "dredged vessels".

3-22 21. Page 4-14, 2nd para., 2nd sentence. The calculations appear to be incorrect, "35,460" should be "36,179,000", "0.156 inches" should be "4.16 inches". This comparison is not a true description of the actual conditions that will occur during disposal. The material will not and cannot be distributed in an even layer as implied. Therefore this paragraph should be deleted or modified to recognize the theoretical shortcomings.

3-23 22. Page 4-16, 2nd para. "Loss of energy in the form of fuel required to transport barges to and from site", should have "hopper dredges and/or" inserted between "transport" and "barges".

3-24 23. Page 5-1, 2nd para. The experience and expertise of individuals preparing the EIS should be noted.

3-25 24. Page B-10, 3rd para. from top. Same as comment 3. above.

DEPARTMENT
OF NATURAL
RESOURCES

4 October 1982

Mr. Michael S. Moyer
Criteria and Standards Division (WH 585)
Environmental Protection Agency
401 M Street, SW
Washington, D.C. 20460

Dear Mr. Moyer:

I have reviewed the Draft Environmental Impact Statement for the San Juan Harbor, Puerto Rico Dredged Material Disposal Site Selection, dated 13 August 1982. Review copies were provided to me at the end of September when EPA's regional office in San Juan determined that they had not been delivered from Washington.

Two issues should be addressed before final publication:

4-1 1. On page 3-27, the statement is made that the West Indian manatee has not been seen in coastal waters off San Juan in recent history. That statement should be modified to reflect the fact that manatees have been sighted both east and west of the entrance to San Juan Bay during a special manatee survey conducted by the Department during FY 1979.

The statement concerning Rare and Endangered Species on page 3-37 should also be modified to include the manatee.

2. Serious doubts have been raised concerning the bioassay which provided much of the basis for the final recommendation of the disposal site. I believe that they should be resolved speedily, and the report should be corrected. The final outcome may not be affected materially, but what appear to be obvious contraditions should be eliminated.

4-2 a. Bioassay manuals note that the dilution water should be uncontaminated, or should at least come from the site proposed for disposal. The report notes that control samples of seawater were obtained from the east coast of Florida, rather than from coastal waters

Commonwealth of Puerto Rico, Department of Natural Resources
OFFICE Muñoz Rivera Avenue, Stop 3, San Juan, Puerto Rico
MAILING ADDRESS Box 5887, Puerta de Tierra, Puerto Rico 00906

of Puerto Rico in the vicinity of the disposal site. As a result, some of the control seawater actually contaminated the test samples for some parameters.

4-3 b. The conclusion is reached (on page C-1) that "No limiting permissible concentration (LPC) based on suspended particulate phase (SPP) or liquid phase (LP) bioassays would be approached during ocean disposal of any of the five sediments."

We cannot understand this conclusion when it is obvious that some parameters are greatly exceeded even without the application of the test sediments. The statements in Paragraph 35 (page C-10) indicate such conditions:

- "Sediments SJ3 and SJ5 had arsenic concentrations 28.5 and 8.5 times (respectively) the control seawater concentration (0.002 ppm)."

- "The concentrations of mercury in the liquid phase of SJ1 and SJ2 were 11 and 6 times (respectively) the control seawater concentration and the LPC."

- "Although the concentrations of cadmium in all of the 5 liquid phase samples were considerable higher than the suggested LPC (5 ppb), they were not different from the control seawater (66 ppb). The cadmium concentration of seawater from the east coast of Florida was 13.2 times the LPC."

The 100-meter depths off the north coast of Puerto Rico represent optimum locations for fishing for important resources, such as silk snapper (lutjanus vivanus), queen snapper (rhomboplytes aurorubens), and grouper (epinephelus sp.). which are exploited continuously by commercial fishermen. Therefore, we consider that such sediments would bring toxic wastes into the area, which would jeopardize marine life and humans who utilize those resources.

4-4 I note further that on page 3-13 and in Figure 3-3, you refer to the NOAA storm tide analysis prepared about 1973. On the basis of experience with Hurricane David in 1979, it is our belief that higher surge levels may be expected to affect the coasts of Puerto Rico than were estimated in the NOAA report. FEMA is funding a proposal to upgrade that report with more recent data. The project will be undertaken during FY 1983, and results should be available within one year.

While it is true that Puerto Rico has not been affected by a land-falling hurricane for some fifty years, they have occurred in the past, and are likely to occur again. The possibility should not be discounted. However, for the purposes of this project, I will assume that there will be ample warning of such an event, and the dredging and ocean dumping activity will be temporarily suspended.

I earnestly request that you review and modify the draft EIS in accordance with the comments submitted herewith. I and my staff stand ready to respond to any inquiries you may have on the matter. Please call me at (Area 809) 724 8774.

Sincerely yours,

Hilda Diaz Soltero
Secretary of Natural Resources

cc: District Engineer, Jacksonville
U.S. Army Corps of Engineers

Mr. Weems Clevenger
EPA, San Juan Area Office

COMMONWEALTH OF PUERTO RICO / OFFICE OF THE GOVERNOR

Environmental Quality Board

OADA #435/82

November 1, 1982

Mr. Michael S. Moyer
Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, S.W.
Washington, DC 20460

RE: Draft Environmental Impact Statement for the San Juan Harbor, Puerto Rico Dredged Material Disposal Site Designation

Dear Mr. Moyer:

The Environmental Quality Board has reviewed the Draft Environmental Impact Statement (E.I.S.) referred to above and has the following comments to offer:

5-1 1. According to the Draft EIS (appendix C-4) all seawater used in bioassay controls was obtained from Florida. The water used for these bioassays should be obtained from the interim site, not from Florida.

5-2 2. The Draft EIS states that West Indian manatees (*Trichechus manatus*) have not been sighted in coastal waters off San Juan in recent history. According to the Manatee Survey Annual Performance Report (DNR, Belitsky 1979) manatees were sighted during aerial surveys along the northeastern and eastern coast of Puerto Rico from Dorado to Lima Point at Naguabo, (period covered July 1, 1978 - April 15, 1979). Belitsky reports that a small calf was washed ashore in weakened condition west of San Juan in 1975 and died on the beach. Furthermore, he mentions that infrequent sightings with numbers comprising small percentages of the total counts suggest that the northern coast may be a marginal habitat.
More recently on April 12, 1982, an adult female died on the beach near La Perla sector in San Juan just southeast of the interim site.

OFFICE OF THE BOARD: 204 DEL PARQUE ST. CORNER OF PUMARADA / MAILING ADDRESS: P.O. BOX 11488, SANTURCE, PUERTO RICO 00910 / TELEPHONE: 725-5140

5-3 3. A monitoring program should be established in order to detect any significant changes on the impact of the dredged material disposal activities.

5-4 4. We concur with the information on the Draft EIS that toxic substances bioaccumulation should be more exactly determined by carrying out bioassays on three (3) different organisms.

Sincerely yours,

Pedro A. Gelabert
Chairman

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW

Southeast Region / Suite 1384
Richard B. Russell Federal Building
75 Spring Street, S.W. / Atlanta, Ga. 30303

September 24, 1982

ER 82/1342

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

Dear Sir:

6-1 We have reviewed the draft environmental statement for Dredged Material Disposal Site Designation, San Juan Harbor, Puerto Rico, and have the following comments.

The proposed designation of the interim site currently being used as an ocean disposal area for dredged material as a final site should not have discernible impact on fish and wildlife resources. The interim site, centered 2.2 nautical miles off Isla de Cabras, has been used since 1974 with no ill effects. We agree with the conclusions of the Environmental Protection Agency that disposal farther inshore would pose environmental risks to coastal reef habitats and that the additional expense of disposal farther offshore is not justified by measurable environmental benefits.

Surveillance by the U.S. Coast Guard is extremely important to insure that only dredged material is disposed of at the site and that no disposal occurs outside the area's boundaries.

The lack of potential upland disposal sites in the San Juan Metropolitan Area makes ocean disposal essential for the protection of the few remaining wetland areas now serving as wildlife habitat.

Thank you for the opportunity to comment on this draft environmental statement.

Sincerely yours,

James H. Lee

James H. Lee
Regional Environmental Officer

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

August 17, 1982

OFFICE OF THE
ASSISTANT DIRECTOR
FOR ASTRONOMICAL,
ATMOSPHERIC, EARTH,
AND OCEAN SCIENCES

Mr. Michael S. Meyer
Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, SW
Washington, D.C. 20460

Dear Mr. Meyer:

7-1 The National Science Foundation has no comment on the Environmental Impact Statement for the San Juan Harbor, Puerto Rico Dredged Material Disposal Site Designation.

Thank you for the opportunity to comment.

Sincerely,

Adair F. Montgomery

Adair F. Montgomery
Chairman
Committee on Environmental
Matters

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
Atlanta GA 30333
(404) 262-6649

September 22, 1982

Mr. Michael S. Moyer
Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Moyer:

8-1 We have reviewed the Draft Environmental Impact Statement (EIS) for the San Juan Harbor, Puerto Rico, Ocean Dredged Material Disposal Site Designation. We are responding on behalf of the U.S. Public Health Service and are offering the following comments for your consideration in preparing the final document.

The continued acceptability of the proposed site and the disposal material should be periodically monitored in the future. Any organisms which could be harvested from the site for consumptive purposes or which could adversely affect other organisms used for consumptive purposes should be periodically checked for any potential bioaccumulation of toxic and hazardous materials.

We appreciate the opportunity to comment on the Draft EIS. Please send us one copy of the final document when it becomes available. Should you have any questions about our comments, please contact Mr. Robert Kay of my staff at FTS 236-6649.

Sincerely yours,

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Center for Environmental Health

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

September 24, 1982

Mr. Michael S. Moyer
Environmental Protection Agency
Criteria and Standards Division (WH-585)
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Moyer:

9-1 This is in reference to your draft environmental impact statement entitled "San Juan Harbor, Puerto Rico, Ocean 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 these comments, which we hope will be of assistance to you. We would appreciate receiving four copies of the final environmental impact statement.

Sincerely,

Joyce M. Wood

Joyce M. Wood
Director
Office of Ecology and Conservation

Enclosure: Memo from: Andrew Robertson
Office of Marine Pollution Assessment

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OFFICE OF MARINE POLLUTION ASSESSMENT
Rockville, Maryland 20852

Rec'd 9/22/83
EC:das

September 21, 1982

TO: PP/EC - Joyce Wood

FROM: RD/MP - Andrew Robertson

SUBJECT: DEIS 8208.13 - San Juan Harbor, Puerto Rico, Ocean Dredged Material Disposal Site Designation

9-2 This DEIS adequately justifies the continuation of the dredged material disposal site north of Puerto Rico. Although the site is rather close (about 4 km) to shore it is sufficiently deep (100 m on the average) so that no impact on the coast should occur. The site has been used since 1974 without any substantial adverse impact. We suggest, however, that at least two seasonal experiments should be carried out to quantify the rate of descent and initial deposition region of the material. This would presumably document the rapid descent of material from the surface layer and would provide a basis for projecting long term impact of disposal at the site.

RESPONSES TO WRITTEN COMMENTS

1-1 The language in the DEIS has been changed to allow disposing of all materials dredged from San Juan Harbor, not just maintenance dredged materials (see page 1-1). Such rewording eliminates the need to make the recommended change on page 1-4.

1-2 Recommended change made in the Final EIS.

2-1 See comment 1-1.

3-1 See comment 1-1.

3-2 See comment 1-1.

3-3 Recommended change made in the Final EIS.

3-4 Paragraph rewritten in Final EIS.

3-5 The language covered in Mr. Joseph Krivak's letter of May 1, 1982, is enclosed in the EIS. See page 1-8, paragraph 3.

3-6 The alternatives, as presented, do not preclude the disposing of deepening sediment at the ODMDS.

3-7 Alternative areas added to Final EIS.

3-8 Recommended changes made in Final EIS.

3-9 Biannual changed to biennial in Final EIS.

3-10 Recommended change made in Final EIS.

3-11 See comment 1-1.

3-12 Recommended change made in Final EIS.

3-13 Recommended change made in Final EIS.

3-14 The importance of San Juan Harbor to the economy of Puerto Rico is noted elsewhere in the EIS (see page ix).

3-15 Recommended change made in Final EIS.

3-16 Duplication noted; figures left as is.

3-17 Changes made in Final EIS.

3-18 Additional statistical data is not necessary for the designation process.

3-19 Recommended changes made in Final EIS.

3-20 Recommended change made in Final EIS.

3-21 Recommended change made in Final EIS.

3-22 Analogy deemed unnecessary and deleted in Final EIS.

3-23 Recommended change made in Final EIS.

3-24 This information is available upon request.

3-25 See comment 3-8.

4-1 Recommended change made in Final EIS.

4-2 As stated in the EPA/CE publication "Ecological Evaluation of Proposed Discharge of Dredged Material Into Ocean Waters" (July 1977), "Water collected from the disposal site should be used if at all possible. Otherwise uncontaminated seawater or an artificial sea salts mixture of the proper salinity may be used." Due to the expense of transporting water from the San Juan Harbor area, sand filtered water used in the bioassays was obtained from Marineland, Florida. The chemical make-up of this water is show below:

RESULTS OF CHEMICAL ANALYSIS OF MARINELAND SEAWATER

Parameter	Concentration
TOC	5.0
Ammonia - N	0.04
Nitrate - N	0.01

RESULTS OF CHEMICAL ANALYSIS OF MARINELAND SEAWATER (Con't)

Parameter	Concentration
Nitrite - N	<0.01
Organic Nitrogen	0.10
Oil and Grease	<0.2
Ortho Phosphorus	0.03
Total Phosphorus	0.15
Arsenic	<0.001
Beryllium	0.02
Cadmium	<0.001
Copper	<0.01
Chromium	<0.01
Iron	0.05
Lead	0.01
Mercury	<0.0001
Nickel	0.05
Selenium	0.002
Silver	<0.001
Zinc	<0.01
Vanadium	<0.01

4-3 The report has been reproduced as information. EPA cannot change the conclusions in the published report.

4-4 EPA thanks the Department of Natural Resources of Puerto Rico for the additional information.

5-1 See response to comment 4-2.

5-2 See response to comment 4-1.

5-3 Section 228.9 of the Ocean Dumping Regulations establishes that the impact of dumping in a disposal site and sourrounding marine environment will be evaluated periodically for certain types of effects. The information used to make the disposal impact evaluation may include data from monitoring surveys. Thus, "if deemed necessary," the CE District Engineer (DE) and EPA Regional Administrator (RA) may establish a monitoring program to supplement the historical site data (40 CFR °228.9). The CE and RA develop the monitoring plan by determining appropriate monitoring parameters, frequency of sampling, and the areal extent of the survey.

5-4 EPA appreciates the reference to the bioassay procedure.

6-1 EPA appreciates the review and comments provided by the Department of Interior's, Office of Environmental Project Review, Southeast Region.

7-1 EPA appreciates the response provided by the National Science Foundation

8-1 See response to comment 5-3. EPA appreciates the review and comments provided by the Centers for Disease Control, Department of Health and Human Services.

9-1 EPA appreciates the review and comments provided by the National Oceanic and Atmospheric Administration, Department of Commerce.

9-2 See response to comments 5-3 and 9-1.