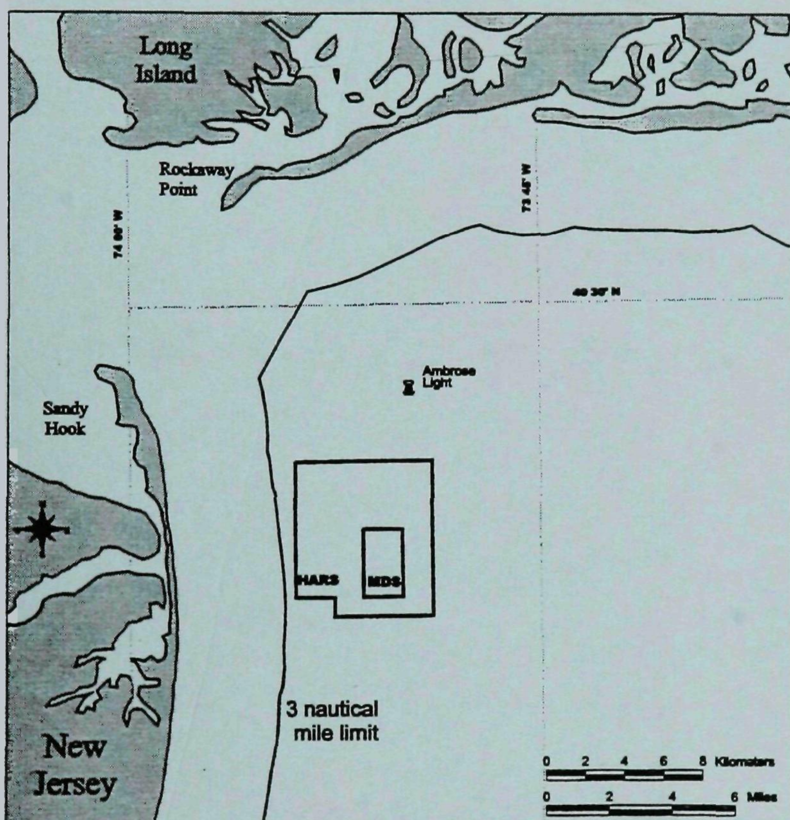
Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex

MAY 1997



REGION 2

U.S. Environmental Protection Agency, Region 2
290 Broadway, New York, NY 10007-1866

Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site in the New York Bight Apex
May 1997

U.S. Environmental Protection Agency - Region 2

Abstract: In accordance with the Marine Protection, Research, and Sanctuaries Act , the National Environmental Policy Act, and the Environmental Protection Agency's (EPA) procedures for the voluntary preparation of environmental impact statements (EIS) on significant regulatory actions, EPA has prepared a supplement to the 1984 Final EIS for the New York Dredged Material Disposal Site Designation (SEIS). Specifically, the SEIS addresses the designation of a Historic Area Remediation Site (HARS). Toward this end, the SEIS evaluates: no action; closure of the New York Bight Dredged Material Disposal Site (a.k.a. the Mud Dump Site [MDS]) with no designation of the HARS; designation of the HARS for the purpose of remediation; and designation of the HARS for the purpose of restoration. It identifies designation of the HARS for the purpose of remediation as the preferred alternative. This alternative would reduce the toxicity of area sediments to sensitive marine organisms and reduce the potential for transferring contaminants to marine birds, mammals, and humans. It represents the most environmentally sound alternative evaluated in the SEIS.

The proposed HARS encompasses a 15.7 square nautical mile area located approximately 3.5 nautical miles east of the Highlands, New Jersey, and 7.7 nautical miles south of Rockaway, New York. It includes the 2.2 square nautical mile MDS, as well as the surrounding areas that have been historically used as disposal sites for dredged materials that require remediation. Simultaneous with the designation of the HARS, the MDS will be closed.

The following Public Hearings have been scheduled to receive comments on the SEIS:

June 16, 1997; 7:00 pm Monmouth Beach Municipal Auditorium 22 Beach Drive Monmouth Beach, New Jersey	June 17, 1997; 7:00 pm Nassau County Social Services Auditorium County Seat Drive Mineola, New York	June 18, 1997; 2:00 pm Port Authority of NY/NJ Oval Room 1 World Trade Center New York, New York

Additionally, written comments will be accepted through June 30, 1997; written comments should be addressed to:

Robert W. Hargrove, Chief
Strategic Planning and Multi-Media Programs Branch
U.S. Environmental Protection Agency
290 Broadway
New York, New York 10007-1866

Approved by: William J. Muszynski Jeanne M. Fox
Regional Administrator
EPA Region 2

Date: May 6, 1997

Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex

MAY-1997

Prepared by

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Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex

U. S. Environmental Protection Agency, Region 2
New York City, New York

Comments on this administrative action should be addressed to:

Mr. Robert Hargrove, Chief
Strategic Planning & Multi-Media Programs Branch
U.S. Environmental Protection Agency , Region 2
290 Broadway, 25th Floor
New York City, NY 10007-1866

Comments must be received no later than:

June 30, 1997, 45 days after publication of the notice of availability in the Federal Register for the Supplemental Environmental Impact Statement (SEIS).

Copies of this SEIS, Proposed Rule for MDS Closure/HARS Designation, Site Management and Monitoring Plan, Biological Assessment for Section 7 of the Endangered Species Act, and Cultural Resources Report are available for review at the following locations:

U.S. Environmental Protection Agency
Region 2 Library, 16th Floor
290 Broadway
New York City, NY 10007-1866

U.S. Environmental Protection Agency
Region 2 Field Office Library 2890
Woodbridge Avenue, Building 209, MS-245
Edison, NJ 08837

Hudson River Foundation
40 West 20th Street
Ninth Floor
New York City, NY 10011

New York State Department of
Environmental Conservation, Division of
Marine Resources
205 Belle Meade Road
East Setauket, NY 11733

Mr. Steve Bergman
Bellmore Public Library
2288 Bedford Avenue
Bellmore, NY 11710

New Jersey Department of Environmental
Protection, Library
401 East State Street, CN402
Trenton, NJ 08625

Monmouth Beach Public Library
18 Willow Avenue
Monmouth Beach, NJ 07750

For further information contact:

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228.5(b)	perturbations to the environment during initial mixing	3.3.6, 4.2.2, 4.2.3, 4.2.8, 5.0
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Ocean Dumping Regulation Reference Table for the MDS/HARS SEIS

Ocean Dumping Regulation	Key Words and Phrases	SEIS Chapter Location
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SUPPLEMENT TO THE ENVIRONMENTAL IMPACT STATEMENT ON THE NEW YORK DREDGED MATERIAL DISPOSAL SITE DESIGNATION FOR THE DESIGNATION OF THE HISTORIC AREA REMEDIATION SITE (HARS) IN THE NEW YORK BIGHT APEX

MAY 1997

EXECUTIVE SUMMARY

For the reasons described below, this Supplemental Environmental Impact Statement (SEIS) demonstrates a need to terminate and de-designate the New York Bight Dredged Material Disposal Site, and simultaneously designate that site and surrounding degraded areas as the Historic Area Remediation Site (HARS). The HARS will be remediated with "uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)"[1] in order to reduce impacts at the site to acceptable levels [see 40 CFR Section 228.11(c)]. EPA also recognizes that the success of remediation at the HARS and complete recovery of the associated benthic community be affected by the success of efforts to manage and reduce other sources of contaminants to the New York Bight Apex. The recently-approved Comprehensive Conservation and Management Plan (CCMP) for New York-New Jersey Harbor provides for a variety of actions to be taken by many parties that would reduce contaminant levels from point and nonpoint sources. Implementation of the commitments contained in the CCMP will provide additional relief from contaminant inputs to the HARS from sources such as the Hudson river and atmospheric deposition, and will help ensure the success of the HARS remediation operations.

BACKGROUND

Since the 1800s, the New York Bight Apex and surrounding area has been used for disposal of dredged material and a variety of waste products, including municipal garbage, building materials, sewage sludge, and industrial waste. Dredged material placement in the New York Bight Apex began "officially" in 1888 at a point 2.5 miles south of Coney Island. At that time, the New York Harbor U.S. Congressional Act of 1888 established that the Supervisor of New York Harbor had the authority to grant permits for ocean disposal. Due to shoaling off Coney Island, the dredged material disposal location was moved in 1900 to a point one-half mile south and eastward of Sandy Hook Lightship. In 1903, the location was moved again, to 1.5 miles east of Scotland Lightship. Dredged material placement continued seaward of this area for the next 70 years.

In 1972 the Congress of the United States enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA) to address and control the dumping of materials into ocean waters. Title I of MPRSA authorized the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) to regulate dumping in ocean waters. Since MPRSA was enacted, and through its subsequent amendments, dumping in the New York Bight has been dramatically reduced through actions by EPA, the USACE, the U.S. Coast Guard (USCG), and other agencies. In the New York Bight, this has meant permanent closure of the 12-Mile and 106-Mile sewage sludge sites, the Cellar Dirt site, Acid Waste site, and Woodburning site.

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[1] As provided for in a letter of July 24, 1996, signed by EPA Administrator, Carol Browner, Secretary of Transportation, Federico F. Peña, and Secretary of U.S. Department of the Army, Togo D. West, Jr. (July 24, 1996, 3-Party Letter)

In 1973, EPA designated the New York Bight Dredged Material Disposal Site (Mud Dump Site; MDS) in the New York Bight Apex as an "interim" ocean dredged material disposal site (ODMDS) for dredged materials from the Port of New York and New Jersey. The interim ODMDS was a 2.2-nmi^2 rectangle approximately 5.3 nmi east of Sandy Hook, NJ, and 9.6 nmi south of Rockaway Beach, Long Island, NY. After interim designation, detailed environmental studies were conducted and a site-designation environmental impact statement (EIS) was published in 1982. In 1984, EPA designated the interim MDS as "final" with no changes to the borders of the interim 2.2-nmi^2 site. At the time of designation, the MDS was designated an Impact Category I site[2] with capacity for up to 100 million cubic yards (Myd^3) of dredged material.

Since 1984, the MDS has received approximately 68 Myd^3 of dredged material. The current remaining disposal capacity is approximately 32 Myd^3. Recent bathymetric data show that water depths within the MDS now average 20 m (65 ft). In 1996, EPA and the USACE completed a comprehensive analysis of benthic erosion at the MDS and established "management depths" at the site above which deposited dredged material would not be allowed to shoal. The management depths for Category I and II[3] dredged material were set at 45 ft (14 m) and 65 ft (approx. 20 m) Below Mean Low Water (BMLW), respectively. Because of the need for a 65-ft management depth for Category II material limited the remaining Category II disposal capacity is approximately 1 Myd^3. The balance of the site's capacity (31 Myd^3) remains for Category I dredged material.

In February 1995, EPA Region 2 issued a Public Announcement stating that the Agency would commence a study of a 23-nmi^2 area surrounding the existing MDS. The product of the study was to be a Supplemental Environmental Impact Statement (SEIS) that would evaluate three alternatives under the EPA's ocean dumping regulations:

1. No action (no expansion of the MDS)

2. Expansion of the MDS for Category I material

3. Expansion of the MDS for Category I and II material

Each of the alternatives, particularly Alternatives 2 and 3, were also to evaluate impacts from historical disposal and the potential for remediating or restoring impacted benthic areas.

In May 1995, EPA announced results of toxicity tests conducted with 10-day amphipod bioassays using *Ampelisca abdita* on benthic samples collected in the 23-nmi^2 SEIS Study Area. These data demonstrated that some parts of the Study Area contain sediments that exhibit acute toxicity. These sediments would not comply with 40 CFR Section 227.27 and be unacceptable for ocean disposal. Bathymetric and side-scan data also collected at this time showed evidence of dredged material mounds northwest of the 23-nmi^2 SEIS Study Area. In response, EPA expanded the Study Area by adding an approximately 7-nmi^2 rectangle northwest of and abutting the western border of the original 23 nmi^2 area. The resulting 30-nmi^2 (103.2 km^2) Study Area encompassed benthic areas that showed evidence of dredged material disposal in the New York Bight Apex.

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[2] For explanation of Impact Category I, See Table 1-1 or 40 CFR Section 228.10(c)(1)

[3] See Section 1.1 Page 1-4 of Chapter 1 of this SEIS

Other studies—some not specifically directed at evaluating dredged material impacts—further characterized the physical, chemical, and biotic conditions of the Study Area and Bight Apex.

- Chemical analysis of infaunal (worm) tissue from parts of the Study Area confirmed that some sediment contaminants are being bioaccumulated in lower trophic levels.
- The hepatic tissue (tomalley) of Bight Apex lobsters was found to have levels of PCBs and 2,3,7,8-TCDD (dioxin) above currently acceptable action levels and guidelines.
- Several shipwrecks were located in the Apex and Study Area, triggering a need for a National Historic Preservation Act (NHPA) evaluation and an evaluation of the spatially-limited reef habitat created by the wrecks.

The assembly of this new information generated heightened concern about the environmental consequences of historical ocean disposal in the Bight Apex, as well as the continued disposal of Category II dredged material. This in turn brought into question the appropriateness of continued use or expansion of the MDS. The concerns led to Federal actions detailed in a July 24, 1996, letter to several New Jersey Congressmen, signed by EPA Administrator Carol Browner, Secretary of Transportation Federico F. Peña, and Secretary of the Army Togo D. West, Jr. (July 24, 1996, 3-Party Letter):

> ". . . Accordingly, the Environmental Protection Agency (EPA) will immediately begin the administrative process for closure of the MDS by September 1, 1997. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with management standards in 40 C.F.R. Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 C.F.R. Section 228 as the Historic Area Remediation Site. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228.11(c)). The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)[4]. . ." (EPA/DOT/USACE, 1996)

The July 24, 1996, 3-Party Letter further stated: "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Subsequent to the July 24, 1996, 3-Party Letter, EPA Region 2 issued a Public Announcement in September 1996 modifying the scope of the SEIS from evaluating the potential expansion of the Mud Dump Site to evaluating the designation of a Historic Area Remediation Site (HARS). In the same announcement, the Agency stated that it was beginning the administrative process to close (de-designate) the MDS.

[4] Hereafter referenced to as "Material for Remediation" or "Remediation Material".

NEED FOR REMEDIATION

Field studies of the New York Bight Apex have found undesirable levels of bioaccumulative contaminants and toxicity in the surface sediments of much of the MDS and in sediments immediately surrounding the MDS. Further, it was found that some of these sediments cause toxicity in amphipod bioassays. Amphipods are small-bodied crustaceans that live in the surface layers of sediment, and are important prey items for many coastal marine organisms. These and other organisms are used by EPA and the USACE to evaluate sediment samples from proposed dredging sites.

While it is impossible to quantify how much of New York Bight Apex contamination is the direct result of past dredged material disposal, other ocean dumping activities (e.g., former sewage sludge disposal at the 12-Mile Site), or other sources (e.g., via Hudson River plume or atmospheric deposition), the presence of these degraded sediments in the Apex is cause for concern. Organisms living in or near these degraded surface sediments in nearshore waters will be continually exposed to contaminants until the contaminants are buried by natural sedimentation, placement of Remediation Material, or otherwise isolated or removed. Exposed sediments can directly and indirectly impact benthic and pelagic organisms. Impacts to terrestrial organisms (including human beings) are also possible if the contaminants were to undergo trophic transfer.

EPA employed several types of evaluations to determine the extent and location of potential environmental impacts in the vicinity of the MDS and historic dredged material disposal areas. These included the type of bioassays normally conducted on sediment samples from proposed dredging sites, contaminant-bioaccumulation evaluations of infaunal organisms and sediment from the Study Area, and evaluation of the benthic community structure in the potentially impacted areas. The results of these evaluations and the main factors that make remediation necessary are summarized below.

Contaminant Toxicity

Potential toxicity of sediments was evaluated using the same 10-day amphipod (*Ampelisca abdita*) bioassay test used to evaluate the suitability of sediment for ocean disposal by EPA Region 2 and the USACE New York District (NYD). The data from amphipod bioassays of sediments from 1994 Study Area samples indicated widespread toxic conditions in sediment from areas around the MDS. If these surface sediments from the Study Area were from a proposed Region 2/NYD dredging project site, the sediments would have been categorized as Category III and found to not meet the limiting permissible concentration (LPC) in EPA's Ocean Dumping Regulations (40 CFR Section 227.27), and thus would not be permitted for disposal at the MDS.

Contaminant Bioaccumulation/Trophic Transfer

Contaminant bioaccumulation was evaluated by analyzing the tissues of infaunal worms collected from the Study Area sediments. Infaunal organism bioaccumulation of sediment-associated contaminants can, if accumulated to high enough levels, result in both acute and chronic impacts and eventually transform benthic community structure. Such changes can affect the food source of demersal predators. When demersal predators feed on infauna with contaminated tissues, the contaminants can be transferred to and potentially accumulate in the predator. These contaminants can then potentially be consumed by humans. EPA's evaluation of contaminant bioaccumulation in the Study Area was similar to the Agency's Green Book Tier IV "steady-state" evaluations, which are used in determining compliance with the ocean dumping criteria. The results showed that there were areas in the vicinity of the MDS where these benthic worms were accumulating undesirable levels of contaminants from the sediments.

Contaminants in Sediments
Contaminant concentrations in sediments in the vicinity of the MDS were compared to National Oceanic and Atmospheric Administration (NOAA) ER-L (Effects Range-Low) and ER-M (Effects Range-Median) values which have been derived from a broad range of biological and chemical data collected synoptically from field and laboratory experiments. Although ER-L/ER-M values are not appropriate for regulatory decisionmaking, they are useful in sediment evaluations when considered concurrently with other data. In general, the comparisons of ER-L/ER-M values to contaminant levels in sediments from parts of the Study Area indicated that, based on contaminant levels in the sediment, negative biological effects could be possible at many stations. This conclusion is corroborated by the results of the toxicity and contaminant bioaccumulation tests described above.

Contaminant Levels in Area Lobsters
Additional evidence of degraded sediments in the New York Bight was found in NOAA tissue data from lobsters that were harvested in the New York Bight Apex in 1994. PCB and 2,3,7,8-TCDD (dioxin) concentrations in the hepatic tissue (tomalley) of the lobsters were above U.S. Food and Drug Administration consumption guidelines. Other contaminants were also present in the hepatopancreas and other tissues, but the concentrations of these contaminants were within consumption guidelines.

Lobster study data revealed that food sources of Bight Apex lobsters are contaminated, that contaminants are being accumulated, and that concern about potential human-health risks is warranted. It must be kept in mind, however, that the lobsters analyzed in the NOAA study were harvested from wild stocks in the Apex, whose populations migrate seasonally through the region, including perhaps the SEIS Study Area. Contamination of these animals cannot be definitively linked to specific areas of dredged material disposal, to other past dumping activities, or to other ongoing pollution sources. Nor does the study data indicate that human consumption of lobster muscle tissue (meat) presents health risks. However, the contaminant data set complements other evidence of benthic contamination in the Bight Apex region.

Solutions to Sediment Degradation in the Study Area
The need to terminate and de-designate the New York Bight Dredged Material Disposal Site, and simultaneously redesignate the area of that site and surrounding degraded areas as the Historic Area Remediation Site (HARS) is demonstrated by the presence of toxic effects (a Category III sediment characteristic), dioxin bioaccumulation exceeding Category I levels in worm tissue (a Category II sediment characteristic), ER-L/ER-M exceedances in some Study Area sediments, as well as TCDD/PCB contamination in area lobster stocks. Individual elements of the aforementioned data do not prove that sediments within the Study Area are imminent hazards to the New York Bight Apex ecosystem, living resources, or human health,. However, the collective evidence presents cause for concern, justifies the conclusion of the July 24, 1996, 3-Party Letter that a need for remediation exists, and demonstrates that the MDS is an Impact Category I site.

ALTERNATIVES EVALUATED UNDER THIS SEIS

Four alternatives were considered under this SEIS to address the need for remediation.

Alternative 1: No-Action

- No change to size or management of the present Mud Dump Site (MDS)
- No remediation of areas outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas

- Disposal of Category I dredged material continues per the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/ USACE NYD, 1997a) until current remaining disposal capacity is reached
- Category II dredged material capacity will be reached by September 1, 1997

Under Alternative 1, the size, location, and management of the MDS are unchanged. Only Category I dredged material will be disposed at the MDS after September 1, 1997 (the remaining capacity for Category II dredged material will be filled before September 1, 1997).

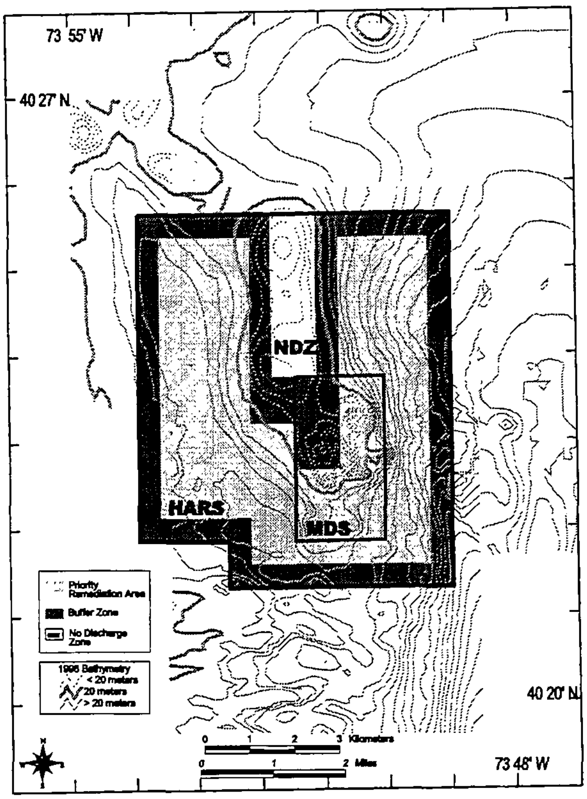
Alternative 2: Close MDS-No HARS Designation

- Closure of the present Mud Dump Site
- No Historic Area Remediation Site (HARS) designated
- No remediation of sediments outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas created by past dredged material disposal

Under Alternative 2, the MDS is closed, no Historic Area Remediation Site (HARS) will be designated, and degraded sediment areas in and around the MDS will not be actively remediated or restored.

Alternative 3: HARS Remediation

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ), including the MDS and sediments that have toxicity or bioaccumulative contaminants. (Refer to Appendix B for HARS latitude/longitude coordinates.)
- Remediation conducted by capping degraded sediment areas with at least 1 m of Material for Remediation
- Approximately 40.6 Myd^3 required to remediate the 9.0-nmi^2 (31-km^2) PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Remediation work prioritized by degree of sediment degradation



Under Alternative 3, the MDS will be closed. Simultaneous with the closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 CFR Section 228 as the Historic Area Remediation Site. The basis for designating the HARS is that it (1) allows remediation of sediments degraded by historical disposal (40 CFR Section 228.11), (2) complies with EPA's site-designation criteria [40 CFR Sections 228.5 and 228.6(a)], and (3) meets the intent of the July 24, 1996, 3-Party Letter (EPA/DOT/USACE, 1996).

Alternative 4: HARS Restoration

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the PRA, NDZ, and BZ, including the MDS, surrounding areas that has been historically used for disposal of dredged material and other wastes (e.g., building materials, sewage sludge, industrial wastes), and sediments degraded by bioaccumulative contaminants or toxicity.
- Restoration work conducted by covering fine-grain sediment areas with at least 1 m of sandy (0-10% fines) Material for Remediation
- Approximately 46.4 Myd^3 required to restore the 10.3 nmi^2 (35.5 km^2) of fine-grained sediments in the PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Restoration work prioritized by degree of sediment degradation

Alternative 4 is similar to Alternative 3, with additional conditions that capping operations within the HARS use only sandy (0-10% fines) Material for Remediation, and the areas to be capped include fine-grain surface sediments that are attributable to historical dredged material disposal. The Restoration HARS for Alternative 4 overlaps the entire area delineated by the Remediation HARS for Alternative 3 and includes additional areas with fine-grain sediments. The total size of the HARS under Alternative 4 is 15.7 nmi^2 (54 km^2), and includes the present MDS, the surrounding areas that have been used historically as disposal sites for contaminated material, and area sediments exhibiting toxicity and degraded with bioaccumulative contaminants. Implementation of Alternative 4 will restore benthic conditions within the New York Bight Apex Study Area to conditions found in the area prior to dredged material disposal.

PROPOSED ACTION

Each alternative was evaluated under criteria set forth in the EPA's Ocean Dumping Regulations [40 CFR Sections 228.5, 228.6, and 228.10]. Based on a comprehensive evaluation of physical, chemical, biological, and socioeconomic data relative to the 30-nmi^2 Study Area, EPA has selected Alternative 3 as the Preferred Alternative and Proposed Action. The Proposed Action is to simultaneously terminate/de-designate the MDS and designate the site and surrounding areas that have been used historically as disposal sites for contaminated material as the HARS.

The 15.7-nmi^2 (54-km^2) HARS will include the entire current MDS area. Within the HARS will be a 9.0-nmi^2 Priority Remediation Area (PRA), a 0.27-nmi wide Buffer Zone (BZ) with a total area of 5.7 nmi^2, and a 1-nmi^2 No Discharge Zone (NDZ). The Material for Remediation (Remediation Material) is "... uncontaminated dredged material (i.e., dredged material that meets current category I standards and will not cause significant undesirable effects including through bioaccumulation)..." (July 24, 1996, 3-Party Letter).

The Remediation Material for the 9-nmi^2 PRA of the HARS will be uncontaminated dredged material (i.e., dredged material that meets current category I standards and will not cause significant undesirable effects including through bioaccumulation) from the Port of New York and New Jersey and surrounding areas. Consistent with the July 24, 1996, 3-Party letter, the designation of the HARS will help "assure long-term use of category 1 dredged material."

BASIS FOR THE HARS DESIGNATION

Under the authority of Section 102 of MPRSA, EPA is responsible for designating ocean sites for dredged material. EPA's regulations for this activity are found in 40 CFR Section 228.

The Agency considers MPRSA site designations on a case-by-case basis, designates appropriately sized sites in suitable areas, and implements site-specific management and monitoring plans (SMMP). Goals of the EPA site designation process include limiting impacts to the environment; providing for efficient site management and monitoring operations; and, where appropriate, supporting multiple users (e.g., the USACE, a local port authority, and the owners of berthing areas).

The other major Federal law relevant to designation of MPRSA sites is the National Environmental Policy Act (NEPA). NEPA is the basic U.S. charter for protecting the environment. Section 102(C) of the Act specifies that a detailed statement by the responsible official is to be prepared for "major Federal actions significantly affecting the quality of the human environment." The purpose and intent of these statements are specified in the Council of Environmental Quality Regulations for Implementing NEPA (40 CFR Sections 1500-1508). The statements assemble and clearly present accurate and pertinent "environmental information to public officials and citizens before decisions are made and before actions are taken [§15001(b)]." Although EPA is not legally required to develop EISs for its own actions, including evaluating and designating MPRSA sites, the Agency has voluntarily established a policy (39 FR 37119, October 21, 1974) to publish EISs site designations and similar actions as part of its open decision-making process. All EISs relating to MPRSA site designations, including this SEIS, have been developed under this voluntary Agency policy.

Environmental information used to produce this document results from numerous studies and field surveys by several agencies and investigators working in the New York Bight over the past several years. The summary of data and interpretations presented are a synthesis of all available information found to be recent, accurate, and applicable to the evaluations, and provide a technically sound basis for the Agency's decisions embodied in the accompanying proposed site-designation Rule.

PUBLIC PARTICIPATION

An opportunity to review the preliminary draft chapters during development of the SEIS by interested parties was provided. Public comments on the SEIS will be accepted until approximately June 30, 1997. In addition, copies of the proposed site designation Rule and HARS Site Management and Monitoring Plan (HARS SMMP) may be obtained for review and comment by contacting Mr. Mario Del Vicario, Chief, Place-Based Protection Branch, U.S. EPA Region 2, New York City, NY, 10007-1866 (Voice 212-637-3781; E-mail delvicario.mario@epamail.epa.gov). Additional copies of the SEIS may be obtained by contacting Mr. Robert Hargrove, Chief, Strategic Planning & Multi-Media Programs Branch, U.S. EPA Region 2, New York City, NY, 10007-1866 (Voice: 212-637-3495; E-mail: hargrove.robert@epamail.epa.gov).

ALTERNATIVES ANALYSIS

The impact assessments and use-conflict criteria in the Ocean Dumping Regulations were divided into two groups, those that were "discriminating" and those that were "nondiscriminating." The nondiscriminating impacts, while useful in assessing the acceptability of the alternatives, do not significantly differ among the alternatives and did not provide substantial utility for identifying the Preferred Alternative. On the other hand, the discriminating impacts have substantial differences among the four alternatives. These impacts were used to rank the alternatives and select the Preferred Alternative.

The evaluation of each alternative included the consideration of all possible detrimental, mitigatable, or beneficial impacts that could result from implementation of the alternatives. The evaluations were conducted with an iterative, weight-of-evidence approach. The following information summarizes the pros and cons resulting from this analysis.

Alternative 1: No Action

Pros

- No impact to fish and shellfish resources, shorelines, or special areas of concern
- Limited short-term impact to benthic community within the disposal site
- Extension of the dredged material mound may provide longer berm and incrementally improve fish and shellfish habitat
- No new impacts to Bight Apex navigation
- No impact to cultural resource sites
- Provides approximately 31 Myd^3 of Category I capacity

Cons

- Contaminant trophic transfer and potential human-health or ecological risks for areas outside the MDS unaffected
- Sediment areas degraded by toxic and bioaccumulative contaminants outside the MDS are not remediated or restored. This area is 6.8 nmi^2, three times bigger than the current MDS.
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)." and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Alternative 2: Close MDS-No HARS Designation

Pros

- No impact to fish and shellfish resources, shorelines, or Special Areas of Concern
- No short-term impact to benthic community within the Study Area
- Reduced potential for impacts to Bight Apex navigation
- No impact to cultural resources

Cons

- Does not address the need for benthic remediation inside or outside the MDS
- Contaminant toxicity and bioaccumulation potential from degraded sediments unchanged
- No change to potential human-health and ecological risks, including potential impacts to endangered and threatened species, from contaminant trophic transfer.
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)." and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Alternative 3: HARS Remediation

Pros

- Meets the need for remediation
- Degraded sediment areas (exhibiting Category II and III type characteristics) throughout the PRA are capped with at least 1 m of Material for Remediation
- Decreased contaminant toxicity and bioavailability to fish and shellfish resources; increased habitat quality
- Reduced potential for trophic transfer of contaminants, including to human beings (seafood consumers)
- Decreased ecological and human-health risk
- The 500 m buffer zones delineated around all identified shipwrecks (1) ensure that Material for Remediation does not impact cultural or historic resources, (2) allow for further study of the sites for potential National Registry of Historic Places (NRHP) eligibility, and (3) have little impact on overall PRA remediation
- Habitat associated with the shipwrecks are maintained; no impact to reef fish and shellfish habitat
- Meets the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)" and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Cons

- Small areas of unremediated sediment in the vicinity of HARS shipwrecks will remain exposed, and may continue to potentially impact fish and shellfish resources at these habitats
- Habitat disruption during PRA remediation operations
- Losses of some sandy and hard/rough-bottom habitat in degraded sediment areas

Alternative 4: HARS Restoration

Pros

- Meets the need for remediation
- Degraded sediment areas (exhibiting Category II and III type characteristics) throughout the PRA capped with at least 1 m of sandy (1-10%) Material for Remediation
- Decreased contaminant bioavailability and possible sublethal effects to fish and shellfish resources; increased habitat quality
- Reduced potential for trophic transfer of contaminants, including to human beings (seafood consumers)
- Decreased ecological and human-health risk
- The 500 m buffer zones delineated around all identified shipwrecks (1) ensure that material for restoration does not impact potential cultural or historic resources, (2) allow for further study of the sites for potential NRHP eligibility, and (3) have little impact on overall PRA restoration
- Habitat associated with the shipwrecks are maintained; no impact to reef fish and shellfish habitat
- Meets the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)."

Cons

- Loss of mud, muddy-sand, and rough/hard-bottom habitats; possible negative effects to living resources (e.g., lobster and winter flounder)
- Lengthy restoration period, and continued exposure of degraded sediments to the biotic zone of the New York Bight Apex
- Limited availability of Remediation Material from the Port of New York and New Jersey and surrounding areas
- Small areas of unrestored sediment in the vicinity of HARS shipwrecks will remain exposed, and may continue to potentially impact fish and shellfish resources at these habitats
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

PREFERRED ALTERNATIVE

An iterative comparison of the physical, chemical, biological, and socioeconomic impacts of the four alternatives has led EPA to select Alternative 3 as the Agency's Preferred Alternative. Alternative 3 was found to have the most benefits and the least negative impacts by meeting the need for remediation in the Historic Area Remediation Site, and helping assure the long-term use of Remediation Material from the Port of New York and New Jersey and surrounding areas.

Alternative 3 is the alternative that can most quickly remove from the biotic zone of the New York Bight Apex the potential risks presented by the degraded sediments of the PRA. Capping the PRA with Material for Remediation will also prevent the degraded sediment erosion and dispersion by storm events and other seafloor processes, and the associated potential toxicity and contaminant bioaccumulation from these sediments.

Alternative 3 also presents the most positive and fewest negative impacts to commercial, recreational, and ecologically important fish and shellfish. Fish and shellfish inhabiting degraded areas will be only temporarily displaced by placement of at least a 1 m cap of Material for Remediation. Few fish and motile shellfish will be directly impacted by the remediation operations, but infauna and epifauna prey organisms will be buried. The associated fish and shellfish will not be able to forage at the remediated areas until the prey communities (benthic infauna) become reestablished. Recolonization of the prey communities, specific to the quality of the Remediation Material, is expected to occur within about one year from placement of material; full recovery may take several years. Area-specific recovery periods will depend largely on the season during which the Remediation Material is placed on the site, recruitment success of infaunal and epifaunal species, and storm events, if any.

The July 24, 1996, 3-Party Letter states "designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material." As Alternative 4 only allows for the use of sandy Material for Restoration, otherwise acceptable Remediation Material from the Port that is composed of silts and clays would be excluded from restoration operations, rather than being used for remediation. In addition, such materials would potentially need to be disposed in non-ocean sites (e.g., harbor pits and landfills). The placement of silt and clay material suitable for remediation in nearshore and upland locations will, in addition to being expensive, unnecessarily consume disposal capacities of non-ocean sites that can accept Category II and III material; it would also waste a resource that can expeditiously remediate the degraded sediments of the HARS. Filling of nearshore and upland disposal sites with large volumes of silt and clay material suitable for remediation is less preferable than using such sites for Category II and III disposal, where transportation costs, containment costs, and environmental risks can be minimized.

Some areas of high-relief and mixed habitat (e.g., east of the Mud Dump Site) will be permanently lost under Alternative 3, but no more so than would occur under Alternative 4. Leaving these areas unremediated, as would occur under Alternatives 1 and 2, will allow continued exposure of degraded sediments in these areas. Except for the isolation of the degraded sediment by burial, and the loss of some hard-bottom habitat, the diverse habitat types that exist within the borders of the HARS will be maintained during and after the remediation operations. When remediation work is complete at the HARS, benthic conditions within the site are expected to remain static, affected only by occasional severe storms, coastal pollution, and fishing activities.

Management of the HARS under Alternative 3 is summarized in Chapter 5. Details are provided in EPA's (1997) HARS SMMP document (see Appendix C). The division of the PRA into nine 1-nmi^2 areas facilitates comprehensive benthic characterization of the site, as well as management of the Remediation

Material placement operations and post-placement monitoring. If monitoring activities show that the remediation work for a particular areas is incomplete, or otherwise not containing the underlying degraded sediments, additional remediation or other work will be conducted.

With respect to endangered and threatened species under Alternatives 1 and 2, there would be a continued exposure of degraded sediments to the biotic zone of the New York Bight Apex. Further, given the limited availability of sandy (0-10%) Remediation Material to achieve Alternative 4, Alternative 4 would not reduce the potential bioaccumulation of contaminants by benthic and demersal species living in the vicinity of the HARS within a reasonable time frame. The Preferred Alternative will cap the PRA with Remediation Material and reduce the exposure of degraded sediments to the biotic zone.

Finally, compliance with the National Historic Preservation Act (NHPA) under Alternative 3 is met by avoidance of the six shipwrecks in the HARS during remediation operations. Only four of the wrecks are located in the PRA. The continued exposure of degraded sediments within 500 m of the wreck structures is considered by EPA to an acceptable balance for (1) compliance with the NHPA, (2) preservation of the wrecks for future cultural-resource evaluations, and (3) use of the wrecks as reef structures by fish and shellfish species.

1.0 PURPOSE AND NEED FOR ACTION

This Supplemental Environmental Impact Statement (SEIS) presents an evaluation of the New York Bight Dredged Material Disposal Site (Mud Dump Site; MDS) and surrounding areas, and supports the Environmental Protection Agency's (EPA) action to close the MDS. "Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 C.F.R. Section 228 as the Historic Area Remediation Site" (HARS) (EPA/DOT/USACE, 1996).

The environmental information used to produce this document results from numerous studies and field surveys by several agencies and investigators working in the New York Bight over the past several years. The summary of data and professional interpretations presented herein are syntheses of all available information found to be recent, accurate, and applicable to the evaluations. As information from the New York Bight continues to be acquired through several ongoing studies—some focused on ocean disposal activities, others on large-scale phenomena that extend outside the Bight (e.g., stock assessments of migratory fish), this information will be considered in making future site management and monitoring decisions. The existing information and data have been synthesized in this SEIS, and provide a technically sound basis for the Agency's decisions embodied in the accompanying site-designation Proposed Rule.

1.1 U.S. Ocean Dumping — History, Regulations, and Pertinence to the MDS

Since the 1800s, the New York Bight Apex[1] and surrounding areas have been used for disposal of dredged material and a variety of waste products, including municipal garbage, building materials, sewage sludge, and industrial waste. Ocean disposal of garbage was stopped in 1934. Other waste product disposal ended as a result of the passage of the Ocean Dumping Ban Act.[2]

Dredged material disposal in the New York Bight Apex began "officially" in 1888 at a point 2.5 miles south of Coney Island. At that time, the New York Harbor U.S. Congressional Act of 1888 established that the Supervisor of New York Harbor had the authority to grant permits for ocean disposal (Williams, 1979). Due to shoaling off Coney Island, the dredged material disposal location was moved in 1900 to a point one-half mile south and eastward of Sandy Hook Lightship. In 1903, the location was moved again, to 1.5 miles east of Scotland Lightship.

Congress enacted the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) to address and control the dumping of materials into ocean waters. Title I of MPRSA authorized EPA and the U.S. Army Corps of Engineers (USACE) to regulate dumping in U.S. ocean waters.

Since MPRSA was enacted, and through its subsequent amendments, dumping in the New York Bight has been dramatically reduced through actions by EPA, the USACE, the U.S. Coast Guard (USCG), and other agencies. In the New York Bight, this has meant permanent closure of the 12-Mile and 106-Mile sewage sludge sites, the Cellar Dirt site, Acid Waste site, and Woodburning site. There are nine ocean dredged material sites currently designated in the New York Bight: the MDS for New York-New Jersey Harbor

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[1] The New York Bight Apex is defined as the area of approximately 2,000 km^2 extending along the New Jersey coastline from Sandy Hook south to 40°10' latitude and east along the Long Island coastline from Rockaway Point to 73°30' longitude.

[2] Sewage sludge dumping ended at the 12-Mile Site in 1987 and at the 106-Mile Site in 1992.

dredged material and eight sites (four off New Jersey and four off New York) for barrier-beach inlet material.

Throughout the country, EPA and the USACE share responsibility for managing dredged material. Under Section 103 of MPRSA, the USACE evaluates permit applications for projects proposing to place dredged material in ocean waters. The USACE evaluation includes determining whether sediment from a dredging project complies with EPA's regulations in 40 CFR Section 227. Also under MPRSA Section 103, EPA conducts an independent evaluation of the environmental effects of the proposal and must concur with the USACE determination before a permit can be issued.

Under the authority of Section 102 of MPRSA, EPA is responsible for designating ocean sites. EPA's regulations for this activity are found in 40 CFR Section 228. EPA and the USACE work cooperatively to designate, monitor, and manage sites, and to evaluate dredged material permits and projects. National technical guidance for determining whether dredged material is acceptable for ocean dumping is contained in the *Ocean Testing Manual* (Green Book; EPA/USACE, 1991). Regional testing/implementation manuals, developed by EPA Regions and USACE Districts, provide specific testing and evaluation methods (e.g., bioassay species, analyte detection limits, administrative requirements) for dredged material projects at specific sites or groups of sites. The regional testing manual (RTM) that covers the MDS was published in 1992 (USACE NYD/EPA Region 2, 1992).

While EPA's MPRSA site designation process seeks to achieve national consistency among U.S. sites, it also allows flexibility to meet local needs. The Agency considers ocean site designation on a case-by-case basis, designates appropriately sized sites in suitable areas, and implements site-specific management/monitoring plans. Goals of the EPA site-designation process include limiting impacts to the environment; providing for efficient management and monitoring operations; and, where appropriate, supporting multiple users (e.g., the USACE, a local port authority, and the owners of berthing areas). In addition, EPA evaluates the impact of disposal at and near the site; where there are certain adverse conditions resulting from activities at the site, the site is categorized as Impact Category I (40 CFR Section 228.10). For an Impact Category I site, EPA places appropriate limitations on use of the site to reduce the impacts to acceptable levels [40 CFR Section 228.11(c)].

In areas where EPA has not designated an MPRSA dredged material site, or when the USACE District Engineer determines that it is not feasible to use an EPA-designated site, the District Engineer may select an alternative site in accordance with EPA criteria in 40 CFR Section 228 [MPRSA Section 103(b)]. Under this scenario, compliance with the ocean dumping criteria of 40 CFR Section 227 is still required and EPA concurrence on the permit or civil works project must still be obtained. Currently, there are no USACE-selected ocean sites in the New York Bight. In summary, the presence of an EPA designated site does not authorize or imply that the dredging project can use the site without (1) sediment evaluation (2) USACE permit/project review, and (3) EPA concurrence (refer to box on Page 1-3).

The other major Federal law relevant to ocean dumping and the designation of sites is the National Environmental Policy Act (NEPA). NEPA is the basic U.S. charter for protecting the environment. Section 102(C) of the Act specifies that a detailed statement by the responsible official is to be prepared for "major Federal actions significantly affecting the quality of the human environment." The purpose and intent of these statements are specified in the Council of Environmental Quality Regulations for Implementing NEPA (40 CFR Sections 1500-1508). The statements are to assemble and clearly present accurate and pertinent "environmental information to public officials and citizens before decisions are made and before actions are taken [40 CFR Section 15001(b)]." In regard to ocean dumping, environmental impact statements (EISs) are developed by EPA for site designations and the USACE for large dredging projects. Even though EPA is not legally required to develop EISs for its own actions, including evaluating and designating sites, the Agency has voluntarily established a policy (39 FR 37119, October 21, 1974) to publish EISs for site designations and similar actions as part of its open decision-making process.

Alternatives Analyses for Ocean Dredged Material Site Designations and Dredged Material Disposal Projects

Like other site designation EISs, the MDS designation EIS (EPA, 1982) first assessed the need for an open-ocean site, then evaluated candidate designation sites that were environmentally acceptable and economically feasible. National Environmental Policy Act (NEPA) evaluations for USACE dredging permits and Federal civil works dredging projects include evaluations of candidate disposal sites. There are significant differences between the alternatives analyses for site designations and the alternatives analyses for dredged material disposal projects. The following summarizes and contrasts the two types of alternatives analyses.

Alternatives Analyses for Ocean Site Designations. Candidate designation sites are open-ocean areas that are governed by the Marine Protection Research and Sanctuaries Act of 1972 (MPRSA). Site designation identifies an area that would be suitable to receive the material if a permit were issued, and does not constitute automatic site use or promote the ocean option over non-ocean alternatives for specific projects. As a result, an EPA alternatives analysis of candidate sites does not include specific evaluation of non-ocean alternatives, such as potential upland sites, estuarine sites, or sites where islands or other above-water containment facilities are proposed. Ocean candidate sites are differentiated from one another by their site-specific characteristics, including any potential impacts to environmental resources (e.g., fisheries) and other uses of the ocean (e.g., navigation). Significant modification of a designated site requires either another EIS or a Supplement to the original EIS.

Alternatives Analyses for Dredged Material Projects. Site use is subject to the requirements for an MPRSA permit or Section 103 equivalent. All dredged material projects must undergo a NEPA alternatives analysis in accordance with USACE procedures and USACE NEPA regulations in 33 CFR Section 230. In the case of proposed permits under MPRSA, under Subpart C of 40 CFR Section 227 (Need for Ocean Dumping) it must be demonstrated that no other "practicable alternative" locations or methods, including non-ocean alternatives, are available. To accomplish this, the permittee or the USACE conduct an alternatives analysis which evaluates available alternative locations and methods (ocean and non-ocean), as well as recycling and treatment. Before a MPRSA permit proceeds, the EPA Regional Administrator and the USACE District Engineer must determine that the criteria of Subpart C are satisfied. When other low-impact or beneficial-use alternatives are practicable, a MPRSA permit is not issued. Readers interested in further information on comparing all dredged material alternatives may refer to "Evaluating Environmental Effects of Dredged Material Management Alternatives — A Technical Framework" (EPA/USACE, 1992).

Brief History of the Mud Dump Site, 1973-1997. In 1973, EPA designated the Mud Dump Site as an "interim" ocean dredged material site. The interim site was a 2.2-nmi^2 rectangle in an area of naturally occurring sand bottom, approximately 5.3 nmi east of Sandy Hook, NJ and 9.6 nmi south of Rockaway Beach, Long Island, NY (Figure 1-1). In the comparison of the alternatives in the site-designation EIS (EPA, 1982), five "favorable" and three "unfavorable" factors were described for the interim MDS.

After completion of environmental studies and publication of the site-designation EIS in 1982, EPA designated the interim MDS as an Impact Category I site in 1984, with no changes to the borders of the 2.2-nmi^2 site. Depths of the site ranged from 15.8 to 28.8 m (51.8 to 94.5 ft) below mean low water (BMLW) at designation, with capacity for up to 100 million cubic yards (Myd^3) of dredged material. That capacity limitation was intended to assure that dredged material mounds would not present a hazard to navigation in the Bight Apex.

Since 1984, the MDS has received approximately 68 Myd^3 of dredged material. Recent bathymetric data show that water depths within the MDS currently average 20 m (65 ft) (EPA Region 2/USACE NYD, 1997). The current remaining capacity is approximately 32 Myd^3.

The Green Book (EPA/USACE, 1991) specifies test methods, criteria, and a decision framework for evaluating water-column and benthic impact for a proposed dredged material project. The USACE NYD/EPA Region 2 (1992) *Implementation Manual, Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal* (Regional Testing Manual, RTM) complements the Green Book with information on permit procedures, laboratory work-plan requirements, analyte lists, laboratory methods, and QA/QC procedures.

EPA Region 2 and the USACE New York District have evaluated testing results to determine a dredged material's category and suitability for ocean disposal at the MDS. Sediments are segregated into a 3 category system, with Category I being allowed for ocean disposal without restriction, Category II allowed for ocean disposal with restriction (capping), and Category III is prohibited from ocean disposal. In particular, Category I material is material that will not cause unacceptable toxicity or significant undesirable effects including through bioaccumulation in accordance with 40 CFR 227.6 and is suitable for "unrestricted" ocean disposal. Readers should note that the above is a regional categorization system; it is not applied to ocean sites in other areas of the country.

In 1996, EPA and the USACE completed a comprehensive analysis of benthic erosion at the MDS and afterwards established "management depths" at the site above which deposited dredged material would not be allowed to shoal. The management depths for Category I and II dredged material were set at 45 ft (14 m) and 65 ft (approx. 20 m) BMLW, respectively. The establishment of the 65-ft management depth for Category II material[3] limited the remaining Category II capacity to approximately 1 Myd^3. The balance of the site's capacity (31 Myd^3) is for Category I dredged material.

[3] The 65-ft BMLW management depth for Category II dredged material includes a 1 m cap of sand. Refer to the MDS Site Management and Monitoring Plan (EPA Region 2/USACE NYD, 1997) for additional information on current Category I and II dredged material practices.

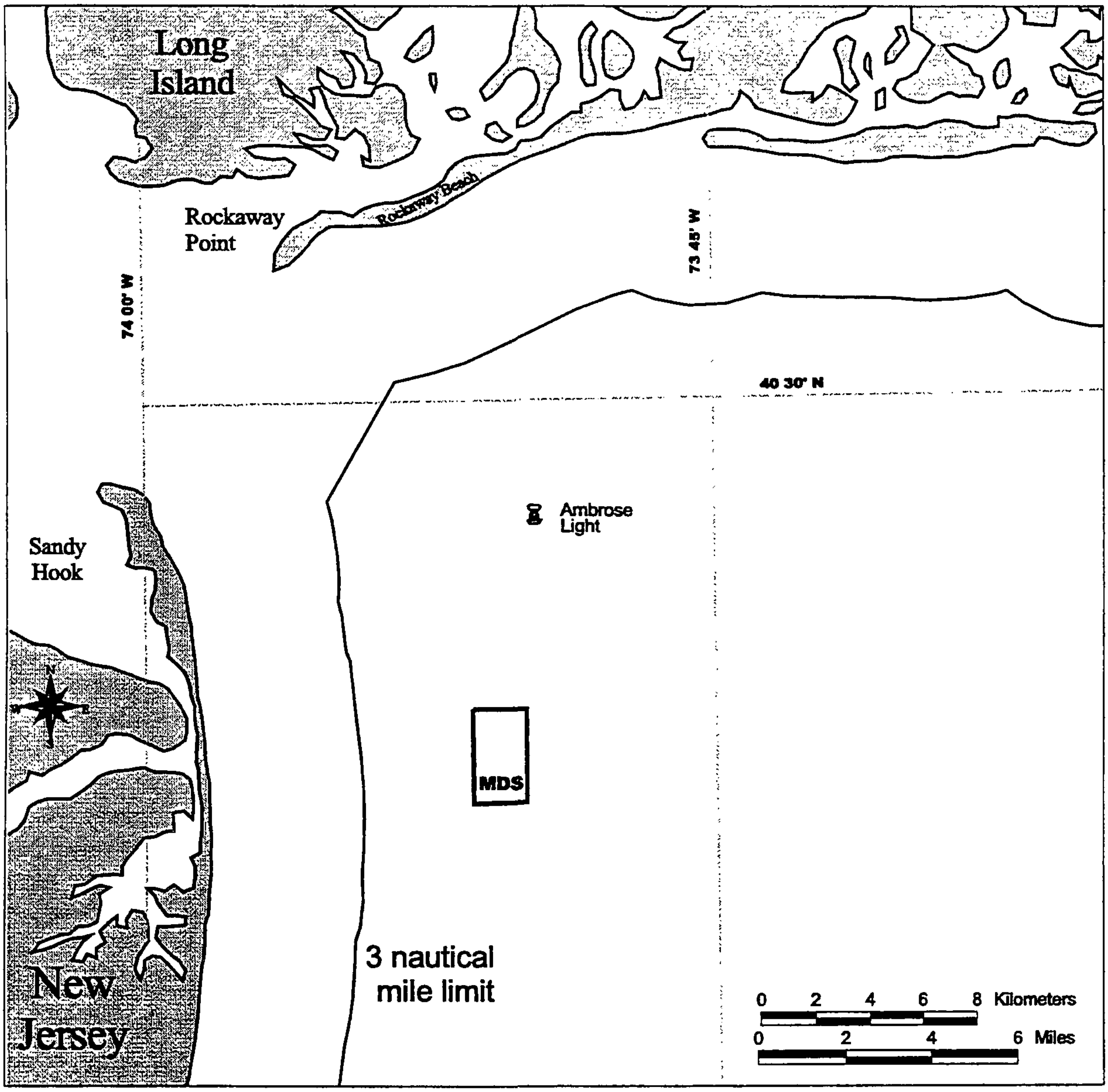

Figure 1-1. Location of the current Mud Dump Site (MDS), designated in 1984.

MDS Favorable Factors	MDS Unfavorable Factors
• Within region of influence from previous dumping • Within shellfish closure zone • Within influence of Hudson-Raritan Plume • Site not filled to capacity • Low in biotic density	• Shallowest site • Adjacent to important recreational fishing grounds • Within Precautionary Zone, but outside of major shipping lanes

Source: EPA (1982)

Between 1984 and 1996, several events and Federal Agency actions relating to the MDS led EPA to begin the administrative process for closure of the MDS by September 1, 1997, and to designate the site and surrounding areas that have been used historically as disposal sites as the Historic Area Remediation Site (HARS). With designation of the MDS in 1984, EPA and the USACE conducted dredged material testing, permitting, disposal, and monitoring at the site, as specified by Federal regulations and policy. Technical advances in laboratory and field methods during this period provided dredging program managers with improved tools and increasingly accurate and precise information about dredging site sediments and predicting effects of their disposal at the MDS.

In February 1995, EPA Region 2 (1995a) issued a Public Announcement stating that the Agency would commence a study of a 23-nmi^2 area surrounding the existing MDS. The product of the study was to be a Supplemental Environmental Impact Statement (SEIS) that would evaluate the following three alternatives according to EPA's ocean dumping regulations.

1. No action (no expansion of the MDS)

2. Expansion of the MDS for Category I material

3. Expansion of the MDS for Category I and II material

Each of the alternatives, particularly Alternatives 2 and 3, were also to be evaluated relative to impacts from historical disposal and the potential for remediating or restoring impacted benthic areas.

Development of the SEIS was started while several major Bight Apex field studies were still in progress. In May 1995, EPA announced toxicity test results[4] from benthic samples collected in the 23-nmi^2 SEIS Study Area (EPA Region 2, 1995b). These data showed that if the Study Area sediment samples had come from a proposed dredging site, sediments in some parts of the Study Area would have been classified as Category III and determined to be unacceptable for ocean disposal. Bathymetric and side-scan data also collected at this time also showed evidence of dredged material mounds northwest of the 23-nmi^2 SEIS

[4] The toxicity tests reported by EPA Region 2 (1995a) were from 10-day amphipod bioassays using *Ampelisca abdita*. Study Area sediments and reference area sediments were tested side-by-side under identical conditions [refer to EPA/USACE (1991) and USACE NYD/EPA Region 2 (1992) for further description of test procedures].

Study Area (Subarea 1). In response to this new information, EPA expanded the Study Area by adding an approximately 7-nmi^2 rectangle (Subarea 2) northwest of and abutting the western border of Subarea 1. The resulting 30-nmi^2 (103.2 km^2) Study Area encompassed all benthic areas that showed evidence of dredged material disposal in the New York Bight Apex (see Figure 1-2).

Other studies—some not directed at evaluating dredged material impacts—further characterized the physical, chemical, and biotic conditions of the Study Area and Bight Apex.

- Chemical analysis of infaunal (worm) tissue from the Study Area confirmed that some sediment contaminants are being bioaccumulated in the lower trophic levels.
- The hepatic tissue (tomalley) of Bight Apex lobsters was found to have levels of PCBs and 2,3,7,8-TCDD (dioxin) above currently acceptable action levels and guidelines.
- Several shipwrecks were located in the Apex and Study Area, triggering a need for a National Historic Preservation Act (NHPA) evaluation and an evaluation of the spatially-limited reef habitat created by the wrecks.

The assembly of this new information generated heightened concern about the environmental consequences of historical ocean disposal in the Bight Apex, including the continued disposal of Category II dredged material. This in turn brought into question the appropriateness of continued use or expansion of the MDS. The concerns led to Federal actions detailed in a July 24, 1996 letter to several New Jersey Congressmen, signed by EPA Administrator Carol Browner, Secretary of Transportation Federico F. Peña, and Secretary of the Army Togo D. West, Jr. (July 24, 1996, 3-Party Letter):

> "... Accordingly, the Environmental Protection Agency (EPA) will immediately begin the administrative process for closure of the MDS by September 1, 1997. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with management standards in 40 C.F.R. Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 C.F.R. Section 228 as the Historic Area Remediation Site. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228.11(c)). The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)..." (EPA/DOT/USACE, 1996)

The July 24, 1996, 3-Party Letter further states that "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material," and that the three agencies will work to develop a sound dredged material management plan for the Port, reduce the backlog of dredging projects, and start a feasibility study for a 50-foot deep port.

Subsequent to the July 24, 1996, 3-Party Letter, EPA Region 2 (1996a) issued a Public Announcement in September 1996 modifying the scope of the SEIS from evaluating the potential expansion of the Mud Dump Site to evaluating the designation of a Historic Area Remediation Site (HARS). In the same announcement, the Agency stated that it was beginning the administrative process to close (de-designate) the MDS.

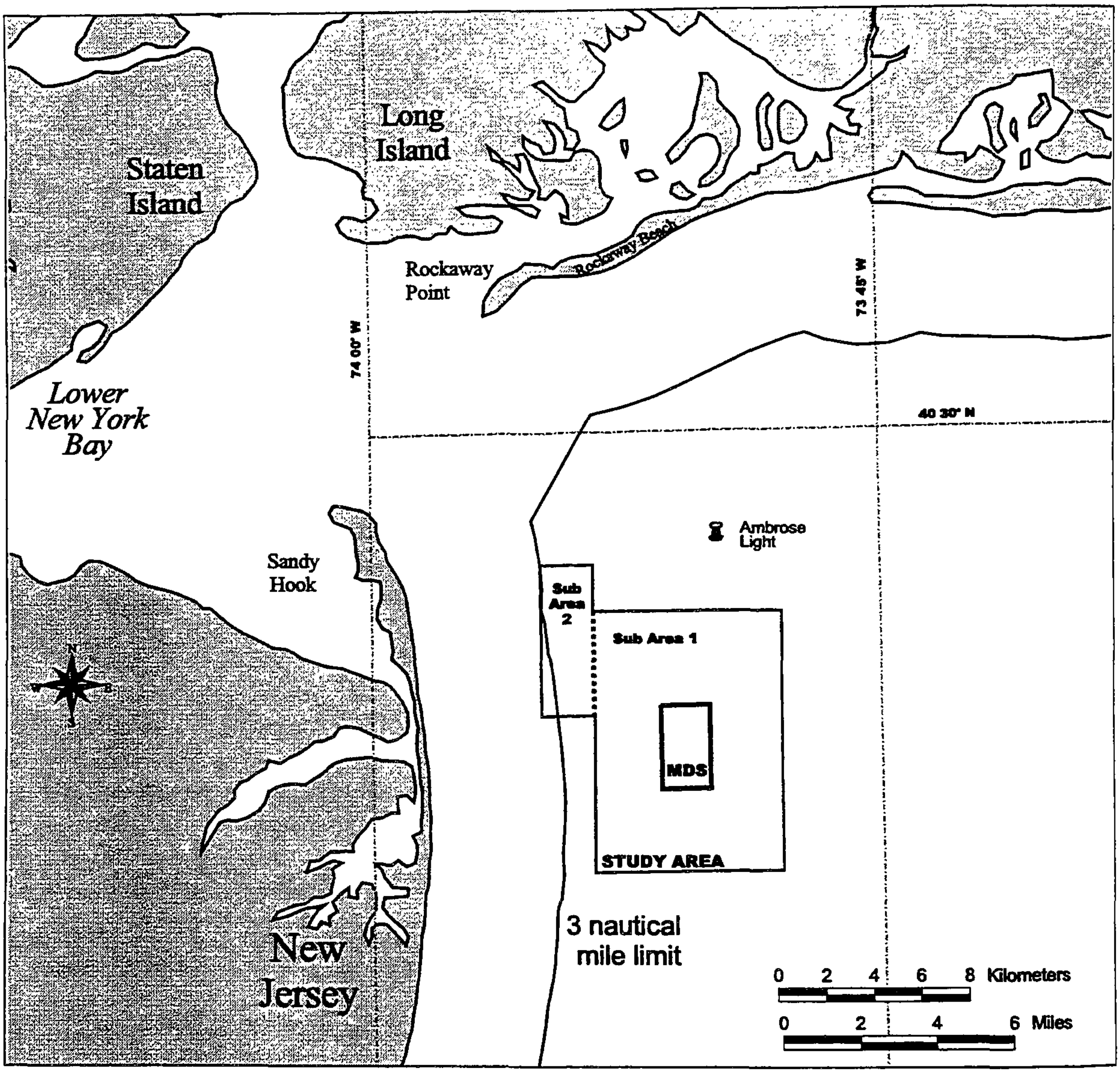

Figure 1-2. Location of Mud Dump Site (MDS) and Study Area Subareas 1 and 2.

The following sections and chapters of this SEIS evaluate a comprehensive set of physical, chemical, biological, and socioeconomic data relative to the 30-nmi^2 Study Area and the portion of the Study Area that EPA is proposing to designate as the HARS (Figure 1-3). Where living and nonliving resources or phenomena could not be adequately characterized directly within the confines of the Study Area, the scales of the evaluations were expanded to include the larger Bight Apex (e.g., for characterizing physical conditions such as waves, currents and weather patterns) or the full New York Bight (e.g., for characterizing the status of migratory fish and shellfish stocks).

1.2 Need for Remediation

As presented above and examined in detail in Chapter 3, field studies of the New York Bight Apex have found bioaccumulative contaminants and toxicity in surface sediments of much of the MDS and surrounding areas, and that some of these sediments can cause toxicity to sensitive marine organisms exposed to it. It is impossible to quantify how much of this contamination is the direct result of past dredged material disposal, or how much can be attributed to other ocean disposal activities (e.g., former sewage sludge dumping at the 12-Mile Site) or land-based discharges (e.g., via Hudson River plume or atmospheric deposition). However, the presence of these degraded sediments in the New York Bight Apex is cause for concern.

Degraded surface sediments in nearshore waters are continually exposed to the ecosystem until they are buried by natural sedimentation, the placement of dredged material, or otherwise isolated or removed. While exposed, these sediments can directly and indirectly impact benthic and pelagic organisms. Impacts to terrestrial organisms (including human beings) are also possible if the contaminants undergo trophic transfer.

Under the MPRSA permitting procedures, dredged material is evaluated for both potential toxicity and contaminant bioaccumulation. These evaluations include the use of bioassays with marine organisms of ecological relevance to ocean site environments, specifically, small infaunal worms, clams, and crustaceans. Infaunal organisms that burrow or construct tubes on or in sediment are good evaluative tools because their high surface area to mass ratio and limited mobility (compared to fauna such as fish) maximizes exposure to the test sediments, (Brown and Neff, 1993; Boese and Lee, 1992; Lee *et al.*, 1989). Infaunal organisms are also more likely than other organisms to bioaccumulate contaminants, exhibit effects, and transfer contaminants to higher trophic levels. Deposit feeding infauna are especially susceptible to contaminant toxicity and bioaccumulation because they actively ingest sediment particles while foraging for microorganism prey and organic matter. Such organisms are also exposed to sediment constituents by dermal contact and respiration activities.

Use of Bedded Sediment Bioassays in Dredged Material Management Decisionmaking

The primary tool for EPA/USACE dredged material evaluation is the bedded sediment bioassay of whole sediment. These bioassays are particularly useful because they integrate additive and synergistic effects of multiple contaminants and can be used to differentiate contaminant-related effects from noncontaminant effects present on the seafloor (e.g., grain size, temperature, light). In most applications, control, reference, and test samples are run side-by-side. Comparison of the results from the three types of samples determines if the test run is acceptable and whether the sediment from the dredging site meets the requirements of EPA's Ocean Dumping Regulations.

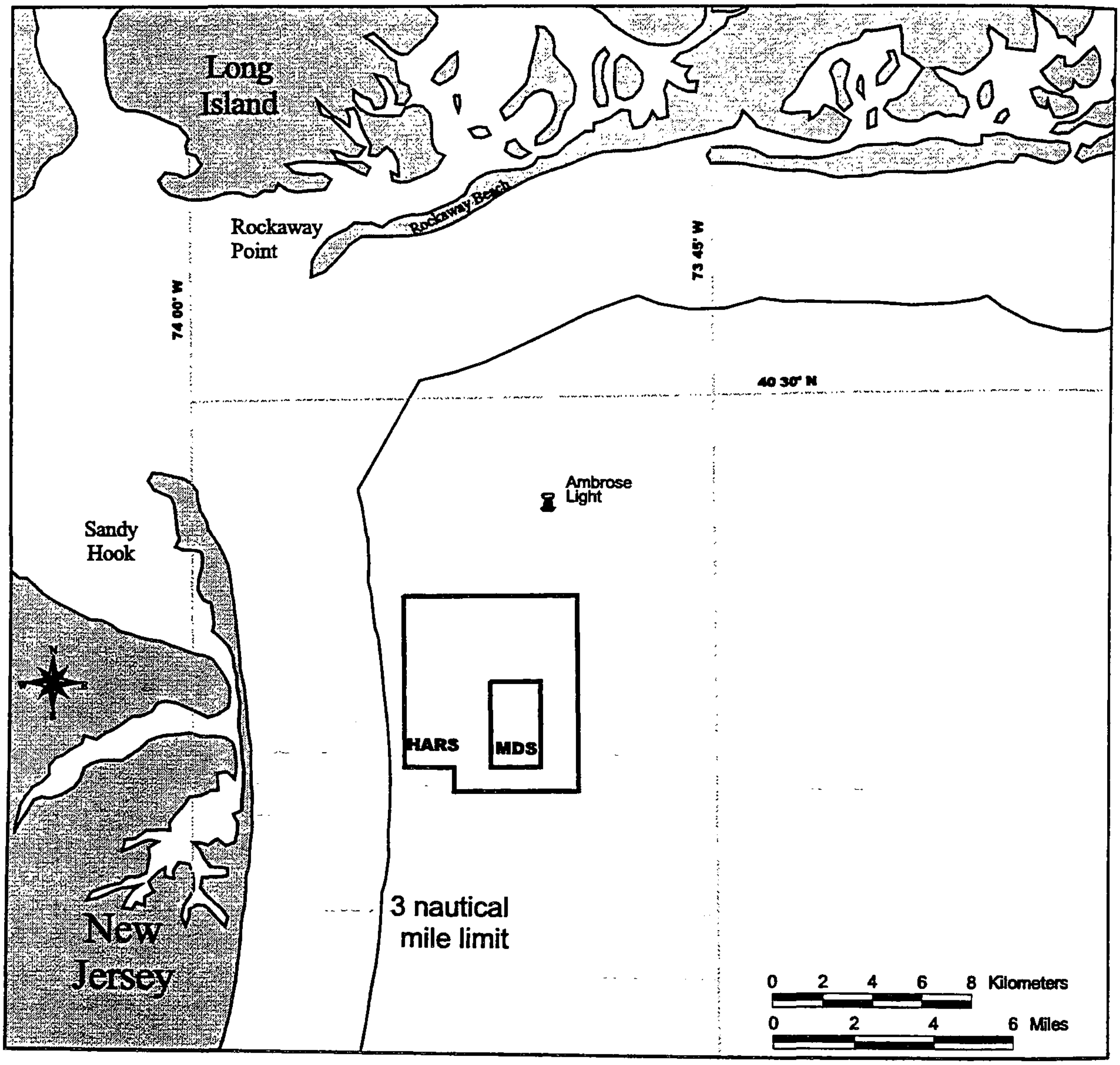

Figure 1-3. Location of the current Mud Dump Site (MDS) and Historic Area Remediation Site (HARS).

If biologically available contaminants in sediments from an area are too high for specific infauna to tolerate, individual organisms are killed by the toxic effects or they migrate to more hospitable habitats. From an ecosystem perspective, the loss of contaminant-sensitive infauna from a benthic area represents a loss of potential prey organisms for higher trophic level species, such as bottom foraging fish. Such an occurrence also removes the potential for contaminant trophic transfer. However, shallow-water benthic ecosystems such as the Bight Apex are very complex, and overlapping biological linkages are variably affected by different physical and chemical parameters. Like in other nearshore ecosystems, Bight Apex communities are resilient to physical (e.g., storm events) and chemical impacts (e.g., pollution). If conditions become inhospitable for one species, another similar species usually fills the physical space and ecological niche of the former. Thus, contaminant-induced changes in infaunal communities are usually difficult to detect and evaluate. Furthermore, the magnitude of large-scale natural processes, such as seasonal changes in water temperature and currents, natural variability of predator/prey abundances, and anthropogenic activities such as fishing, can mask the effects of sediment contamination. Widespread infauna toxicity is usually detectable only when the sediment contamination is so acute that few or only highly specialized (i.e., "pollution-tolerant") infauna are able to inhabit the area.

As a result of these uncertainties and the difficulty in detecting negative impacts to benthic infauna or higher organisms actually living in the Bight Apex, EPA evaluated sediment degradation and the need for remediation by indirect (i.e., surrogate) methods. Sediment toxicity was evaluated using bioassays normally conducted on sediment samples from proposed dredging sites in the harbor (see Section 1.2.1). Similarly, the Agency evaluated the potential for contaminant bioaccumulation by collecting infaunal organisms and sediment from the Study Area, and conducting the corresponding chemical analyses (see Sections 1.2.2 and 1.2.3).

1.2.1 Study Area Contaminant Toxicity

The method used to assess toxicity in the SEIS Study Area was the 10-day amphipod (*Ampelisca abdita*) bioassay, the same toxicity test used to evaluate the suitability of sediment in EPA Region 2 and the USACE NYD. This sensitive bioassay is one of several tests developed to evaluate proposed dredging projects, and thus protect ocean sites from receiving dredged material that is potentially toxic to the site environment. While the uses of the amphipod bioassay to evaluate disposal site sediments was a nonroutine procedure, the generated data have both ecological relevance[5] and allows for direct comparison with data from samples of current MDS disposal projects.

The data from amphipod bioassays of the Study Area samples indicated widespread toxic conditions in sediment around the MDS (EPA Region 2, 1995b). If these surface sediments from the Study Area (sampled in 1994) were from a proposed Region 2/NYD dredging project site, the sediments would have been categorized as Category III, found to not meet the limiting permissible concentration (LPC) in EPA's Ocean Dumping Regulations (40 CFR Section 227.27), and thus not permitted for disposal at an ocean site.

1.2.2 Study Area Contaminant Bioaccumulation/Trophic Transfer

While acute sediment toxicity is considered by EPA and other resource agencies to be a clear negative and unacceptable impact, contaminant bioaccumulation is more difficult to predict and evaluate. However bioaccumulation is of a concern because it can be an indicator of trophic transfer phenomena. While individual organisms that accumulate contaminants in the field or in laboratory studies might not

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[5] Amphipods are prey items for many organisms in the Bight Apex, including fish.

experience a detrimental impact, the degree to which the contaminants are accumulated can be an indicator that the organism's population, community, or predator may be at risk of impact.

Infaunal bioaccumulation of sediment-associated contaminants can result in both acute and chronic impacts and eventually transform benthic community structure (Lee, *et al.,* 1989). Such changes affect the food source of demersal predators. When demersal predators feed on infauna with contaminated tissue, the contaminants can be transferred to and potentially accumulate in the tissue of the predator. These contaminants can then potentially continue through the marine trophic levels, and possibly to human consumers of seafood. Fortunately, most infaunal predators with the potential to transfer contaminants to human food tend to be relatively large, motile species (e.g., crabs, lobsters, fish) with correspondingly large forage areas. The result is that most marine predators have lower contaminant burdens than their infaunal prey located in a small part of their large foraging areas. Additionally, contaminant bioaccumulation is often species specific, and assessment of the potential for effect is complicated by a number of physical and chemical factors. These factors include:

- Number and concentration of bioaccumulative contaminants in the sediments,
- Bioaccumulation efficiencies
- Biomagnification potential among receptors,
- Background body burdens,
- Synergistic effects,
- Life history, and
- Habitat range and contaminants in other areas of species' range.

Each of the above adds complexity to the evaluation of contaminant bioaccumulation in the SEIS Study Area.

EPA's approach to evaluating potential contaminant bioaccumulation in the Study Area was to collect and analyze infaunal worms for known bioaccumulative compounds. The evaluation was similar to Green Book Tier IV "steady-state" evaluations. The results of the study were able to show where and to what levels Study Area infauna were accumulating contaminants from the sediments. The study results also provided data that could be compared to data from bioaccumulation bioassays of past and proposed dredged material disposal projects and potentially used in trophic-transfer studies and risk assessments.

1.2.3 Other Indicators of Sediment Degradation in the Study Area

Other indicators of degraded sediment in the Study Area were the relatively high contaminant concentrations in whole sediment samples and findings of elevated contaminant levels in area lobsters.

As discussed in Chapter 3, sediment contaminant concentrations of Study Area samples were compared to NOAA ER-L (Effects Range-Low) and ER-M (Effects Range-Median) thresholds. ER-L/ER-M thresholds have been derived from a broad range of biological and chemical data collected synoptically from field and laboratory experiments (Long and Morgan, 1991; Long *et al.,* 1995). Although ER-L/ER-M thresholds have not been established as criteria for regulatory decisionmaking, they are useful in sediment evaluations when considered concurrently with other data. In general, the ER-L/ER-M comparison to Study Area data indicated that, based on contaminant presence in the sediment alone, negative biological effects are possible at many stations. This conclusion is corroborated by the results of the toxicity tests described above.

Additional evidence of degraded sediments in the New York Bight was found in tissue data from lobsters that were harvested in the New York Bight Apex in 1994 (NOAA, 1996). PCB and 2,3,7,8-TCDD (dioxin) concentrations in the hepatic tissue (tomalley) of the lobsters were above U.S. Food and Drug Administration consumption guidelines. Other contaminants were also present in the hepatopancreas and other tissues, but the concentrations were within consumption guidelines. Collectively, the study data reveal that food sources of Bight Apex lobsters are contaminated, that contaminants are being accumulated, and that concern about potential human-health risks is warranted. It must be kept in mind, however, that the lobsters analyzed in the NOAA study were harvested from wild stocks in the Apex, whose populations migrate seasonally through the region, including perhaps the SEIS Study Area. Contamination of these animals cannot be definitively linked to specific areas of dredged material disposal, to other past dumping activities, or to other ongoing pollution sources. Nor does the study indicate that human consumption of lobster muscle tissue (meat) presents health risks. However, the contaminant data set complements other evidence of benthic contamination in the Bight Apex region.

1.2.4 Solutions to Sediment Degradation in the Study Area

The presence of toxic effects (a Category III sediment characteristic), high levels of bioaccumulative contaminants (a Category II sediment characteristic), ER-L/ER-M exceedances in Study Area sediments, as well as TCDD/PCB contamination in area lobster stocks, support the need to designate a HARS and conduct remediation work. While individual elements of the available data do not indicate that sediments within the Study Area are imminent hazards to the New York Bight Apex ecosystem, living resources, or human health, the collective evidence presents cause for concern and justifies the conclusion of the July 24, 1996, 3-Party Letter (EPA/DOT/USACE, 1996) that a need for remediation exists. The data also support a finding that, to the extent these effects are attributable to ocean dumping activities, the MDS and parts of the surrounding areas would be an Impact Category I Site [40 CFR Section 228.10(c)(1); refer to Table 1-1]. Therefore, it is appropriate to modify use of the site and provide for appropriate remediation (40 CFR Section 228.11).

Chapter 4 of this SEIS compares four alternatives and selects the Preferred Alternative which is remediation of the degraded sediments.

1.3 Proposed Action

The Proposed Action, in accordance with 40 CFR Section 228.11, is to simultaneously close/de-designate the MDS and designate the site and surrounding areas that have been used historically as disposal sites for contaminated material as the HARS (Alternative 3 in Chapter 2). The HARS will be 15.7 nmi^2 (54 km^2) and include the entire current MDS area. Within the HARS will be a 9.0-nmi^2 Priority Remediation Area (PRA), a 5.7 nmi^2/0.27-nmi wide Buffer Zone (BZ), and a 1-nmi^2 No Discharge Zone (NDZ). The Remediation Material for the 9-nmi^2 PRA of the HARS will primarily be obtained from maintenance dredging projects in the Port of New York and New Jersey and surrounding areas.

The "Material for Remediation" (Remediation Material) is defined as:

> ". . .uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)."
>
> (EPA/DOT/USACE, 1996)

This material shall be selected so as to ensure it will not cause significant undesirable effects including through bioaccumulation or unacceptable toxicity, in accordance with 40 CFR 227.6.

Table 1-1. Five Factors to be Considered in the Determination of Impact Category I
[40 CFR Section 228.10(c)(1)]

(1) Impact Category I: The effects of activities at the disposal site shall be categorized in Impact Category I when one or more of the following conditions is present and can reasonably be attributed to ocean dumping activities;

(i) There is identifiable progressive movement or accumulation, in detectable concentrations above normal ambient values, of any waste or waste constituent from the disposal site within 12 nautical miles of any shoreline, marine sanctuary designated under Title III of the Act, or critical area designated under section 102(c) of the Act; or

(ii) The biota, sediments, or water column of the disposal site, or of any area outside the disposal site where any waste or waste constituent from the disposal site is present in detectable concentrations above normal ambient values, are adversely affected by the toxicity of such waste or waste constituent to the extent that there are statistically significant decreases in the populations of valuable commercial or recreational species, or of specific species of biota essential to the propagation of such species, within the disposal site and such other area as compared to populations of the same organisms in comparable locations outside such site and area; or

(iii) Solid waste material disposed of at the site has accumulated at the site or in areas adjacent to it, to such an extent that major uses of the site or of adjacent areas are significantly impaired and the Federal or State agency responsible for regulating such uses certifies that such significant impairment has occurred and states in its certificate the basis for its determination of such impairment; or

(iv) There are adverse effects on the taste or odor of valuable commercial or recreational species as a result of disposal activities; or

(v) When any toxic waste, toxic waste constituent, or toxic byproduct of waste interaction, is consistently identified in toxic concentrations above normal ambient values outside the disposal site more than 4 hours after disposal.

The maintenance of Port waterways and possible deepenings is expected to produce large volumes of Remediation Material, comprised primarily of silts and clays. It should be mentioned, however, that most of the materials (approx. 75%) produced by the maintenance of the Port are unacceptable for ocean disposal, thereby requiring the identification of alternative means of disposal for these materials. Currently, there are several operations and maintenance (O&M) dredging projects for the Port in the planning, review, or contracting stages, and preliminary studies; as well as a 50-ft Port deepening project. As stated in the July 24, 1996, 3-Party Letter, "the designation of Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Details of the Proposed Action and the other three alternatives are presented in Chapter 2 of this SEIS. Comparison of the environmental consequences of the Proposed Action and the considered alternatives are presented in Chapter 4.

1.4 Basis for the SEIS

As discussed above in Section 1.1, EPA established a voluntarily policy (39 FR 37119, October 21, 1974) to publish EISs for ocean site designations and similar actions as part of its open decision-making process. This SEIS has been prepared under this policy, following the regulatory guidance provided by 40 CFR 1502.9(c)(1). Other subparts of 40 CFR Section 1502.9 that have guided the development of this SEIS state that agencies "may also prepare supplements when the agency determines that the purposes of [NEPA] will be furthered by doing so [40 CFR Section 1502.9(c)(2)]," and that the SEISs should be prepared, circulated and filed in the same fashion as the draft and final EIS unless alternative procedures are approved by the Council on Environmental Quality [40 CFR Section 1502.9(c)(4)]. EPA has adhered to these paragraphs and subparts of the regulations, as described below.

> **Preparing SEISs under**
> **40 CFR Section 1502.9(c)(1)**
>
> *(c) Agencies:*
> *(1) Shall prepare supplements to either draft or final environmental impact statements if:*
> *(i) The agency makes substantial changes in the proposed action that are relevant to environmental concerns; or*
> *(ii) There are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.*

- **EPA is making substantial changes to its earlier action [40 CFR Section 1502.9(c)(1)(I)].**
  EPA intends by its rulemaking authority under MPRSA to designate a HARS that includes the current MDS area and surrounding areas that have been impacted by dredged material disposal. This action requires (1) closing the current MDS, (2) designating the HARS, (3) developing and implementing a HARS management and monitoring plan, and (4) coordinating with other agencies (USACE, NMFS, MMS, etc.) that have jurisdictional authority or who are trustees of natural resources in the area.

- **There are significant new circumstances and information relevant to environmental concerns in areas adjacent to the current MDS [40 CFR Section 1502.9(c)(1)(ii)].**
  Surveys of the present MDS and surrounding areas have revealed regions of degraded sediment strongly linked to historic dredged material disposal. Some of the sediments in these areas (1) are toxic to bioassay organisms used to identify Category III sediments in proposed dredging projects, (2) contain infauna that have significantly bioaccumulated sediment contaminants, and/or (3) have whole-sediment contaminant levels that significantly exceed NOAA effects-level calculations. Furthermore, the hepatic tissue (tomalley) of lobsters in the area have levels of PCBs and 2,3,7,8-TCDD (dioxin) above currently acceptable action levels and guidelines (NOAA, 1996; EPA Region 2, 1996b).

- **This SEIS furthers the purposes of NEPA [40 CFR Section 1502.9(c)(2)].**
  Designating a HARS that includes the present MDS and impacted areas created by historic dumping clearly furthers NEPA's purposes, which include being a responsible "trustee of the environment for succeeding generations, . . . [using] the environment without degradation, risk to health or human safety, or other undesirable or unintended consequences, . . . [and preserving] an environment which supports diversity and variety. . . [NEPA Section 101(b)]."

- **This SEIS has been prepared, circulated, and filed in the same fashion as the 1982 EIS that was used to designate the current MDS [40 CFR Section 1502.9(c)(4)].**
  As with all draft, final, and supplemental EISs developed by or for the EPA, this SEIS has been developed from technical data and information available from Federal, State, and local agencies, affected industry, and other involved parties. New York-New Jersey Dredging Forum individuals participating in the MDS/HARS Work Group have been provided opportunity and encouraged to communicate directly with the authors of this SEIS, and have been allowed to review and comment on preliminary SEIS text and conclusions. EPA's five general and eleven specific criteria for designating ocean disposal sites, found in 40 CFR Sections 228.5 and 228.6(a) (Tables 1-2 and 1-3), were addressed in the 1982 MDS designation EIS and are addressed again in this SEIS in the Chapter 4 comparison of environmental consequences for the alternatives.

1.5 Issues of Concern Addressed by This SEIS

The primary focuses of this SEIS are on the environmental conditions at and around the MDS and the effects of sediment placement operations on the adjacent environment and natural resources. There are several socioeconomic concerns, specified in 40 CFR Sections 228.5 and 228.6(a) (refer to Tables 1-2 and 1-3), which are also addressed in this SEIS.

1.5.1 Environmental Concerns

The major environmental concern about the present MDS and the designation of the HARS involves the potential for ecological or human-health effects, and the need to take appropriate remedial action to safeguard against such effects. The data presented and evaluated in the Affected Environment chapter (Chapter 3) characterizes the present conditions in the Study Area. The Environmental Consequences chapter (Chapter 4) compares the four alternatives described in Chapter 2, relative to potential environmental impacts. Issues addressed in these chapters include:

- Characterization of areas affected by historical and ongoing dredged material disposal.
- Delineation of degraded benthic areas within the Study Area;
- Expected presence and impacts of contaminants in the benthos at the present MDS and the proposed HARS;
- Actual and perceived impacts to commercial and recreational fisheries and human health; and
- Existing and future impacts to endangered species and ecologically important habitats.

1.5.2 Socioeconomic Concerns

Many of the socioeconomic concerns about closure of the current MDS and the designation of the HARS have been introduced earlier in this chapter. These concerns are addressed in the July 24, 1996, 3-Party Letter (EPA/DOT/USACE, 1996) and can generally be grouped into two categories:

1. Community concerns about environmental threats and use conflicts presented by the historic disposal areas, the present MDS, and the proposed HARS; and

2. Ensuring the health of the Port and the environment for the 21st Century

These socioeconomic concerns are addressed in Chapters 3 and 4.

Table 1-2. Five General Criteria for the Selection of Ocean Dredged Material Sites.
[40 CFR Section 228.5]

Part 228.5(a)	*The dumping of materials into the ocean will be permitted only at sites or areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.*
Part 228.5(b)	*Locations and boundaries of disposal sites will be so chosen so that temporary perturbations in water quality or the environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.*
Part 228.5(c)	*If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on a interim basis for ocean dumping do not meet the criteria for site selection set forth in §§ 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.*
Part 228.5(d)	*The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.*
Part 228.5(e)	*EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.*

Table 1-3. Eleven Specific Factors To Be Considered in the Selection of Ocean Dredged Material Sites.
[40 CFR Section 228.6(a)]

Para. No.	
(1)	*Geographical position, depth of water, bottom topography, and distance from the coast;*
(2)	*Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;*
(3)	*Location in relation to beaches and other amenity areas;*
(4)	*Types and quantities of wastes* [dredged material] *proposed to be disposed of, and proposed methods of release, including methods of packaging the waste* [dredged material], *if any;*
(5)	*Feasibility of surveillance and monitoring;*
(6)	*Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;*
(7)	*Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);*
(8)	*Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance, and other legitimate uses of the ocean;*
(9)	*The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;*
(10)	*Potentiality for the development or recruitment of nuisance species in the disposal site;*
(11)	*Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.*

1.6 References

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Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects with ranges of chemical concentrations in marine and estuarine sediments. Environ. Mgmt. 19(1):81-97.

NOAA. 1996. Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex. National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center, National marine Fisheries Service, James J. Howard Marine Science Laboratory, Highlands, NJ. May 1996. 72 pp + tables and figures.

USACE NYD/EPA Region 2. 1992. Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal. U.S. Army Corps of Engineers New York District and Environmental Protection Agency Region 2, New York, NY. Draft release December 1992, Revision 1: June 1994. 46 pp + appendices.

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2.0 ALTERNATIVES

EPA has evaluated four separate site-designation alternatives for the area of the current Mud Dump Site and its surrounding areas. The components of the four alternatives are described in this chapter relative to the 30-nmi^2 Study Area (see Figure 1-2 in Chapter 1).

Readers may find it useful to periodically consult the descriptions of the following alternatives while reviewing the physical, chemical, and biological information about the affected environment and the predicted impacts of the alternatives, in Chapters 3 and 4 respectively. This is particularly true for Chapter 4, where impacts of the four alternatives are compared to one another (as specified by EPA's Ocean Dumping Regulations), and determinations are made in selecting the Preferred Alternative. Although the first few pages of Chapter 4 summarize the main components of the alternatives, the details of the components are presented only in this chapter.

2.1 Alternative 1: No-Action

Alternative 1
No Action

- No change to size or management of the present Mud Dump Site (MDS)
- No remediation of areas outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas
- Disposal of Category I dredged material continues per the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/ USACE NYD, 1997a) until current remaining disposal capacity is reached
- Category II dredged material capacity will be reached by September 1, 1997

Under Alternative 1, the operation and management of the MDS would continue according to the existing EPA Region 2/USACE NYD (1997a) Site Management and Monitoring Plan (MDS SMMP).

The objectives of the MDS SMMP are as follows:

A. Provide that no significant adverse environmental impacts occur from the disposal of dredged material at the MDS.

B. Ensure that dredged material disposal mounds do not exceed the USACE NYD/EPA Region 2 management depth [currently 45 ft below mean low water (BMLW) for Category I dredged material and 65 feet BMLW for Category II dredged material].

C. Recognize and correct any potential unacceptable conditions before they can cause any significant adverse impacts to the marine environment or present a navigational hazard to commercial and recreational water borne vessel traffic.

D. Determine/enforce compliance with USACE ocean dumping permit conditions.

E. Provide a baseline assessment of conditions at the MDS.

F. Provide a program for monitoring the MDS.

G. Describe special management conditions/practices to be implemented at the MDS.

H. Specify the quantity of material to be disposed at the MDS, including the presence, nature, and bioavailability of the contaminants in the dredged material.

I. Specify the anticipated use of the MDS, including the closure date.

J. Provide a schedule for review and revision of the MDS SMMP.

The MDS SMMP is jointly funded and implemented by the USACE NYD and EPA Region 2.

A major element of the MDS SMMP is the Monitoring Program (MP) for the site. The MP addresses both the regulatory and technical concerns associated with open-water (i.e., ocean) disposal of dredged material, and the MDS in general. The program is organized by tiers, with successive tiers containing increasing detailed, accurate, and expensive means to obtain data for evaluation. The tiered MP is an environmentally-sound and cost-effective means for generating the technical information necessary to understand and manage the disposal site environment, and, if needed, to quickly implement corrective actions.

Under Alternative 1, the current MDS SMMP would remain implemented and unchanged until the 2.2 nmi^2 MDS is filled to its designated 100 Myd^3. Consistent with the July 24, 1996, 3-Party Letter, and because of the approximate 1 Myd^3 capacity Category II dredged material capacity being filled, all discharges at the MDS after September 1, 1997 would be Category I material.

Category I material disposed at the MDS would be primarily of fine-grain silts and clays.

2.2 Alternative 2: Close MDS-No HARS Designation

Alternative 2
Close MDS-No HARS Designation

- Closure of the present Mud Dump Site
- No Historic Area Remediation Site (HARS) designated
- No remediation of sediments outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas created by past dredged material disposal

Under Alternative 2, the MDS would be closed/de-designated effective September 1, 1997. No remediation placement operations would be conducted within the 9.0-nmi^2 (31-km^2) area of the Bight Apex found to be degraded by bioaccumulative contaminants and toxicity, nor would restoration operations be conducted in the 15.7-nmi^2 (54-km^2) area of fine-grain sediments attributable to dredged material disposal. Any remediation or restoration that occurs at degraded or fine-grain sediment areas would depend on natural deposition of cleaner sediments from other locations, including resuspension and relocation of benthic materials from shallow waters (<20 m) of the Bight Apex, and deposition of natural sediments (e.g., from the Hudson River plume, as watershed pollution controls become effective).

Alternative 2 is the alternative that represents the least change to the Bight Apex environment from current environmental conditions. Any environmental changes that occur in the area after September 1, 1997 would be the result of both positive and negative natural processes (e.g., storms, natural biological variability) and non-disposal anthropogenic impacts (e.g., fishing, atmospheric deposition, and Hudson River plume sediments). Surveillance and monitoring of the site under the current MDS Site Management and Monitoring Plan (SMMP; EPA Region 2/USACE NYD, 1997a) would stop when the disposal site is closed/de-designated. However, EPA and the USACE would continue to work with applicable Federal agencies on future monitoring work and determine any future management actions as necessary.

2.3 Alternative 3: HARS Remediation

> *Alternative 3*
> **HARS Remediation**
>
> - Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
> - The HARS is composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ), including the MDS and sediments that have toxicity or bioaccumulative contaminants. (Refer to Appendix B for HARS latitude/longitude coordinates.)
> - Remediation conducted by capping degraded sediment areas with at least 1 m of Material for Remediation
> - Approximately 40.6 Myd^3 required to remediate the 9.0-nmi^2 (31-km^2) PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
> - Remediation work prioritized by degree of sediment degradation

Under Alternative 3, the MDS would be closed. Simultaneous with the closure of the MDS, the site and surrounding areas that have been used historically as disposal sites and would be redesignated under 40 CFR Section 228 as the Historic Area Remediation Site. The basis for designating the HARS is that it (1) allows remediation of sediments degraded by historical disposal (40 CFR Section 228.11), (2) complies with EPA's site-designation criteria in 40 CFR Sections 228.5 and 228.6(a), and (3) meets the intent of the July 24, 1996, 3-Party Letter (EPA/DOT/USACE, 1996).

The 15.7-nmi^2 HARS would be composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ). The location of the site and its components is shown in Figure 2-1. (See Appendix B for latitude/longitude coordinates). All identified degraded sediments (i.e., exhibiting Category II and III characteristics) are within the 9-nmi^2 U-shaped PRA, and would be capped with at least 1 m of Remediation Material.

At least 40.6 Myd^3 of Remediation Material would be required to cap the 9.0-nmi^2 (31-km^2) PRA (divided into nine 1-nmi^2 cells for management purposes). The actual placement volume of Remediation Material may be larger, to ensure at least a 1 m cap throughout the PRA. Because of the inability to remediate all of the PRA within a short period, remediation operations would be prioritized by degree of degradation. Areas exhibiting the greatest relative degree of degradation would be remediated first.

As stated in the July 24, 1996, 3-Party Letter, the Material for Remediation would be "uncontaminated dredged material (i.e. dredged material that meets Category I standards and will not cause significant undesirable effects including through bioaccumulation)... [and] .... designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material." Most of the Material for Remediation used under Alternative 3 would be composed of fine-grain silts and clays. However, other coarse-grain material, including sands and gravels, that become available can also be used to remediate the HARS, where appropriate [Draft HARS SMMP (EPA Region 2/USACE NYD, 1997b)]. Sandy Material for Remediation could potentially become available from new work projects in the Port (e.g., 50-Foot Deepening Project discussed in the July, 24, 1996, 3-Party Letter).

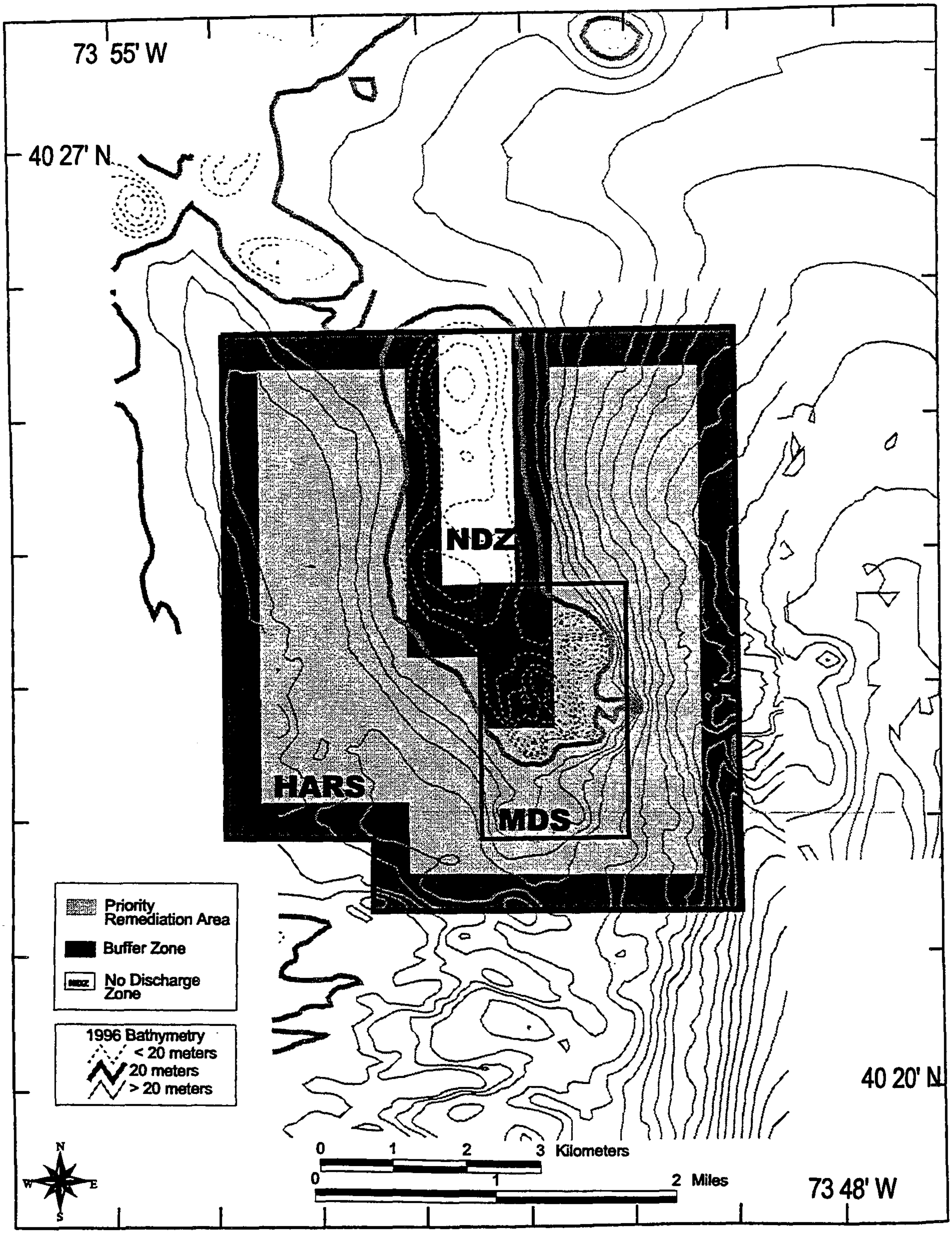


Figure 2-1. Alternative 3 Historic Area Remediation Site (HARS), with Priority Remediation Area (PRA), Buffer Zone (BZ), and No Discharge Zone (NDZ).

The Buffer Zone (BZ) is an approximately 5.7-nmi^2 area (0.27-nmi wide band around the PRA) in which no placement of Remediation Material would be allowed, but may receive Remediation Material that incidentally spreads out of the PRA.

The No Discharge Zone (NDZ) is an approximately 1.0-nmi^2 area in which no placement or incidental spread of Material for Remediation will be allowed. This area is not degraded, and is generally above the 20 m (approx. 65-ft) depth contour (the depth at which large storms such as hurricanes and noreasters are able to generate sufficient water turbulence to resuspend and transport benthic sediments).

The operation and management of the HARS under Alternative 3 would be conducted under a HARS Site Management and Monitoring Plan (HARS SMMP), developed pursuant to Section 506 of the Water Resources Development Act of 1992 (WRDA'92), specifically to ensure that the objectives of the site are met, and to safeguard against unexpected or potentially negative effects (see 40 CFR Sections 228.10 and 228.11). The objectives of the Draft HARS SMMP are as follows (EPA Region 2/USACE NYD, 1997b):

A. Provide for the remediation of required areas within the HARS by placing a one-meter cap (minimum required cap thickness) of Material for Remediation on sediments within the PRA (inside the HARS). Sediments within the PRA have been found to exhibit Category II and Category III dredged material characteristics and will be remediated.

B. Provide that no significant adverse environmental impacts occur from the placement of Material for Remediation at the HARS. The phrase "significant adverse environmental impacts" is inclusive of all significant or potentially substantial negative impacts on resources within the HARS and vicinity. Factors to be evaluated include:

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

   2. Movement of materials toward productive fishery or shell fishery areas;

   3. Absence from the HARS of pollution-sensitive biota characteristic of the general area;

   4. Progressive, non-seasonal, changes in water quality or sediment composition at the HARS, when these changes are attributable to Material for Remediation placed at the HARS;

   5. Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the HARS, when these changes can be attributed to the effects of Material for Remediation placed at the HARS;

   6. Accumulation of Material for Remediation constituents in marine biota near the HARS.

C. Recognize and correct any potential unacceptable conditions before they cause any significant adverse impacts to the marine environment or present a navigational hazard to commercial and recreational water-borne vessel traffic. The term "potential unacceptable conditions" is inclusive of the range of negative situations that could arise as a result of placement of the Material for Remediation at the HARS such that its occurrence could have an undesirable affect. Examples could include things such as: the Remediation Material placement mounds exceeding the required management depth or barges dumping Material for Remediation in the wrong locations.

D. Determine/enforce compliance with MPRSA Permit conditions.

E. Provide a baseline assessment of conditions at the HARS.

F. Provide a program for monitoring the HARS.

G. Describe special management conditions/practices to be implemented at the HARS.

H. Specify the quantity of Material for Remediation placed at the HARS, and the presence, nature, and bioavailability of the contaminants in the Material for Remediation.

I. Specify the anticipated use of the HARS, including the closure date (the date upon which EPA Region 2/USACE NYD determines that all areas with the PRA of the HARS has been remediated by placement of at 1 m of Remediation Material).

J. Provide a schedule for review and revision of the HARS SMMP.

The Draft HARS SMMP contains a monitoring program (HARSMP), organized into tiers of increasing levels of investigative intensity, which generate increasingly detailed and accurate data for evaluators and site managers. The tiers are structured based on the type of monitoring (physical, chemical, biological) required, and do not need to be conducted sequentially. The results of the lower tiers are evaluated and used where applicable to initiate higher tiered monitoring. The main focus of the HARSMP is on the impacts of Remediation Material placement in the PRA, which are evaluated through the seven hypotheses. Copies of the draft HARS SMMP are available by contacting Douglas A. Pabst at U.S. EPA Region 2, New York City, NY (tel. 212-637-3797, e-mail: pabst.douglas@epamail.epa.gov).

2.4 Alternative 4: HARS Restoration

Alternative 4 is similar to Alternative 3, with additional conditions that capping operations within the HARS would use only sandy (0-10% fines) Material for Remediation, and capped areas include fine-grain surface sediments that are attributable to historical dredged material disposal. The Restoration HARS for Alternative 4 overlaps the entire area delineated by the Remediation HARS for Alternative 3 (Figure 2-2). The total size of the Alternative 4 HARS is 15.7 nmi^2 (54 km^2), and includes the present MDS, the surrounding areas that have been used historically as disposal sites, and area sediments degraded by bioaccumulative contaminants and toxicity. Implementation of Alternative 4 would restore benthic conditions within the New York Bight Apex to conditions found in the area prior to dredged material disposal.

Alternative 4
HARS Restoration

- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the PRA, NDZ, and BZ, including the MDS, surrounding areas that has been historically used for disposal of dredged material and other wastes (e.g., building materials, sewage sludge, industrial wastes), and sediments degraded by bioaccumulative contaminants or toxicity.
- Restoration work conducted by covering fine-grain sediment areas with at least 1 m of sandy (0-10% fines) Material for Remediation
- Approximately 46.4 Myd^3 required to restore the 10.3 nmi^2 (35.5 km^2) of fine-grained sediments in the PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Restoration work prioritized by degree of sediment degradation

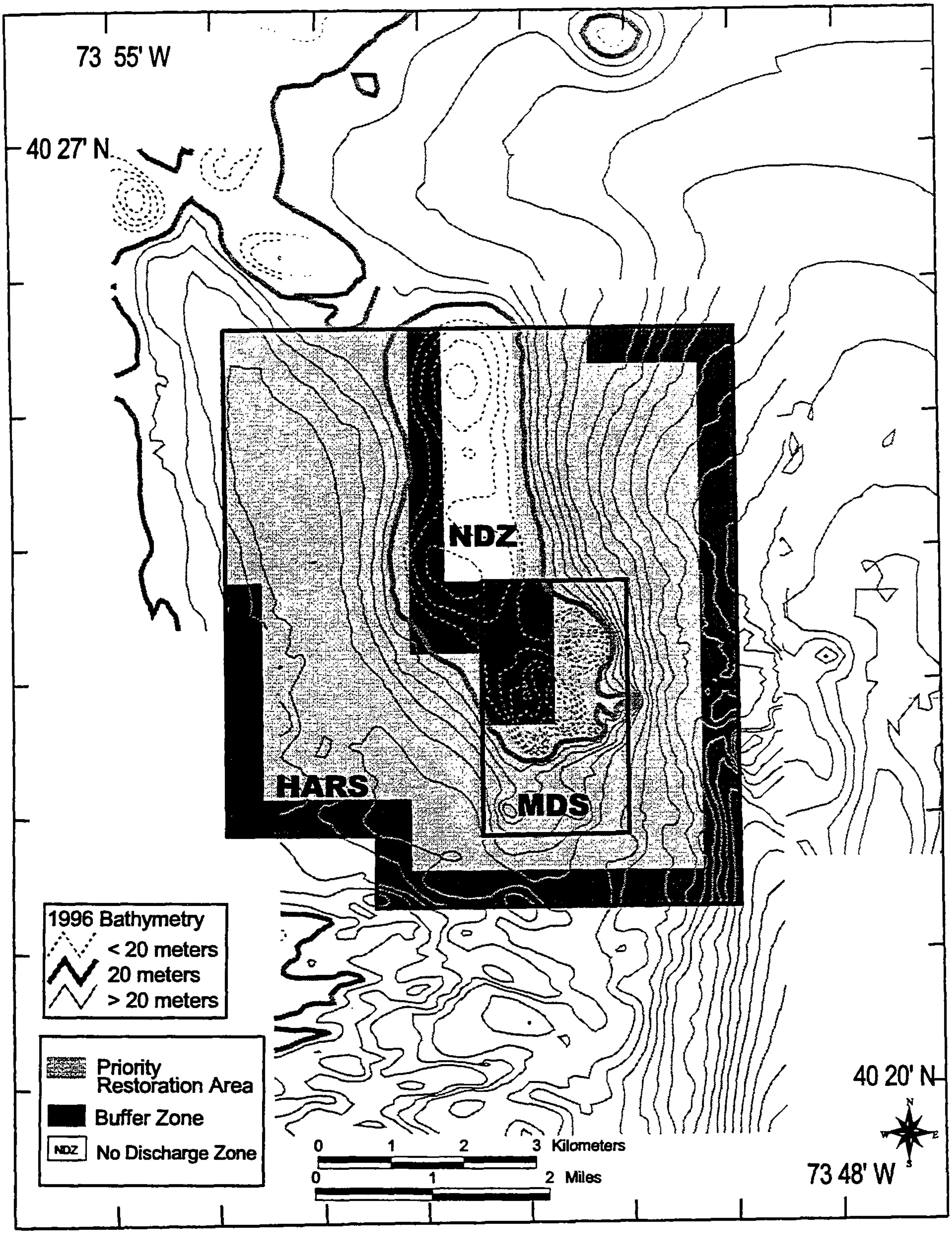


Figure 2-2. Alternative 4 Historic Area Remediation Site (HARS), with Priority Restoration Area (PRA), Buffer Zone (BZ), and No Discharge Zone (NDZ).

Components of the Alternative 4 HARS are a PRA, NDZ, and BZ, with the location of the PRA determined from analyses of sediment grain-size distribution, chemical, and toxicological samples collected throughout the Study Area. The Alternative 4 PRA is 10.3 nmi^2 (35.5 km^2) and would require approximately 46.4 Myd^3 of Material for Remediation. The actual placement volume of the Remediation Material may be larger, to ensure at least a 1 m cap throughout the PRA. The Alternative 4 HARS has no BZ on the two northwest corners of the U-shaped PRA, because (1) fine-grain sediments attributable to dredged material disposal are found in these areas, and (2) only sandy (0-10%) Material for Remediation would be used for restoration operations.

As with Alternatives 3, the Material for Remediation used for Alternative 4 would be obtained from dredging projects in the Port of New York and New Jersey and surrounding areas. Because most of the Port's dredged material consists of silts and clays, which are not suitable for restoring the fine-grain sediment areas to predisposal conditions, PRA restoration under Alternative 4 is expected to take 3-5 times longer than remediation of the PRA under Alternative 3. However, the duration of both alternatives cannot be accurately estimated until proposed dredging sites are sampled and evaluated.

Also like Alternative 3, no placement or incidental spread of Material for Remediation would be allowed in the NDZ, but incidental spreading of material into the BZ from placement operations in the PRA would be allowed. In general, the operation and management of the HARS for restoration would be the same as described above for remediation work under Alternative 3, except that the only sandy Material for Remediation would be placed within the PRA.

2.5 References

EPA/DOT/USACE. 1996. Letter to New Jersey U.S. Congresspersons, signed by Carol M. Browner, Administrator, U.S. Environmental Protection Agency; Federico F. Peña, Secretary, U.S. Department of Transportation; and Togo D. West, Jr. Secretary of U.S. Department of the Army. July 24, 1996. 4 pp

EPA Region 2/USACE NYD. 1997a. Site Management and Monitoring Plan (SMMP) for the New York Bight Dredged Material Disposal Site (Mud Dump Site). October 1996 Draft SMMP. U.S. Army Corps of Engineers, New York District and U.S. Environmental Protection Agency, Region 2, New York City, NY. 32 pp

EPA Region 2/USACE NYD. 1997b. Site Management and Monitoring Plan (SMMP) for the Historic Area Remediation Site (HARS). April 1997 Draft HARS SMMP. U.S. Environmental Protection Agency, Region 2 and U.S. Army Corps of Engineers, New York District, New York City, NY. 42 pp

3.0 AFFECTED ENVIRONMENT

This chapter discusses current conditions in the Study Area. The New York Bight and the area encompassing the Study Area have been influenced by anthropogenic activities since the region was first settled in colonial times. Environmental impacts resulting from anthropogenic activity in the Bight fall into two distinct categories — direct impacts from intentional discharges and disposal of waste into the waters of the Bight, and indirect impacts resulting from releases of point and nonpoint source pollution in the watershed which is carried to the Bight via the Hudson River outflow as well as atmospheric releases and deposition on the Bight. Dredged material and sewage sludge disposal are examples of the first category. Stormwater runoff, atmospheric deposition, and other nonpoint source (NPS) pollution fall within the second category. Clearly, the lengthy and high-density development of the greater New York City metropolitan region has significantly affected and changed the environment of the New York Bight through both of these input categories. However, there are important differences between the two categories. Discussing them separately helps to characterize the historical and existing condition of the environment and provides decision-makers with the necessary understanding to protect and restore the attributes and resources of the Bight.

Use of the New York/New Jersey Harbor and Bight as a repository of waste and dredged materials is documented back to the 1800s, and the practice probably goes back much further. Caspe (1995) states that raw sewage, garbage, refuse, and street sweepings were routinely disposed into the inner harbor until the early 1900s. As the harbor area developed and the population increased, public complaints about odor and debris problems, and environmental degradation resulting from these disposal practices, forced the disposal activities out of the inner Harbor area to the outer Harbor, and eventually to the ocean waters of the inner and outer Bight. Other material disposed into the Bight in the past includes soils, rocks, and debris excavated during construction of bridges, tunnels, and buildings (Williams, 1979).

With the passage of the National Environmental Policy Act (NEPA), the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), the Clean Water Act (CWA), and other federal and state environmental laws in the late 1960s and early 1970s, much of the intentional disposal of waste in the Harbor and Bight was regulated, restricted to specific sites, and in many cases, stopped entirely. Beginning in the late 1980s, disposal at many designated sites was discontinued and the sites were dedesignated (Table 3-1). The location of both present and historic disposal sites in the Bight Apex are shown in Figure 3-1. All dredged material disposed in United States waters, including the New York Bight, must comply with EPA and USACE regulations, and be in accordance with permits issued by the Army Corps of Engineers.

Concurrent with recent years' control and reduction of dumping in the New York Bight, other sources of pollution were also regulated. Untreated industrial and municipal waste and effluents are no longer allowed to flow unchecked into New York and New Jersey waterbodies and airsheds. Across-the-board improvements in pollution control regulations and technologies, waste minimization efforts by dischargers, and a general increase in the public's concern about the environment of the Harbor and Bight have reduced contaminant inputs (Bopp *et al.*, 1993; Bopp and Simpson, 1989), reduced impacts, and improved the overall health of the ecosystem. It is within the context of decreasing inputs of contaminants and nutrients to the New York Bight Apex, and generally improving environmental conditions in the MDS and Study Area that this Supplemental Environmental Impact Statement was developed.

The primary impact from dredged material disposal in ocean waters occurs in the benthic region [water column impacts from dredged material disposal are intermittent, short lived, and minimal (Vogt and Walls, 1994; Engler and Mathis, 1989)]. These impacts can vary greatly within an affected environment and are beneficial in some aspects and detrimental in others.

Topography, water column depth, sediment texture, organism habitat, chemical levels, and benthic infaunal and fish communities may all be influenced by disposal of dredged materials (Vogt and Walls, 1994). In order to understand the specific influences from the dredged material disposal and the address the actions being evaluated means that this SEIS will focus on the benthic environment in the Study Area and assess the present conditions in the areas that have historically received wastes.

Table 3-1. History of ocean disposal sites in the New York Bight.

Site Name	Material Disposed	Key Dates or Initial Year of Use	Year of Interim (I) and Final Designation (F)	Final Year of Site Use	Site De-designation Year
12-Mile Site	Sewage Sludge	1924	1973 (I) 1979 (F)	1987	1990
Acid Waste Site	Industrial acid waste byproducts	1948	1973 (I) 1983 (F)	1988	1991
Cellar Dirt Site	Construction and excavation debris	1940s	1973 (I) 1983 (F)	1989	1994
Wood-burning Site	Wood pilings and other navigation hazards from Harbor	1960	1973 (I)	1991	De-designation in process (Use of this site has been prohibited since 12/31/93 under WRDA 1990)
106-Mile Deepwater Municipal Sewage Sludge Disposal Site	Mixed waste types prior to final site designation (1960s - 1980s); Multiple wastes including acid iron waste and sewage sludge; sewage sludge only after final site designation	1986	1984 (F)	1992	1994
106-Mile Site (Industrial)	Industrial wastes	1960s	1984 (F)	1987	1990
Inlet sites (Dredged material sites)	Inlet maintenance sediments	1990	1990 (F)	Active	NA
New York Bight Dredged Material Disposal Site (Mud Dump Site)	Dredged material	1973	1973 (I) 1984 (F)	Active	NA

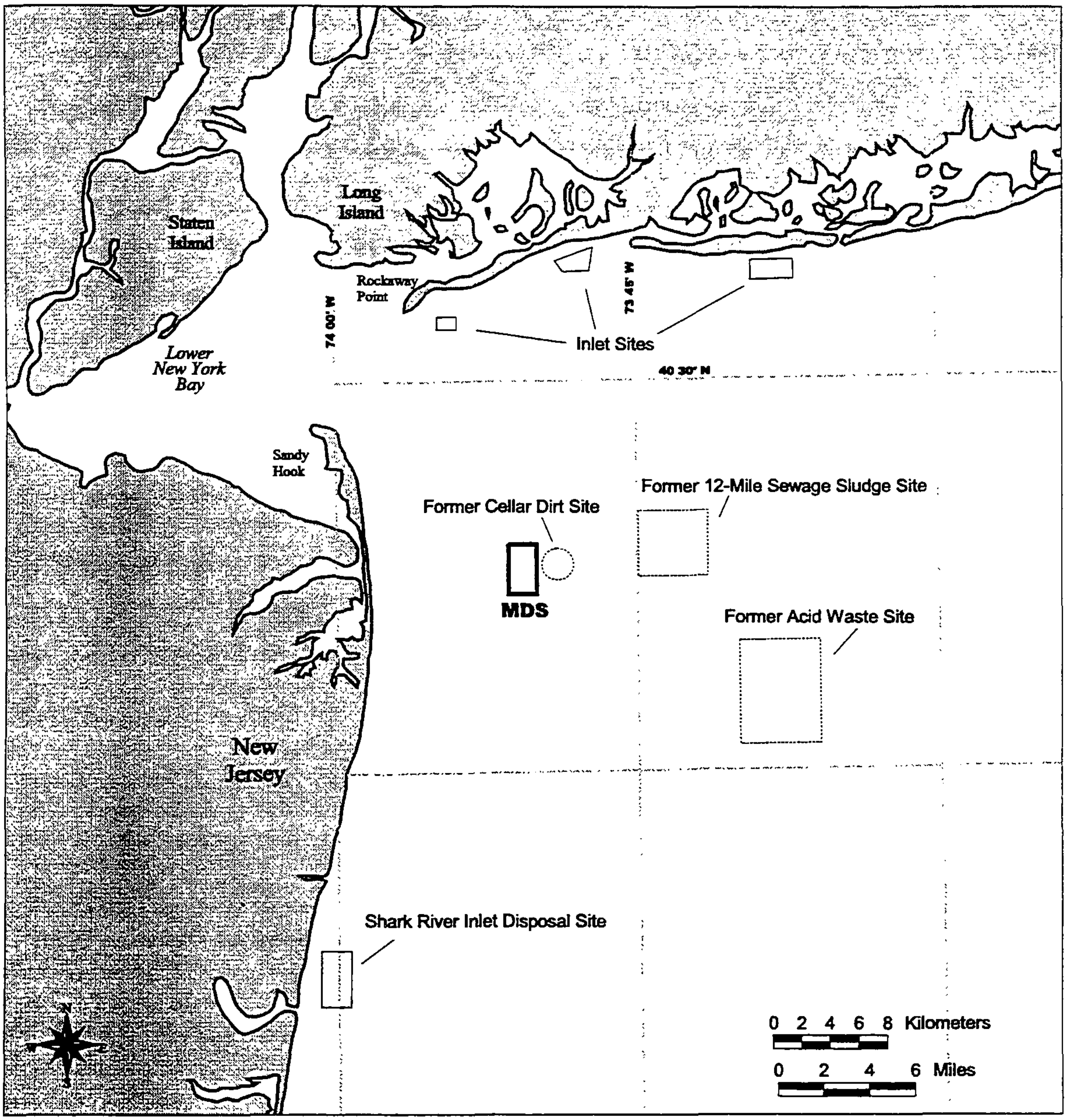


Figure 3-1. Location of present and former disposal sites in the New York Bight Apex.

This chapter describes present environmental conditions and socio-economic uses in the Study Area relative to dredged material disposal and benthic areas contaminated by historical dumping activities. The description of the affected environment focuses on the physical, chemical, and biological conditions. The socio-economic discussion focuses on potential use conflicts in the Study Area (see box for specific topics addressed). Information being considered is referenced to sections of the Ocean Dumping Regulations in section headings as appropriate. Wherever possible recent data from the Study Area evaluated in support of this SEIS was used. When data were not available, data from the New York Bight Apex or nearby regions were used. This information provides the basis for recommendations relevant to the alternatives described in Chapter 4 of this SEIS.

Factors Evaluated in the Affected Environment Chapter
Section numbers of the discussion are in parentheses

Geographic location (Section 3.1)

Input of Pollutants to the MDS Area (Section 3.2)
- Pollution Inputs (3.2.1)
- Historical Dumping (3.2.2)
- Types and Quantities of Materials Disposed (3.2.3)
- Release Methods and Management Practices (3.2.4)
- Existence and Effects of Current and Previous Dumping (3.2.5)
- Feasibility of Surveillance and Monitoring (3.2.6)

Physical Environment (Section 3.3)
- Geological Setting (3.3.1)
- Physical Characteristics of Study Area (3.3.2)
- Meteorology and River Runoff (3.3.3)
- Physical Oceanography (3.3.4)
- Erosion Potential (3.3.5 and 3.3.6)
- Critical Depth (3.3.7 and 3.3.8)
- Post Depositional Transport/Retention (3.3.6)
- Toxic Chemical Contaminant Distribution (3.3.9)
- Sediment Quality (3.3.9)
- Water Quality (Section 3.3.10)

Biological Environment (Section 3.4)
- Plankton Community (3.4.1)
- Benthic Invertebrates (3.4.2)
- Fish and Shellfish (3.4.3)
- Marine and Coastal Birds (3.4.4)
- Marine Mammals (3.4.5)
- Other Concerns for the Biological Community(3.4.6)

Socio-economic Environment (Section 3.5)
- Commercial and Recreational Fisheries (3.5.1)
- Mariculture (3.5.2)
- Shipping (3.5.3)
- Military Usage (3.5.4)
- Mineral/Energy Development (3.5.5)
- Recreational Activities (3.5.6)
- Natural or Cultural Features of Historic Importance (3.5.7)
- Other Legitimate Uses of the Study Area (3.5.8)
- Areas of Special Concern (3.5.9)

3.1 Geographic Location and Physical Description of the Affected Environment

***Geographic Location* [40 CFR Section 228.6(a)(1)]:** The Study Area is located on the inner continental shelf of the northwest Atlantic Ocean within the geographic area known as the inner New York Bight (Figure 3-2). The inner Bight or Bight Apex is approximately 2000 km^2 and comprises about 5% of the area of the greater New York Bight. Figure 3-3 shows the Study Area which is the focus of this SEIS (approximately 5% of the Bight Apex). The Study Area comprises about 1% of the Bight Apex. The boundaries of the Study Area were determined after careful examination of historical disposal records for the region and after conducting studies on the affected environment in and around the MDS.

This evaluation process led first to the delineation of an area referred to as Subarea 1 (see Figure 3-3), a 22.9 nmi^2 rectangular area encompassing the MDS (EPA Region 2, 1995). In January 1996, further research and studies focusing on historical disposal activities resulted in the addition of Subarea 2, a 7 nmi^2 rectangular area which is contiguous with the northwest corner of Subarea 1 (Figure 3-3) (EPA Region 2, 1996a).

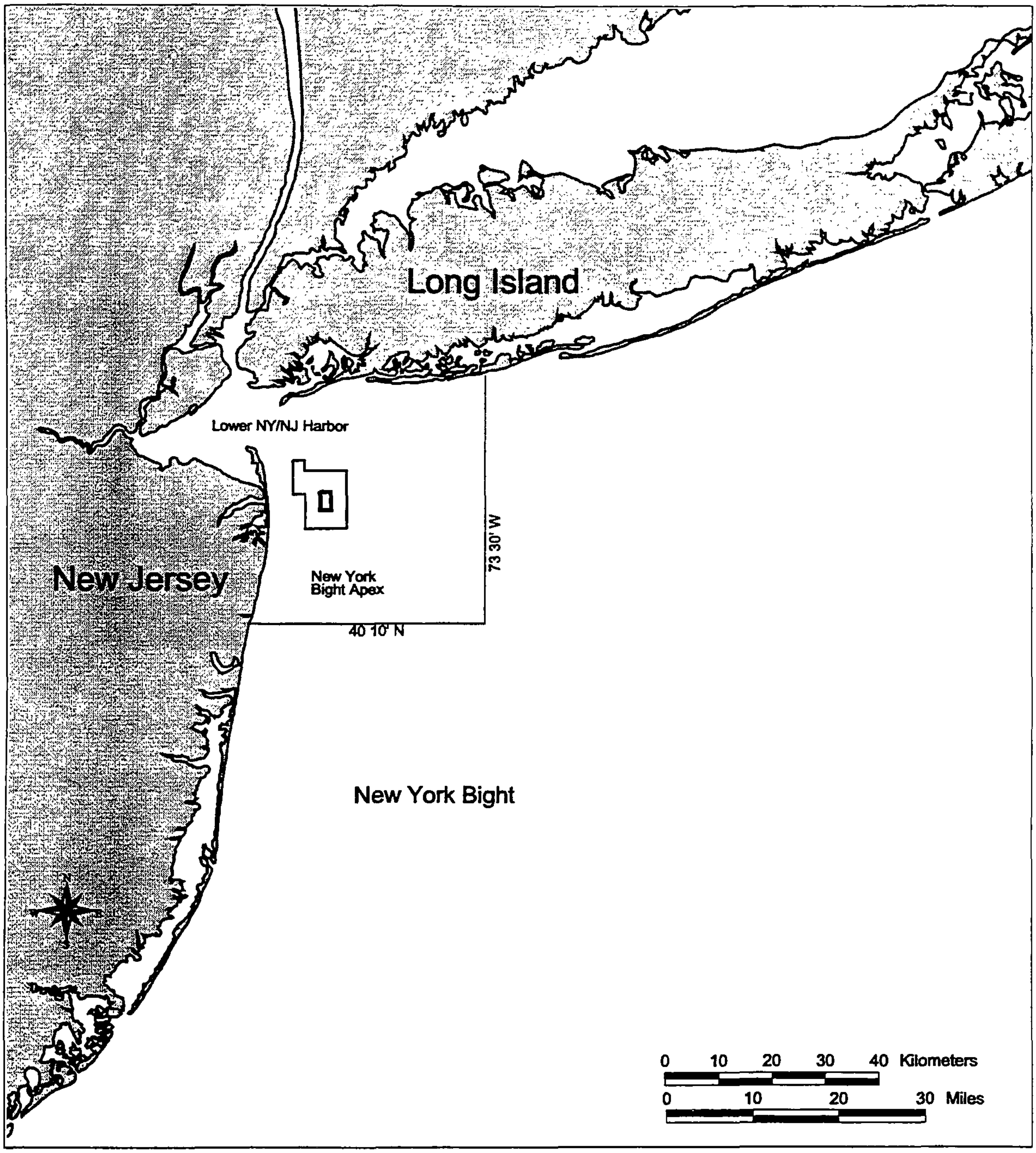


Figure 3-2. The Mud Dump Site and SEIS Study Area are located in the New York Bight Apex in the Northwest Atlantic Ocean.

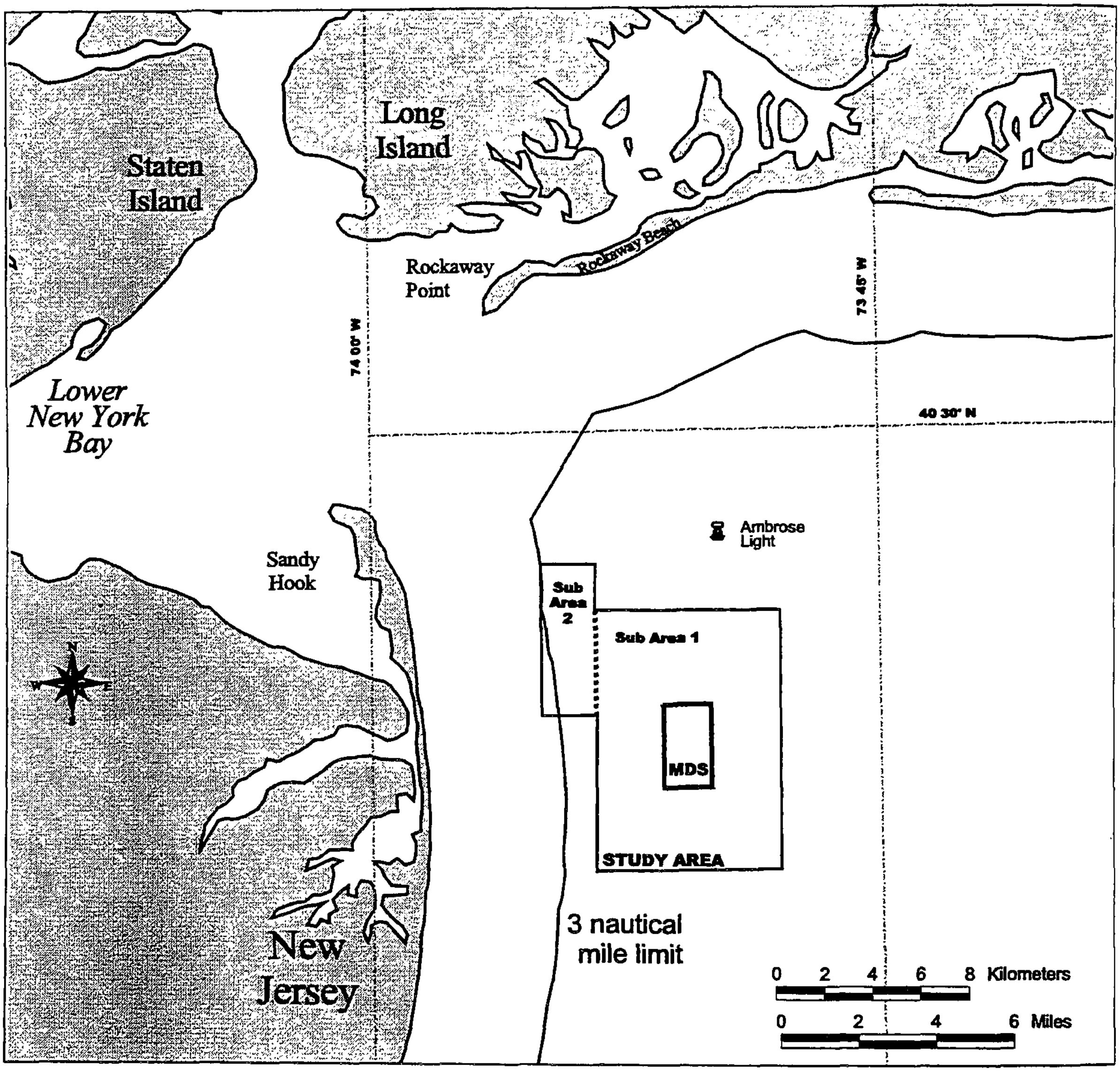


Figure 3-3. Location of the Study Area including the 3-nmi line that delineates State and Federal waters. The eastern most large rectangle is discussed in the text as Subarea 1; the smaller area to the northwest is Subarea 2.

Latitude/Longitude Coordinates of Subarea 1	
40°20' N	73°48.0'W
40°20' N	73°53.0'W
40°26' N	73°48.0'W
40°26' N	73°53.0'W

Latitude/Longitude Coordinates of Subarea 2	
40°23.5' N	73°53.5'W
40°23.5' N	73°55.0'W
40°27.0' N	73°53.5'W
40°27.0' N	73°55.0'W

Together, these two subareas make up the 30 nmi^2 Study Area which is the primary focus of all the studies completed to describe and understand the affected environment. The characterizations of current conditions provided in this chapter will be used to evaluate the alternatives considered in Chapter 4.

***Water Depth* [40 CFR Section 228.6(a)(1)]:** Water depths below Mean Low Water (MLW]) in the Study Area range from 14 to over 42 m. Depths in the northern half of the Study Area and in the MDS have been significantly decreased by historical disposal activities (see Section 3.2). Water depths in these areas presently range between 14 and 26 m (Figure 3-3). The shallowest depths (14 m) are in the northern-most portion of Subarea 2. These shallow depths extend southward through the axis of Subarea 2 (Figure 3-3). In the northeastern and southeastern quadrant of the Subarea 1, water depths increase, reaching depths of 40 m at the eastern boundary of the Study Area. Depths along the southern third of the Study Area have not been significantly affected by the dredged material disposal; water depths consistently increase seaward from about 22 m in the Shrewsbury Rocks area (southeastern corner of Subarea 1) to 42 m in the Hudson Shelf Valley. A shallow basin extending northwest from this topographic high is approximately 26 m at its deepest point and less than 22 m in the central parts of Subarea 2.

***Topography* [40 CFR Section 228.6(a)(1)]:** The topography of the Study Area is dominated by the dredged material disposed and mounded in the area over the past 100 years (Figure 3-4). The axis of this manmade feature rises as high as 12 m above the surrounding sea floor and extends approximately 8 km (5 nmi) southeastward from the entrance to New York/New Jersey Harbor before turning southward for another 3 km (1.8 nmi). At the northwest corner of the present MDS, the mound turns southeasterly, reflecting mound growth from disposal in the MDS since the early 1980s (see Section 3.2.2 for a description of the historical disposal). To the east of this mound, the topography grades rapidly and smoothly into the drowned Hudson Shelf Valley. A topographic low, known as the Christiaensen Basin, is situated in the northeast quadrant of the Study Area. This feature connects directly to the Hudson Shelf Valley which runs north and south through the eastern most third of the Study Area and forms the dominant topographic feature in this part of the Study Area. The material disposed at the former Cellar Dirt Site is clearly visible as a mound rising above the Hudson Shelf Valley sediments on the central east boundary of the Study Area.

The topography of the west central portion of Subarea 1 and Subarea 2 is dominated by a shallow basin on the natural seaward slope of the seabed from the New Jersey shore. This basin was formed by historical disposal of dredged material southeast of New York/New Jersey Harbor and at the present MDS. The southwestern quadrant of the Study Area is dominated by the seaward extension of a geological feature known as the Shrewsbury Rocks.

***Distance from Coast* [40 CFR Section 228.6(a)(1)] *and Proximity to Beaches and Amenities* [40 CFR Section 228.6(a)(3)]:** The Study Area is seaward of the three-mile limit for state waters except for a small area on the southern two-thirds of the western border of Subarea 2 (Figure 3-3).

The closest approach of Subarea 2 to the New Jersey shore is 5.3 km (2.8 nmi). The closest approach to the New Jersey shore of Subarea 1 is 7.5 km (4.1 nmi). The shoreline of Long Island, New York lies 13.1 km (7.1 nmi) north of Subarea 2.

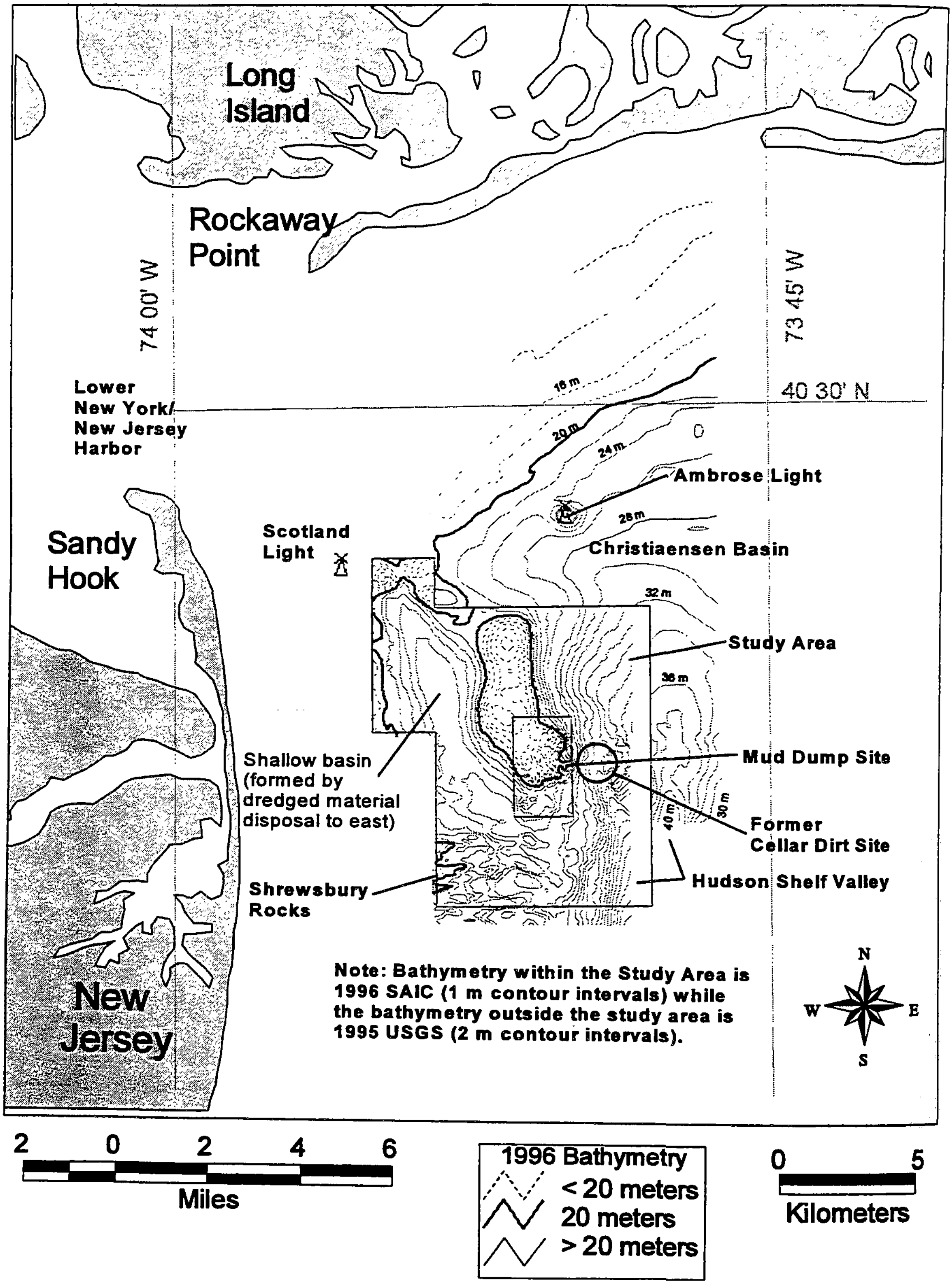


Figure 3-4. Topography and water depths in the Study Area. Depth contours are from precision bathymetry studies conducted in 1995 and 1996 (SAIC, 1995a; SAIC, 1996a,b; USGS, 1996).

3.2 Input of Pollutants to the MDS Area

This section reviews historical sources and quantities of pollutants entering the inner New York Bight, including historical dredged material disposal. The section also discusses the changes in the amounts and types of pollutants which have entered the area during the past decade and provides context for the relative importance of dredged material disposal as a source of pollutants to the system. The discussion focuses only on inputs to the Study Area; issues of bioavailability and potential transfer of contaminants to living resources are considered in Sections 3.4.6 and 3.5.1.1.

3.2.1 Pollution Inputs [Sections 228.5(e) and 228.6(a)(7)]

Historic pollution input and loading to the Bight, and changes in the these inputs in response to environmental management actions, are described in this section.

3.2.1.1 Historic Pollution Inputs

From the late 1800s through the early 1990s, New York/New Jersey Harbor and the New York Bight received wastes from urbanization and growing industrialization (Williams, 1979). Until the late 1800s, these wastes were discharged within the New York/New Jersey Harbor complex (Caspe, 1995). Over time, visual impairment and environmental degradation increased, public acceptability of the odor levels associated with these disposal practices lessened, and the capacity of the inner Harbor to receive wastes was exceeded. These factors resulted in the transfer of disposal operations from the inner Harbor to the outer Harbor and eventually to the ocean. Ultimately, offshore disposal locations were consolidated into a set of specific sites (Figure 3-1) that were designated and managed under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) and subsequent amendments. The MDS was designated as an interim dredged material disposal site in 1973. Formal designation was completed in 1984. The site designation process included the preparation of an Environmental Impact Statement (EIS) in accordance with NEPA requirements under EPA's policy of developing voluntary EISs for site designations.

Relative loading of contaminants by major sources to the inner New York Bight as of the mid 1980s (Stanford and Young, 1988).

Source	Range (%)	Median (%)
Dredged Material	30 - 83	56
Hudson River outflow	13 - 45	27
Sewage sludge disposal	3 - 24	16
Other sources		5
Atmospheric		
Coastal outflow		
Acid wastes		

The materials discharged into the Harbor and Bight complex in the early part of the 20th century ranged from direct discharges of raw sewage, garbage, refuse, and street sweepings (Caspe, 1995) to byproducts of sewage treatment and industrial processes to sediments dredged from shipping channels. Other materials disposed routinely in the Bight included excavation materials from bridge, tunnel, and building construction (Williams, 1979). Contaminants also found their way to the Bight from upstream sources and via atmospheric pathways (HydroQual, 1989a; Stanford and Young, 1988). By the mid-1980s, the Bight was receiving over 5 million metric tons of solid waste and dredged material, over 36 thousand metric tons of various contaminants, and approximately 140 thousand metric tons of nitrogen annually (Stanford and Young, 1988).

3.2.1.2 Recent Changes in Pollutant Inputs

Significant changes in the use of the Bight as a repository of anthropogenic wastes began in 1986 with the transfer of sewage sludge disposal from the 12-Mile Sewage Sludge Disposal Site to the 106-Mile Deepwater Municipal Sewage Sludge Site (106-Mile Site), located seaward of the continental shelf (Hunt *et al.*, 1995). This single action removed disposal of over eight million wet tons of waste per year from the inner Bight. At about the same time, point source pollution throughout the NY-NJ metropolitan region was reduced. Dredged material disposal activities were specifically confined to the Mud Dump Site and three inlet sites (Table 3-1 and Figure 3-1).

The closure/de-designation of waste disposal sites in the New York Bight has resulted in major decreases in the amount of many wastes and associated pollutants directly entering this system from disposal practices. For example, data included in a recent compilation of contaminant inputs to the New York Bight Apex (HydroQual, 1989a) show that the transfer of sewage sludge disposal from the 12-Mile Site to the 106-Mile Site resulted in a 7 to 37 percent reduction of metals loading to the Bight Apex and a 39 percent reduction in BOD loading (Table 3-2). Stanford and Young (1988) independently estimated that this action decreased loadings of many contaminants to the inner Bight by about 25%, although reduction in the inputs of solids and total PCB were reduced by less than 4 percent. This suggests that sewage sludge disposal was only a minor source of solids to the inner Bight.

Table 3-2. Reduction in contaminant loading to the New York Bight Apex following transfer of sewage sludge disposal to the 106-Mile Site in 1987 (estimated from HydroQual, 1989a).

Parameter	Reduction (%)
Solids	3.4
BOD_5	39.0
Arsenic	6.5
Cadmium	25.0
Chromium	27.0
Copper	37.0
Lead	22.0
Nickel	7.0
Zinc	22.0
Total PCB	1.7

By 1989, there were only three major quantifiable sources of contaminants to the Bight and Bight Apex: dredged material disposal, outflow from the Hudson River (across the Sandy Hook — Rockaway Point transect), and atmospheric inputs (HydroQual, 1989a). Acid waste disposal contributed minor amounts of contaminants to the Bight through 1988. Sources located along coastal New Jersey and Long Island also contributed minor amounts of contaminants (HydroQual, 1989a). Although remobilization of contaminants from sediments and coastal transport [associated with the general southerly net circulation in the New York Bight and sources to the north (HydroQual, 1989b) were recognized as potentially important source terms, they could not be quantified due to lack of data.

Of the three major sources to the New York Bight Apex, outflow from the Hudson River and dredged material disposal are clearly the dominant inputs, although the relative importance of these two sources varies with each contaminant (Figure 3-5). Continued reduction in the input of contaminants, especially those associated with dredged materials, likely occurred in response to revised testing under the 1991 EPA/USACE Dredged Material Testing Manual (EPA/USACE, 1991).

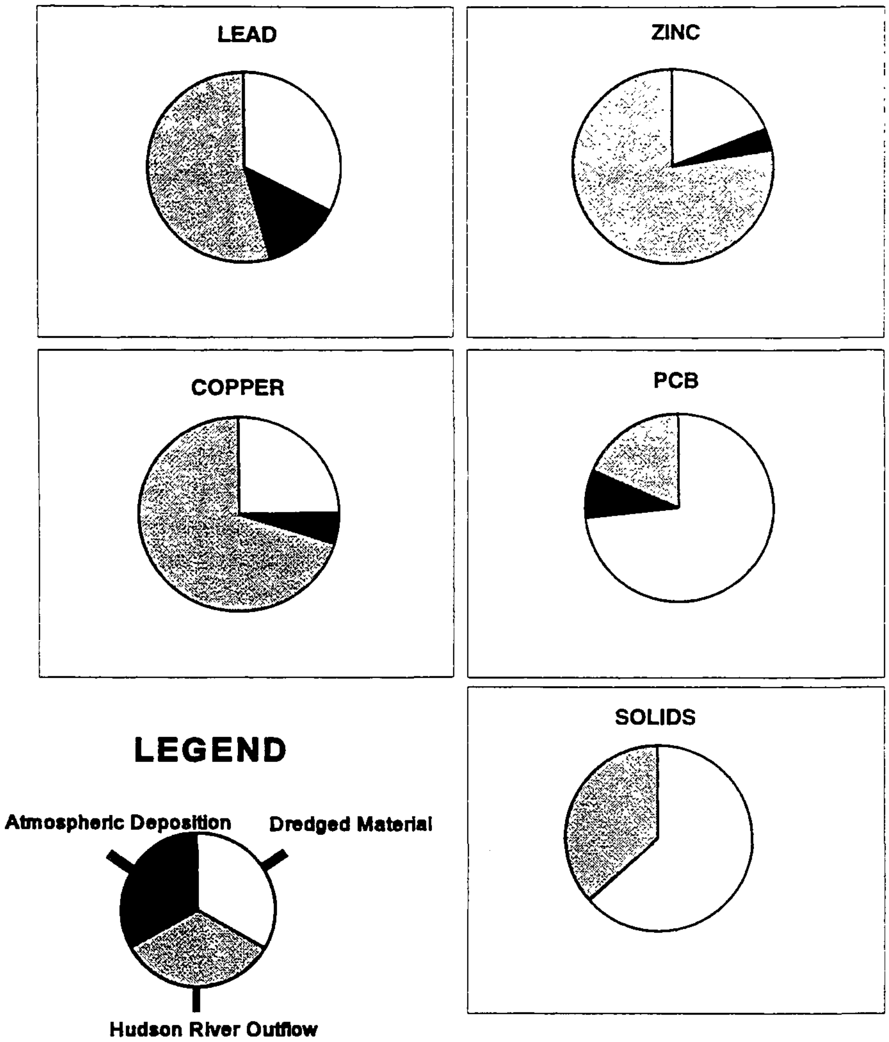


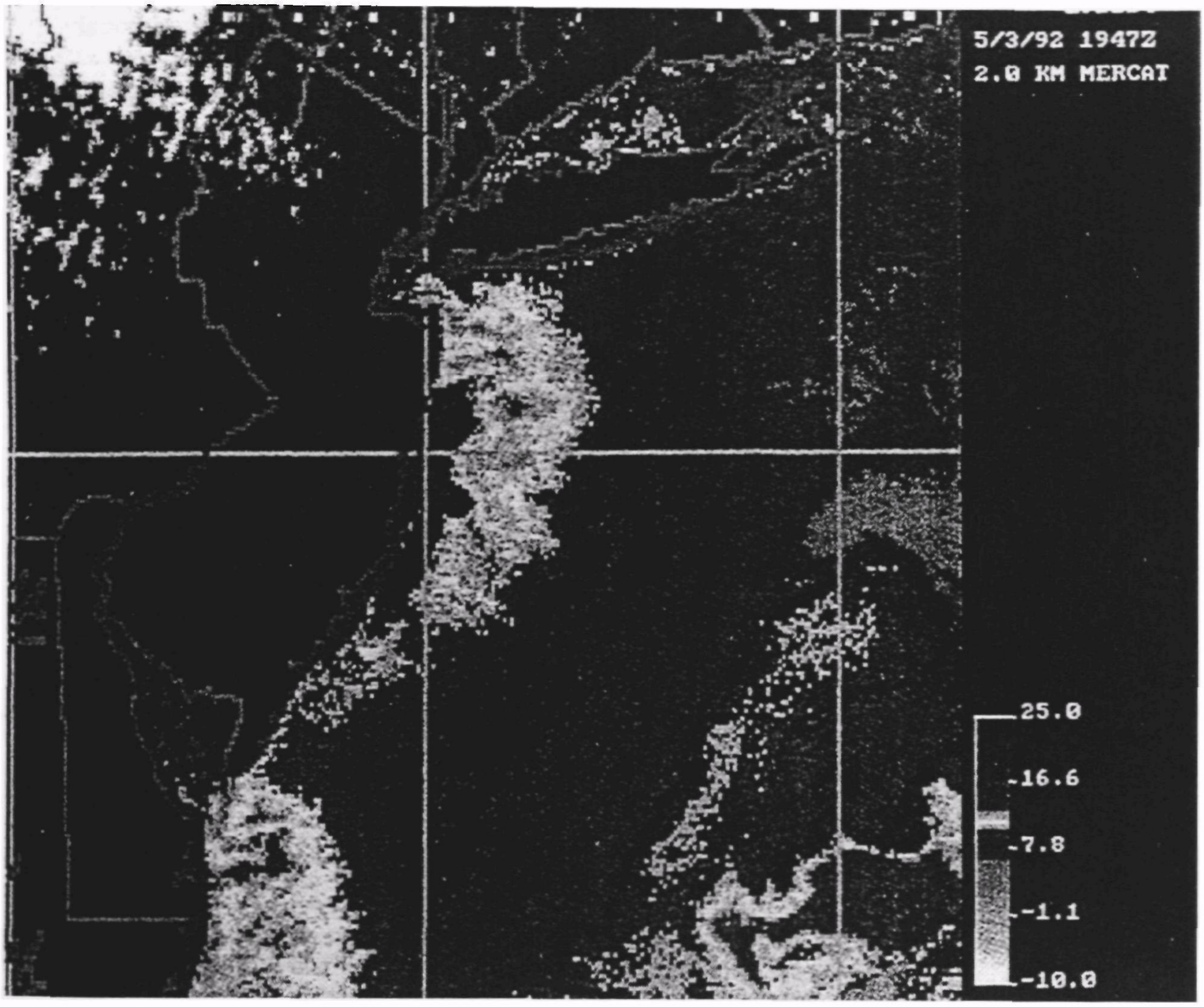
Figure 3-5. Relative inputs of representative pollutants to inner New York Bight in the late 1980s (from HydroQual, 1989a). Data on dredged material is from pre-1991 and do not reflect effects of updated testing requirements for acceptability for ocean disposal implemented under the 1991 Green Book (USACE/EPA 1991). As discussed in the accompanying text, there has been a downward trend in pollution levels entering the New York Bight over the past two decades. This is due in part to pollution control regulations and upgraded treatment facilities completed since the 1970s throughout the water and airsheds of the greater New York metropolitan region. Additionally, new dredged material testing requirements have reduced the level of contaminants in dredged material recently disposed at the MDS. Thus, the late 1980s data shown above likely overestimate the current fraction of contaminants entering the Bight through dredged material disposal. Unfortunately, no equivalent study has been conducted to allow comparison of this 1989 HydroQual study to present conditions. The available information suggests that the total amount of contaminants entering the Bight in association with all sources has decreased in the past few years.

Estimates of the importance of atmospheric inputs to the New York Bight are highly dependent on the area of the Bight included in the evaluation; this must be considered carefully within the context of this SEIS. For several contaminants, atmospheric sources can be a major contribution to the input to the greater Bight (Stanford and Young, 1988). Duce *et al.* (1976) estimated that atmospheric sources contribute less than 25% of the total contaminant input within 100 km of the shore. More recently, HydroQual (1989a) concluded that atmospheric inputs may be the dominant source of metals and organic compounds such as PCBs and PAHs over the greater Bight. HydroQual (1989a) also calculates that about ten percent of the Bight-wide atmospheric input occurred in the Bight Apex.

Bopp *et al.* (1995) examined sediment core data and water column particulates collected in the mid-1980s for inputs of DDT and found that the Hudson River Plume is a significant source of these compounds to the sediments located within the Study Area. Specifically, Bopp *et al.* (1995) indicate that the composition of the DDT signature in sediments from the Shrewsbury Rocks area are consistent with those from the Sandy Hook area, a region clearly dominated by the Hudson River outflow. The results from this study suggest that the outflow of the Hudson River provides a large fraction of measurable pollution depositing in the Shrewsbury Rocks area. Because areas off Sandy Hook and Shrewsbury Rocks area extend into the Study Area, the results imply that the Hudson River Plume is also a major source of contaminants to the sediments of the Study Area. Further, DDT in surface sediments collected near the disposal sites in the Bight suggest that resuspended sediments have DDT ratios that are similar to those from the mouth of the New York/New Jersey Harbor and that atmospheric sources enhance, but do not dominate, the DDT signature of those sediments (Bopp *et al.*, 1995).

Since the 1970s, the levels of chemical contaminants discharged to the Hudson River watershed and water ways of the New York/New Jersey Harbor complex have continued to decrease as a result of permitted effluent limitations has become more stringent, improvements to the combined sewer overflow (CSO) systems have been completed (Brosnan and Heckler, 1996), and implementation of nonpoint source controls has taken place (Brosnan *et al.*, 1995). Results of extensive annual water quality monitoring in New York/New Jersey Harbor has clearly shown the effectiveness of these controls (NYC, 1993,1994, 1997; Brosnan and Heckler, 1996). For example, New York City reports that metals loading from its treatment facilities declined by 50 to 97 percent between 1985 and 1993. Moreover, application of sophisticated analytical techniques to monitor sewage effluent also resulted in substantially lower estimates of PCB loading to the Harbor (NYC, 1993) from these sources. Input of total PCBs to the Harbor from water pollution control facilities (WPCF) in 1993 was calculated at 0.37 kg/d; wet weather loadings from CSOs and storm runoff added an additional 0.16 kg/d. These loadings are approximately 45% of the inputs calculated in previous Harbor Estuary Program Reports (NYC, 1993). As a result, estimates of contaminant inputs to the Bight in association with the Hudson River Plume have decreased. In addition, continued reduction of emissions from industrial and energy production in the past decade have lowered atmospheric inputs to coastal waters. Tighter restrictions on the types of dredged material that can be disposed in the ocean, in conjunction with lower volumes of dredged material disposed at the MDS, have resulted in continued decreases in the amount of contaminants loaded to the Bight Apex.

Currently, most of the nutrients entering the Bight come from the Harbor in association with the Hudson river Plume (HydroQual, 1989a). Although atmospheric inputs are significant at a Bight-wide scale, these inputs are equal to those associated with the Hudson River Plume only if augmented by return of nutrients to the water column from sediments (HydroQual, 1989a). Further, HydroQual (1989a) estimated that nutrient input from dredged material disposal is minor in the Bight.



The Hudson River Plume, readily detected using thermal and visible satellite imagery, frequently extends across the Study Area and MDS.

Major decreases in nutrient loading to the Bight resulted from the transfer of sewage sludge disposal to the 106-Mile Site (Table 3-2) in 1987. The disposal of sewage sludge at the 12-Mile Site was believed to be a major factor in the over-enrichment in the Bight Apex area, eutrophying the receiving waters and contributing to low dissolved oxygen levels in the water and sediments of the New York Bight Apex with negative effects on benthic communities and other life in this environment. For example, prior to site transfer, areas of low dissolved oxygen were especially severe in the Christiaensen Basin and coastal New Jersey. In the late 1980s, dissolved oxygen measurements showed consistent and significant annual depressions of oxygen in the bottom waters along the New Jersey Coast and in the vicinity of the dumpsites in the Bight Apex (HydroQual, 1989b). Low oxygen levels were most pronounced along the northern third of the New Jersey Coast (lowest mean concentrations of 4.0 mg/l) with levels often dipping below 1 mg/l between Mansquan and Barnegat Inlets and between Little Egg and Absecon Inlet. Prior to the transfer of the sludge disposal to the 106-Mile Site, minimum dissolved oxygen levels in bottom waters were often less than 3 mg/l from the New Jersey shoreline to a distance of 30 to 40 miles offshore.

After the transfer of sewage sludge disposal to the 106-Mile Site, dissolved oxygen levels recovered rapidly in the inner Bight with values remaining above 4 mg/l from 1986 through 1988, compared with values below 0.5 mg/l at the most heavily impacted station during the summer months from 1983 through 1985 (Mountain and Arlen, 1995). Other improvements in water and sediment quality in the inner Bight were documented following the removal of this major source of nutrients and contaminants from the Bight. Clear responses and recovery of the ecosystem are evident from studies conducted from 1987 through 1989 to evaluate the response to this major reduction in loading (Studholme *et al.*, 1995). Many of these findings are considered in subsequent discussions in this section, however, for clarity, the major findings are summarized in Table 3-3. The findings clearly indicate that conditions in the Bight Apex improved following the transfer of sewage sludge disposal from the inner Bight to the 106-Mile Site.

3.2.2 Historical Dumping [40 CFR Sections 228.5(e) and 228.6(a)(7)]

A comprehensive summary of ocean disposal practices in the inner New York Bight between the early 1800s and 1978 is provided in Williams (1979). His review of historical bathymetric charts, seismic reflection data, and sediment cores reveals a progressive filling of the Hudson River channel between the Sandy Hook-Rockaway transect and the northeastern corner of the present Mud Dump Site between 1845 and 1978 (Figures 3-6 to 3-11). Disposal in the region seaward of New York/New Jersey Harbor in 1888 was officially initiated "to relieve health problems, congestion, and accelerated shoaling of navigation channels long associated with uncontrolled disposal within the city and adjacent waterways" (Williams, 1979). Available information did not show significant disposal of material in areas immediately offshore from the mouth of the New York/New Jersey Harbor between 1845 (Figure 3-6a) and 1885 (Figure 3-6b), although records indicate that a position 2.5 miles south of Coney Island was designated in 1888 to receive wastes. This designated area was moved to "a point one-half mile south and eastward of Sandy Hook Lightship" in 1900 due to shoaling and fouling of adjacent [Coney Island] beaches (Williams, 1979).

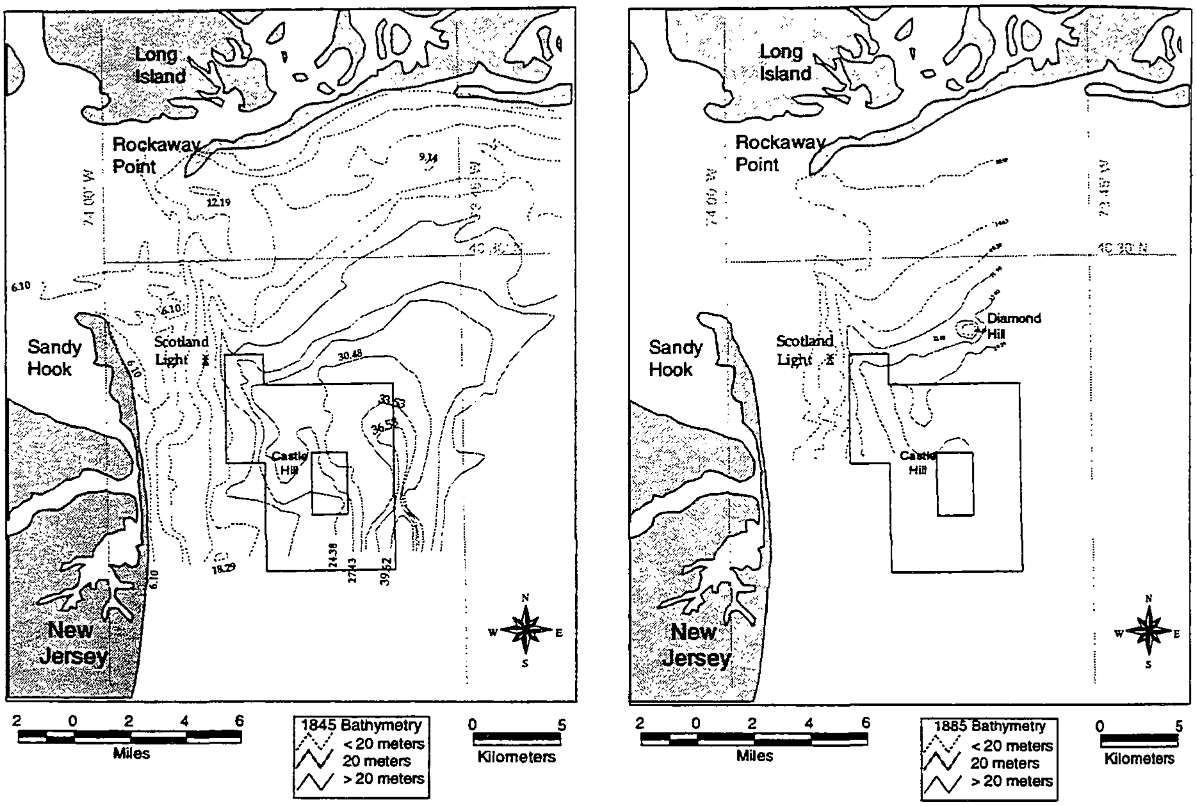
Stability of Disposed Sediments in the Bight

The long-term stability of materials disposed at depths greater than 20 m in the New York Bight is demonstrated in the discussion by Williams (1979) regarding the appearance of a mound in an area called Diamond Hill (present Ambrose Light) between 1845 and 1885 (Figure 3-6). Williams indicates that material in the mound includes large rocks, possibly from major excavations for bridges, tunnels, and roads, as well as the destruction of buildings in the New York area between 1850 and 1875 and the disposal of cellar dirt debris. The apparent stability of this mound is evidenced by its unchanged shape over the years following disposal and little apparent movement of the material disposed into surrounding sediments between 1885 and 1936.

Table 3-3. Improvements to water and sediment quality in the inner Bight following transfer of sewage sludge disposal from the 12-Mile Site to the 106-Mile Site.

Measurement	Response	Reference
Rate of seabed oxygen consumption	Lower rates Rates became typical of background sediments	Phoel *et al.* (1995)
Surface sediment REDOX potential	- Decreased levels - Smaller area of high values Decreased AVS levels Decreased sediment porosity and total organic carbon levels	Draxler (1995) Packer *et al.* (1995)
Bottom water dissolved oxygen	Higher concentrations Smaller areas of hypoxia Lower near-bottom dissolved oxygen gradient	Mountain and Arlen (1995) Studholme *et al.* (1995) Draxler (1995)
Total bacteria and fecal coliform levels in sediments	Lower concentrations Smaller area with elevated levels	Gaines and Reid (1995) O'Reilly *et al.* (1995)
Metals enrichment - sediments	Lower concentrations Less enrichment Smaller area of enrichment	Zdanowicz *et al.* (1995)
Benthic community	More species More crustaceans - Lower abundance of pollution indicator species	Reid *et al.* (1995)
Megafauna	No changes detected More lobster at previous high-impact area Lobstering increased in previously unfished areas Decreased incidence of finrot and internal lesions in winter flounder	Phelan (1995) Wilk *et al.* (1995) Pacheco and Rugg (1995)

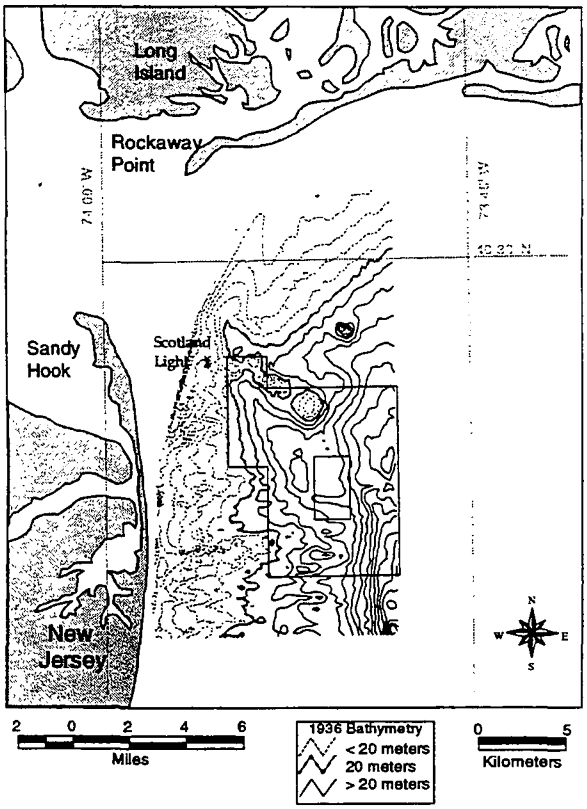
Between 1900 and 1950, disposal locations moved progressively seaward along the Hudson River Channel as topographic relief became positive (i.e., mounding was evident). Generally, the limiting depth described in Williams for these areas appears to be about 15 m. Historical records show that the solid wastes that were disposed during this period included "mud, one-man stone, steam ashes, derrick stone, street sweepings, and cellar dirt ('masonry material, brick, tile, wood, natural soil and rock')" (Williams, 1979). Further, Williams notes that shoaling problems caused relocation of the site for "derrick stones" disposal in 1924 to a point 6 miles from the Scotland Lightship in waters >19 m.



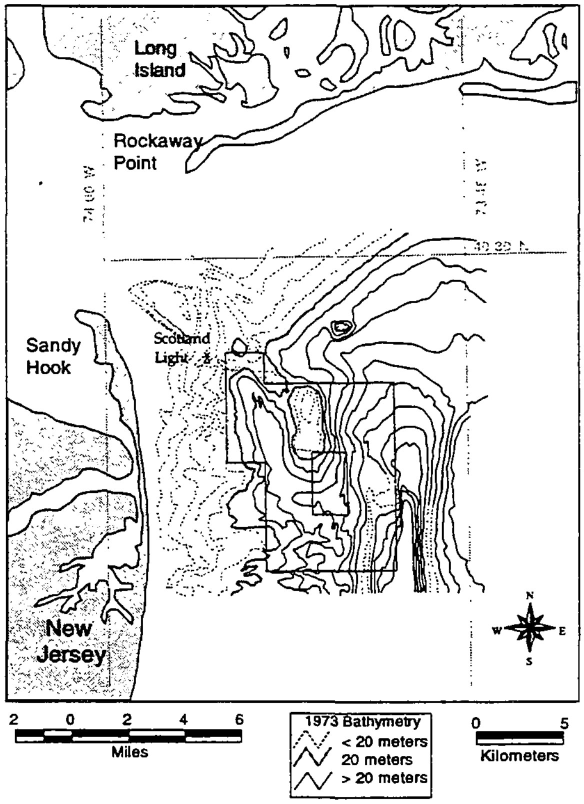
a. **1845 (digitized from Williams, 1979).** The historic location of Scotland Light, the Castle Hill area, and the Study Area are overlain for perspective. Note that the depth contours of the Hudson Shelf Valley extend towards the entrance to the New York/New Jersey Harbor.

b. **1885 (digitized from Williams, 1979).** The historic location of Scotland Light, Castle Hill area, and Study Area are overlain for perspective. Note the mound at the present day Ambrose Light position (Diamond Hill) and depth contours of the Hudson Shelf Valley pointing towards the entrance to the New York/New Jersey Harbor.

Figure 3-6. Historic changes in the bathymetry of the New York Bight Apex, including the Study Area examined under this SEIS.



c. **1936 (digital data from NOAA/NOS data base).** The historic location of Scotland Light and the Study Area are overlain for perspective. Note that the depth contours of the Hudson Shelf Valley in the northern portions of the Study Area point offshore (away) from the entrance to New York/New Jersey Harbor.



d. **1973 (data digitized from Williams, 1979).** The historic location of Scotland Light and present Study Area are overlain for perspective. Note that the depth contours of the Hudson Shelf Valley in the northern portions of the Study Area point offshore (away) from the entrance to New York/New Jersey Harbor and extend southward into the Study Area and across the northern boundary of the present MDS.

Figure 3-6. Historic changes in the bathymetry of the inner New York Bight Apex, including the Study Area examined under this SEIS. ***(continued).***

Disposal of material seaward of the Castle Hill area resulted in shallowing of the drowned Hudson River channel (Figure 3-6c). An examination of the overall change in the bathymetry southeast of Scotland Light between 1885 and 1936 (Figure 3-7) showed that about 9,000 hectares of seabottom (a 14.5 km by 11.5 km region) had been affected by the disposal operations by 1936 (Williams, 1979), and a mound of material of about 15 m maximum height had been created. No apparent changes in the topography of the Diamond Hill and Castle Hill areas were noted between these years.

Disposal practices between 1936 and 1973 resulted in the appearance of an elongated hill of about 10 m to the south of Castle Hill (Freeland and Merrill, 1976; Williams, 1979; Dayal *et al.*, 1981) (Figure 3-6d). About 5 m of material had acreted to the southeast of Castle Hill (Figure 3-8). The water depth in this area was as shallow as 16 m below mean low water (MLW) at the mound peak. Williams indicates that the disposal mound that developed between 1936 and 1973 was nearly circular (4.8 km diameter) and covered an area calculated to be about 18 km^2. This latter area is almost entirely within the northwest quadrant of Subarea 1 of the Study Area and extends into the northeast corner of the present MDS.

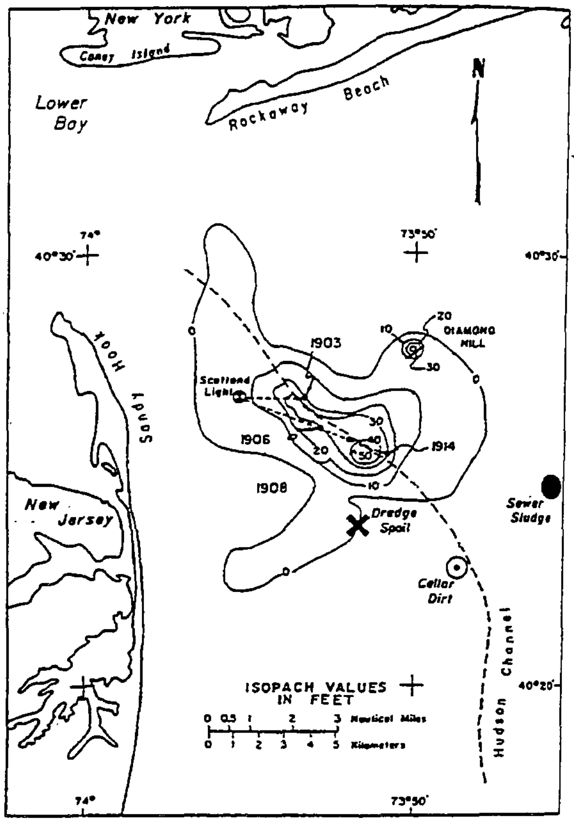
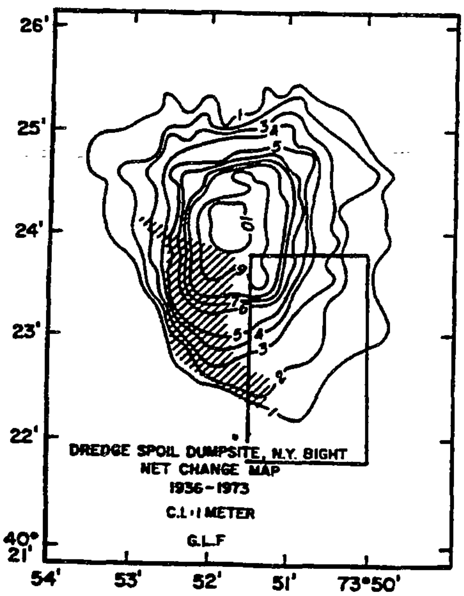


Figure 3-7. Map showing the lateral and vertical growth of the dredged material mound in the Hudson Shelf Valley off the entrance to New York/New Jersey Harbor between 1885 and 1936 (figure from Williams, 1979).



Source: From Freeland and Merrill 1976

Figure 3-8. Map showing the lateral and vertical growth of the dredged material mound in the Hudson Shelf Valley off the entrance to New York/New Jersey Harbor between 1936 and 1973 (figure from Williams, 1979).

Disposal between 1973 and 1984 continued to increase the spatial extent and height of the disposed material towards the south and southeast. By 1978, an increase in the mound height was clearly evident in two areas in the region of the northwest corner of the MDS (Dayal *et al.*, 1981). Two distinct peaks appeared in the bathymetry data; each peak was generally about 16 m below mean low water, although the southern most Peak shoaled to about 14 m in a small area. Continued propagation of the dredged material mound to the south and southeast was evident in bathymetric data collected in 1980 and documented in the 1982 Mud Dump Site Environmental Impact Statement (EPA Region 2, 1982) (Figure 3-9).

High precision bathymetry surveys of the MDS have been conducted annually since the early 1980s by the USACE. Comparison of the data from the 1980s (Parker and Valente, 1988; SAIC, 1992) through 1995 (SAIC, 1996a) show continued mound growth from the deposited dredged material throughout the MD but primarily within the northern and central regions (Figure 3-10).

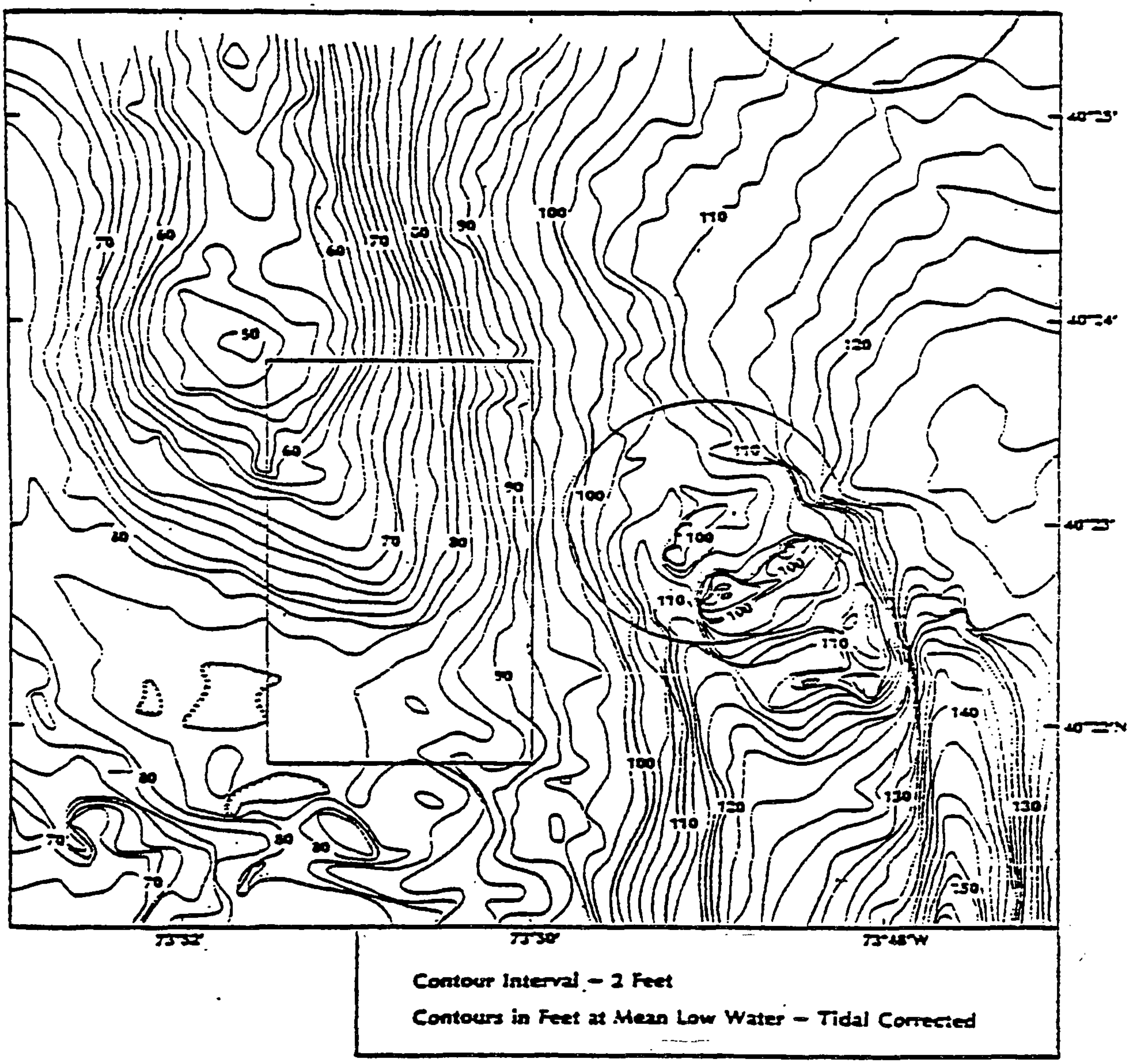


Figure 3-9. Detailed bathymetry of the seafloor in the vicinity of the MDS and the Cellar Dirt Site in 1978 (From EPA Region 2, 1982). Note the extension of the dredged material mound into the present MDS (small rectangle in the center of the figure) and in the area of the Cellar Dirt Site (circle to the right of MDS).

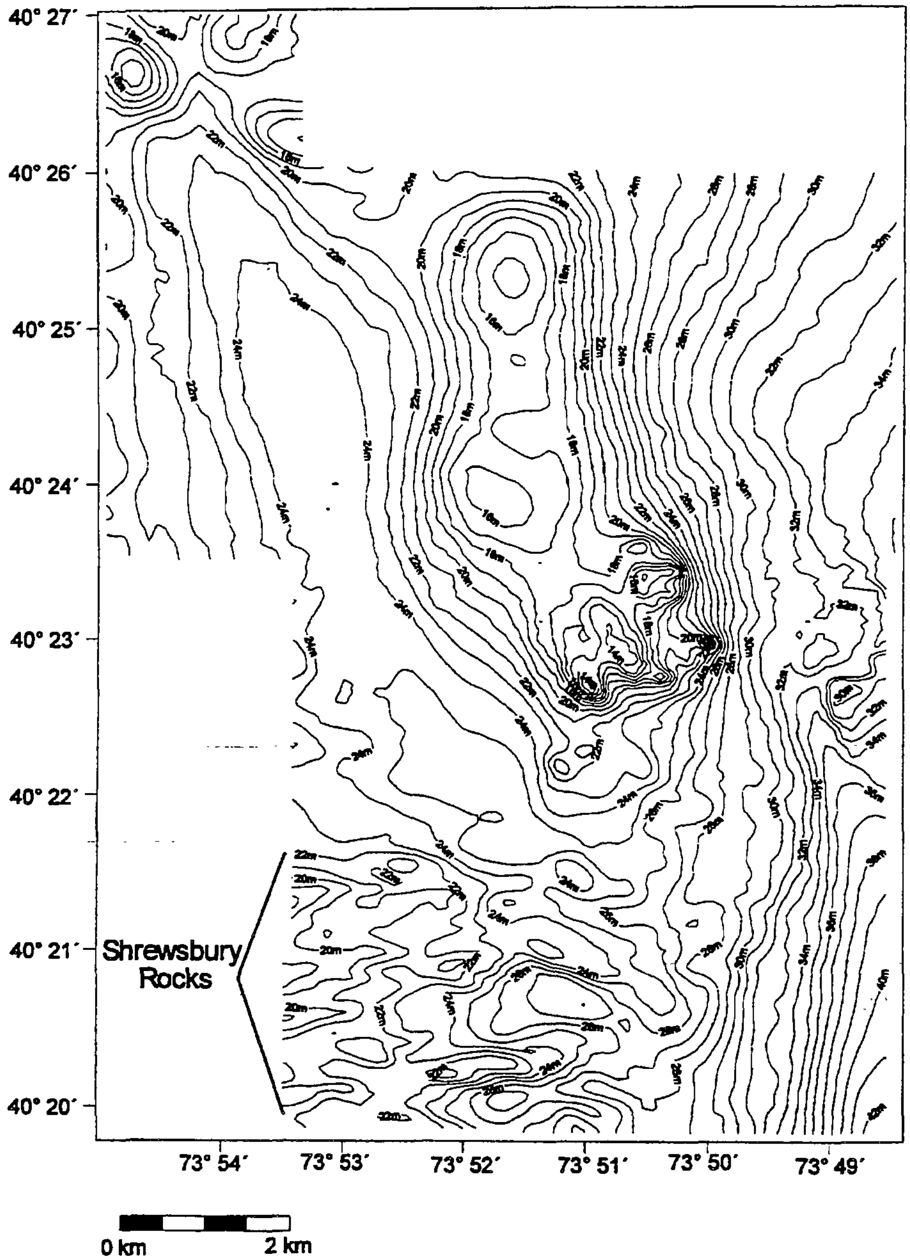
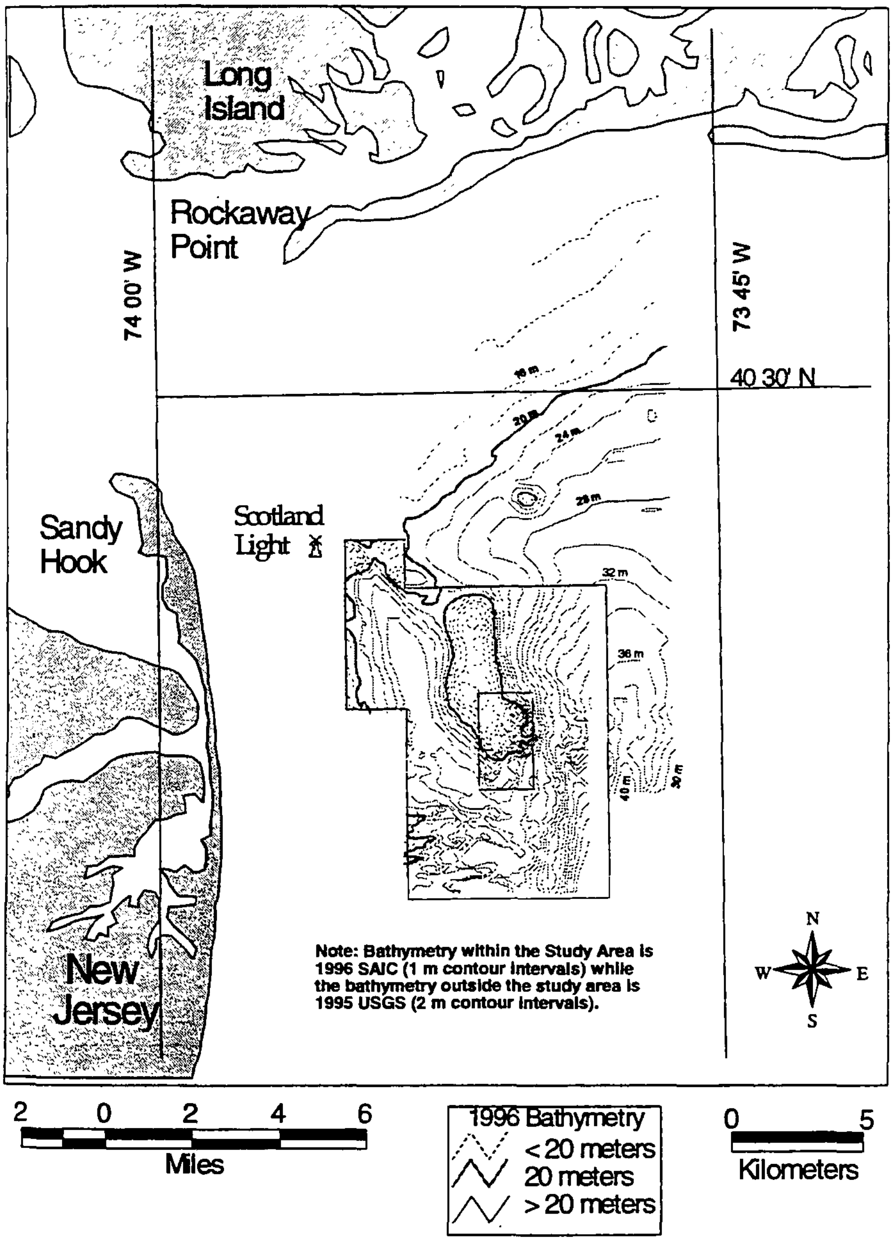


Figure 3-10. High resolution two-dimensional representation of the bathymetry of the Study Area (from SAIC, 1996a).

Clearly evident in the data are distinct mounds of recent project specific dredged material deposits within the site. Less evident, but definitively documented by bathymetric data, other monitoring records (SAIC, 1995b), and the side scan data (SAIC, 1995a), is the dredged material from the Port Newark/Port Elizabeth Dredging Project that was deposited in the south central half of the MDS in 1993 and capped with Category I material from the Ambrose Channel. A topographic high resulting from the disposal at the Cellar Dirt Site is also evident in recent bathymetric survey data (SAIC, 1995a). The most recent compilation of detailed bathymetry data of the MDS and nearby areas shows these features and delineates the extent of dredged material deposition in the inner Bight (Figure 3-11).

The recent bathymetry data (SAIC, 1996a) show that the deepest water depths (42 m) are located along the eastern boundary of the southeastern quadrant of the Study Area in the Hudson Shelf Valley (Figure 3-11). The shallowest depths in the area are located in the northwestern and central portions of the Study Area. A three-dimensional representation (with exaggerated vertical scale) shows the ridge of dredged material described above, as well as the location of recently completed dredged material disposal activity (Figure 3-12).

The 1995 bathymetric data was complimented by a detailed side scan sonar survey of the Subarea 1 completed in March 1995 (SAIC, 1995a), a side scan survey of Subarea 2 in January 1996 (SAIC, 1996a), and a precision bathymetry study in May of 1996 (SAIC, 1996b).



re 3-11. **Bathymetry of the inner New York Bight in 1995 and 1996 (from SAIC, 1995a,1996a; USGS, 1996).** The historic location of Scotland Light and the Study Area are overlain for perspective. Note the depth contours in the historic mound outside of the MDS are similar to the 1973 data. Mounding of deposited dredged material in the MDS is evident from the shallower depth contours in the northern half of the MDS relative to 1973.

The 1995 survey of Subarea 1 showed a complex set of bottom features including sand waves, ripples, trawl scour marks, rocks, individual dredged material disposal events, and regional sediment irregularities and smooth topographic features (SAIC, 1995a). In addition, the side scan survey revealed individual dredged material disposal event signatures (circular features approximately 20 m in diameter characterized by a slightly raised outer ring of material) throughout the northern half of the Study Area in areas on and away from the major disposal mounds (SAIC, 1995a). These features are clustered together or found as singular events resulting in small scale variability (not easily sampled by traditional grab sampling) and lead to the conclusion that this entire area has received dredged material. These dredged material disposal signatures were also evident in an area immediately outside the southeast boundary of the MDS. Moreover, the side scan data and bathymetric data reveal the distinct topographic feature running seaward from the New Jersey Coast known as the Shrewsbury Rocks. This feature extends into the Study Area and includes the location of the MDS reference site (Figure 3-12).

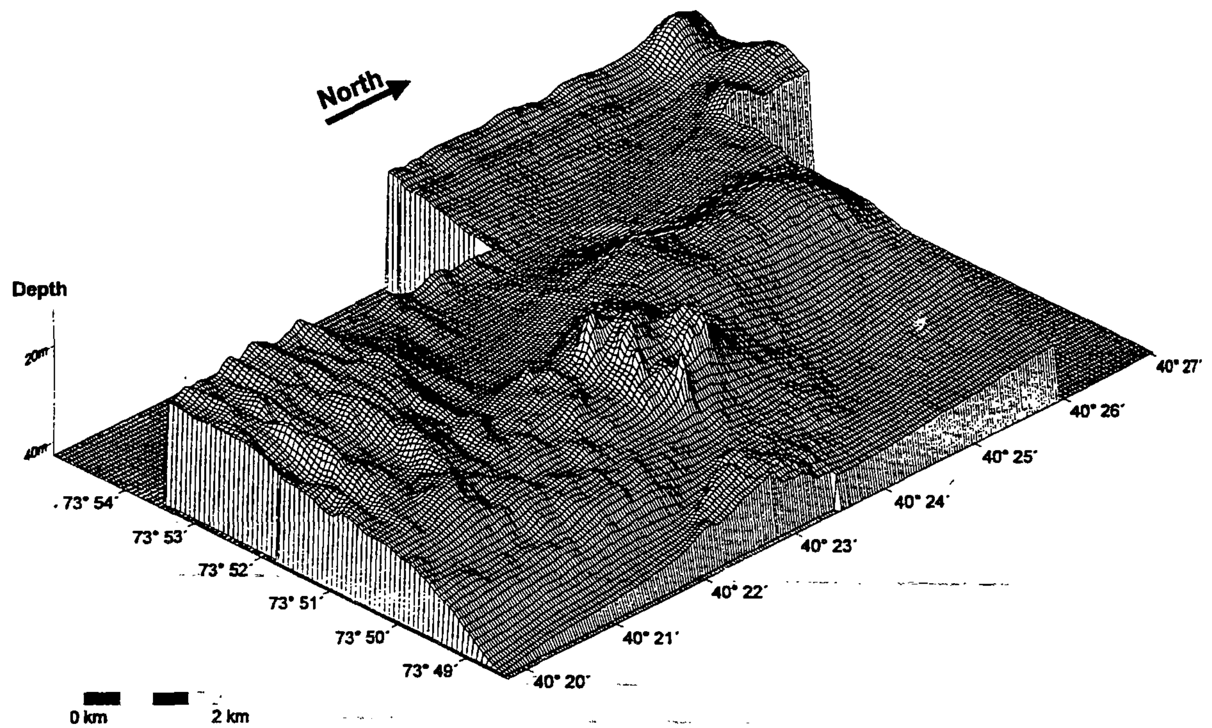


Figure 3-12. High resolution three-dimensional representation of the bathymetry of the Study Area (from SAIC, 1996a). The vertical exaggeration is 90:1. Mounds within the MDS represent post-1980 disposal; mounds in the remainder of the Study Area were created by disposal from the late 1800s through 1980. Mounds in the Cellar Dirt Site are evident at the east central boundary of the Study Area.

The January 1996 side scan and sediment grab survey to the northwest of the original Study Area found clear evidence of the historical disposal in the area including mounds and visual evidence of building materials and other manmade materials. The grab samples from the shallow depths in the northern portion of the area surveyed in January consistently had bricks and other anthropogenic artifacts (Pabst, personal communication, February 1996). The cobble and gravelly nature of the sediments in the northern most portion of this survey area indicate a winnowing of fine grained sediments.

The above information demonstrates that disposal of solid wastes and dredged material in the New York Bight has resulted in a continuous filling of drowned Hudson River channels over the past 150 years from just outside the New York/New Jersey Harbor to areas beyond the southern most-boundary of the present MDS. Disposal activities have altered the bottom topography such that a distinct ridge of dredged material extends through the Study Area and MDS from the northwest to the southeast. The disposal has created a topographic low (basin) west of the dredged material disposal mounds. To the east of the ridge of dredged material, depths rapidly increase into the Hudson Shelf Valley.

3.2.3 Types and Quantities of Material Disposed in the Study Area [40 CFR Section 228.6(a)(4)]

Historical: Williams (1979) presents one of the most complete compilations of disposal volumes for the Bight through 1978. Williams (1979) estimates that up to 850 million m^3 of various types of material were disposed in the inner New York Bight between 1890 and 1973. This material was comprised of dredged material plus wastes that are no longer permitted for disposal in the ocean (i.e., sewage sludge, garbage, cellar dirt, etc.). The annual rate of disposal of these materials was estimated at about 10 million m^3 yr^{-1}. Bathymetric analysis reported by Williams (1979) suggested that 37% (318 million m^3) of the total disposed material had accumulated on the bottom by 1973. The 318 million m^3 estimate most likely reflects the volume of dredged material disposed up to 1973. The reader is cautioned that Williams' calculations may have been affected by errors systematic to the historical navigational and depth measurement methods and the accuracy of the planometering techniques available at that period. Additionally, the retention of the material disposed into the inner Bight up to this time cannot be accurately calculated because of incomplete disposal records. Other investigators have estimated different volumes for these wastes (Table 3-4).

Table 3-4. Historical and recent dredged material disposal volumes in the New York Bight Apex and Mud Dump Site.

Period	Volume for Period (million m^3)	Annual Volume (million m^3/yr)	Source
1890 to 1915	225	9	USACE (1915) as cited in Williams (1979)
1890 to 1960	709[a]	10	USACE (1960) as cited in Williams (1979)
1960 to 1965	50 ca	10	Dewelling and Anderson (1973) as cited in Williams (1979)
1965 to 1970	50 ca	10	Pararas-Carayannis (1973) as cited in Williams (1979)
1936 to 1973	156	4.2	Dayal *et al.* (1981)
1970 to 1974	54 ca	13.5	Dewelling and Anderson (1976) as cited in Williams (1979)
1973 to 1978	52	10.4	Dayal *et al.* (1981)
1979 to 1988	45.8 ca	5.1	Wilber and Will (1994)
1974 to 1994	142.6	7.1	USACE NYD (1995)
1990 - 1995	20.2	3.7	USACE NYD disposal records through 1995

[a]Includes sewage sludge, garbage, and other municipal wastes

Gross (1976) calculated that about 250 million m^3 of solid materials were disposed between 1888 and 1973. He further estimated that 88 million m^3 of materials were disposed between 1963 and 1973 at an annual rate of 8-9 million m^3. Dayal *et al.* (1981) showed that between 1930 and 1980 annual dredged material disposal volumes ranged from 0[1] to 10 million m^3yr^{-1} in the vicinity of the present MDS and showed dramatic variations in the volume disposed from year to year. Much of the variability in these estimates results from the type of material included in the calculation (i.e., only dredged material or dredged material plus other materials such as sewage waste and garbage) and availability of accurate records and other documentation of the input.

Documentation of the amount and type of material disposed in the Bight has improved greatly over the past 20 years allowing more accurate portrayal of the disposal volumes. These more accurate data were recently used to calculate the dredged material volume disposed at the MDS over the past 20 years (USACE NYD, 1995; Wilber and Will, 1994). Calculations show the average annual rate of dredged material disposal was 4.75-11.6 million yds^3yr^{-1} (4-9 million m^3yr^{-1}) over this period. The annual volume disposed during the past 10 years has ranged from 1.9-15.2 million yds^3yr^{-1} (1.4 to 11.6 million m^3yr^{-1}) (Figure 3-13). Between 1990 and 1995, the combined federal and private annual volume of dredged material disposed at the MDS was 4.26 million yds^3yr^{-1} (3.3 million m^3yr^{-1}) (USACE NYD unpublished data). With the exception of 1984 and 1989, the annual rate of disposal has remained between ~2 and 5 million yds^3yr^{-1} (1.5 and 4 million m^3yr^{-1}) over the last 15 years.

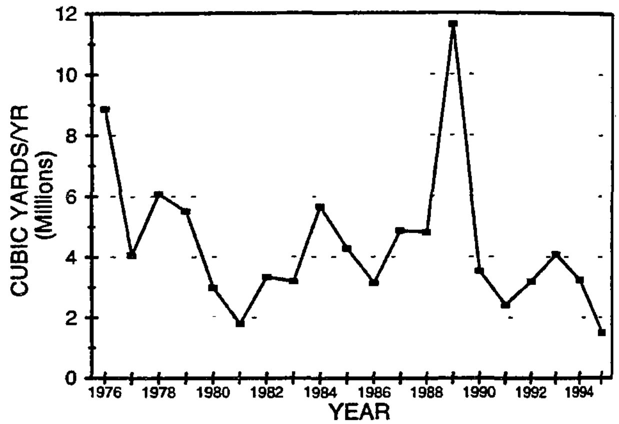


Figure 3-13. Annual volumes of dredged material disposed at the MDS from 1976 through 1995.

3.2.4 Existence and Effects of Current and Previous Dumping in the Area [40 CFR Section 228.6(a)(7)]

Generally, impacts from dredged material disposal can be classified as physical, chemical, biological, and socio-economic. It is notable that impacts from dredged material disposal do not result *a priori* in detrimental effects, nor are the impacts within a designated disposal site necessarily long-term. For example, Clark and Kasal (1994) point to the potential beneficial results of dredged material disposal on marine fisheries from berms placed in the environment. They suggest that appropriate placement of dredged material may provide positive impacts to marine fisheries. Although substantial quantitative information is not available, ancillary data from inshore dredged material disposal sites tend to support this suggestion (USACE, 1988). Evidence available in Rhoads *et al.* (1978) and Rhoads and Germano (1986) indicate that recolonization of dredged material mounds occurs, with minimal long-term effects on the environment, and often an enhancement in productivity, as a result of the disposal operation. Last, water column impacts from dredged material disposal is "minimal to non existent" (Engler and Mathis, 1989).

However, field surveys conducted in support of the SEIS have identified two areas within the Study Area that contain sediments that are degraded toxicologically and chemically (Battelle, 1996a). These may be exerting indirect impacts to the biological communities and fish that inhabit these areas. These areas are

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[1] Offshore disposal during World War II did not occur.

discussed in Section 3.3.9. The cause of these areas of degraded sediment may be related to dredged material disposal, although other sources of contamination [i.e., the Hudson River Plume, as found in the EIS prepared for the MDS designation (EPA Region 2, 1982)] may significantly contribute sediments and contaminants to these areas. Actions taken to reduce contaminant inputs to the New York/New Jersey Harbor from the bordering metropolitan areas and the Hudson River watershed in general (see Section 3.0) have substantially and significantly reduced the introduction of contaminants and volumes of wastes and dredged material to the region (see Section 3.2.1). These actions may have contributed to the apparent improvement in benthic biotic diversity in the Study Area relative to that found in the original site designation EIS (see Section 3.4.2).

There is some evidence that fine-grained sediments disposed at the MDS have been transported into the Christiaensen Basin (SAIC, 1995c) and in a southeasterly direction out of the site and down the Hudson Shelf Valley. Data from sediment cores collected in New York /New Jersey Harbor, the Study Area, and the Hudson Shelf Valley in the mid 1980s were used by Bopp *et al.* (1995) to evaluate this potential transport to the southeast. They report that high rates of deposition, detectable concentrations of 2,3,7,8 TCDD, and trends in Cs_{137} and K_{40} are consistent with translocation of sediments from the New York/New Jersey Harbor area via dredged material disposal in the MDS. Other evidence indicates that sewage sludge formerly disposed at the 12-Mile Site was a major contributor of contaminants to the drowned valley (Lewis *et al.*, 1989; Bopp *et al.*, 1995). Bopp *et al.* (1995) indicate that additional coring and analysis is required to provide more definitive assessments of the translocation of materials from the MDS.

The New York/New Jersey Harbor Dredged Materials Management Forum and several Harbor stakeholders have raised concerns about potential effects of the dredged material disposal on habitats in the Study Area [e.g., Memo from Remediation and Restoration Subcommittee to Mud Dump Work Group 12/15/95; EPA meetings with local fishing community (April 25 and May 6, 1996)]. These concerns are especially evident relative to potential changes in sediment type including grain size, contaminant levels and bioavailability, bioaccumulation and human health concerns, topographic alteration, and certain socio-economic uses including use of the area for recreational and commercial fishing and alteration of fish habitats. As is described in detail in the sections that follow, surface sediments of the MDS and Study Area appear to have gradually become less contaminated over the last two decades. In general, the Study Area is characterized as having a heterogenous distribution of contaminants, and contaminant concentrations and sediments from the MDS and Study Area could not be distinguished based on chemical characteristics (Battelle, 1996a). Further, areas of elevated contamination are restricted to topographic lows located primarily to the northeast and east of the MDS and in a narrow elongated basin extending south-southeastward through the Study Area (Battelle, 1996a). Sediment toxicity testing using EPA and USACE dredged material testing methods indicate that some sediments in these areas are toxicologically degraded (Battelle, 1996a).

On the basis of toxicity and chemical contaminants, marginally degraded and degraded sediments can be found in the northeast portions of the MDS and contiguous areas to the northeast in the Study Area (discussed further in Section 3.3.9) and in the basin west of the disposal mound. Other sediments in the Study Area do not appear to be degraded.

Another potential impact from dredged material disposal at the MDS may include bioaccumulation of contaminants in organisms. Bioaccumulation of some contaminants to unacceptable levels in the hepatopancreas of lobsters collected from the vicinity of the Study Area has been documented (NOAA, 1996) (discussed further in Section 3.5.1). The source of the contaminants to the lobster has not been clearly identified. The elevated levels are observed in lobsters from a broad area including locations distant from the MDS. There are also several sources of contaminants to the area, including dredged material disposed at the MDS, the Hudson River Plume outflow, and historical sewage sludge disposal at the 12-Mile Site that was subsequently transported down the Hudson Shelf Valley. These sources have been documented to contribute substantive amounts of contaminants to the New York Bight, and therefore may influence the levels of these contaminants in these organisms. Because of the past history of disposal in the Bight and continuing introduction of contaminants from sources other than dredged material, no one source can be identified as the primary cause of the observed levels. Moreover, the relative historical contribution of dredged material to the total input of contaminants and the bioavailability of associated contaminants can not be assessed relative to these other sources.

No effects of the current disposal on sea traffic into New York/New Jersey Harbor have been reported or recorded.

In summary, the primary physical impact of the dredged material disposal in the New York Bight Apex has been changes to the original topography of the Study Area. Other impacts include elevated contaminant levels in the fine-grained sediments found on and near the dredged material mound. The presence of elevated levels of toxic and bioaccumulative contaminants in surface sediments is cause for concern. In particular, contaminant bioaccumulation by infaunal organisms presents the potential for food chain/trophic transfer and accompanying risk to seafood consumers. Elevated levels of PCBs and dioxin/furan compounds in infauna species and lobster hepatopancreas samples collected from the vicinity of the MDS show that these compounds can be found in these tissues. However, we can not identify dredged material disposal at the MDS as the sole or major cause, given the proximity of the area to major pollutant sources such as the Hudson River outflow. Finally, impact, either positive or negative, of dredged material disposal on fishing activities within the area is not clearly definable (see NOAA NMFS memo to Co-Chairs of the Site Closure Working Group, June 16, 1995, Response to Questions). Fish and shellfish resources throughout the Bight are impacted by shoreline habitat losses, overfishing, eutrophication, and pollution from many sources. Many fish and shellfish species are migratory, or the MDS area is only a small part of their foraging range. Possible fish and shellfish impacts from the disposal site are masked by these other factors.

3.3 Physical Environment

This section describes the physical attributes of the Study Area, including the geological setting, the sedimentary make-up, the prevailing meteorological and oceanographic processes affecting the Study Area, and the distribution of contaminants in the sediments and water column. Each of these factors is important in determining the transport, dispersion, and fate of dredged material disposed in the Study Area as well as any related effects on the physical environment.

3.3.1 Geological Setting [Section 228.6.(a)(1)]

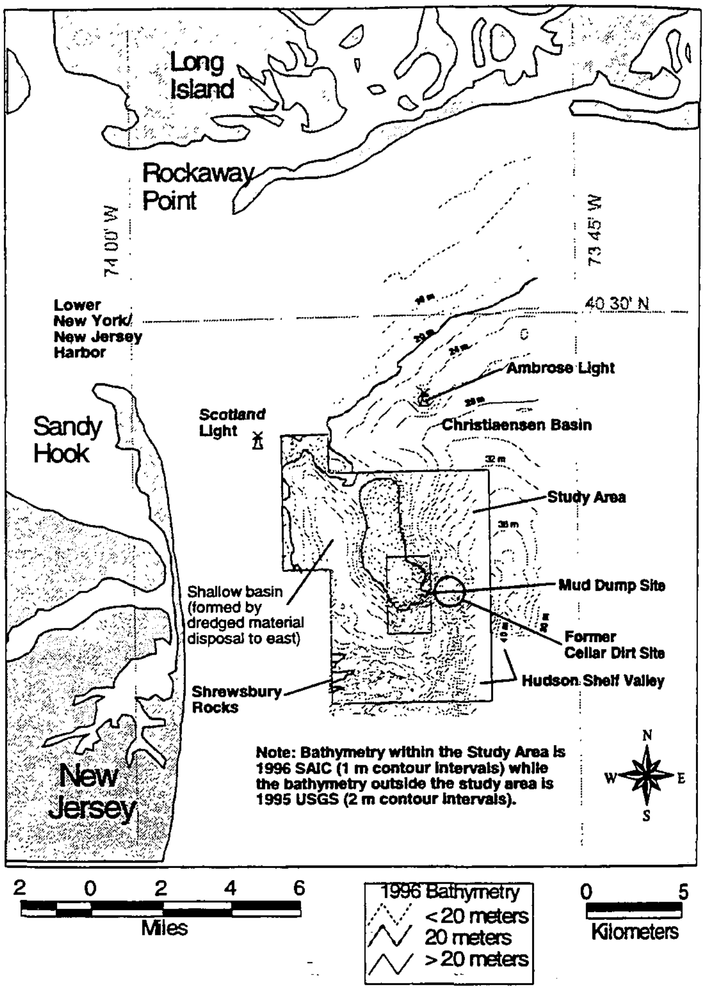
Many of the physical and topographical features which characterize the New York Bight today are the result of glacial and fluvial processes which took place during the appearance and subsequent recession of Pleistocene epoch continental glaciers in southern New England. As these glaciers moved south toward the Bight, they significantly altered the landscape, eroding land, rocks, and portions of the continental shelf. With the end of the Ice Age, melting glaciers caused sea levels to rise inundating areas that were previously dry and forming signature coast lines.

Apart from the Sandy-Hook - Rockaway transect and New York and New Jersey barrier beaches, the Shrewsbury Rocks, located on the New Jersey coast near the Study Area, form the most significant geological marker in the Bight. These shoals, which extend in a northeasterly direction across the Bight from the New Jersey shore, are comprised of eroded edges of coastal plain sedimentary strata (Williams, 1979). Williams and Duane (1974) state that the Shrewsbury Rocks "mark the demarcation between two distinct geomorphic provinces." The area to the north of the rocks was significantly altered by flows from the Raritan and Hudson Rivers that carried large volumes of sediment into the Bight during the glacial recession (Williams, 1979). According to Williams (1979), this area "contains thick (~35m) accumulations of Quaternary age sand and gravel overlying the deeply eroded Upper Cretaceous strata." In contrast, the area to the south of the Shrewsbury Rocks received little sedimentary deposition and is characterized by only a thin layer of Quaternary sediments (Williams, 1979). Stubblefield *et al.* (1977) further summarize that the geological processes resulted in a "discontinuous sheet of relatively clean, well sorted, coarse sand 0-8m in thickness (Swift *et al.*, 1972)" that "grades downward into a thin basal unit of coarse sand, gravel, and shell hash which is exposed at the surface where the sheet is thinnest." The geological processes affecting the coastline are described by Williams (1979)

> *As sea level has risen during the past 10 to 15 millennia effects of Holocene marine processes have been superimposed. The Long Island coast is a low-relief relict sand plane where offshore barrier islands and elongated spits predominate. The New Jersey Coastline is straight and regular except for Sandy Hook spit which has grown and recurved during the Holocene epoch into Lower New York Bay as a result of a large littoral drift to the north.* (Williams, 1979)

A comparison of coastal features represented in bathymetry maps from the 1880s (see Williams, 1979) with current NOAA navigation charts clearly shows the northward growth of Sandy Hook and the westward growth of Rockaway Beach relative to coastlines of over 100 years ago. Landward transport of fine sediments resuspended in the inner bight appears to contribute to sediment deposition in these areas and in the Harbor (Stubblefield *et al.*, 1977) and is consistent with the conclusions of Simpson *et al.* (1976) that little or no sediment accumulates naturally in the Bight Apex.

3.3.2 Physical Characteristics of the Study Area [Section 228.10(b)(4)]



The extensive use of the New York Bight Apex as a disposal area over the last 100 or more years has led to major changes in its physical character. It is therefore necessary to characterize not only the naturally occurring sediments in the Study Area, but other surface sediments that may be present due to past dredged material disposal or other disposal practices. Physical characteristics discussed in these two contexts include major bathymetric features of the Bight Apex area, the sediment type, texture, and organic content of the sediment, the stability of the bottom materials, and the distribution of sediment types and dredged material throughout the Study Area.

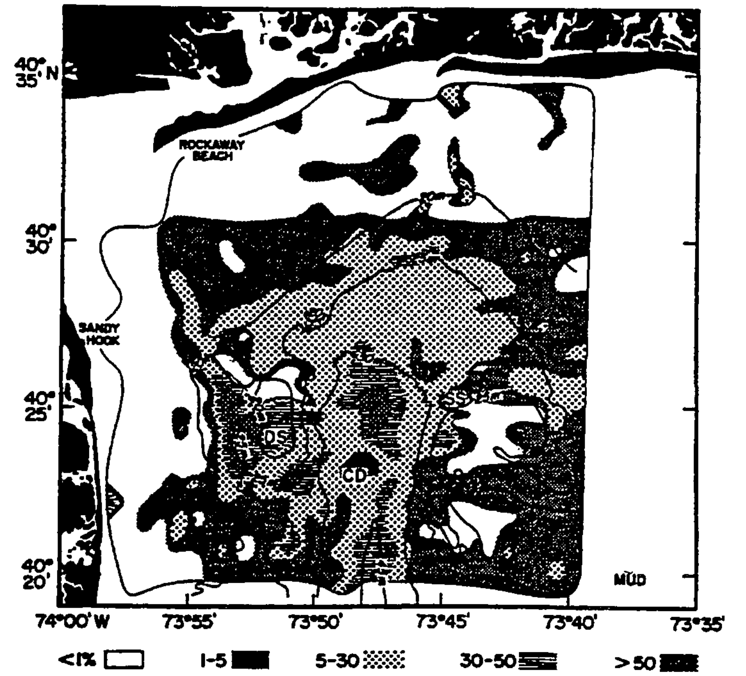
***Major Bathymetric Features*:** The New York Bight Apex and Study Area are characterized by several natural and man-made topographic features. Seaward of the New Jersey shore, the continental shelf deepens in a relatively smooth manner until it reaches 200m depth approximately 100 miles offshore. The shelf, which includes a series of ridges and swales, is bisected from northwest to southeast by the Hudson Shelf Valley. The valley extends from the entrance of New York Harbor across the New York Bight to the Continental Shelf. The shallow northern portion of the Valley passes through the northern and eastern portions of the Study Area. The Shrewsbury Rocks, which extend northeast from the New Jersey shore across the Bight, form a second major feature of the inner Bight. These shoals are cut by the Hudson Shelf Canyon in the southeastern portion of the Study Area. A third major natural feature in the Apex is the Christiaensen Basin, a shallow depression in the seafloor north of the Hudson Shelf Valley that extends into the northeast corner of the Study Area.

Man's impact on the general topography of this area is most evident in the topographically distinct dredged material mound that has filled the upper most Hudson Shelf Valley near New York Harbor. This feature extends as much as 12 meters above the historic seafloor in the northern and central portions of the Study Area.

In addition to being the topographically significant, each of the major features discussed above has distinctive sediment characteristics (grain size, carbon content, etc.) that are controlled by natural processes and anthropogenic activities, and are important to the biological communities that inhabit the area. These sediment characteristics are considered next from an historic perspective and as currently manifest.

Surface Sediment Grain Size (Texture): The natural surface sediments of the greater New York Bight are characterized as a "sheet of sand up to 10 m thick with small areas of gravel and muddy sand" of quartz and feldspars (Freeland and Swift, 1978). The surface sediments within the New York Bight are very heterogeneous (Dayal *et al.*, 1983), especially in the inner New York Bight landward of the Hudson Shelf Valley. Typically, finer grained sediments (muddy sand) are associated with swales and other topographic lows (Harris, 1976; Krom *et al.,* 1985; SAIC, 1995a;1996a; 1996b; Battelle, 1996a). Dayal *et al.* (1983) describe the historical (pre-disposal) sediments within the MDS and Study Area as quartzose sands that are typical of the continental shelf of the New York Bight. They further indicate that the Mud Dump Site (MDS) rests "directly on the once exposed green sand bed."

Surface sediment texture in the inner New York Bight for the year 1973 is represented in Figure 3-14. This map shows that areas of muddy sands (5 to 50% mud) were present in the Christiaensen Basin and in the Hudson Shelf Valley during this period (Freeland and Swift 1978). These topographic lows were surrounded by broad expanses of sediment that are very sandy (<5% mud). The latter are typical of sediments described as pre-dumping by Dayal *et al.* (1983). The map also shows an area of coarse grained sediment (<1% mud) southeast of the entrance to New York Harbor. This area coincides with the location of dredged material disposed over the previous 100 years.



Source: Freeland, Swift, and Cok, in press

Figure 3-14. Representation of percent mud in the sediments of the New York Bight Apex area as of 1973 (Freeland and Swift, 1978).

In a slightly more refined map of surface sediment texture (Figure 3-15), Freeland *et al.* (1979) show the muddy sediments of the Christiaensen Basin extending down the upper Hudson Shelf Valley. Also evident in this figure is a region of muddy sand to the southwest of the Christiaensen Basin. This region is separated from the Christiaensen Basin by an area dominated by sand. Further to the south, the surface sediments are sandy. The former cellar dirt site, characterized as an area of sandy gravel and artifactual gravel on the western slope of the Hudson Shelf Valley, is distinct in this figure. In addition, Freeland *et al.* (1979) characterize the Shrewsbury Rocks region as an area of sandy gravel.

Figure 3-15 shows that the Study Area encompasses the sandy gravel areas reported in 1973 as well as the regions of sandy mud near the historical and present MDS. The topographic information described previously indicates that the sandy region separating the two sandy mud areas includes the historical dredged material disposal mounds.

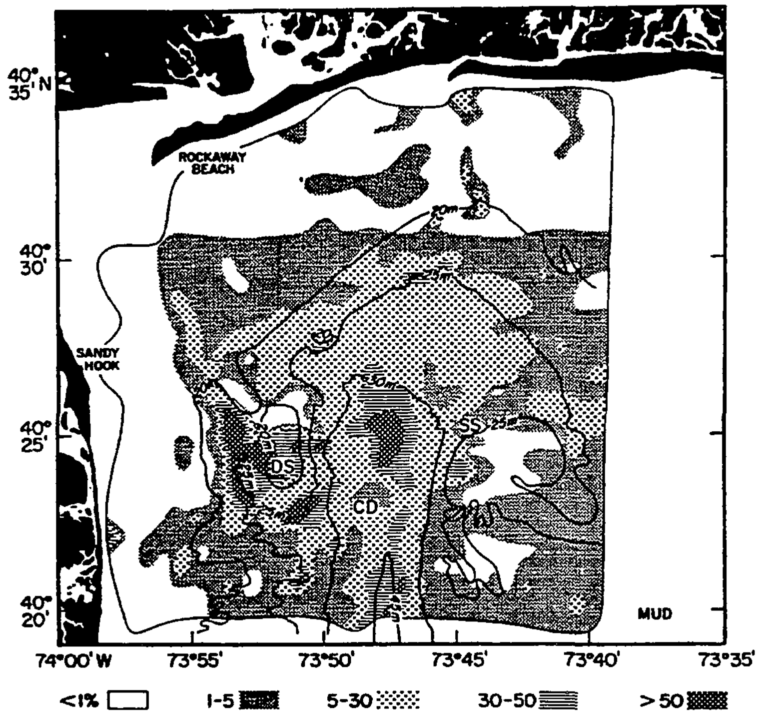


Figure 3-15. Representation of percent mud in the sediments of the New York Bight Apex area prior to 1976 (Freeland *et al.*, 1979). DS = dredged material site; CD = cellar dirt; SS = sewage sludge.

Since the late 1970s, when the maps shown in Figures 3-14 and 3-15 were generated, disposal of dredged material has further altered the surface sediment texture in the area, especially that of the MDS. Data compiled from studies conducted in the early 1990s show that the surface sediments in the MDS are highly heterogeneous (Figure 3-16). This distribution is consistent with the disposal history in the site and recent dredged material management practices. For example, capping operations conducted in 1993 to manage Category II sediment disposed in the southwestern portion of the MDS created a large expanse of sandy sediments in the southern third of the MDS in 1992 (SAIC, 1995b).

Recently, side scan (SAIC, 1995a;1996a; 1996b) and grab sample data (Battelle, 1996a; SAIC, 1996b) continue to show an area of muddy sediments west of the MDS (Figure 3-16). This area coincides with the muddy sand region noted in the above discussion of Freeland *et al.*'s (1979) results and is in the shallow basin created west of the dredged material mound by dredged material disposal. Recent data also indicate that the sediments in the Christiaensen Basin and the Hudson Shelf Valley remain muddy sand (Figure 3-16). Furthermore, the sandy areas in the northwestern and northern portions of the Study Area reported to be void of fine grained sediments in 1973 by Freeland *et al.* (1979) are still present in the 1995 and 1996 data (Battelle, 1996a; SAIC, 1996b).

Detailed spatial distributions of the surface sediment texture are provided by side scan surveys (SAIC, 1995a; 1996a) and extensive mapping of the sediments with a sediment profile camera (McDowell, 1995). These surveys show a complex set of surface sediment characteristics in the Study Area. For example, sand wave and ripple fields tend to be concentrated in the southern portions of the Study Area, along the eastern and southern slopes of the dredged material mounds in the MDS, east of the MDS along the head of the Hudson Shelf Valley, and along the slopes of the dredged material mound in the northwest quadrant of the Study Area (SAIC, 1995a) (Figure 3-17). Individual occurrences of large rocks (>2 m in size) or rock piles are scattered throughout the Study Area. Outcrops are found throughout the Study Area, but are particularly evident in the former Cellar Dirt Site (Figure 3-18). This area is distinctive in that it has a high acoustic reflectance signature, which is indicative of rocks or other hard features that reflect sound waves, rather than absorb acoustic energy (e.g., smooth soft sediment). The high reflectance surface extends to the north and south of the Cellar Dirt Site and along the eastern flank of the dredged material mound in the MDS (Figure 3-19). Large low-reflectance bottom areas are also evident in the side scan records. These areas include the deep water in the extreme southeast portion of the MDS, the shallow basin west of the dredged material mound, and areas within the MDS that have recently been disposed on or capped with sand (SAIC, 1995a; 1996a).

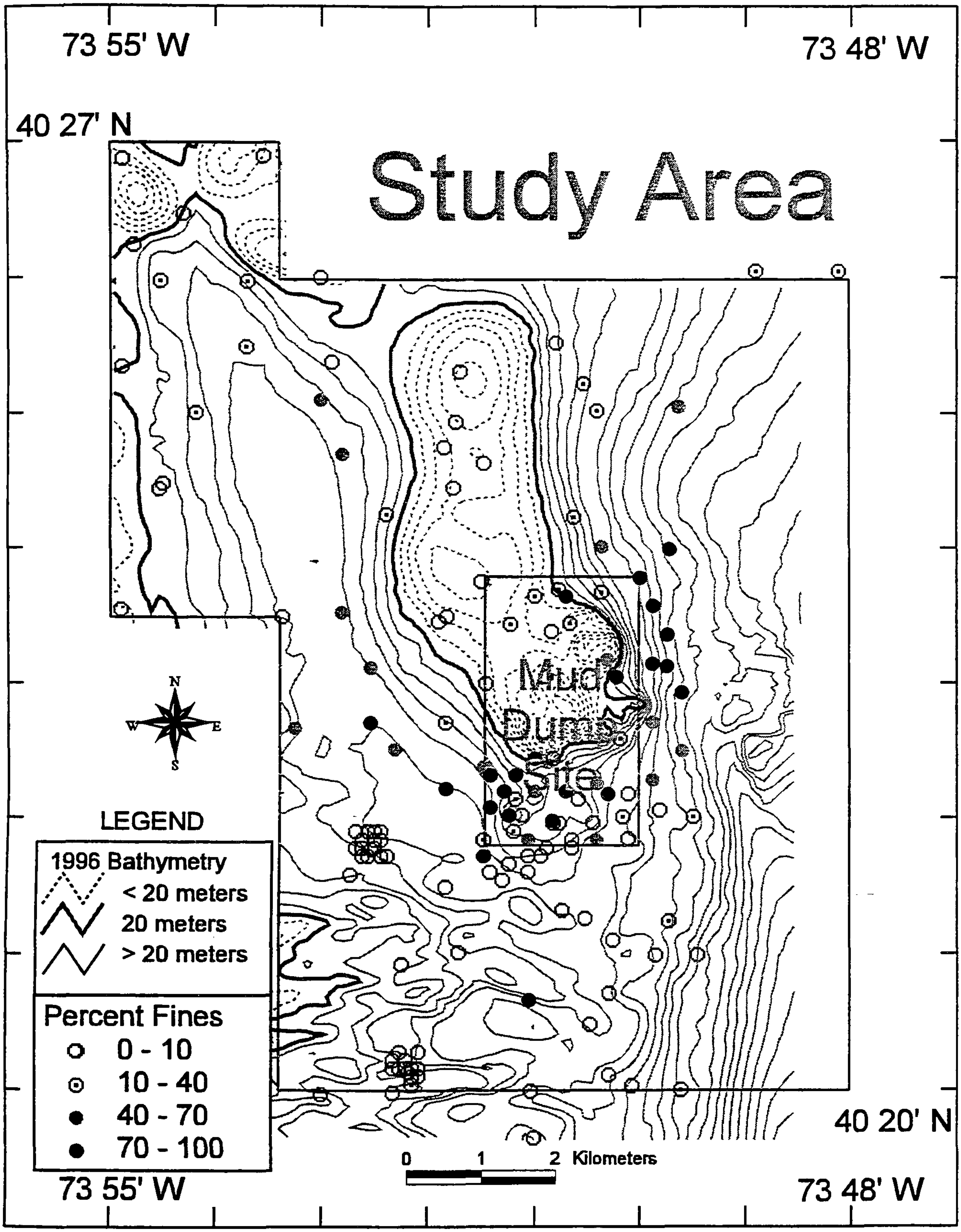


Figure 3-16. Compilation of surface sediment grain size data for stations in the Study Area sampled from 1990 through 1996.

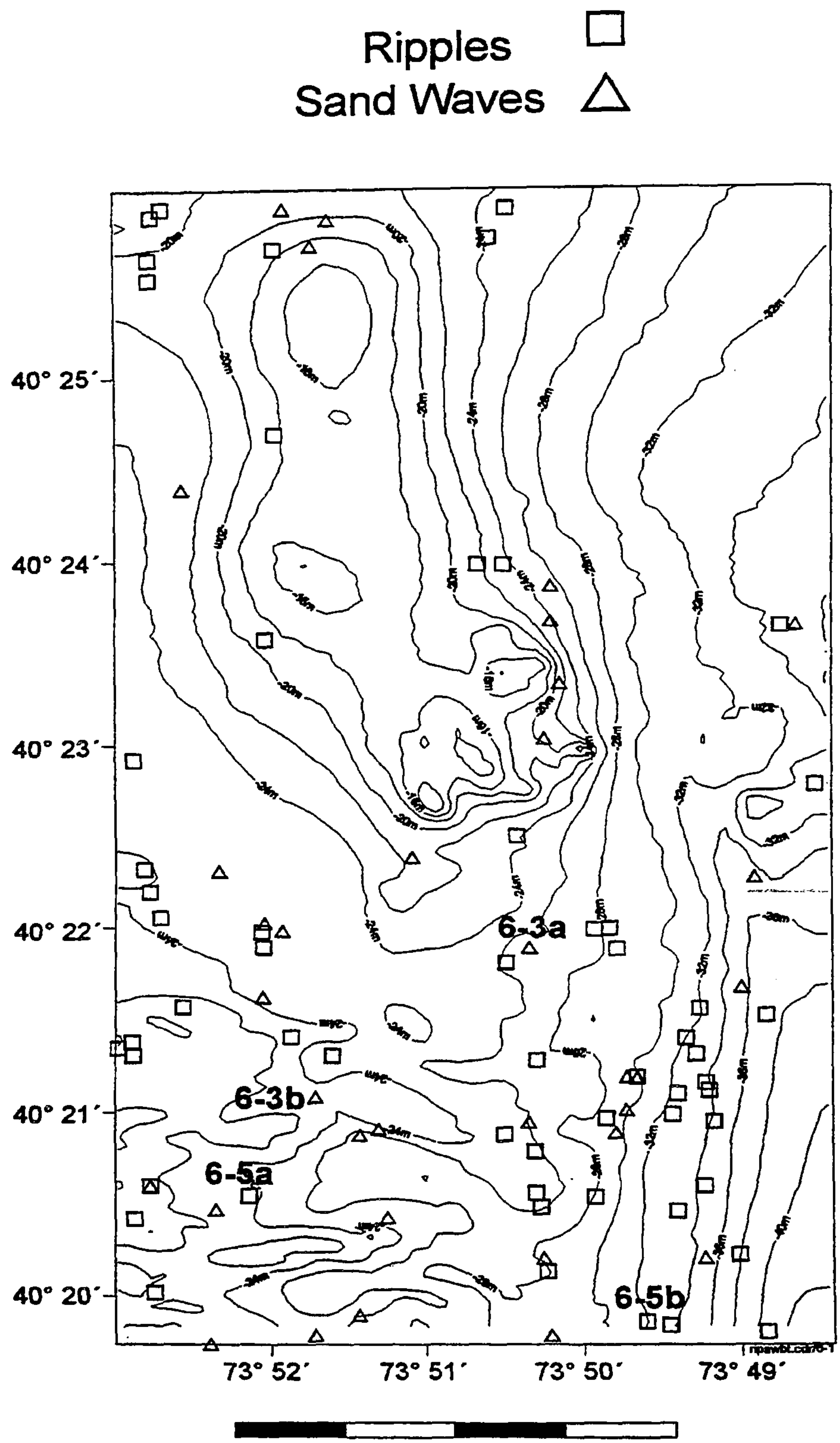


Figure 3-17. Locations of ripple and sand fields identified in Subarea 1 of the Study Area by side scan (SAIC, 1995a). Areas identified with these features are superimposed on the 1995 bathymetric data.

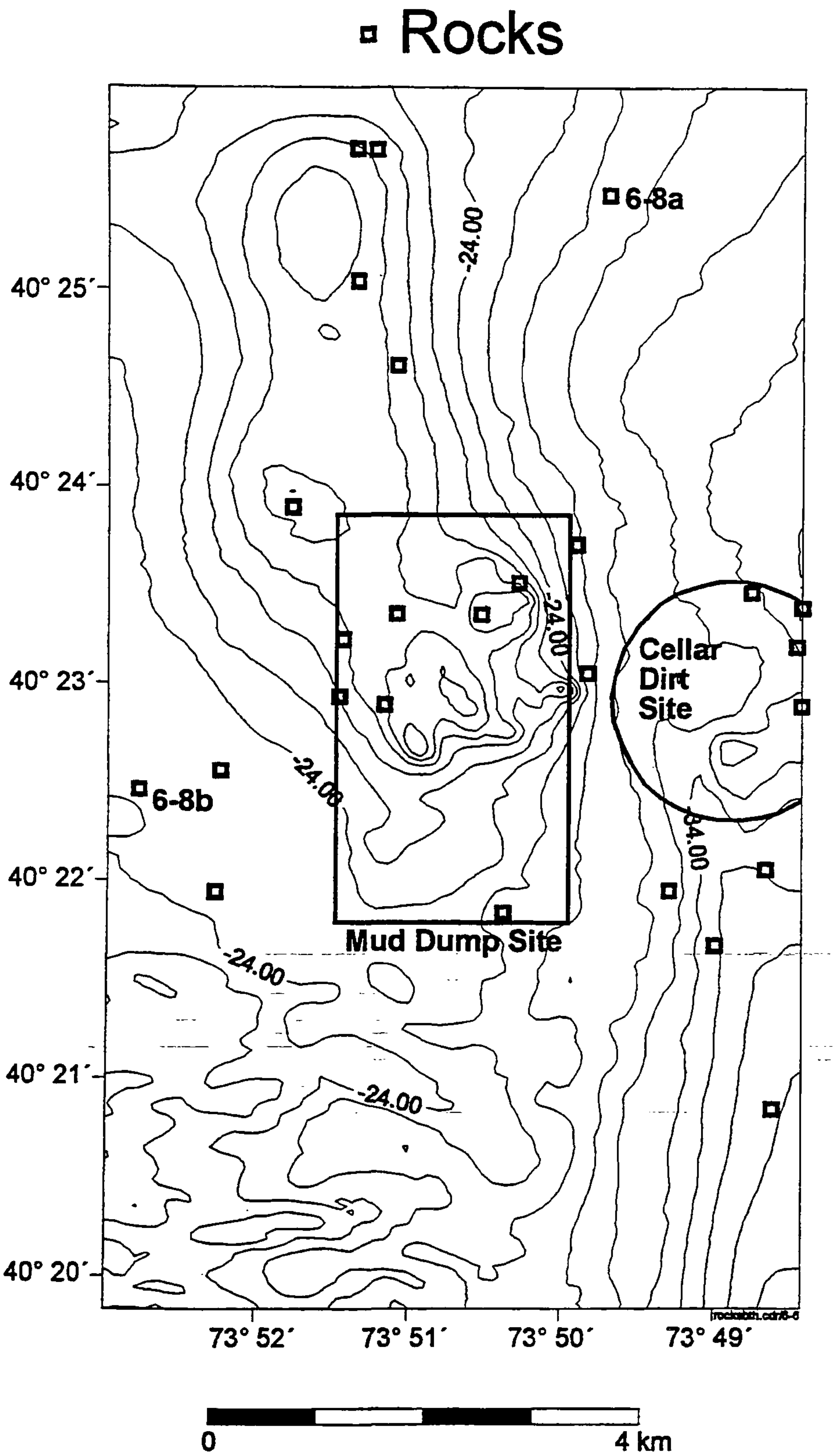


Figure 3-18. Locations of large rocks (>2 m) in Subarea 1 identified from side scan data obtained in 1995 (SAIC, 1995a).

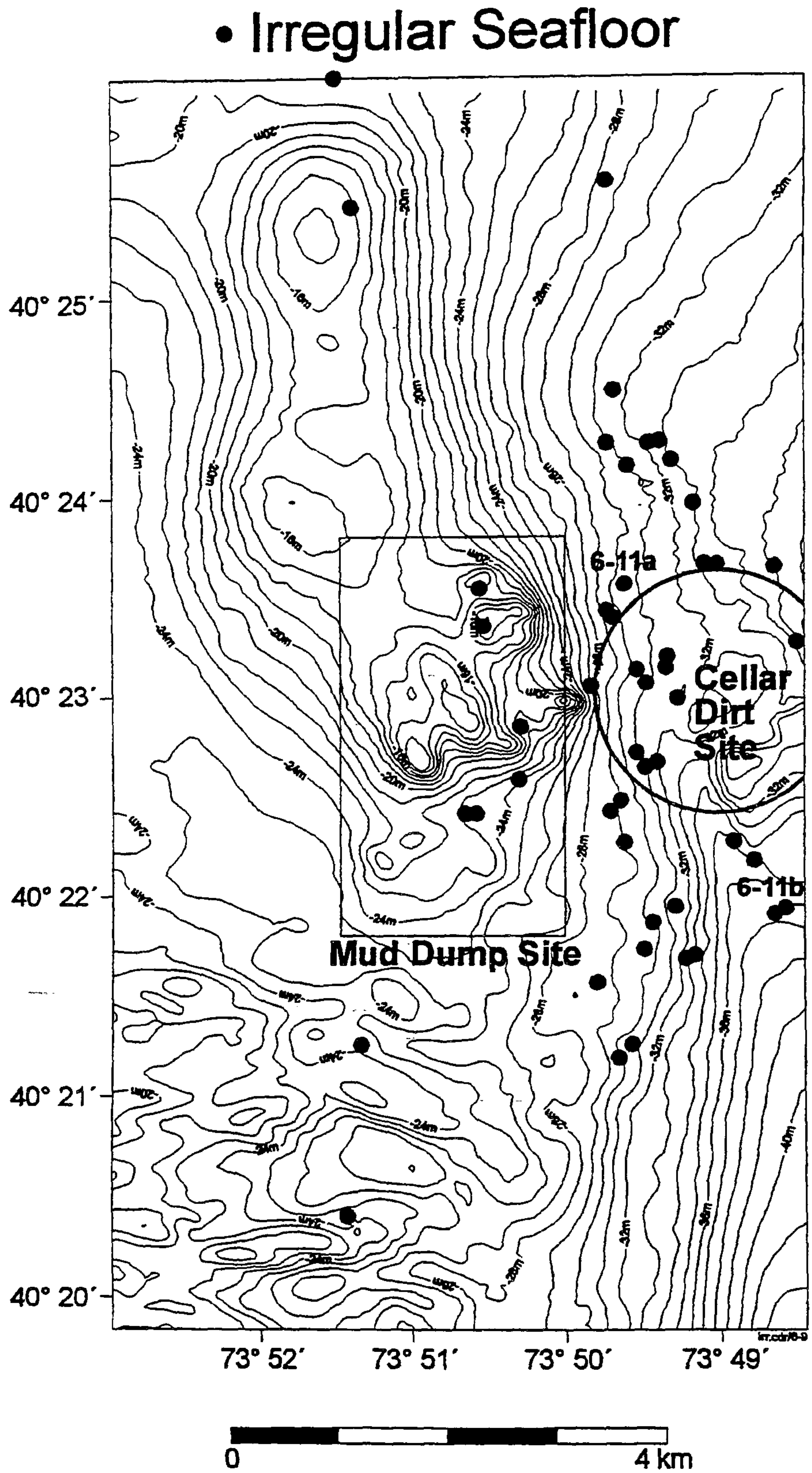


Figure 3-19. Areas with irregular seafloor in Subarea 1 identified by side scan surveys of 1995 (SAIC, 1995a).

Validation of this remotely sensed textural data can be seen in the surface sediment grain-size distribution obtained from grab samples collected during surveys conducted from 1990 through 1996 (Figure 3-16), as well as detailed sediment profile images collected in October 1995 (McDowell, 1995) (Figure 3-20). These recent data demonstrate that areas no longer actively receiving dredged material (historic mound in the north-central and northwest portions of the Study Area) have relatively consistent grain size distributions (Figure 3-20). Finer grained surface sediments are generally found at the fringes of the dredged material disposal mound (McDowell, 1995) and in the shallow basins.

***Grain Size Distributions in the Dredged Material Mounds*:** Vertically, sediments in the historical disposal mound have been found to be heterogeneous, consistent with the recorded disposal and site management operations history of the area. Dayal *et al.* (1981;1983) describe the sediments in the dredged material mound as being composed of various thicknesses of laminated sediments, especially in the center of the mound. The sediment in the mound, based on core samples obtained in 1973, is described as "black mud that frequently ranges to sandy mud (Dayal *et al.*, 1983)." Much of this material was high in organic content and also had identifiable artifactual materials such as sludge, broken concrete, spent caustic soda ash, coal fragments, wood cinders, metal and rust flakes, glass shards, and other man-made items. Red clay material typical of Newark Harbor was found as lamination, balls of contorted clay, and in beds up to 25-cm thick (Dayal *et al.*, 1981). Dayal *et al.* (1983) provide the following summary of the dredged sediments sampled in 1973.

> "*The sediments of the dredged-material deposit are composed of a variety of sediment types, which can be classified as quartzose and glauconitic sands, muds, sandy muds, gravel intermixed with muds, and artifactual material such as coal and fly ash, wood, slag, metal flakes, glass, and so on. Black sandy mud is characteristic of dredged material whereas glauconitic and gravelly quartzose sands are typical of the natural underlying deposit in surrounding areas.*" (Dayal *et al.*, 1981).

Geotechnical surveys of the subbottom characteristics of the inner New York Bight, conducted by the USGS in 1995, found a loss of signature in the MDS and other areas that have historically received dredged material (William Schwab, USGS, Woods Hole, MA, personal communication, November 1995). The loss of signal is consistent with a heterogeneous, poorly sorted sediment.

Surface Sediment Organic Carbon Content: The organic carbon content of sediment can significantly influence the chemical and biological conditions of sediment (Steimle, 1990; Steimle *et al.*, 1982). Although the distribution of organic carbon in the sediment is strongly affected by grain size distributions, it is the organic content of the sediments that often influences chemical concentrations in the sediments (Hunt, 1979; Dayal, *et al.*, 1981;1983; Krom *et al.*, 1985; Steimle *et al.*, 1982; Battelle, 1996a) as well as the biological community (Wilber and Will, 1994; Battelle, 1996a).

Generally, increasing levels of organic carbon in the surface sediments correlates with increasing amounts of fine grained sediment fractions (Figure 3-21). In recently collected sediments from the MDS and Study Area (Battelle, 1996a), the strength of this correlation was very strong ($r^2 = 0.92$) . The lowest organic matter content in the sediments is associated with sediments having the highest fraction of sand, while the highest organic matter content correlates to sediments with high fine grained content.

Areas of high fine grained sediments are generally located on the eastern side of the MDS and immediately adjacent areas in the Hudson Shelf Valley and Christiaensen Basin and the shallow basin in the west-central portion of the Study Area. Generally, the highest organic carbon concentrations in sediments from the Study Area are found in the topographic lows found in the region (Figure 3-22).

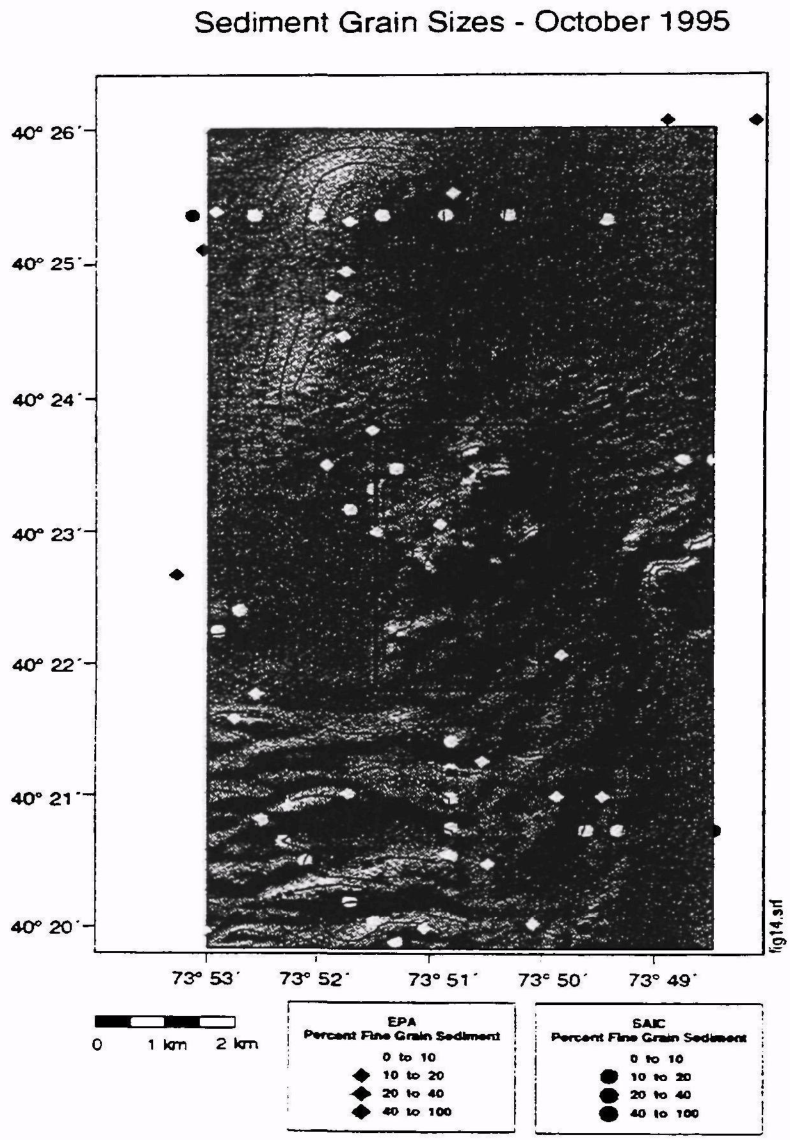
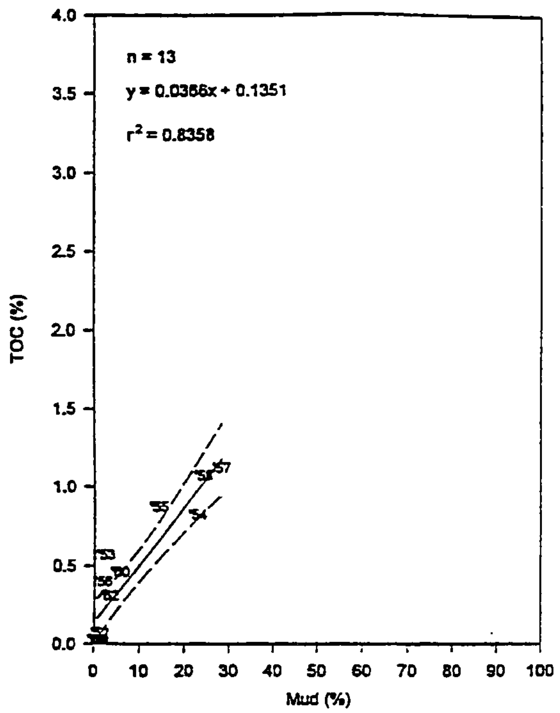


Figure 3-20. Grain size major mode distribution in the Study Area (Subarea 1) measured in October 1995 (SAIC, 1996).



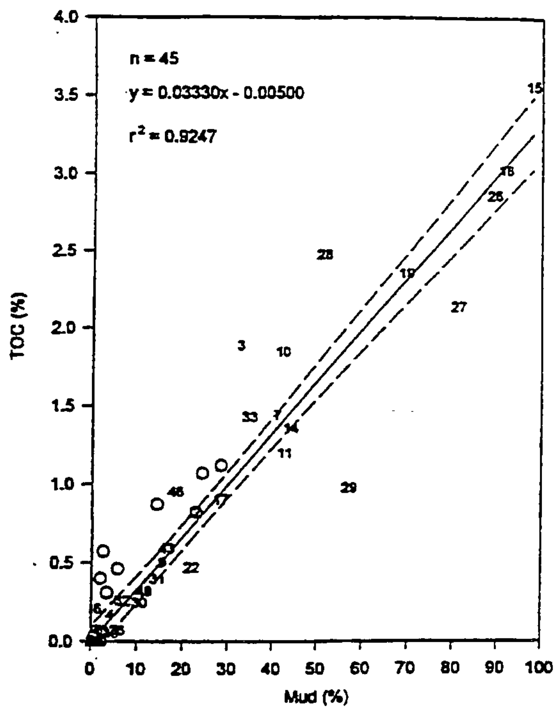


Figure 3-21. Correlation between mud content and organic carbon content of surface sediments (upper 10 cm) from the Study Area (Battelle, 1996a). The correlation statistics shown are for samples collected in October 1994. Samples collected in January 1996 are shown as open circles for comparative purposes.

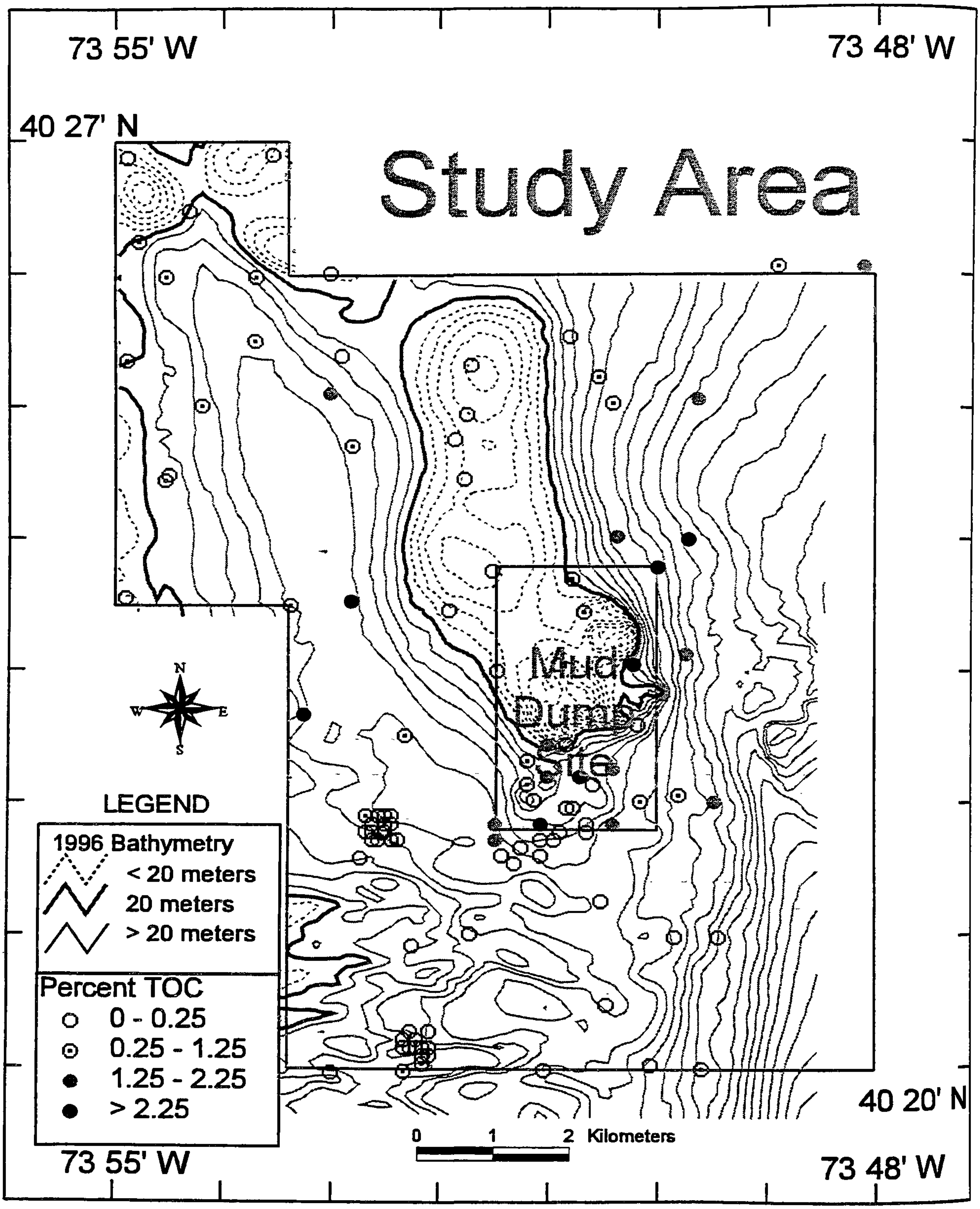


Figure 3-22. Spatial distribution of total organic carbon in the surface sediments from the Study Area. Data are from surveys conducted between 1990 and 1995 (Battelle, 1996a; Charles and Muramoto, 1991; SAIC, 1995d). Results are superimposed on the bathymetry of the Study Area measured in 1995/1996 (SAIC, 1996a).

3.3.3 Meteorology and River Runoff [Section 228.6(a)(6)]

The coastal maritime weather of the New York Bight is characterized by a climate of extremes typical of the Northeast U.S. with hot summers and cold, stormy winters. Offshore air temperatures for the area range from a mean monthly low in February of 1°C to a high in July of 22°C; extremes in the collected hourly temperature range from -19°C to 34°C. Weather conditions are variable in the fall and winter with a series of storms producing strong winds and high seas; weather conditions are more stable in the summer. Prevailing winds in the fall and winter tend to be out of the northwest, but stormy northeasterlies are not uncommon. These two to three-day northeast storms produce severe conditions offshore with high winds, cold rain, and steep seas due to the open fetch to the northeast. Prevailing winds in the summer are southerly, increasing in mid-morning to rarely greater than 20 knots and usually dying down at dusk. The area experiences considerable rainfall throughout the year with a slight seasonal low in the winter months. Mean monthly precipitation ranges from about 3 to 4.5 inches (Figure 3-23). Offshore fog is not common, but can be produced during spring when a warm moist southerly flow of air passes over cold ocean water.

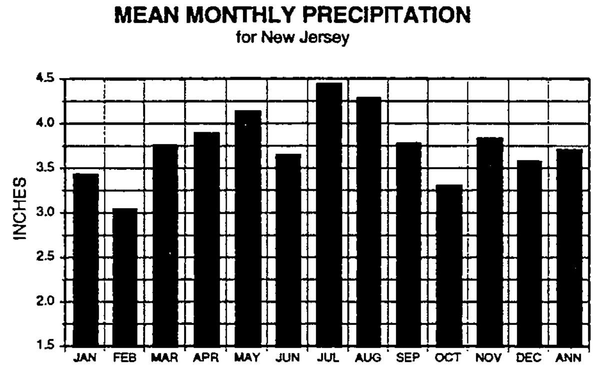


Figure 3-23. Mean monthly precipitation received over New Jersey. Data are from the National Weather Service.

Winds in the area of the New York Bight are an important influence on the Study Area since they generate surface waves and affect the water column characteristics and flow throughout the waters of the continental shelf (Beardsley *et al.*, 1976). For instance, the breakdown of the water-column thermal stratification, which occurs in the fall, is in large part forced by the storm winds of the fall. The average current flow over the continental shelf of the New York Bight is toward the south-southwest at about 5 cm/s near the surface. These currents decrease to about 1 cm/s near the bottom (Mayer *et al.*, 1979). These currents are forced by intense low pressure northeasterly atmospheric systems in the winter. However, the occurrence of energetic wind-driven transient current events, primarily during the winter months, significantly alter the mean flow pattern.

The National Weather Service maintains offshore meteorological buoys and platforms throughout the coastal and offshore waters of the United States. In the New York Bight, four meteorological stations exist and have been maintained for the last 10 to 20 years. They include weather buoy 44025 at 40.3°N/73.2°W, south of Fire Island, NY; weather buoy 44008 at 40.5°N/69.4°W, south of Nantucket; weather buoy 44009 at 38.5°N/74.7°W, southeast of Cape May, NJ; and the Ambrose Light platform ALSN6 at 40.5°/73.8°W.

The Ambrose Light platform, located less than 10 km from the Study Area, is the closest weather station. Data from Ambrose are presented for the period from November 1984 through December 1993 in Figures 3-24 and 3-25. The large-scale wind and wave patterns recorded at the Ambrose Light Platform are similar to data from the other three meteorological stations. Wind speeds are strongest during the fall and winter months with winds exceeding 30 knots greater than 5% of the time in November, December, January and February. Wind speeds peak in December when winds exceed 30 knots more than 6% of the time. During

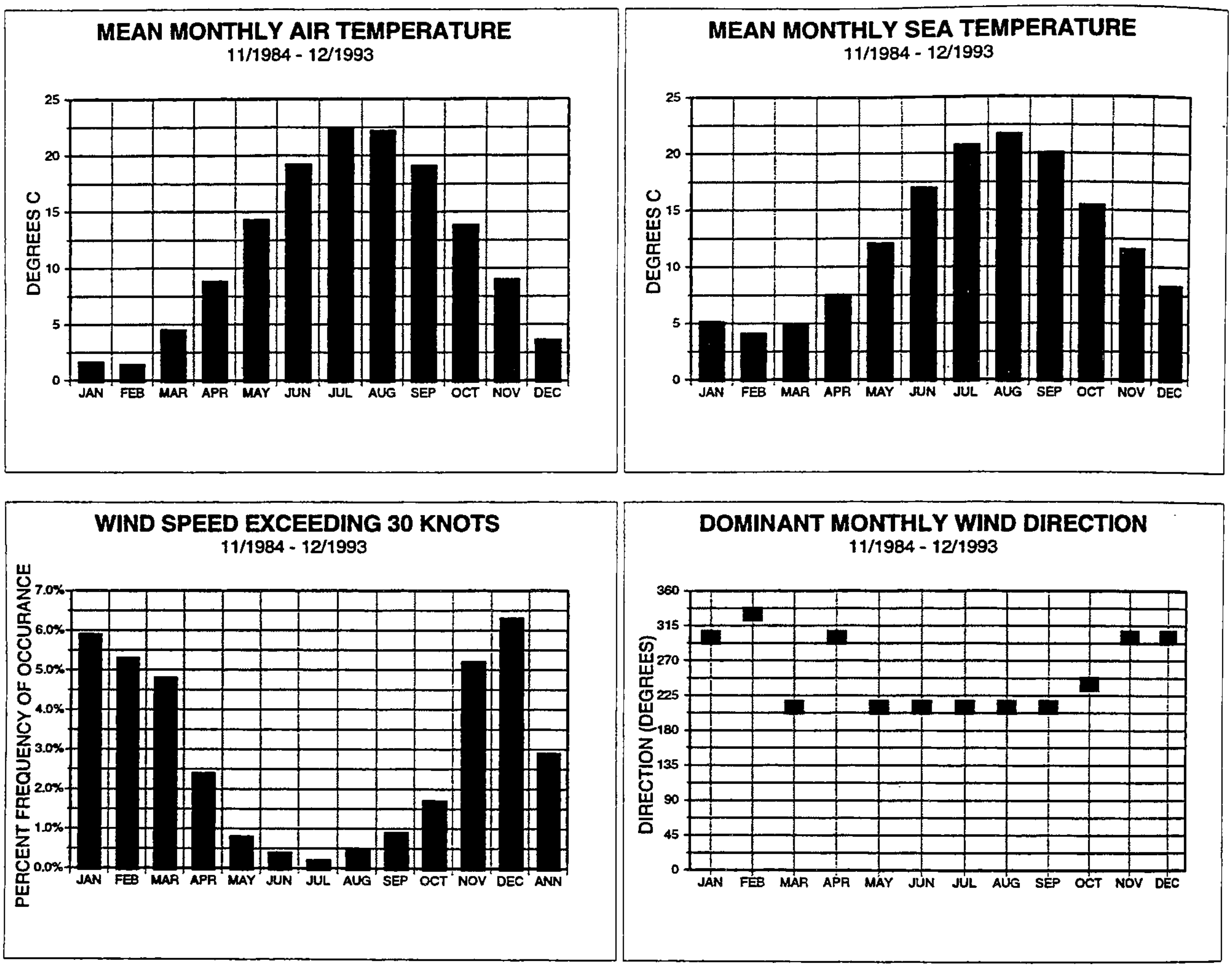


Figure 3-24. Comparison of the mean monthly air and sea temperatures, dominant monthly wind direction, and winds exceeding 30 knots in the New York Bight at the Ambrose Light Platform for November 1984 to December 1993.

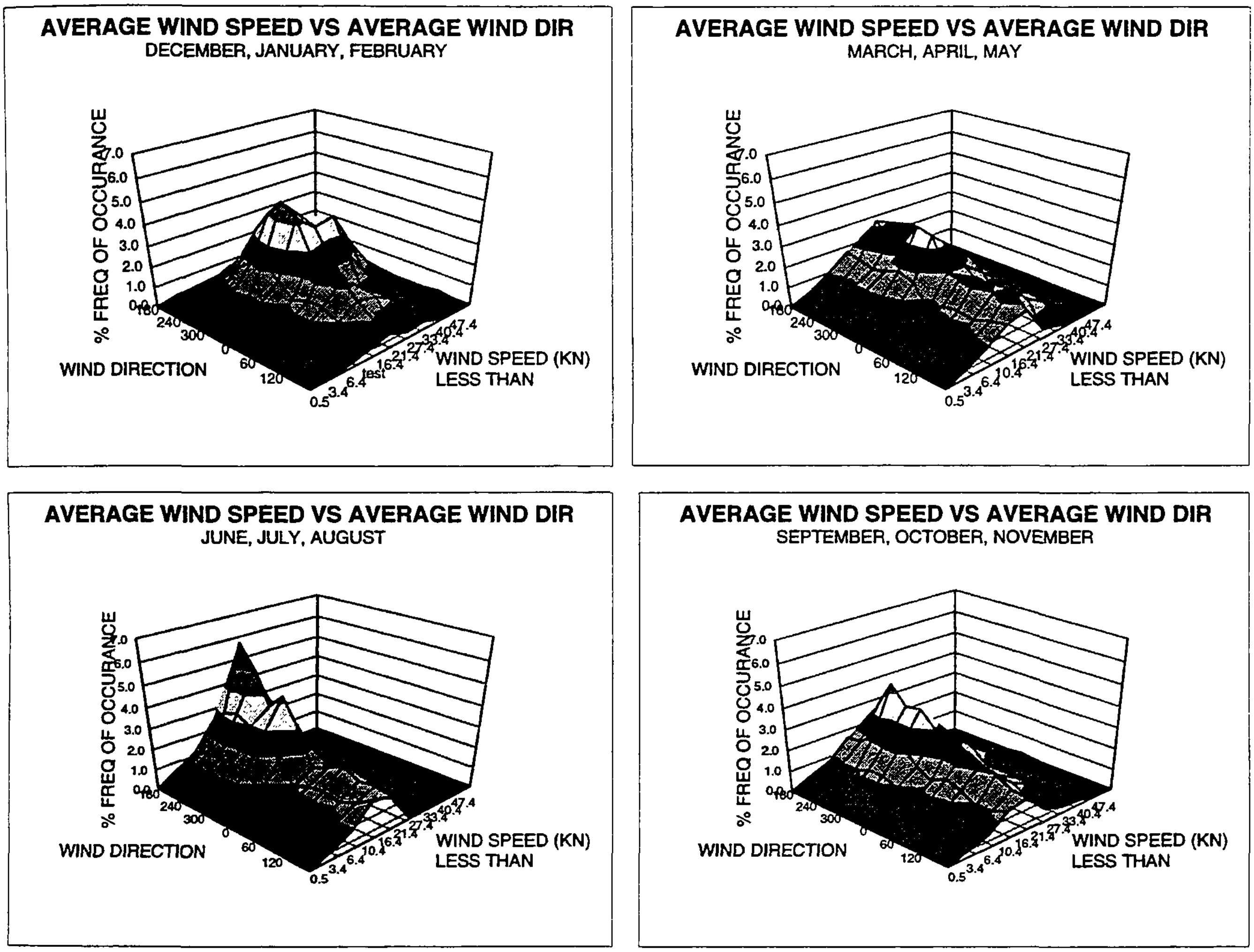


Figure 3-25. Comparison of average wind speed and direction by calendar quarter at the Ambrose Light Platform. Each panel depicts the frequency of occurrence for a given wind speed and direction.

these months, the predominant wind direction is out of the northwest. During March and April winds are more southerly but still strong. March winds exceed 30 knots over 4.5% of the time. Resulting waves are a function of both wind speed and direction as the fetch is limited to the east and north at Ambrose Light and in the Study Area. With predominant winds out of the northwest during the winter, the average monthly wave heights are lower than during the spring when predominant winds are weaker but southerly. The most common occurrence of high waves is in March and December with wave heights exceeding 2 m greater than 5% of the time. Long period swell (wave periods exceeding 12.5 sec) results from either severe local storms or storms offshore in the north Atlantic. Long period swell occurs most often in the spring and in the October to December period.

The Hudson and Connecticut Rivers are the two largest sources of fresh water in the Northeast United States. Together they significantly affect the salinity distribution and circulation of the apex of the New York Bight and the Study Area. Ketchum and Keen (1955) showed that the total annual discharge of the Hudson and other rivers displaces a volume of water equal to 50% of the total volume of the Bight apex. This is quickly dispersed by active circulation in the Bight (residence time of fresh water equals 6 to 10 days). The mean discharge of the Hudson River at Poughkeepsie is about 560 m^3/s (Bowman and Wunderlich, 1977); about half of the annual discharge occurs between the months of February and March. Figure 3-26 presents the mean monthly discharges of the Hudson and Connecticut Rivers. The Hudson River discharge peaks in April, with a monthly mean flow of 750 m^3/s, and is lowest in August when the mean is only 175 m^3/s. The mean discharge of the Connecticut River at Thompsonville, Connecticut is about 530 m^3/s. The discharge peaks in April, with a mean flow of 1275 m^3/s, and is lowest in July when the mean flow is only 200 m^3/s. The mean monthly flow on either of these rivers may vary by as much as a factor of 10 from year to year. The effect of the seasonal variation of the Hudson and Connecticut River discharge rates on the hydrographic properties in the apex of the New York Bight and the Study Area are presented in Section 3.3.10.

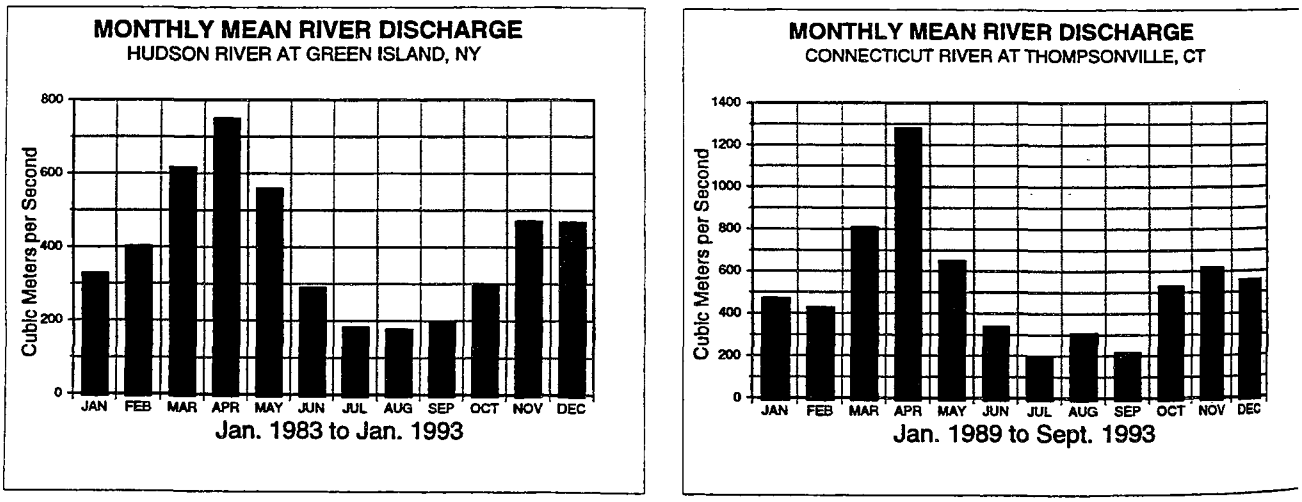


Figure 3-26. Monthly mean river discharge from the Hudson and Connecticut Rivers. These rivers together contribute the majority of the fresh water flow into the New York Bight.

3.3.4 Physical Oceanography [Sections 228.6.(a)(1) and 228.6.(a)(6)]

The transport, dispersion, and eventual fate of dredged material released into the marine environment depends both upon the physical characteristics of the dredged material and the structure and dynamics of the water column. The physical parameters which are important in the transport and dispersion of dredged material, either during or subsequent to disposal, include ocean currents, waves (storms), and the density structure of the water column. Currents (including tides, density-driven, and wind-driven currents) directly affect the transport and dispersion of dredged material. In shallow water, waves can resuspend sediments and dredged material particles previously deposited on the sea floor for subsequent transport by local currents. The density structure of the receiving water, relative to the density of the released dredged material, influences how long the dredged material remains in the water column. In this section, these parameters are characterized for the Study Area from historical data.

3.3.4.1 Regional Circulation Pattern

The Study Area is located on the shallow continental shelf within the New York Bight. The general structure of current velocity in the Middle Atlantic Bight has been extensively described by previous investigators (see review by Beardsley and Boicourt, 1981). Beardsley and Boicourt (1981) have shown that the structure of circulation is quite complex with great temporal and regional variability. Low frequency meteorological forcing (over 3 to 10 day periods) is responsible for much of the current fluctuation over the continental shelf. During the spring and summer, when the wind energy is much diminished and the water column is stratified, the maximum energy in the water column shifts from being primarily influenced by meteorological conditions to being influenced by inertial and tidal energy (Mayer, 1982). The amplitude of the semidiurnal forcing also decreases in the offshore direction during this period (Beardsley and Boicourt, 1981). Generally, the magnitude of the currents increases with distance offshore and decreases with depth (Beardsley and Boicourt, 1981).

The mean flow of the water column, based on long-term current meter moorings on the Atlantic shelf, is towards the southwest along depth contours through the New York Bight (Figure 3-27). Average speeds are 2 to 4 cm/s. Mean water residence time in New York Bight is approximately 9 months. Figure 3-28, redrawn from Beardsley, *et al.* (1976), summarizes over 20 long-term current meter mooring instrument records in the Middle Atlantic Bight. Mayer *et al.* (1979), using long-term mooring data at a 47 m water depth, observed that the mean surface flow in the Bight was 4-6 cm/s, veering to the west with increasing depth. At 1 m above the bottom, the mean flow was less than 1 cm/s. Superimposed on slow mean drift are fluctuations in current speed and direction caused by storm systems

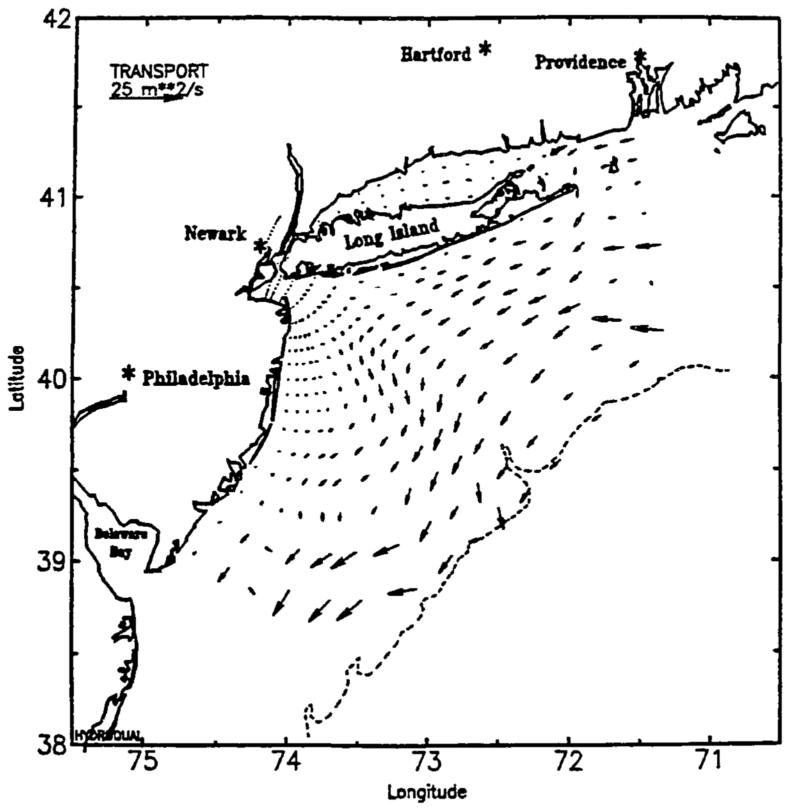


Figure 3-27. General circulation structure of the New York Bight.

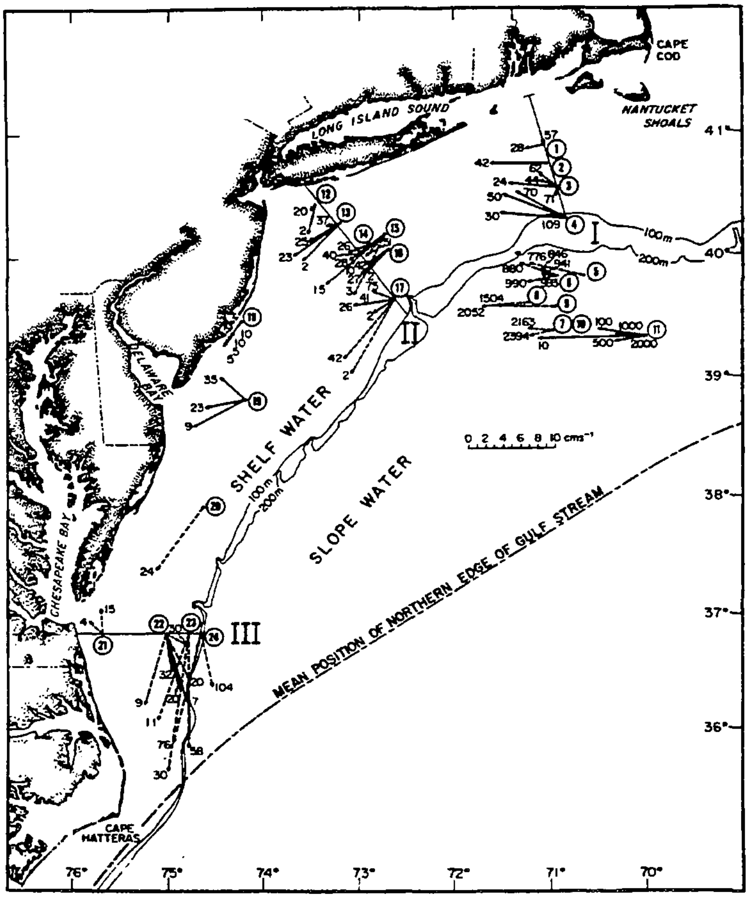


Figure 3-28. Mean current vectors from current meters moored in the Middle Atlantic Bight region. Vectors show the direction and speed (cm/s) of the currents during the winter (solid arrows) and summer (dashed arrows). Circles indicate station numbers (figure from Beardsley *et al.*, 1976).

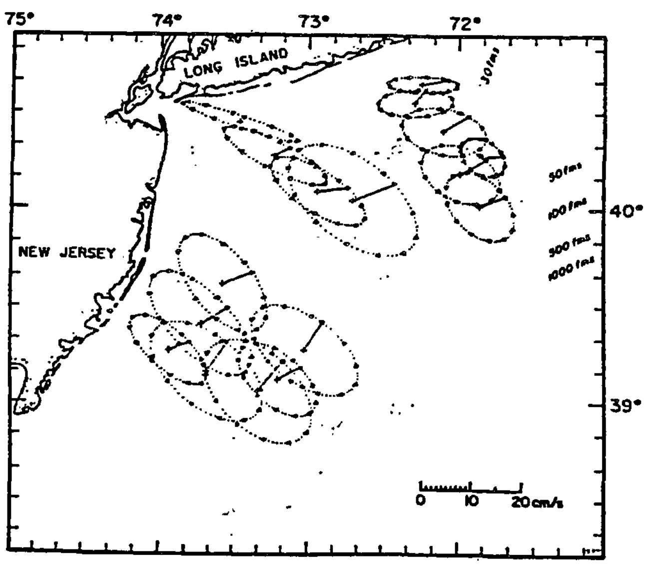


Figure 3-29. Tidal ellipses (M_2) from 17 moorings located in the New York Bight (Mayer, 1982). Starting phase is indicated with the single vector. All motions are clockwise.

with peak flows measured at 40cm/s sustained (Mayer *et al.*, 1979) and by the regular to-and-fro motions of the astronomical tides in shallow water. A significant aspect of the mean flow over the inner Bight is a shoreward velocity component in the bottom boundary layer (Beardsley, *et al.*, 1976). Numerous current meter measurements made in the shallow water of the Bight at heights of 1-5 m above the bottom all show a shoreward component of the flow when averaged over the long term. This is a wind-driven effect which will be discussed further.

Like all water bodies, the Bight responds to the frictional drag of local wind on the water surface. The wind stress in the Bight tends to be directed offshore during winter when it is at its maximum. In summer, the wind stress is directed more alongshore from the southwest. These wind-driven flows are most important to the sediment transport climate, as the majority of sediment transport occurs during large storms when wind stress is highest and wave heights are their largest. It is well documented (Beardsley and Boicourt, 1981) that the mean southwestward circulation is dramatically altered by weather events, particularly cyclonic winter storms. Southwestward flow is greatly enhanced by winter northeasterly storm events on the shelf. Beardsley and Boicourt (1981) showed that strong winter storms could produce along-isobath currents from 20 to 50 cm/s in the mid-shelf region. Mayer *et al.* (1982) found that during periods of sustained wind stress directed from the northeast (January 1976 and November 1976 through January 1977), upwelling occurred in the apex of the Bight as the near-bottom water flowed upshelf. This effect was found to be enhanced in the Hudson Shelf Valley. Han and Mayer (1981) found offshore bottom layer flow only in response to northward wind stresses.

The semidiurnal tidal current energy can represent a substantial percentage (10-80%) of the total energy on the continental shelf in the New York Bight (Mayer *et al.*, 1982), and the M_2 tide (the principal lunar semidiurnal component of the tidal forces) accounts for approximately 80% of the semidiurnal energy (Mayer *et al.*, 1979 as cited in Mayer *et al. 1982*). M2 tidal ellipses are plotted for 17 locations in the Bight in Figure 3-29 (after Mayer, 1982). Tidal currents associated with the M2 tide are clockwise with the major axis if the tidal ellipses are oriented roughly perpendicular to the isobaths. The ellipses are thinner nearer shore and are directed into the mouth of the Hudson. Peak ebb and flood tide flows are approximately 10-15 cm/s.

3.3.4.2 Study Area Region Specific Currents

SAIC (1995c; 1993b;c), measured near bottom currents at the MDS during the winter (November 1992 to March 1993) and the summer (June through September 1993) as part of a sediment capping study. The following discussion, modified from SAIC (1993b;c), summarizes the information relative to observed near-bottom currents in the Study Area.

Mean currents during the winter deployment at three bottom tripod locations were weak (< 16 cm/s) for the majority (>78%) of the observations (Figure 3-30) . Mean current speeds exceeded 32 cm/s only 1-3% of the time for all records. The predominant near-bottom flow was northward (300°-30°) SAIC (1993b). During summer (Figure 3-31) the mean currents were weak, ranging from 6 to 9 cm/s. Less than 3% of the observed current speeds of all three sites were greater than 20 cm/s, with flow direction variable. The semidiurnal M_2 tidal constituent was responsible for the majority of the fluctuations in the current records for periods less than 3 days. The oscillatory tidal currents were primarily bi-directional and oriented northwest-southeast with peak ebb and flood current values of 6-8 cm/s. Low frequency current fluctuations (greater than 3 days) during winter were probably associated with wind forcing with current velocities up to 20 cm/s.

3.3.4.3 Wave Climate

Near-bottom currents in the Study Area are rarely energetic enough to initiate the resuspension and transport of bottom sediment. Large waves, on the other hand, are occasionally large enough and long enough to penetrate to the bottom. These waves can enhance the bottom shear stress and resuspend the deposited sediments, but by themselves do not result in net transport of sediments as the to-and-fro wave motions are essentially closed ellipses. However, when a mean near bottom current velocity is superimposed on the wave velocities, sediment transport results.

Figure 3-32 summarizes the wave climate in the area of the Study Area. Data are from the National Weather Service offshore meteorological platform at Ambrose Light (ALSN6) located at 40.5°/73.8°W, for the period November 1984 through December 1993. Figure 3-32 shows the frequency of occurrence of waves which exceed 1 meter, 2 meters, and 3 meters in height. The highest waves were recorded during the winter months and in the early spring with waves exceeding 2.0 m about 4% of the time and 3.0 m about 1% of the time. The most common occurrence of high waves is in March and December with wave height exceeding 2 m greater than 5% of the time. The prevailing direction of waves in the region follows the prevailing wind directions, from the northwest in fall and winter and from the south in spring and summer. Additional data show mean monthly significant wave heights of 0.9 m for the nine year period ending in December 1993. The maximum recorded waves were measured at a significant wave height of 7.3 m. During the winter months the predominant wind direction is out of the northwest where the fetch is limited. During March and April winds are weaker but more southerly. The unlimited fetch generates large waves with long periods. The dominant wave periods exceed 12.5 seconds over 4% of the time in April as well as October and December.

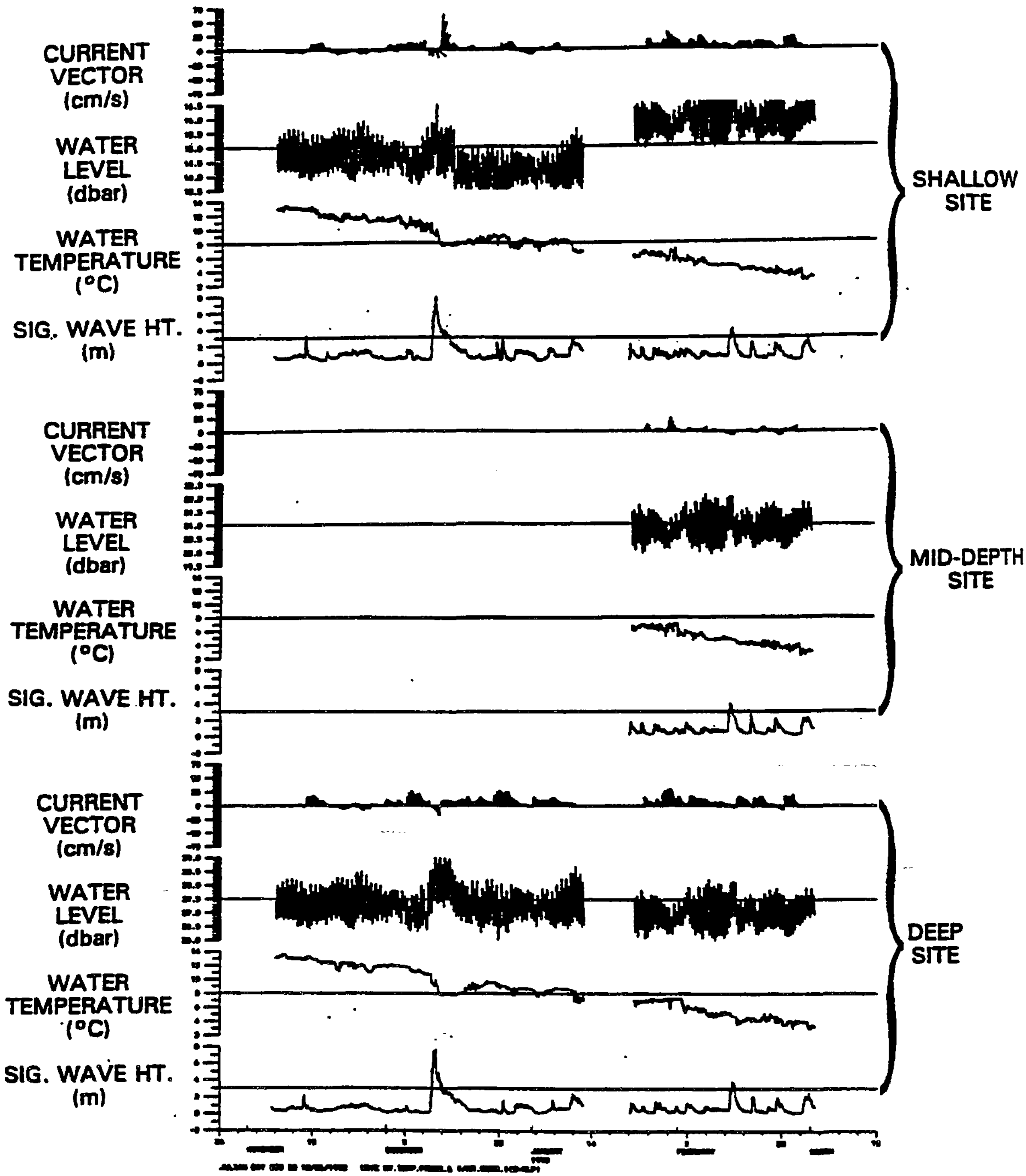


Figure 3-30. Time series current vectors and hourly bottom pressure, water temperature, and significant wave height from November 1992 through March 1993 at the MDS. Data from three depths are shown; upper is shallow; middle is mid-depth; lower is a deep site (SAIC, 1993b). Northward flowing currents are represented by a stick oriented upward; the strength of the current is represented by the length of the stick (SAIC, 1993c).

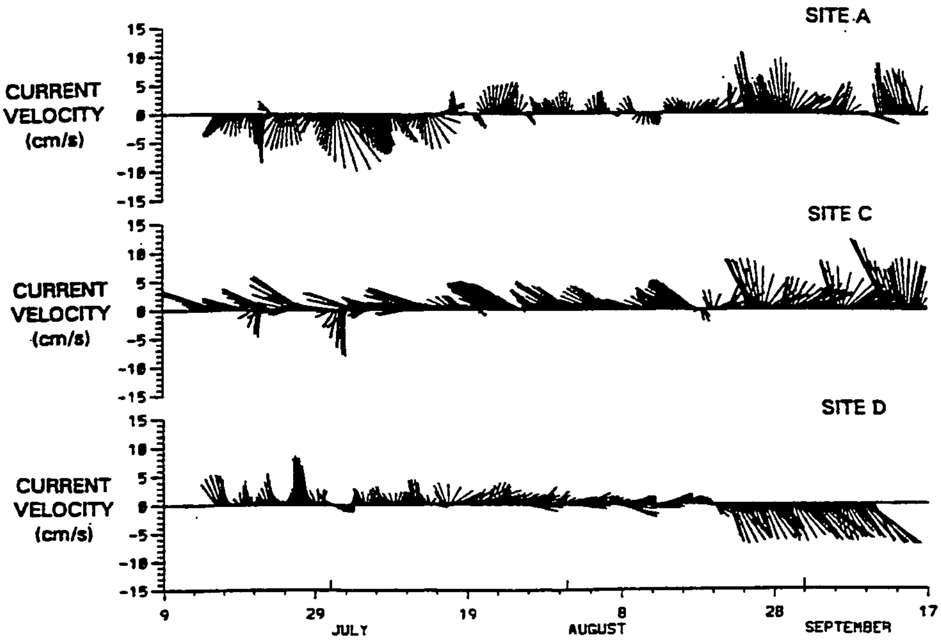


Figure 3-31. Current vectors from June through September 1993 at three sites in the vicinity of the MDS. Northward flowing currents are represented by a stick oriented upward; the strength of the current is represented by the length of the stick (SAIC, 1993c).

Of primary concern in this analysis are near-bottom wave orbital velocities, since they provide the energy to resuspend bottom sediments. In most areas of the continental shelf in the New York Bight, threshold erosion velocities for sandy substrate, ranging from 12 to 40 cm/s, are only exceeded by the steady component of flow for relatively short periods during storms. Peak wave orbital velocities just above the bottom depend upon the water depth, wave height and period. Water depths in the Study Area range from 16 to 40 m. Table 3-5 shows peak near-bottom wave orbital velocities for waves in the height and period range measured at Ambrose Light over depths found at the Study Area. Waves of height 2.0 m, which occur over 5% for the time during the winter months, with a 10 second period, will result in 43 cm/s orbital bottom velocities at 24 m water depth.

Table 3-5. Peak near-bottom wave orbital velocity.

Water Depth (m)	Peak Near-Bottom Wave Orbital Velocity (cm/s)									
	Wave Period (sec)	8			10			12		
	Wave Height (m)	1.0	2.0	3.0	1.0	2.0	3.0	1.0	2.0	3.0
16		24	52	78	31	61	92	33	67	100
24		32	32	48	22	43	65	25	50	74
32		40	20	30	16	32	47	19	39	58
40		6	12	19	12	23	35	15	31	46

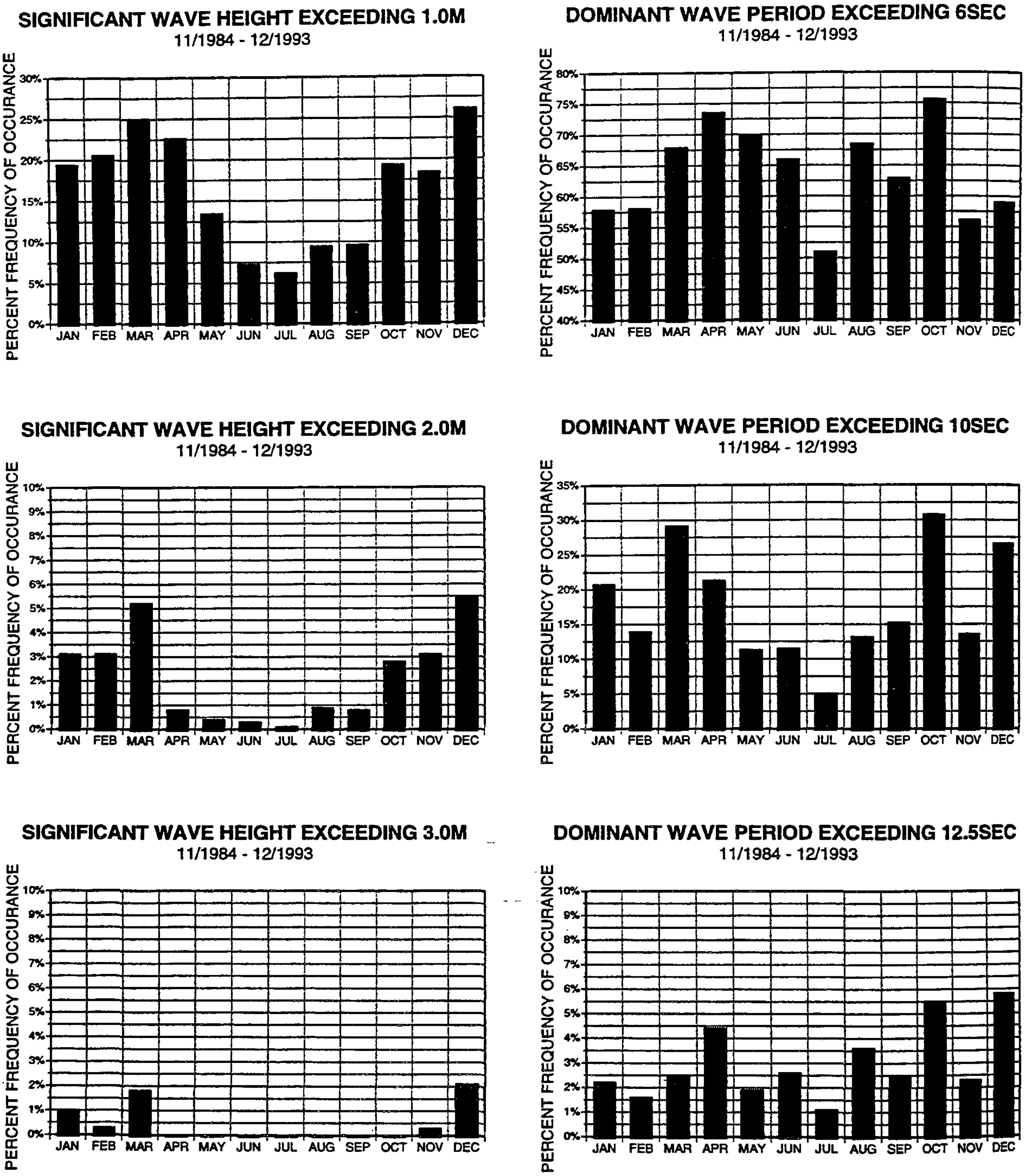


Figure 3-32. Significant wave heights and dominant wave periods in the vicinity of the MDS from 1984 through 1993. Data is from the National Weather Service's offshore meteorological platform at Ambrose Light (ALSN6). The first column represents frequency of occurrence of significant wave heights (percent of all waves that exceed 1, 2, and 3 m height). The second column represents the frequency of occurrence of the dominant wave period (percent of all wave periods that exceed 6, 10, and 12.5 seconds) during each month of the year.

3.3.5 Sediment Transport [Section 228.6(a)(6)]

Dredged material particles may be transported horizontally in one of two ways. They may be carried by local currents while still in the water column immediately after disposal, or they may be deposited on the sea floor and then periodically resuspended into the water column and carried by the currents. Near-bottom currents in the Study Area are rarely strong enough to resuspend and transport deposited sediments. However, large waves associated with storms are occasionally large enough and long enough to resuspend the bottom sediments. Conditions which may lead to sediment resuspension and transport are considered below.

3.3.6 Plume Transport [Sections 228.5(b) and 228.6(a)(6)]

During release of a volume of dredged material from a barge into the water column, the behavior of the plume follows three phases: convective descent, during which the plume settles under the influence of gravity; dynamic collapse, occurring when the descending plume impacts the bottom or reaches a neutrally buoyant position in the water column and diffuses due to its own momentum; and passive diffusion, beginning when transport and diffusion of the plume are caused more by the ambient oceanographic conditions (currents and turbulence) than by the dynamics of the plume body (Scorer, 1957; Woodward, 1959; Csanady, 1973; Brandsma and Divoky, 1976; Tsai and Proni, 1985; Ecker and Downing, 1987; Kraus, 1991). This analysis is somewhat idealized, but it contains all the important hydrodynamic elements of the physical process. See Figure 3-33.

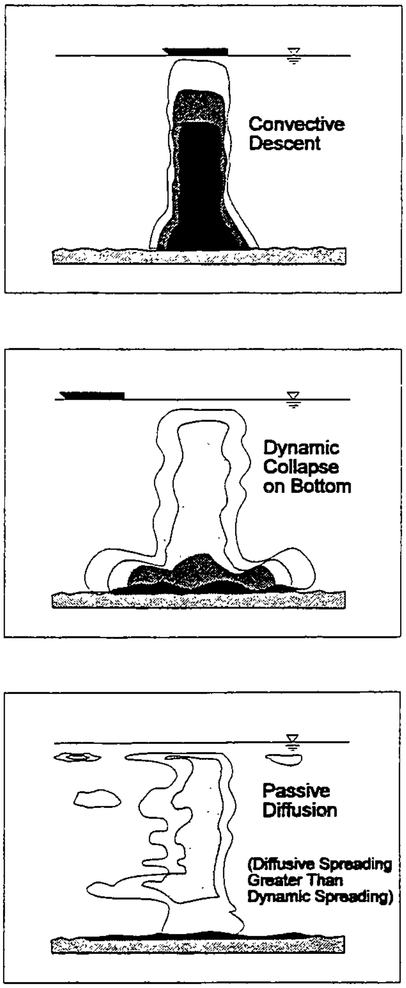


Figure 3-33. Illustration of idealized dredged material plume behavior.

During the convective descent phase, the dredged-material plume maintains its identity as a single plume by the formation of a vortex ring structure. This analysis done by Brandsma and Divoky (1976) was based on Scorer's (1957) and Woodward's (1959) treatment of a buoyant plume composed entirely of fluid. These studies showed that once released, the plume will descend due to its initial momentum and its negative buoyancy. During its descent, it experiences drag from the ambient fluid that it is displacing. The plume grows as the receiving water is entrained, and the suspended sediment concentration is reduced by the drag due to the turbulence and subsequent dilution. The convective descent phase will typically last only a few seconds to minutes in shallow water.

If the plume immediately impacts the bottom, the dynamic collapse phase occurs as the plume impacts the bottom and momentum spreads the plume horizontally. In shallow water, dredged materials have sufficient momentum to travel hundreds of meters laterally after impact with the bottom. If, while mixing with the receiving water the plume's density approaches the local density, the plume may reach the depth of neutral buoyancy before hitting the bottom. This is more likely to occur under conditions of a stratified water column. In this case, the dynamic collapse phase is somewhat different. The plume's downward vertical momentum will tend to make it overshoot the neutral buoyant depth. The plume will then tend to rise to the depth of neutral buoyancy. The result is decaying vertical oscillations around the depth of neutral buoyancy. These oscillations increase the turbulence and increase the speed with which the plume tends to collapse vertically and spread out horizontally as it seeks hydrostatic equilibrium. Studies have shown that dredged material plumes released in shallow water (<25 m) usually experience dynamic collapse by impacting the bottom as their initial momentum is too great to be overcome by the plume buoyancy.

The final phase is the period of passive diffusion which occurs when transport and diffusion of the plume are caused more by the ambient oceanographic conditions (currents and turbulence) than by the momentum of the plume itself. Passive diffusion is the long-term dispersion and transport of the plume in which the cloud is passively carried by the local currents while undergoing gaussian diffusion. It operates on time scales of hours to days.

Kraus (1991) reported on measurements of 18 disposal events at a dredged material site in the Gulf of Mexico off Mobile, Alabama. Discharge volumes ranged from 500 to 5,000 cubic yards per release in shallow depths (15 to 20 m). Plume tracking was conducted using acoustic methods. Discrete water samples were also collected. Plume spreading during the convective descent phase was typically observed to be 100 to 200 m; plume spread during the passive diffusion phase was several hundreds of meters.

A field study of the dredged material disposal plume dynamics at the MDS in the New York Bight (water depth approximately 28 m) was reported by Dragos and Peven (1994). Several plumes from 4,000-6,000 cubic yard discharges were tracked for up to 2½ hrs. Within approximately 15 min (well past the convective descent phase), initial dilutions of approximately 3,000:1 to 600,000:1 were reached (based on dioxin and TSS analyses). At that time, plume spreading was generally less than 500 m. Turbidity from the plumes was observed in the water column until about 2 hours after the disposal event. During this period, the plumes were carried by local currents up to about 1 km from the discharge point.

Low concentrations of suspended fine dredged material particles may persist for several hours in the water column during which they will be passively diffused. Because of the complicated nature of the circulation in the Study Area (see Section 3.3.4), including the two layer effect of stratified conditions during the summer, it is difficult to make simple calculations regarding the transport of fine dredged material during the passive diffusion phase. Since the disposal plume may be buoyant and may be entering a stratified system, the passively diffusing plume may be trapped below the thermocline or at the surface. The water above and below the thermocline may be moving in two different directions. However, considering the results of the field observations of disposal plume dynamics reported above, it is unlikely that fine particles from discharge events will extend beyond 1 km from the discharge point.

3.3.7 Sediment Resuspension and Transport [Section 228.6(a)(6)]

The transport of bottom sediments in the New York Bight primarily occurs when occasional storm events generate near-bottom oscillatory currents which, combined with the mean currents, produce conditions under which bedload and suspended-load transport can occur. In the vicinity of the Study Area, a few annual storm events account for the major transport of bottom sediments (Manning *et al.*, 1994; Vincent *et al.*, 1981). When these infrequent, storm driven events occur, they lift deposited sediments and inject them into the water column forming a turbid, near-bottom layer. This turbid layer can be several meters thick and is the layer in which sediment transport occurs.

Manning *et al.* (1994) documented storm-driven resuspension and transport of sediments in the vicinity of the New York Bight 12-Mile sewage sludge dump site, which included the northeast portion of the Study Area. Current meter moorings were deployed in water depths ranging from 20 m to 53 m from July 1986 through June 1989 (Figure 3-34). Eight usable near-bottom current records ranging from one month to one year in duration were analyzed. The continental shelf bottom boundary layer model of Glenn and Grant, 1987, was used to estimate resuspended sediment transport based on the measured near-bottom currents and wave data recorded at the Ambrose Light Platform. Results indicated that sediment resuspension occurs at the current meter sites approximately 5% of the time, primarily during winter months. Deposition and erosion varied primarily with depth; areas of erosion were generally shallower than 20 to 25 m and depositional areas associated with the deeper depressions of the Hudson Shelf Valley and the Christiaensen Basin (see Figure 3-35). Quarterly side scan and bathymetry studies conducted by Stubblefield *et al.* (1977) from the New Jersey shore across the northern third of the MDS to the former 12-Mile Sewage sludge Disposal Site in 1974 and 1975 tend to confirm these results. This study found that the sea floor in this area showed a "remarkable degree of bottom stability" which persuaded these investigators to conclude that the bottom in the area is in a state of textural equilibrium with the hydraulic climate (wave and current fields). They concluded that muddy sediments, those most likely to be transported by bottom currents and resuspension events, can only exist at depths greater than 24 m in this area.

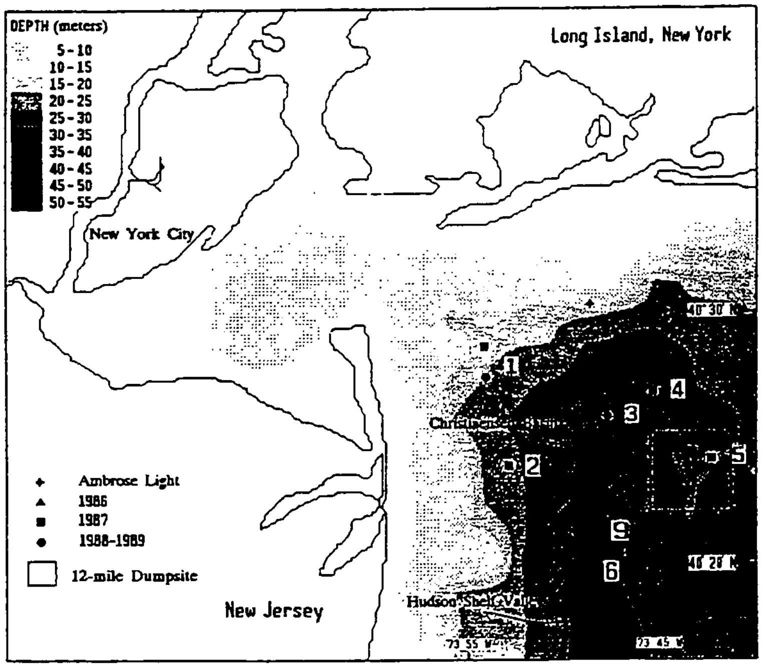


Figure 3-34. Current meter mooring locations from 1986 through 1989 (Manning *et al.*, 1994). Mooring location No. 2 was located within borders of the Study Area.

Vincent *et al.* (1981) estimated the potential sediment transport rate from current meter records in the vicinity of the Study Area. Their findings are summarized in Figure 3-36. The role of oscillatory currents in the resuspending sediment was considered but not explicitly included in the sediment transport calculation. However, since transport of material suspended in the water column is only through mean currents, the potential sediment transport pattern shown in Figure 3-36 is illustrative of the overall movement of fine bottom sediments in the area of the Study Area. The transport potential shows a bidirectional character consistent with the mean currents. The average transport shows two distinct transport patterns: net northward transport in the Hudson Shelf Valley and net southward transport everywhere else. This effect, combined with the depth of the Hudson Shelf Valley and Christiaensen Basin means that the Shelf Valley acts as a sink for the general net southwestward transport of sediment along the shelf in the area of the Study Area. Vincent found that up-valley transport events were associated with northeastward currents on the shelf, but also occurred during quiescent periods.

3.3.8 Depth of Sediment Resuspension [Section 228.6(a)(6)]

Butman, Noble, and Folger (1979) observed sediment resuspension of fine material by storm-generated surface waves in depths to 85 m in the Middle Atlantic Bight. Wave heights at the Study Area are somewhat lower than on the open continental shelf due to shoaling and the restricted fetch. Manning *et al.* (1994) estimated that deposition/erosion varied with depth with areas of erosion aligned with areas shallower than 20 to 25 m and depositional areas associated with the deeper depressions of the Hudson

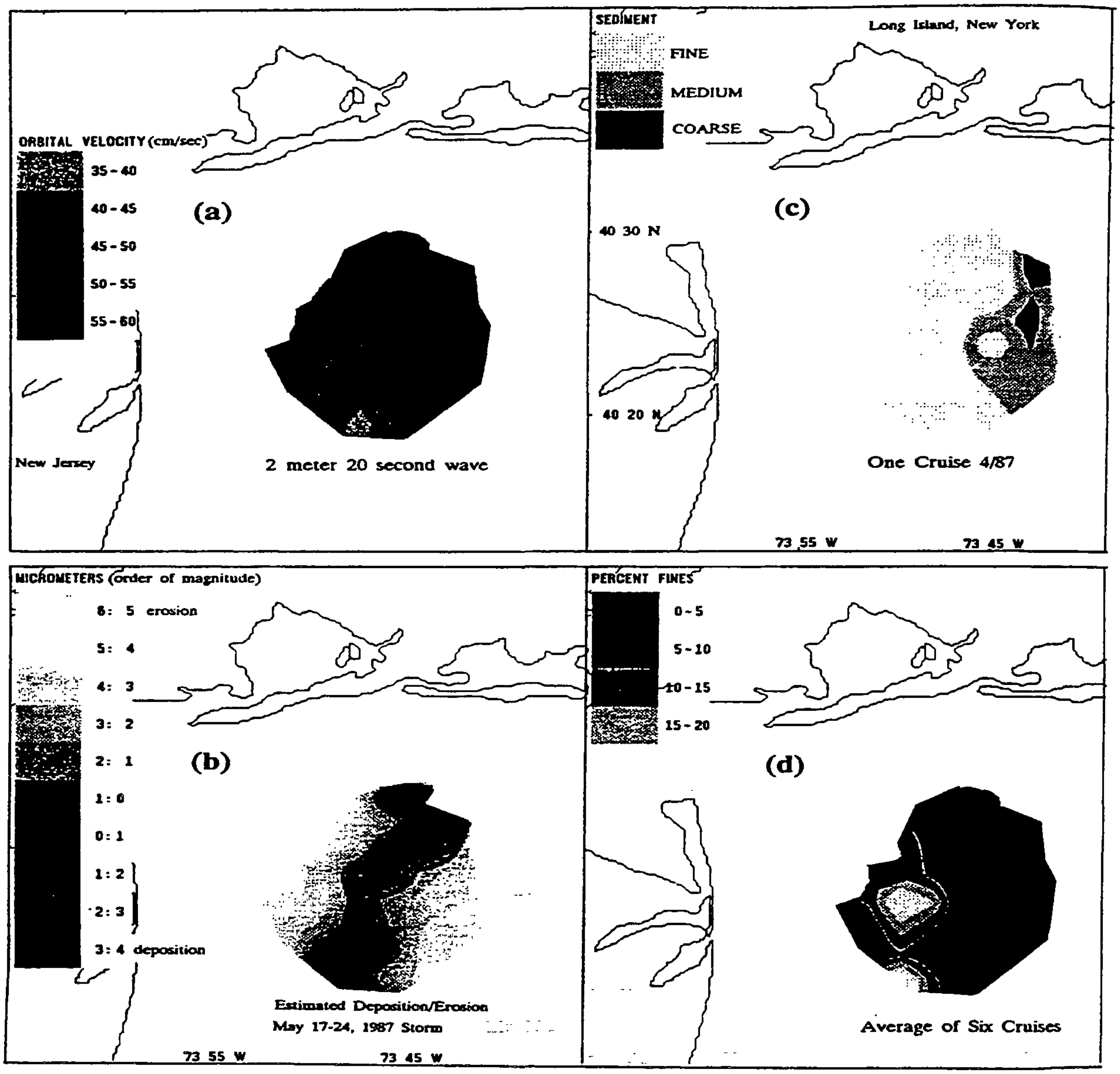


Figure 3-35. Spatial estimates of erosional conditions in the vicinity of the Study Area (Manning *et al.*, 1994). Panel (a) shows distribution of the orbital wave velocity for a 2 m/20-sec wave; panel (b) shows the estimated deposition/erosion under these velocities coupled with a circulation model for May 24, 1987; panel (c) shows sediment type in the Study Area in April 1987; panel (d) shows the amount of fine grained sediments averaged over six surveys.

Shelf Valley and the Christiaensen Basin (> 40 m). In the absence of long-term direct observations of sediment resuspension we can estimate the potential for resuspension from wave measurements.

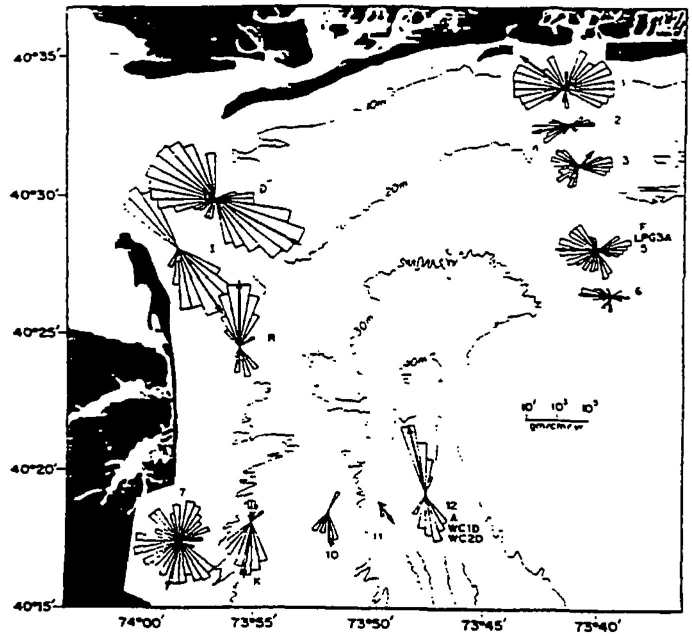


Figure 3-36. Representation of the potential sediment transport rates under a 16 cms^{-1} transport threshold in 10^0-segments for stations in the New York Bight [Vincent *et al.* (1981)]. Solid arrows show the average transport rate.

Resuspension of noncohesive sediments is determined by the bottom shear stress and the size and density of the sediment particles. The bottom shear stress is a function of the current speed, wave height, wave period, water depth, and bottom roughness. A simple way to determine the potential for resuspension of noncohesive sediments by waves and currents is to compare the critical threshold velocity required for initiation of sediment motion for the local sediments and the maximum near-bottom shear stress exerted by the waves. For a given water depth, the maximum near-bottom shear stress increases with increased wave height and period. Combined analyses of the critical threshold velocity for sediment movement, the maximum near-bottom velocity, and the percent occurrence of wave height and period, can be used to determine the potential for sediment resuspension or containment throughout the Study Area.

For wave induced shear stress the modified Shields diagram (Figure 3-37 from Grant and Madsen, 1979) gives the condition for incipient sediment motion in terms of the dimensionless parameters:

$$\Psi_C = \frac{\tau_o}{(s-1)\rho g d}$$

and

$$S_* = \frac{d}{4\nu}\sqrt{(s-1)gd}$$

where

- τ_o = bottom shear stress
- s = sediment density relative to water
- g = acceleration due to gravity
- d = particle diameter
- ν = kinematic viscosity of water
- ρ = density of water

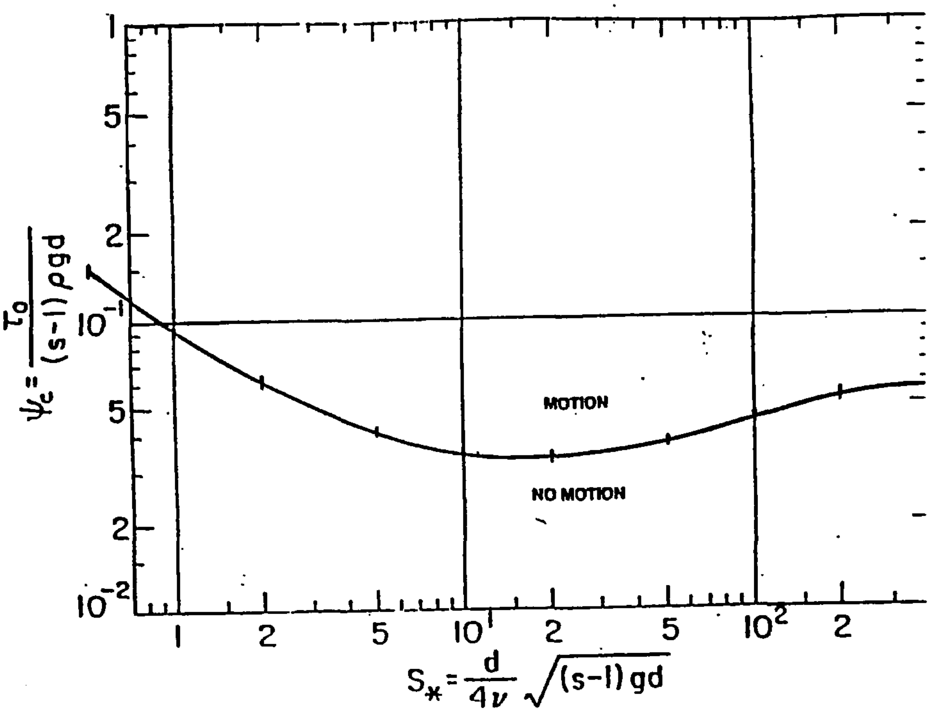


Figure 3-37. Modified shields diagram for the initiation of sediment motion (Grant and Madsen, 1979).

The bottom shear stress is given by

$$\tau_o = \frac{f}{8}\rho U_b^2$$

$$U_b = \frac{\pi H}{T}\,\frac{1}{\sinh(2\pi h/L)}$$

where f is determined from the friction factor diagram (Figure 3-38 from Johnson, 1966), and U_b is the bottom orbital velocity and Ab is the orbital excursion. From linear wave theory and

$$L = \frac{gT^2}{2\pi}\tanh(2\pi h/L)$$

where *T*, *L*, and *H* are the wave period, length, and height respectively and *h* is the water depth.

For a given particle diameter, the bottom shear stress required for initiation of sediment motion can be determined from Figure 3-38. Using a fixed particle density of 2.57, representative for quartz sands, the corresponding wave velocity can be determined using the appropriate friction factor diagram. Then, using linear wave theory, the corresponding wave height and period can be determined. Wave heights needed for resuspension of 1.0 mm diameter sediment at the Study Area are presented in Table 3-6 for water depths from 15 to 35 m. Table 3-6 shows that for storm generated waves with a period of 10 seconds, critical wave heights increase from 1.5 m in 20 m depth to 2.7 m in 35 m depth. These are typical of conditions in the Study Area. Smaller wave heights are required for longer period waves.

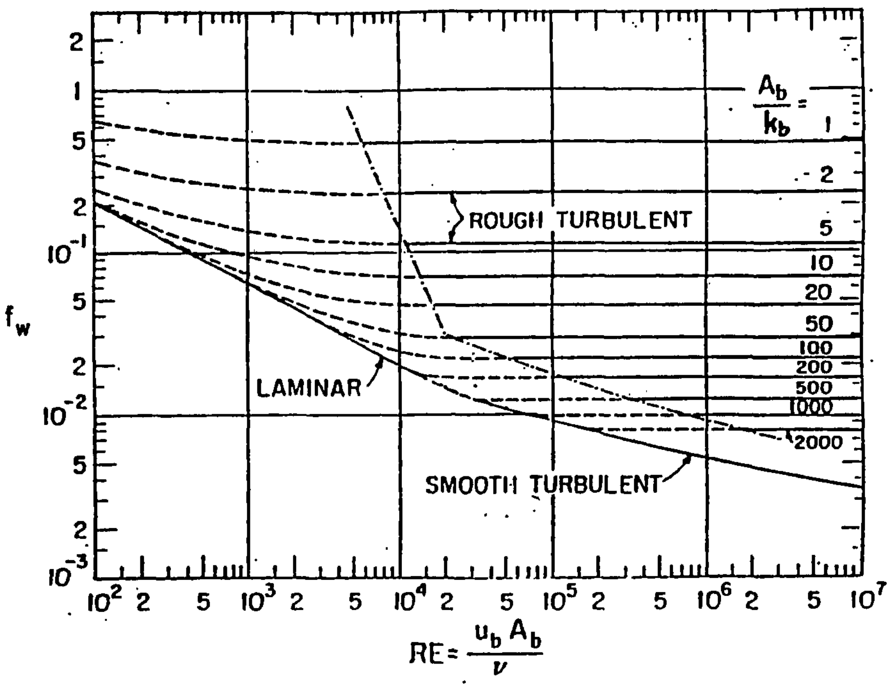


Figure 3-38. Wave friction factor diagram (Johnson, 1966).

Table 3-6. Critical wave heights (m) needed for resuspension of 1.0 mm diameter sediment.

Water Depth (m)	Wave Period (sec)				
	6 sec	8 sec	10 sec	12 sec	14 sec
15	1.9	1.3	1.2	1.1	1.1
20	3.2	1.8	1.5	1.4	1.3
25	5.5	2.4	1.8	1.6	1.5
30	*	3.2	2.2	1.9	1.8
35	*	4.3	2.7	2.2	2.0

SAIC (1995c), measured waves at the MDS intermittently over a 2 year period in 1993 and 1994 and compared them to wave measurements from Ambrose Light. They concluded that wave records from Ambrose Light closely resembled the wave characteristics at the Mud Dump Site, allowing the use of the long-term wave statistics from Ambrose for the present analysis. Long term statistics of the wave conditions at the Study Area are needed to determine reliable statistical estimates of the frequency of occurrence of dredged material resuspension.

Records of significant wave height and period at the Ambrose Light National Weather Service Meteorological Station for the period November 1984 through December 1993 were analyzed to determine the frequency of occurrence of different wave heights and periods. Table 3-7 presents the percent frequency occurrence of significant wave height vs wave period of the winter, spring, summer and fall seasons. The largest waves in the apex of the Bight are generated by winds blowing from the northeast to east (maximum fetch) during winter. The highest waves recorded were between 6.5 and 7.4 meters and occurred during winter 0.1% of the time. Waves between 2.5 and 3.4 m occurred 2.1% of the time in winter, but waves of that height that coincided with periods greater than 11.1 sec occurred only 0.6 % of the time.

Comparing Tables 3-6 and 3-7 shows that waves high enough and long enough to lift 1.0 mm diameter sediment from the bottom in 35 m of water will occur 1.2% during winter, 0.5% of the time in spring and not at all in summer and fall. Waves large enough to resuspend 1.0 mm diameter sediment from the bottom in 30 m of water will occur 1.5% during winter, 0.7% of the time in spring and not at all in summer and fall. For 25 m depth, waves large enough occur 4.0% of the time in winter, 1.6% of the time in spring, not at all in summer, and 1.6% of the time in fall. Finer sediments will be more easily resuspended. These estimates, however, will tend to be high given other factors which affect the potential for resuspension, including the presence of cohesive clumps in the dredged material, bioturbation, and the armoring of the bottom which occurs when fines are removed from the top layer. Note that the wave statistics for Ambrose Light in Table 3-7 are based on nearly ten years of data; the largest waves are not necessarily recorded each year.

Small sized sediment (<0.05 mm), mainly silt and clay, tend to become cohesive over time. The critical velocity for initiation of motion is therefore dependent on the time elapsed after deposition. Erosion of cohesive sediment is an area where considerable uncertainty remains. For short consolidation times, the critical velocities for smaller size sediments would be on the same order as those obtained for d = 0.05 mm. After longer times, higher near-bottom velocities would be required to initiate motion.

The most recent and pertinent evaluation of sediment resuspension in the Study Area has been done by Clausner *et al.* (1996), who evaluated storm-induced erosion frequency at the MDS using data from the 1977-1993 data, and SAIC 1996c, who model sediment resuspension and erosion using data from the 1992-1993 time frame. In general, there is an absence of fine-grain sediments at depths shallower than 65 ft (approx. 20 m) in the Bight Apex. Sediments shallower than 65 ft (e.g., on top of inactive dredged material disposal mounds) consist primarily of coarser/sandy material. Correspondingly, sediments in deeper waters are more heterogeneous. The fine-grain areas are apparently depositional zones for small particles winnowing from nearby dredged material mounds and other fine-grain sediments entering the Bight Apex from other sources, including sediments transported into the Apex by the Hudson River plume (see image page 3-13). Both studies find that storm induced erosion can be significant at depths shallower than 65 feet. These findings were the basis of the 65-ft "management depth" for Category II dredged material disposal in the current MDS (USACE NYD/EPA Region II, 1997).

Table 3-7. Percent frequency of significant wave height (meters) vs. dominant wave period (seconds) at Ambrose Light (40.5N/73.8W), November 1984 through December 1993.

MONTH(S): DECEMBER, JANUARY, FEBRUARY

WAVE HEIGHT

WAVE PERIOD	0.0- 0.4	0.5- 1.4	1.5- 2.4	2.5- 3.4	3.5- 4.4	4.5- 5.4	5.5- 6.4	6.5- 7.4	7.5- 8.4	8.5- 9.4	9.5- 10.4	10.5- 11.4	11.5- 12.4	12.5- 13.4	>13.4	TOT %	TOT N
< 0.5	.1															.1	6
0.5 - 1.4																	0
1.5 - 2.4																	0
2.5 - 3.4	2.6	6.7														9.3	690
3.5 - 4.4	.6	12.7	.4													13.6	1014
4.5 - 5.4	.4	8.3	1.3													10.0	741
5.5 - 6.4	.4	6.3	1.9	*												8.7	644
6.5 - 7.4	.3	5.0	2.1	.3												7.7	572
7.5 - 8.4	1.3	7.5	2.6	.5	.1											11.9	884
8.5 - 9.4	1.9	5.9	.7	.2	.1	*										8.8	655
9.5 - 10.4	2.0	6.1	.7	.3	.1	*	*									9.2	685
10.5 - 11.1	1.6	6.6	.9	.1	.1	*	.1	*								9.3	694
12.5	1.0	5.4	1.2	.2	.2	*	.1	.1								8.1	603
14.3	.5	1.3	.8	.4	*	*										3.1	229
16.7	.1	.1	*	*												.2	17
TOTAL %	12.7	71.8	12.5	2.1	.6	.1	.2	.1								100.0	
TOTAL N	942	5341	926	154	43	10	12	6	0	0	0	0	0	0	0		7434

(* < 0.05%)

MONTH(S): MARCH, APRIL, MAY

WAVE HEIGHT

WAVE PERIOD	0.0- 0.4	0.5- 1.4	1.5- 2.4	2.5- 3.4	3.5- 4.4	4.5- 5.4	5.5- 6.4	6.5- 7.4	7.5- 8.4	8.5- 9.4	9.5- 10.4	10.5- 11.4	11.5- 12.4	12.5- 13.4	>13.4	TOT %	TOT N
< 0.5	*															*	1
0.5 - 1.4																	0
1.5 - 2.4																	0
2.5 - 3.4	1.1	3.7														4.7	352
3.5 - 4.4	.1	6.1	.1													6.3	470
4.5 - 5.4	.3	7.8	.8													9.0	665
5.5 - 6.4	.3	6.9	2.3	*												9.5	708
6.5 - 7.4	.6	7.5	2.0	.1	*											10.2	755
7.5 - 8.4	1.3	13.4	1.8	.3	*	*										16.8	1243
8.5 - 9.4	1.2	8.4	.8	.1	*	*										10.6	785
9.5 - 10.4	.8	10.2	1.0	.2	.1	*	*									12.3	915
10.5 - 11.1	.7	8.9	1.6	.1	.1	*										11.5	853
12.5	.6	4.8	.4	.2	*	*										6.1	453
14.3	.3	1.8	.2	.1	.1											2.5	186
16.7	.1	.3														.4	30
TOTAL %	7.5	79.8	11.2	1.1	.3	.1	*									100.0	
TOTAL N	553	5918	829	80	24	11	1	0	0	0	0	0	0	0	0		7416

(* < 0.05%)

Table 3-7. Percent frequency of significant wave height (meters) vs. dominant wave period (seconds) at Ambrose Light (40.5N / 73.8W), November 1984 through December 1993 *(continued)*.

MONTH(S): JUNE, JULY, AUGUST

WAVE HEIGHT

WAVE PERIOD	0.0-0.4	0.5-1.4	1.5-2.4	2.5-3.4	3.5-4.4	4.5-5.4	5.5-6.4	6.5-7.4	7.5-8.4	8.5-9.4	9.5-10.4	10.5-11.4	11.5-12.4	12.5-13.4	>13.4	TOT %	TOT N
< 0.5	.1															.1	6
0.5 - 1.4																	0
1.5 - 2.4																	0
2.5 - 3.4	.8	2.3		*												3.0	241
3.5 - 4.4	.6	6.2														6.8	538
4.5 - 5.4	.5	11.0	.4													11.9	937
5.5 - 6.4	1.1	14.0	1.3	*												16.4	1299
6.5 - 7.4	1.4	15.1	.9	*												17.5	1380
7.5 - 8.4	2.6	14.9	1.1	.1												18.7	1481
8.5 - 9.4	1.4	7.8	.2													9.5	748
9.5 - 10.4	1.3	4.7	.2	*												6.2	491
10.5 - 11.1	1.2	3.5	.1													4.8	376
12.5	.7	1.9	.1													2.7	212
14.3	.5	.8														1.4	107
16.7	*	.8														.8	67
20.0	.1	.2														.3	22
TOTAL %	12.3	83.3	4.2	.2												100.0	
TOTAL N	970	6587	335	13	0	0	0	0	0	0	0	0	0	0	0		7905

(* < 0.05%)

MONTH(S): SEPTEMBER, OCTOBER, NOVEMBER

WAVE HEIGHT

WAVE PERIOD	0.0-0.4	0.5-1.4	1.5-2.4	2.5-3.4	3.5-4.4	4.5-5.4	5.5-6.4	6.5-7.4	7.5-8.4	8.5-9.4	9.5-10.4	10.5-11.4	11.5-12.4	12.5-13.4	>13.4	TOT %	TOT N
2.5 - 3.4	1.2	4.3														5.5	417
3.5 - 4.4	.5	7.6	.1													8.2	623
4.5 - 5.4	.4	9.5	.7													10.6	805
5.5 - 6.4	.5	8.4	1.5	*												10.4	790
6.5 - 7.4	.6	5.7	1.3	.4												8.0	612
7.5 - 8.4	1.8	11.9	1.8	.5												16.0	1215
8.5 - 9.4	1.2	9.1	.8	.1	*											11.2	854
9.5 - 10.4	1.1	7.9	.8	.1	*											9.9	749
10.5 - 11.1	1.3	7.2	.7	.2	*											9.4	717
12.5	1.2	5.3	.7	.1												7.3	556
14.3	.4	2.5	.1	*												3.1	235
16.7	.1	.1	.2	.1												.4	30
TOTAL %	10.4	79.5	8.7	1.4	*											100.0	
TOTAL N	787	6042	662	109	3	0	0	0	0	0	0	0	0	0	0		7603

(* < 0.05%)

In summary, resuspension of 1.0 mm dredged material deposited in the Study Area will occur infrequently at depths greater than approximately 20 m (65 ft), and very infrequently below 30 m (100 ft) (probably less than 1% of the time over the course of 10 winter seasons). In shallow areas (< 20 m), recently deposited sediments that are less than 1.0 mm are readily resuspended and moved to deeper waters by storm events. This removal of fine sediments gradually causes shallow-water areas to become progressively sandy, armoring the seabed and making it less prone to erosion. Seabed armoring can also result when fine-grain sediments lay relatively undisturbed for lengthy periods and consolidate and compact. Under certain conditions (including above 20 m), compact, cohesive fine-grain sediments can become as resistant to erosion as sandy, unconsolidated large-grain sediments.

3.3.9 Contaminant Distributions and Concentrations

The distribution of metals and organic contaminants within the Study Area is described in the following sections. The quality of the sediments is also discussed.

3.3.9.1 Metals Distributions

Metals concentrations in the sediments of the New York Bight have been measured during several programs over the past 25 years. One of the most comprehensive compilations and reviews of metals data for the New York Bight was published by Krom *et al.* (1985). This compilation includes trace metal, grain size, and total organic carbon (TOC) data obtained between 1973 and 1978 from over 8,000 analyses for 16 elements from about 1,000 stations in the greater New York Bight. This study shows the sediment of the Bight to be extremely varied. The heterogeneity is related in part to a series of ridges (up to 10 m in height) and swales (2-4 km wavelength) on the continental shelf. These ridges and swales form the major topographical features of the Bight seaward of the Hudson Shelf Valley and Christiaensen Basin. Seaward of the these areas, surface sediments of the shelf are primarily composed of coarse to medium sand with swales tending to have higher mud content relative to other areas. Physical and biological reworking of the sediments of the shelf and inner Bight resuspends fine grained sediments, causing redistrubution within the Bight. The sandy sediments in the area also appear to be mobile with sand ridges forming that may have a relatively short duration (Krom *et al.*, 1985).

According to Krom *et al.* (1985), sediments from the New York Bight Apex consist of two distinct types: (1) sandy sediments low in organic matter content and with relatively low amounts of leachable metals (metals stripped from the substrate when treated with weak acid solutions) and (2) silt-clay sediments high in organic matter and high in leachable metals content. The highest metal concentrations were consistently found in the MDS, Christiaensen Basin and, to a lesser extent, the Hudson Shelf Valley. Within these regions, the highest metal concentrations were found in the MDS and vicinity. The sediments of these areas were also found to be distinct in that they had from 9 to 80 times more fine-grained sediments than found on the continental shelf. Metals in the sediments from the continental shelf were generally low, except for those in the Christiaensen Basin and Hudson Shelf Valley.

Within the New York Bight Apex, metals (Zn, Cr, Cu, Pb, Ni, Fe, Hg, and Cd) are highly intercorrelated (Krom *et al.*, 1985). These metals correlate strongly with the organic matter content of the sediments and to a lesser extent with the silt-clay component. Zdanowizc (1991) and others report similar findings from spatial sampling of the inner New York Bight including the MDS.

Historically, Dayal *et al.* (1983) found the "*spatial distribution of heavy metals such as Pb, Cu, Ag, Hg, Cd, Fe, and Mn in the dredged material deposit exhibit highly variable and considerably elevated concentrations over those observed in sediment outside the deposit and in underlying sediment.*" He also noted that organic matter significantly influences the distribution of metals in the dredged material mound and that iron and manganese oxides exert a lesser control on the metal distributions.

To appropriately evaluate trace metal contamination of sediments in the Study Area, background concentrations and distributions within the area must be characterized. Further, because the sediments of the Bight include areas of naturally sandy and naturally fine grained sediments, information on background metals levels in both types of sediment are necessary. Such information is available from several studies conducted from the early 1970s to the mid 1990s (Table 3-8).

Problem of Data Comparability Among Sediment-Metals Studies

Note that investigations have used several methods to extract the metals from sediment samples. Some of these methods extract the metals from the mineral phases more efficiently than others. Thus, incomplete recovery (lower concentrations) of some metals may occur depending on the digestion technique employed. This can cause poor comparability in the amount of total metal measured by the various procedures. However, in contaminated sediments the partial digestion procedures remove the majority of anthropogenic mobilized metals associated with the solid phases and these phases are generally much greater than in the mineral phases left undigested. Thus, reasonably comparable qualitative information can be obtained regarding contaminant variability and general distributions, such that areas with high and low metals concentrations can be described.

The data from the studies listed in Table 3-8 show that the metal concentrations in sandy sediments that have very low amounts of fine grain sediments and organic matter concentrations are similar across the various studies and analytical methods used to generate the data. For example, the background concentration of Cu in sandy sediments ranges from 2 to 10 ppm (dry weight) across these studies (Table 3-8), while that of Pb ranges from 8 to 13 ppm and is more likely near 10 ppm based on the majority of these studies. Background metal concentrations in the silt clay fraction of the sediments is notably higher (i.e., 37 ppm for Cu and 23 for Pb) than that in the sandy sediments.

Surface sediments collected from depositional areas of the New York Bight Apex region have higher metal concentrations than the sandy sediments (Table 3-9). Metal concentrations in the inner Bight are also highly variable. Results summarized in Table 3-9 also show that in general, the highest metals concentrations are for samples collected in the 1970s (see Krom *et al.*, 1985 in Table 3-9). Samples collected in the 1980s (see NOAA, 1982a; JRB, 1984; Lewis *et al.*, 1989 in Table 3-9) have a relatively wide range in metals concentrations. Correspondingly, the highest metal concentrations in sediments collected in early 1990 surveys (see Charles and Muramoto, 1991; McFarland *et al.*, 1994; Battelle, 1996a in Table 3-9) are consistently lower than those collected in the 1970s and 1980s. For example, surface sediment copper concentrations for over 200 samples collected between 1973 and 1978 ranged from 330 to 590 ppm[2] while surface sediment copper concentrations collected in the inner Bight between 1983 and 1986, including the MDS, ranged from 0.2 to 530 ppm. The upper end of the concentration range was clearly similar between these two periods of data. However, the lower-end of the range was substantially lower in the 1980s relative to earlier years.

[2] Note that metal concentrations in sediments from within the disposal mound are even higher (up to 2,200 ppm) than in the surface sediments collected during a similar time period (Dayal, *et al.*, 1983).

Table 3-8. Background contaminant metal concentrations in uncontaminated sandy and silty sediments of the New York Bight and Bight Apex (in ppm dry weight).

Study	Krom *et al.* (1985)		Dayal *et al.* (1981)	Young (1982)	SAIC (1992)	Battelle (1992a)	Battelle (1996a)
Metal	Silt-Clay	Sandy	Sandy	Sandy	Sandy (mean of 5 MDS reference site samples)	Sandy (alternate dredged material disposal sites n = 6)	Sands (from regression analysis, sands only n = 45)
As	NA	NA	NA	NA	6.9	1.8-10.4	3 - 5
Ag	NA	NA	<0.2	NA	<0.2	<.001-0.083	<0.2
Be	NA	NA	NA	NA	<0.4	NA	NA
Cd	NA	NA	<0.2		<0.1	0.004-0.047	<0.1
Cr	46	13	NA	6	8	15-26.4	20-180
Cu	37	2	4.4±0.3	4	8	4.7-7.6	5-10
Hg	NA	NA	<0.2	NA	0.2	0.001-0.028	<0.1
Ni	53	3	NA	6	<0.8	2.5-5.3	<12
Pb	23	8	6±2	13	9	2.0-13.4	5-10
Sb	NA	NA	NA	NA	<1.2	NA	0.05-0.4
Sn	NA	NA	NA	NA	NA	NA	<0.5
Se	NA	NA	NA	NA	<0.2	NA	<0.05
Tl	NA	NA	NA	NA	<0.1	NA	NA
Zn	130	14	NA	19	18	12.8-35.9	15-30

Table 3-9. Ranges in metal concentrations [ppm (μg/g) dry weight] in sediments from the New York Bight Apex, Study Area, and Mud Dump Site. Except for Dayal *et al.* (1983), results are for surface samples (2 to 10 cm).

Metal/Study	Krom *et al.* (1985)	Dayal *et al.* (1983[a])	NOAA (1982)	JBR (1984)	Lewis *et al.* (1989)	SAIC (1992a)	McFarland *et al.* (1994)	Battelle (1996a)	
Region	Bight Apex n = ~200	MDS Multiple depths from 10 cores	Inner Bight Apex and upper Hudson Shelf Valley n = 27	Inner Bight n = NA	Inner Bight n = NA	Study Area and MDS n = 35	MDS Reference (Sandy) n = 5	Within the MDS only n = 11	Within the Study Area only n = 22
Year Collected	1973-1978	1978	1980	1984	1983-1986	1990	August 1991	October 1994	October 1994
As	NA	NA	NA	ND - 21	<3-42	2.8-25.4	NA	3.7-16	3-30
Ag	NA	<0.2-27	NA	0.2 - 14	<0.002-76	1-8	NA	<0.04-5.1	<0.04-7.3
Be	NA	NA	NA	NA	NA	0.2-1.1	NA	NA	NA
Cd	NA	0.2 to 151	<0.25-3.7	0.2 - 11	<0.008-25	0.5-7	<0.01	<0.03-3.1	<0.0-3.2
Cr	380-570	NA	2.3-75	12 - 430	2.5-530	6.6-263	NA	16-182	7.7-187
Cu	329-590	2-2,200	0.8-120	12 - 460	0.2-530	3.4-325	3.5±1.6	5.1-145	3.5-178
Hg	NA	<0.2-7	<0.04-0.45	0.4 - 38	<0.008-17	0.1-8.7	<0.10	<0.3-2	<0.3-2.5
Ni	72-160	NA	1.9-17.6	NA	NA	4-51.7	NA	12-99	<3-89
Pb	370-610	2-1,527	4-135	14 - 527	2-580	5.4-347	21.6±3.3	10-155	15-194
Sb	NA	NA	NA	NA	NA	NA	NA	0.04-0.6	0.04-1.4
Sn	NA	NA	NA	NA	N-A	NA	NA	0.3-15	0.5-19
Se	NA	NA	NA	NA	NA	NA	NA	<0.03-0.8	<0.03-1
Tl	NA	NA	NA	NA	NA	<0.1	NA	NA	NA
Zn	660-1020	NA	7-230	20 -940	7-939	13.7-510	25.8±2.8	29-272	27-329

[a]Data are from cores that penetrated through the dredged material mound into strata below. Some subsurface strata composed fine grained sediment fraction.

The range in copper concentration observed in samples collected from the Study Area in 1991 was also large. However, the highest concentrations observed for this survey was 45% lower than that reported by Krom *et al.* (1985). Data from 45 stations in the MDS and Study Area in 1994, displayed a large range in the measured copper concentrations. The highest Cu concentration measured from this survey was 178 ppm, about 70% lower than the highest concentration reported in the mid 1970s. While a systematic, repeated sampling design is the only way to determine if the apparent decreases in the highest of the high concentrations over the past few years is real or related to differences in the station locations among the surveys, the consistency in the decrease for copper and other metals (e.g., Pb and Zn) suggests that surface sediment contamination in the MDS and Study Area has probably decreased relative to the 1970s. Such decreases probably are correlated with improved evaluation of dredged material for ocean disposal (i.e., EPA/USACE, 1991, "The Green Book"), Region 2/NYD disposal restrictions for Category II and III material, removal of sewage sludge and acid iron waste disposal from the region in the mid 1980s, and the continued winnowing of fine-grained particles from surface sediments by natural transport processes.

The distribution of metals concentrations in the MDS and Study Area are represented in Figure 3-39a and 3-39b. These figures include data from surface sediment samples collected and analyzed between 1991 and 1996. The relative distribution of the data for each metal is generally consistent among the three metals shown. In general, three regions within the Study Area have relatively elevated metal concentrations compared to estimated pre-disposal background values. These include the shallow basin west of the dredged material mound (see figure 3-4 in Section 3.1 for topographic data), the northeast quadrant of the Study Area including the Hudson Shelf Valley, and the eastern portion of the MDS including contiguous areas outside of its eastern border. Mercury measurements comprise the largest set of metals data measured by consistent analytical methods. These data show that a large area including the top of the historical disposal mound and the southern portion of the Study Area have low Hg concentrations (<0.15 ppm dry weight). Areas with concentrations above 0.70 ppm dry weight include the deeper areas described above. The Hg data suggest that the flanks of the historic and current dredged material mound have the highest Hg concentrations.

In summary, trace metal concentrations in the surface sediments of the Study Area and MDS can be segregated into areas of high and low concentrations. Areas of highest concentrations are generally correlated (positive) with areas containing high amounts of fine grained sediments and also high organic matter content as observed for the greater New York Bight and most other coastal sediments (Krom *et al.*, 1985; Zdanowicz, 1991). The association of metals to these bulk sediment parameters (shown in Figure 3-40a and 3-40b) are representative of these correlations and demonstrate that metal concentrations are relatively predictable based on the grain size distribution or organic carbon content of the sediments (see Battelle, 1996a for a complete discussion of these correlations in the Study Area and MDS). Such correspondence provides a mechanism by which metals concentrations in unsampled sediments can be predicted.

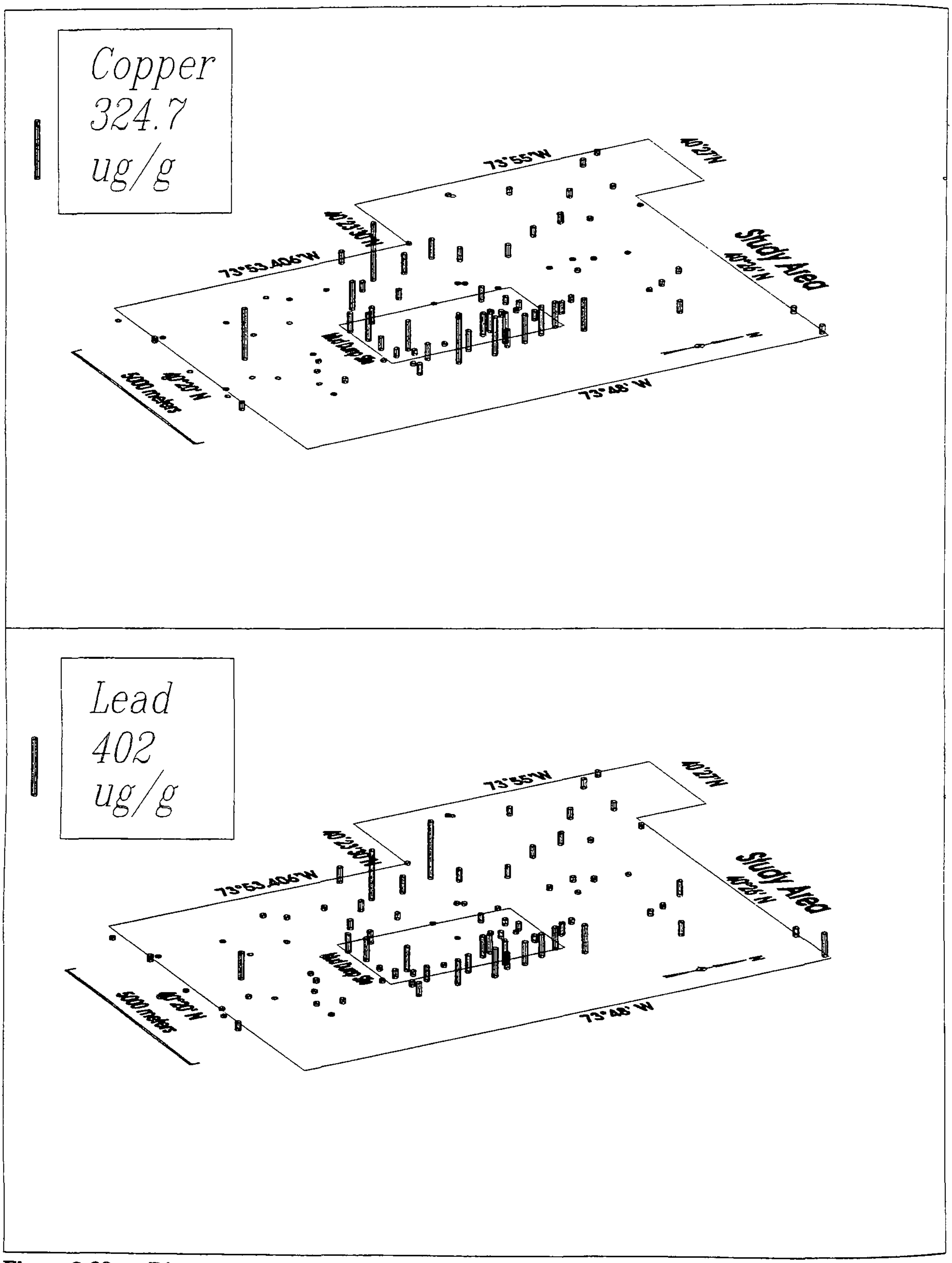


Figure 3-39a. Distribution of metals in surface sediments of the Study Area (a) Copper; (b) Lead. Data are from surveys completed between 1991 and 1995.

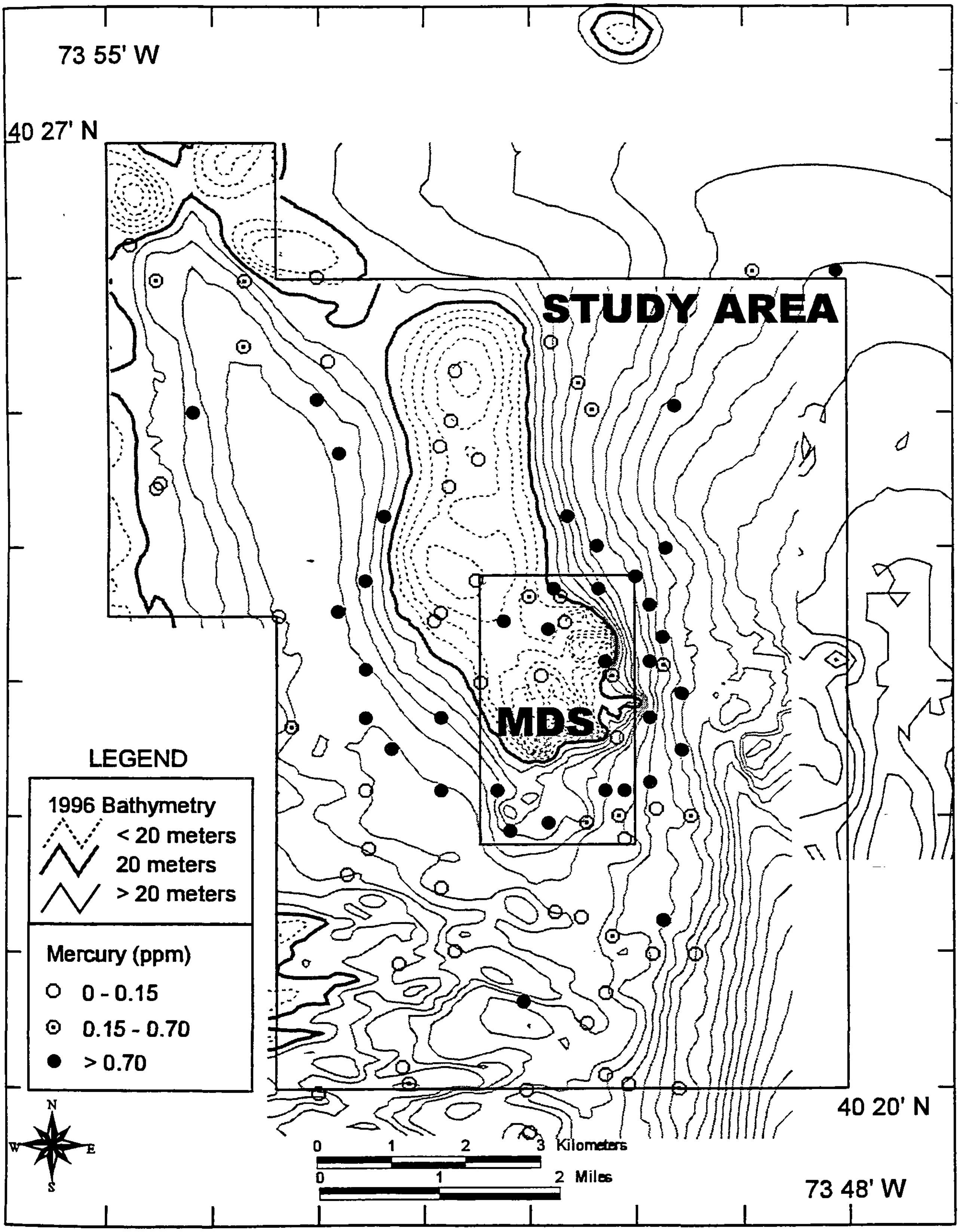


Figure 3-39b. Distribution of Mercury in surface sediments of the Study Area. Data are from surveys completed between 1991 and 1995.

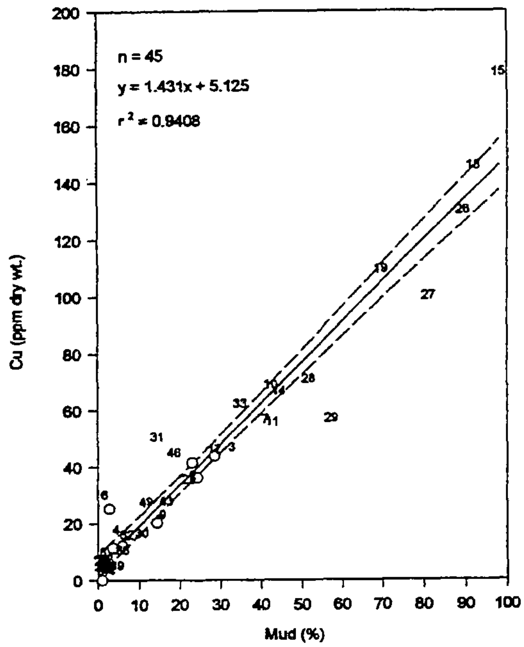


Figure 3-40a. Correspondence between the fraction of mud in surface sediment samples from the Study Area and the copper concentrations. This type of correspondence is found for most of the metals in the Study Area (figure from Battelle, 1996a).

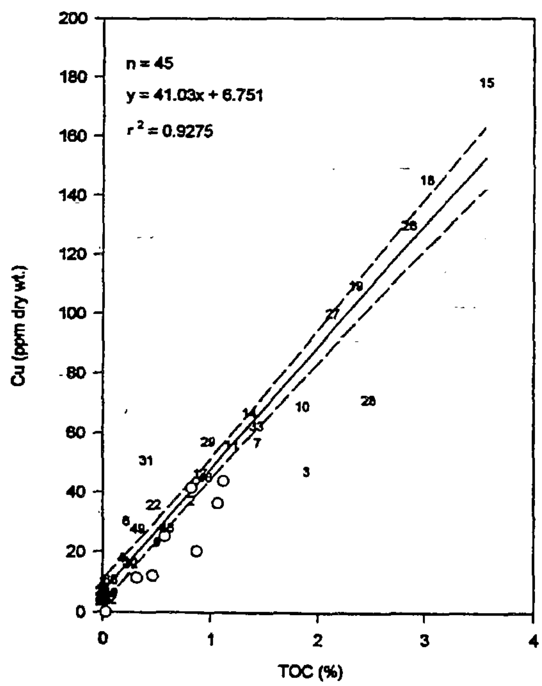


Figure 3-40b. Correspondence between total organic carbon concentration in surface sediment samples from the Study Area and the copper concentrations. This type of correspondence is found for most of the metals in the Study Area (figure from Battelle, 1996a).

3.3.9.2 Organic Contaminants

Compared to the information on the trace metals in the New York Bight, relatively few recent organic contaminant data are available (Table 3-10). Though limited, the available data demonstrate that background organic compound concentrations in New York Bight sediments are generally low (Boehm, 1983) and are strongly associated with the amount of fine grained sediment in a given sample.

Sandy sediment collected recently from the MDS and Study Area have organic contaminant concentrations in the range found in the greater New York Bight (Table 3-10). As observed in the metals data, both historical and recent organic contaminant data in surface sediments of the Study Area are characterized by a large range in concentrations (Table 3-10). As observed in the metals data, the higher organic contaminant concentrations appear to have decreased since the 1980s.

The majority of recent organic contaminant analyses of surface sediments from the Study Area have focused on dioxin and to a lesser degree PCBs (Table 3-10). The observed range in the concentrations of these contaminants is strongly related to the amount of fine grained sediments in the sample. For example, Figure 3-41 shows the concentration of total PCB to the amount of fine grained sediment in samples collected in 1994 and 1996. As in the case of the metals, the highest organic compound concentrations are associated with the fine-grained, organic carbon-rich sediment located in the deeper, hydrodynamically quiet regions of the Study Area.

The distribution of high and low organic contaminant concentrations in the MDS and Study Area closely parallels that of the metals. The distribution of selected organic contaminants is presented in Figure 3-42; the distribution of the contaminants included in this figure is representative of other compounds measured in samples collected in October 1994 (Battelle, 1996a). Other recent data for organic contaminants for surface sediments from the Study Area are limited except for 2,3,7,8 TCDD data. Data on this contaminant are available from surveys conducted in 1991 (Charles and Muramoto, 1991) and from monitoring of the Port of Newark disposal project (SAIC, 1995d) and provide an extensive set of data from areas that are not actively used for dredged material disposal. Combining the 1991 through 1994 data sets enables better resolution of the dioxin distribution in the surface sediments (Figure 3-43). The spatial distribution and concentrations developed from these combined data sets are similar to those described previously for metals and other organic contaminants.

These similarities increase the confidence that the areas of high and low contaminant concentrations within the Study Area and MDS identified from the 1994 sediment collection are adequately described. Comparison of the 1991 and 1994 dioxin data also demonstrates that sediments from outside the active disposal locations within the MDS are relatively stable with respect to contaminant concentrations, and that large changes in concentrations have not occurred since the samples were collected. This information, in combination with the strong correlations between grain size, TOC, and other contaminants (Battelle, 1996a) in the region, indicate that regions within the Study Area that have elevated contaminant concentrations are accurately described.

Table 3-10. PAH, PCB, DDT, and organotin concentrations [ppb (ng/g) dry weight] and 2,3,7,8-TCDD concentrations (pptr [pg/g] dry weight) in surface sediment samples in the New York Bight Apex and Mud Dump Site.

Reference	Boehm (1983) and SAIC (1992)	Boehm (1983)	Lewis *et al.* (1989)	Pruell *et al.* (1990)	Charles and Muramato (1991)	SAIC (1992b)	McFarland *et al.* (1994)	SAIC (1995d)	Battelle (1996a)
Region	New York Bight Background	NY Bight MDS (Christiaensen Basin)	Bight Apex	NY Bight Apex	Study Area	MDS	MDS Reference	MDS	MDS & Study Area
Year	1985/1993	1981	1983-1986	1989	1990	1991	1991 (August)	1994 (April)	1994 (October)
No. Samples	n = NA	n = NA	n = 50	n = 4	n = 22	n = 19	n = 4 Composite	n = 24	n = 45
PAH_T	50 - 500[a]	7,200 - 30,700	NA	NA	NA	NA	NA	NA	11 - 33,100
PCB_T	0.01 - 0.1[a]	3 - 400 (50-1,500)	<2.4 - 500	2.7 - 1,290	<800 - 1,538	NA	58.8±3.3	NA	0.5 - 678
DDT_T	NA	NA	NA	NA	<8-400	NA	NA	NA	<.5 - 151
$Organotins_T$	NA	NA	NA	NA	NA	NA	NA	NA	<4.5 - 128
Dioxin (2,3,7,8-TCDD)	0.00 - 2.8[b]	NA	NA	<1 - 79	<0.9 - 229	0 - 31	0.61±0.09	<0.26 - 15	<0.2 - 42

[a]From Boehm *et al.* (1985).
[b]From SAIC (1992) range at MDS reference areas (North and South).
[c]Concentrations are less than the limit of detection of (1.0 pptr) within an area capped with sand.

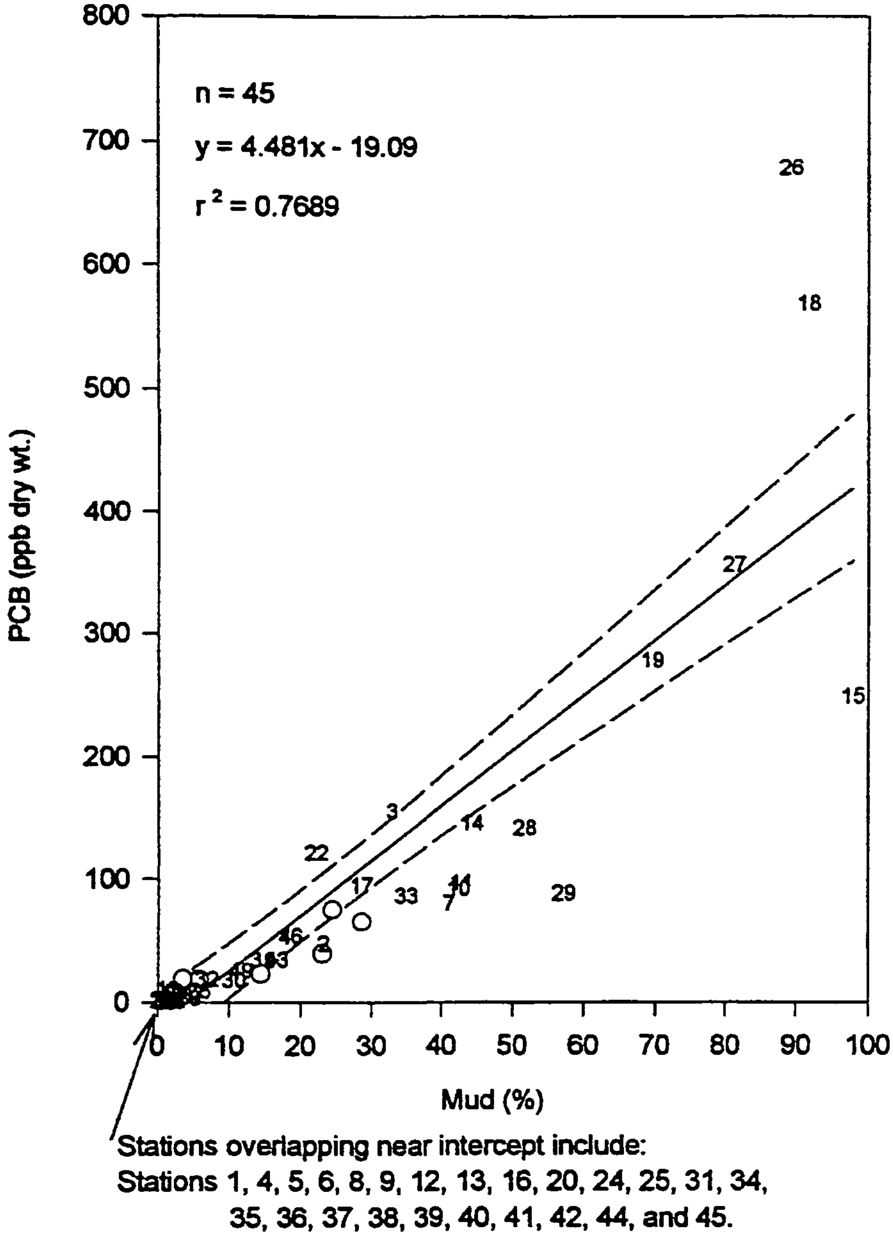


Figure 3-41 . Relationship between the mud fraction in sediments of the Study Area and MDS and total PCBs (data from Battelle, 1996a).

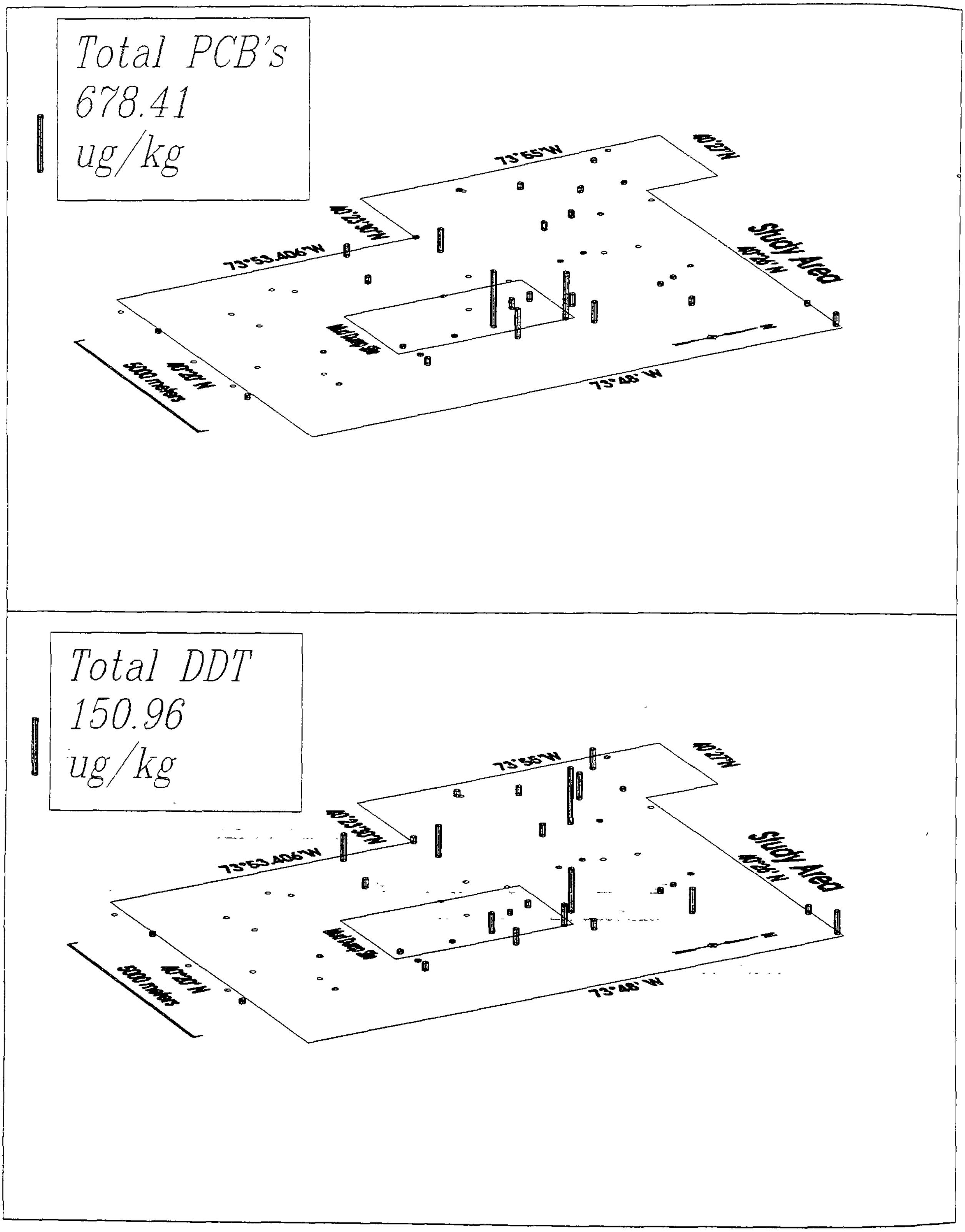


Figure 3-42. Total PCB and total DDT distributions in the Study Area (data from Battelle, 1996a).

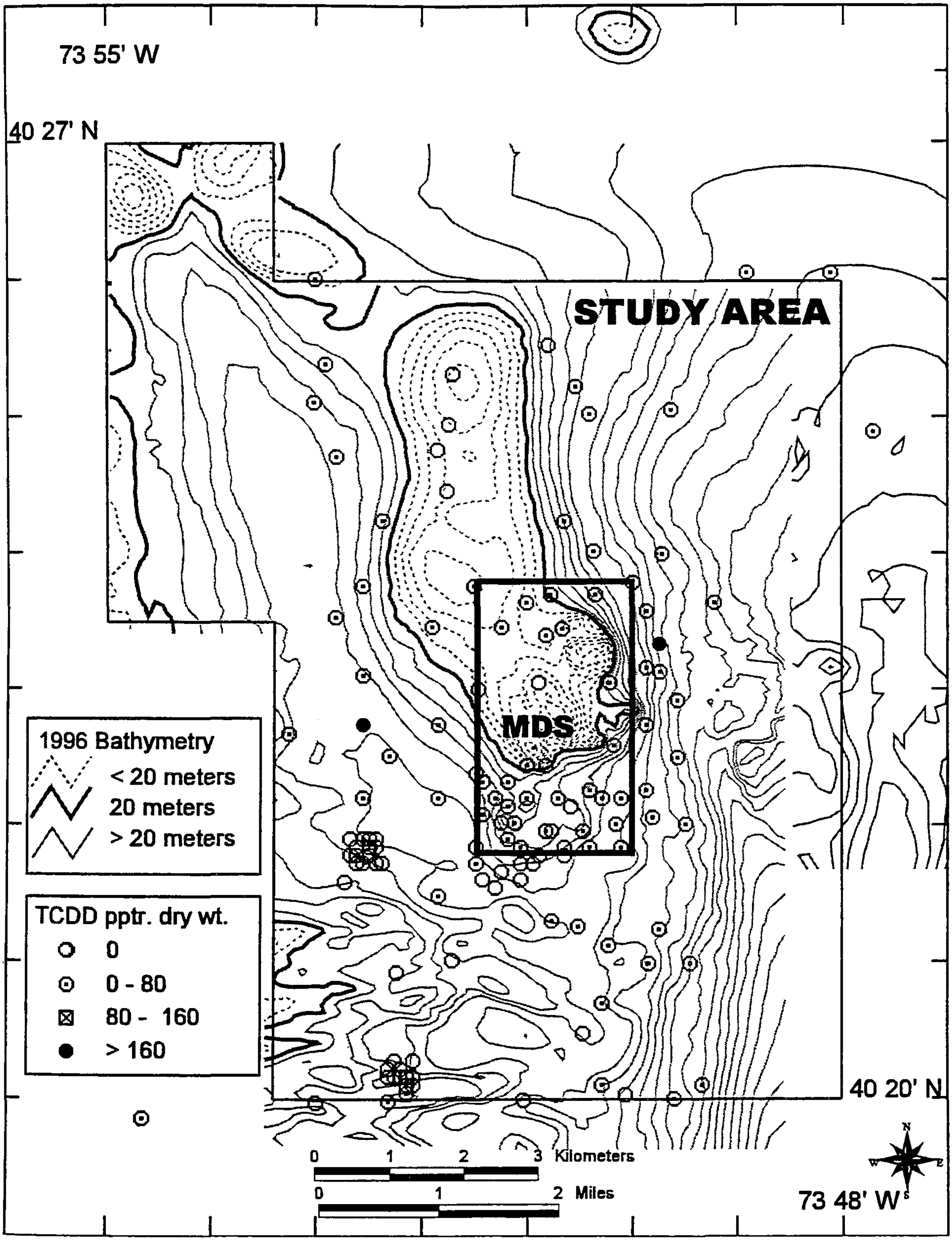


Figure 3-43. Regional distribution of 2,3,7,8-TCDD (pptr dry weight). Distributions were developed from surface sediments collected between 1990 and 1994 using the most recently available MDS data.

3.3.9.3 Sediment Quality

The concentration of a contaminant in a sediment does not in and of itself define whether a sediment is degraded or presents potential impacts to ecological or human health. Sediment quality depends on the availability of the contaminants to organisms (Brungs and Mount, 1978; Spacie and Hamelink, 1985; Dickson *et al.*, 1994) and the potential for impact to the larger ecosystem. Contaminant availability is influenced by many factors including sediment carbon content and quality, organism feeding modes, kinetics of transfer, uptake and elimination rates, and partitioning into lipid material.

There are few direct methods for establishing whether a contaminant presents a direct threat to marine organisms or their predators. One means of directly estimating the potential environmental impacts of a sediment is to measure its toxicity to marine organisms by using the toxicity tests developed to evaluate dredged materials. There are also indirect methods used to estimate whether sediments potentially might cause impact to biological communities, which include calculations involving equilibrium partitioning, empirical bioassay and bioaccumulation studies, and comparison of contaminant concentrations to published sediment quality guidelines such as the NOAA ER-L (Effects Range-Low) or ER-M (Effects Range-Median) (Long and Morgan, 1991; Long *et al.*, 1995). Although these sediment quality indexes do not carry regulatory authority, the generated data can be synthesized by site managers and provide relevant information when assessing overall sediment quality. In particular, the comparison of ER-L and ER-M thresholds and guidelines, derived from a broad range of synoptically collected biological and chemical data from field and laboratory experiments, provide useful information for generally estimating potentials for impact. The ER-L and ER-M guidelines are based on the responses of multiple species to simple and complex mixtures in sediments from several geographic locations, and offer non-specific indicators of toxicity. ER-L guidelines encompass the lower 10 percentile of the effects range data; the ER-M guidelines are the median value of the effects range. Some limitations to the ER-L/ER-M approach are that is an indirect method, not all chemical mixtures interact similarly, and not all species react to contaminants in the same manner. Both direct and in direct methods were investigated under this SEIS to estimate areas within the Study Area might be degraded (Battelle, 1996a).

Chemical Degradation: Measured concentrations of individual contaminants or contaminant classes at 53 stations in the Study Area were compared to ER-L/ER-M values. The results showed three distinct station groupings: 1) stations with no exceedances of ER-L or ER-M values, 2) stations that had some chemicals exceeding ER-L guidelines but no ER-M values, and 3) stations that had chemicals exceeding both ER-L and ER-M guidance values.

No ER-L or ER-M values were exceeded at twelve stations (Figure 3-44). These stations are in the southern most part of the Study Area, south of the MDS and along the top of the historic dredged material disposal mound in the north central portion of the Study Area (Battelle, 1996a).

The second set of data (ER-L guideline exceedances but no ER-M exceedance) grouped into stations with only a few ER-L exceedances (1 to 6) and ones with numerous ER-L exceedances (7 or more) but no ER-L exceedances . Stations with only one chemical above the ER-L guideline were adjacent to areas on the historical mound with no ER-L exceedances and in the southern third of the Study Area (Figure 3-44). One station was located on the eastern boarder of the MDS. Of the 12 stations that had only 2 to 6 ER-L values exceeded (no ER-M exceedances), two were on the historic mound, four were in the MDS or immediately adjacent to it, one was southeast of the MDS in the Hudson Shelf Valley, and one was on the western most boundary of Subarea 2 (Figure 3-44). These locations were generally in the vicinity of the stations with no more than one chemical exceeding an ER-L value.

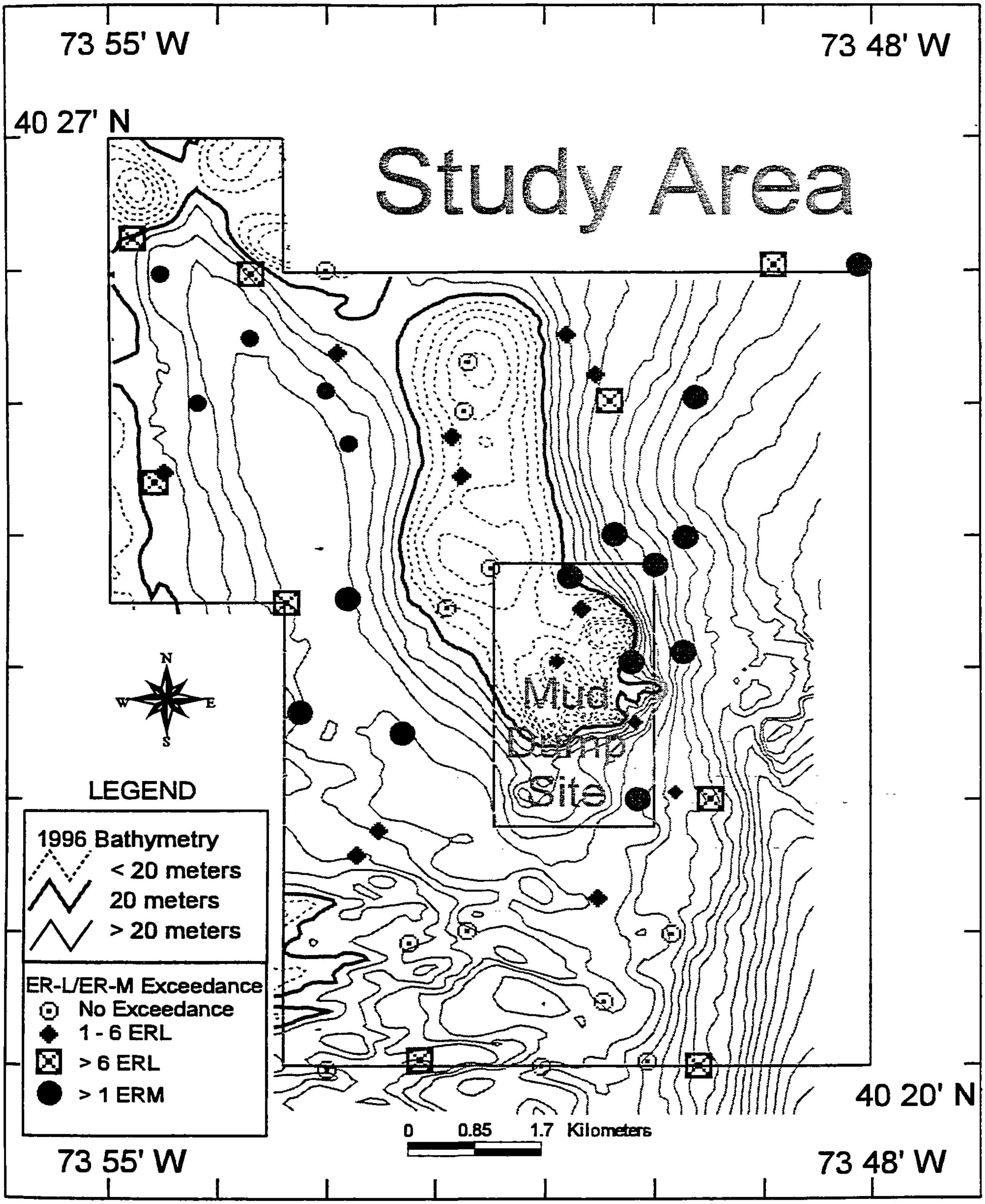


Figure 3-44. Spatial distribution of sediments exhibiting exceedances of NOAA ER-L\ER-M guideline values. Symbols represent the number of chemicals or compound classes exceeding the Long *et al.* (1995) marine ER-L values ⊙ ≤1; ◆ 2 to 6; ⊠ > 6 with no ER-M exceedance; and ● > 1 ER-M exceedance.

The set of data with seven or more contaminants exceeding ER-L guidelines (but no ER-M exceedances) were found in three regions of the Study Area: east of the historic dredged material mound in the northeast quadrant of Subarea 1, in the Hudson Shelf Valley on the eastern side of the Study Area, on the western slope of the historical dredged material mound, and the western slope of the shallow basin in Subarea 2.

The third data grouping (at least one chemical above its ER-M value) also had large numbers of ER-L values exceeded. Regions in the Study Area that fit this characterization are located in two areas: the MDS and contiguous areas to the east and northeast and the basin west of the historic dredged material disposal mound. Mercury, total DDT, or total PCB were the chemicals that most frequently exceeded ER-M guidelines. One location [Station 28 in the eastern portion of the basin west of the MDS (Battelle, 1996a)] was distinct in that the combination of contaminants exceeding ER-M guidelines differed from the combinations found at most other stations in the area. At this location contaminants exceeding the ER-M values were more associated with petroleum and petroleum combustion products.

Generally, stations with very few ER-L exceedances are sandy in nature. Stations with large numbers of ER-L exceedances generally coincided with the muddier, organic-rich areas.

Using the number of ER-L exceedances, sediments from sampled stations in the Study Area were assigned one of three chemically based sediment quality classifications: degraded, marginally degraded, and nondegraded (Battelle, 1996a). Stations with only 0 to 1 ER-L exceedances were assigned "nondegraded", Stations with 2 to 6 exceedances were assigned "marginally degraded", and stations with 7 or more ER-L exceedances were assigned "degraded". The distribution of sediments fitting these chemically based classifications are shown in Figure 3-45. Chemically degraded sediments were generally found in the MDS and areas immediately outside its eastern boundary, and the two basins within the Study Area. Sediments of the shallow basin in the western portion of the Study Area consistently fell into the chemically degraded classification. Sediments in the northeast quadrant of the Study Area seaward of the 23 m depth interval also classified as degraded. Marginally degraded sediments are evident in shallower areas contiguous to the degraded sediments in both basins and near the top of older dredged materials in the MDS.

***Toxicological Degradation*:** Toxicological testing of the sediments in the Study Area with *Ampelisca abdita* found a wide range in percent survival (0% to 99%) (Battelle, 1996a). Following toxicity testing guidance in the dredged material testing manual or "Green Book" (EPA/USACE, 1991), sediments that meet two criteria are considered biologically significant. The first criterion is that the toxicity measured in a test sediment be statistically different than that in a reference sediment for the disposal site; the second criterion is that the survival be at least 20% lower than in the reference sediment. For the tests performed on the sediments of the Study Area, survival of <75% was found to exceed these criteria. The two criteria for significant toxicity were met in all nine MDS sediments sampled and in 19 of the 42 sediments located outside of the MDS. Sediments exhibiting significant toxicity were generally located across the middle of the Study Area (Figure 3-46). Areas that did not elicit a significant response relative to the reference sediment included the northwestern region (Subarea 1) and the northern and southern most portions of Subarea 1.

Statistical examination of the sediment toxicity results identified three levels of toxicological response in these sediments: "high" (≤20% survival), "moderate" (>20% to 75% survival), and "low" (>75% survival). Sediments exhibiting high toxicity were observed in the northeast corner of the MDS and immediately adjacent areas and in the southern most portion of the shallow basin located west of the historical disposal mound (Figure 3-47). Sediments exhibiting moderate toxicity are located in the northwest and southeast quadrants of the MDS and contiguous stations immediately outside of the MDS.

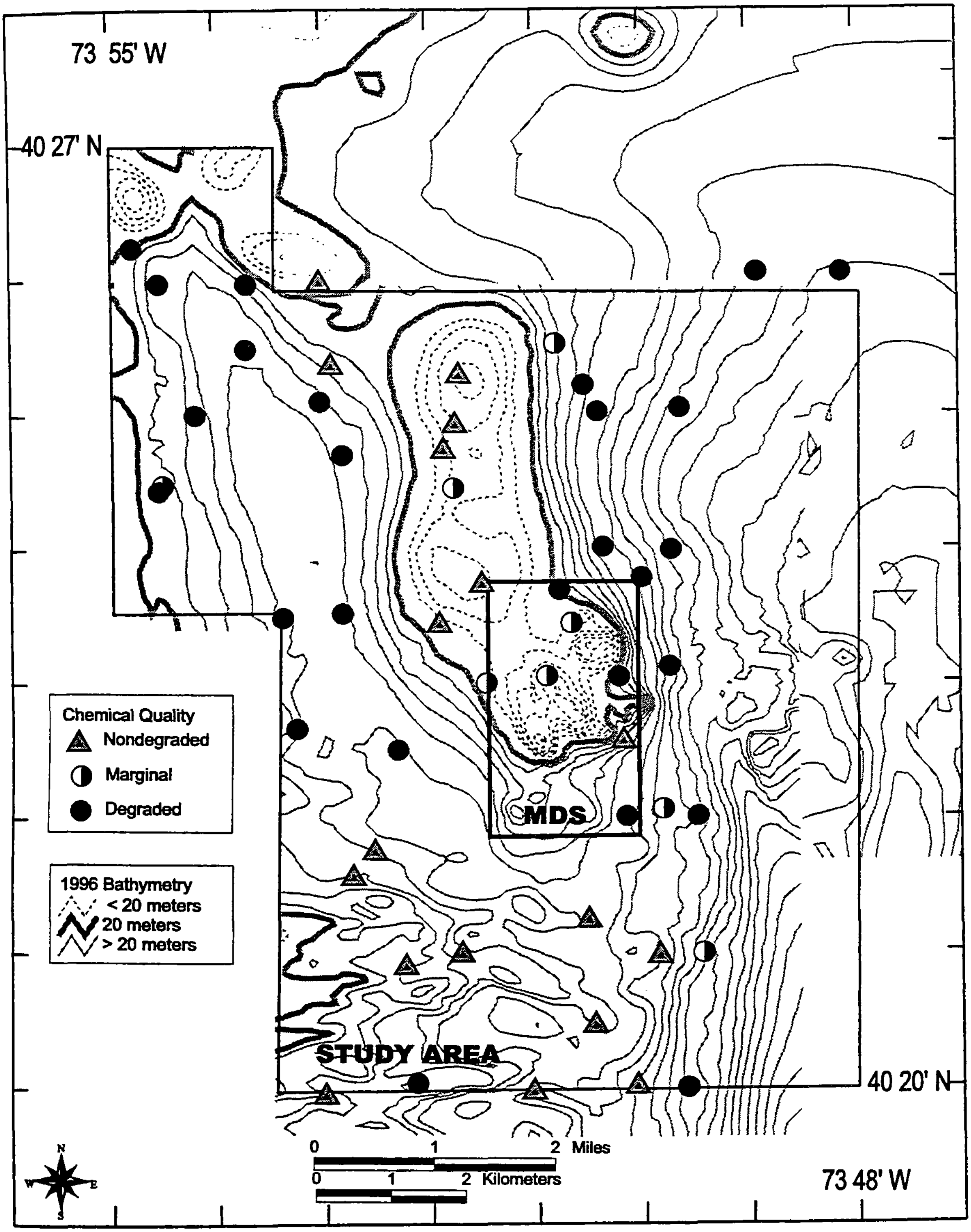


Figure 3-45. Spatial distribution of sediments in the Study Area exhibiting low, moderate, and high chemical degradation. ▲ = 0 or 1 ER-L exceedance, ◑ = 2 to 6 ER-L exceedances, and ● = >6 ER-L exceedances.

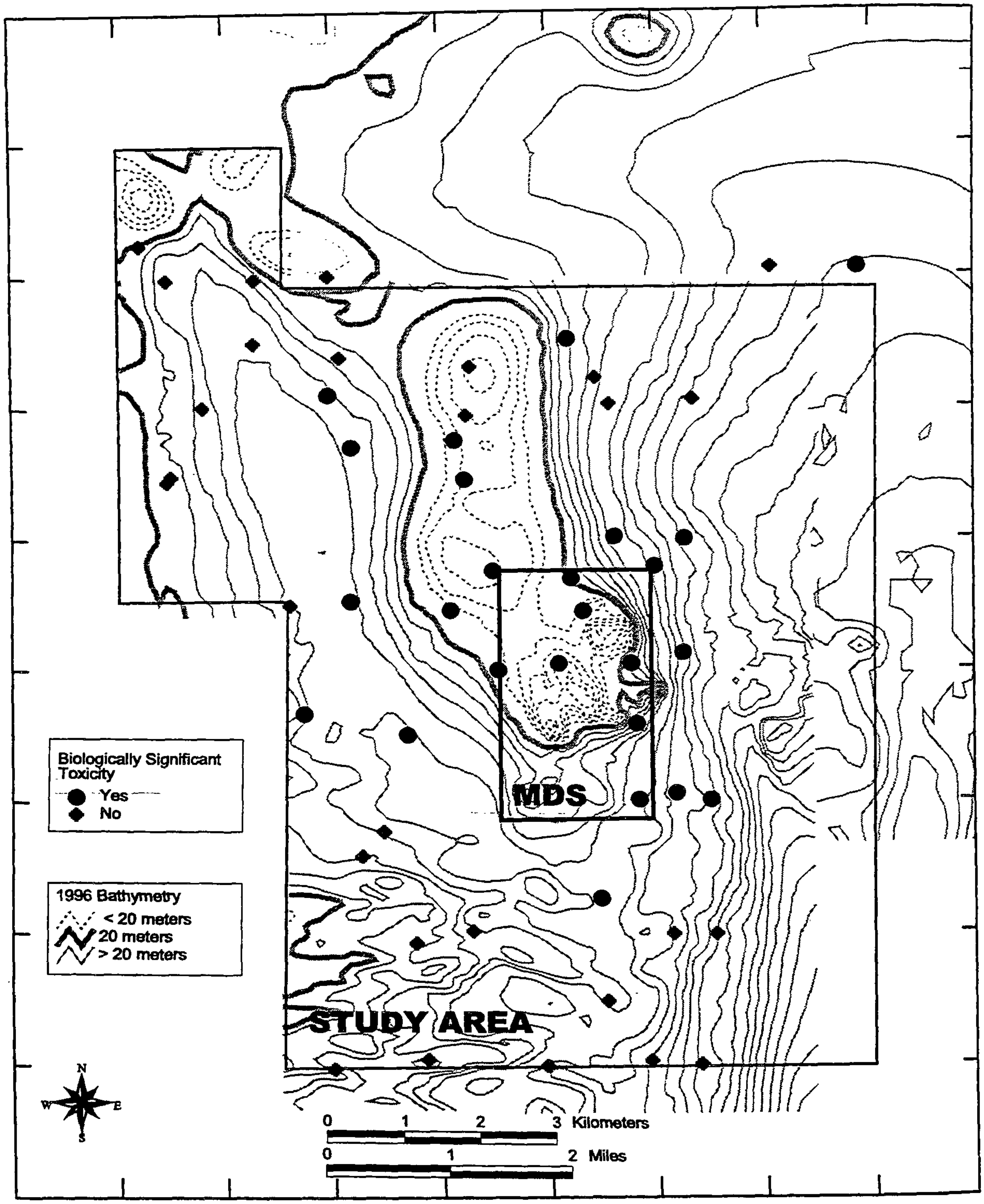


Figure 3-46. Spatial distribution of biologically significant toxicity in sediments in the Study Area. Toxicity results that are both statistically different and ≥20% less than reference sediments for the MDS (Station 43, see Battelle, 1996a) are shown as ●; those that are not significantly different are shown as ◆.

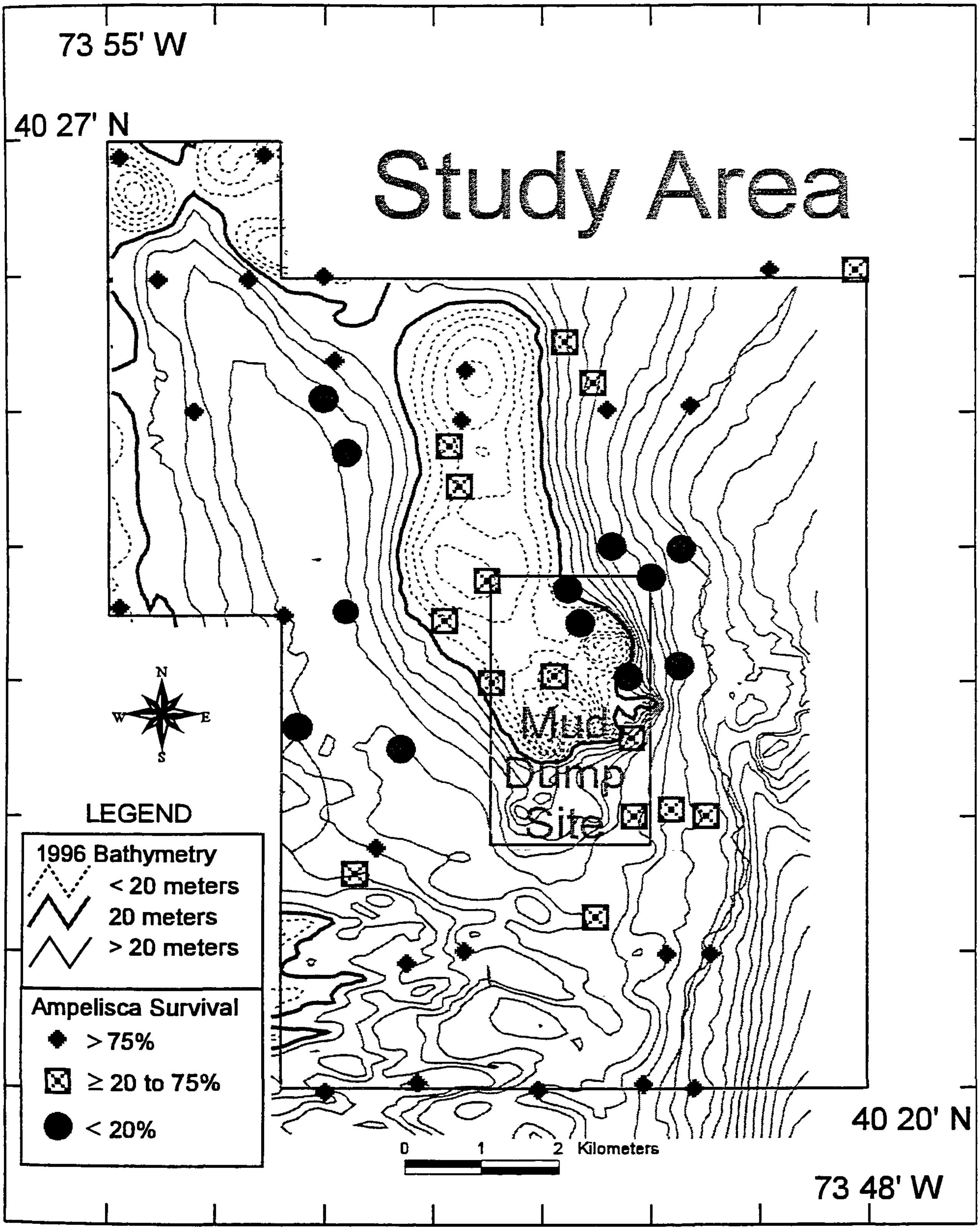


Figure 3-47. Spatial distribution of sediments having low, moderate, and high toxicity in the Study Area. Symbols represent ◆ >75% survival, ⊠ ≥20 to 75% survival, and ● = ≤20% survival for a given station.

Low toxicity was identified in sediments from the northern most portion of the Study Area including all of Subarea 2. Sediments located to the south of the MDS had low toxicity.

By combining the ER-L classification and the toxicological classification data, a simplified sediment quality classification scheme was created. In this procedure, each of the two sediment quality classifications was given a rating of 0 (nondegraded), 1 (marginally degraded), or 2 (degraded). For each station, the rating for the two classifications was summed and the combined score used to determine degraded areas. Stations receiving a total score of 0 were classified as nondegraded; those receiving a score of 4 were classified as degraded. The other stations scored between 1 and 3 depending on the sum of two scores. A total score of 3 (tending towards degraded) occurs only when the rating combination comes from the degraded and marginal classifications; a total score of 1 (tending towards nondegraded) occurs only when the score comes from a combination of nondegraded and marginal classifications. A score of 2 can occur from one degraded and one nondegraded rating or from two marginal ratings. An example of the scoring method is shown below:

Example of the scoring system used to determine the degree of sediment degradation in the Study Area

Station	Undegraded		Marginally degraded		Degraded		Score
	Chemical	Toxicological	Chemical	Toxicological	Chemical	Toxicological	
A	0	0					0
B			1	1			2
C	0					2	2
D					2	2	4

Under this scheme, stations classified as nondegraded are primarily located in the southern third of the Study Area and an area immediately north of the MDS on the historic mound (Figure 3-48). Areas classified as degraded are located in the eastern most portion of the shallow basin on the west side of the historic dredged material disposal mound and the northwest corner of the MDS and contiguous areas. The sediments in the basin in Subarea 2 are marginally degraded as are the areas contiguous with the degraded area in the northeast quadrant of the Study Area and those immediately outside the southeast corner of the MDS. Isolated areas of marginal sediment quality are found along the southern border of the Study Area.

3.3.10 Water Quality [40 CFR Section 228.6(a)(9)]

Water quality is generally based on the amount of particles in the water column (turbidity), dissolved oxygen levels, nutrient and chlorophyll levels, and contaminant concentrations. These water quality parameters can be affected by direct inputs (e.g., continuous and aperiodic point source discharges, ocean disposal activities), indirect inputs (e.g., atmospheric, nonpoint sources), and secondary processes (e.g., remobilization from the seafloor, primary production by marine plants and animals). Within the New York Bight, a dominant influence on water quality is the Hudson River discharge (see Section 3.2.1). This influence is most significant in the inner Bight and coastal New Jersey. The discharge of the river is easily seen in satellite images of sea surface temperature, chlorophyll, and turbidity (Fedosh and Munday, 1982). As a consequence, the concentrations and spatial and temporal distributions of particles, nutrients, and contaminants in the Study Area respond to the outflow of the Hudson River which results in a decreasing offshore gradient for many of the above parameters. The Hudson River plume also strongly influences the

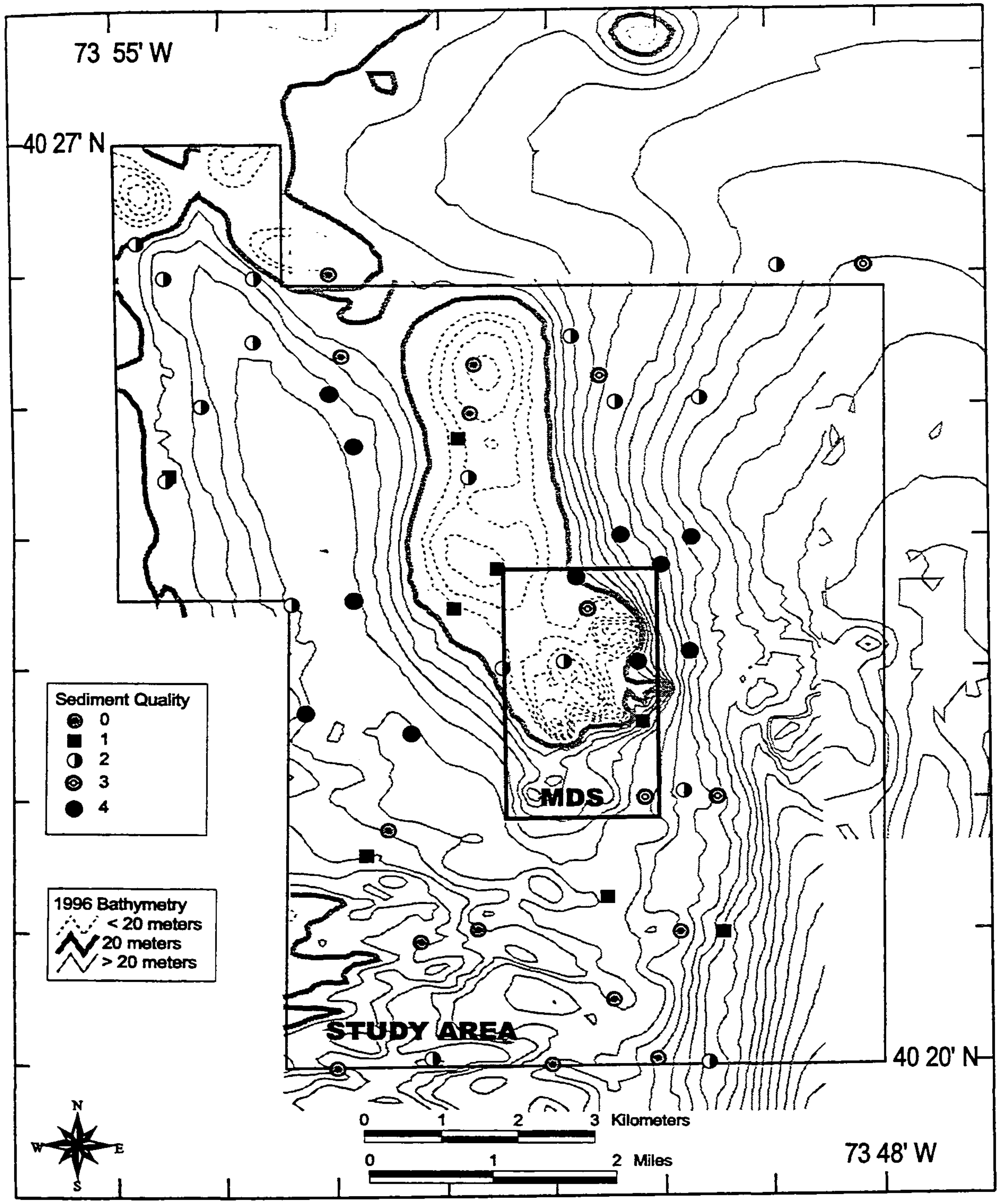


Figure 3-48. Spatial distribution of areas considered degraded in the Study Area. Results are derived from combined chemical and toxicological quality classifications (Battelle, 1996a). ● = nondegraded; ■ = tending towards nondegraded; ◑ = marginally degraded; ◎ = moderately degraded; and ● = degraded.

salinity and density structure of the water column in the Study Area (see section 3.3.10.1). In turn, these physical gradients influence the spatial and temporal variability in turbidity, dissolved oxygen, nutrient, chlorophyll, and contaminant concentrations in the water column of the Study Area.

3.3.10.1 Temperature, Salinity, and Density

The hydrographic structure of the New York Bight, including the influence of the Hudson River estuary, has been well documented (e.g., Bowman and Wunderlich, 1977; Durski, 1996). Temperatures in the New York Bight have a seasonal cycle that is well defined and with little year-to-year variability. There is seasonal evolution from a vertically homogeneous temperature structure in winter to weak stratification in summer. Salinity follows a similar pattern due to the runoff from area rivers including the Hudson and Connecticut Rivers, and several smaller tributaries. In general, freshwater discharges to the Bight and Study Area peak in April and are at their lowest in August.

Bight water reaches its maximum density during the winter (January, February, March) when temperatures are at their lowest and salinity reaches the annual maximum (Bowman and Wunderlich, 1977). During this period, the lowest temperatures occur near the coast, increasing offshore. There is little river runoff and strong vertical mixing, leading to an almost completely unstratified water column. Bottom temperature tends to be slightly warmer than surface temperature. While the water column is well-mixed there is deep wave penetration and the currents essentially act as a single one-layer flow (i.e., near bottom and near surface flows are coupled).

River runoff reaches its maximum at about the same time that warming begins (April, May). In near coastal waters, the entire water column warms while bottom temperatures remain unchanged on the inner and central shelf at the annual low. Strong thermal stratification begins to develop in May resulting in a warm surface layer. In addition, the plume of low salinity water from the Hudson River is strongly evident in the apex of the Bight during this period. This plume generally follows the New Jersey shore to the south and frequently extends into the Study Area and across the MDS (see Figure 3-49). This often results in trapping of a band of high-salinity water between the NJ coast and the river plume to the east.

The thermocline intensifies during summer (June, July, August) while bottom temperatures remain unchanged. Close to the coast, where bottom depth is less than the depth of the thermocline, rapid warming occurs. The surface temperature gradient and depth of the thermocline reach their maximum in early August and remain so for the month. The salinity distribution during low river discharge in summer is characterized by a weak plume around Sandy Hook and patches of surface water of variable salinity are spread throughout the inner shelf of the Bight (Figure 3-49). The two layer water column structure in the summer has a substantial impact on the energy that reaches the sediments of the Study Area. The layering particularly prevents the wind energy from reaching the bottom, effectively decoupling the bottom current velocities from the surface velocities. This decoupling substantially reduces the potential for wave induced sediment resuspension and transport during this period.

During the fall (September, October) and early winter (November, December) the thermocline breaks down due to surface cooling and the increase in wind stress. The vertical overturning deepens the isothermal layer and warms the bottom water. Eventually the shelf waters are almost entirely isothermal. Destabilization of the water column by surface cooling and wind stress is usually stronger than buoyancy from river runoff which breaks down the vertical salinity gradient and leads to a steady increase in surface salinity. Strong winter vertical mixing dissipates any isolated patches of low-salinity water present during the summer. It is during this period and the subsequent winter months that the potential for storm induced resuspension of sediments is at its greatest.

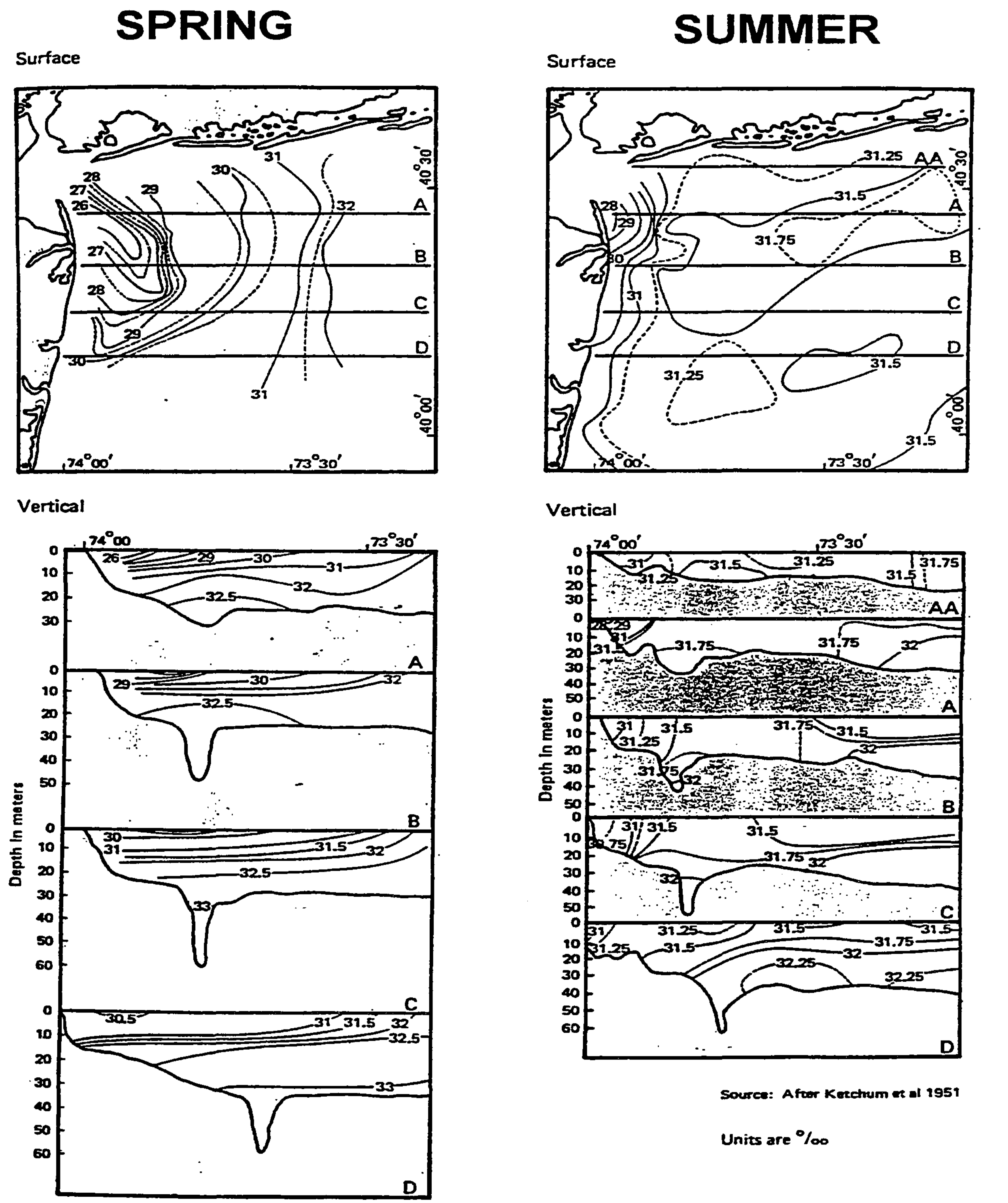


Figure 3-49. Representative surface and vertical salinity features in the inner New York Bight. Surface features represent the typical offshore salinity gradient resulting from high flow (April) and low flow (August) conditions of the Hudson River. Vertical sections for the same conditions are also shown.

3.3.10.2 Water Column Turbidity

Water column turbidity (clarity) can be affected by many factors including growth of phytoplankton, river plumes, and energy events that resuspend sediments. In addition, stratification can affect the vertical structure of turbidity in the water column. All of these factors can be important in the Study Area. For example, satellite imagery of the sea surface can be used to detect levels of surface turbidity in the New York Bight. These images of the New York Bight have been used to show the Hudson River Plume extending southward and close to shore under the influence of southerly nearshore currents and coriolis forces (Fedosh and Munday, 1982). Winds from the northwest followed by southwesterly winds cause the plume to move offshore by as much as 27 Km. Estimates suggest that the plume can override the MDS area approximately half of the time. The frequency that the plume is in the MDS area is higher when the winds are from the southwest.

Turbidity below the surface can be measured using in situ instruments. Such instruments were used to map background turbidity in the MDS and to follow the fate of dredged material plumes in the MDS (Dragos and Peven, 1994). The hydrographic surveys conducted in June of 1994 included high resolution vertical profiling of water column turbidity. Results from this survey showed low turbidity throughout the water column with a small mid-depth maximum in the central portion of the Study Area. This feature appears to extend from the north and west into the Study Area (Figure 3-50) but did not extend to the east of this area (east side of the Study Area). Turbidity in the water column on the east side of the Study Area did not show any distinguishing vertical features during the survey. Contouring the data from the 8 m depth (Figure 3-51) clearly shows this mid-depth turbidity maximum from coastal New Jersey into the MDS. The data did not reveal elevated turbidity in the vicinity of the MDS that might be attributable to dredged material disposal, but did show the Hudson River discharge or coastal currents exerting significant influence on the turbidity in the Study Area. Time series tracking of individual dredged material plumes demonstrated that turbidity associated with disposal events in the MDS (Figure 3-52) quickly reach background levels within a few hours (Dragos and Lewis, 1993; Dragos and Peven, 1994). These data indicate that dredged material disposal in the MDS has transient impact on the water clarity.

Resuspension of surface sediments during high energy events can also effect the turbidity of the water column.

3.3.10.3 Dissolved Oxygen

Prior to the transfer of sewage sludge disposal to the 106-Mile Site, the disposal of sludge occurred at the 12-Mile Site. This discharge substantially enriched nutrients and increased phytoplankton productivity in the Bight Apex area, contributing to unacceptably low dissolved oxygen (DO) levels in the water and sediments of the New York Bight (HydroQual, 1989b). As a result, low summer dissolved oxygen concentrations were routinely observed during the late 1970s and mid-1980s in the bottom waters (HydroQual, 1989b). These annual depressions in bottom water dissolved oxygen were most notable along the New Jersey Coast and in the vicinity of the dumpsites in the Bight Apex. Dissolved oxygen levels inshore of the 20 m depth interval were often below 1.5 mg/l along the New Jersey coast and less than 3 mg/l inshore of the 40 m contour of both the New Jersey and Long Island shores. Areas of DO were lowest along the northern one-third of the New Jersey Coast (lowest mean concentrations of 4.0 mg/L) with levels often dipping below 1 mg/l[3] between Mansquan and Barnegat Inlets and between Little Egg and Absecon Inlet.

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[3] DO levels <2 mg/l are defined as hypoxic and are considered to impair biological function; conditions of zero DO level are termed anoxic and kill organisms that depend on oxygen for survival.

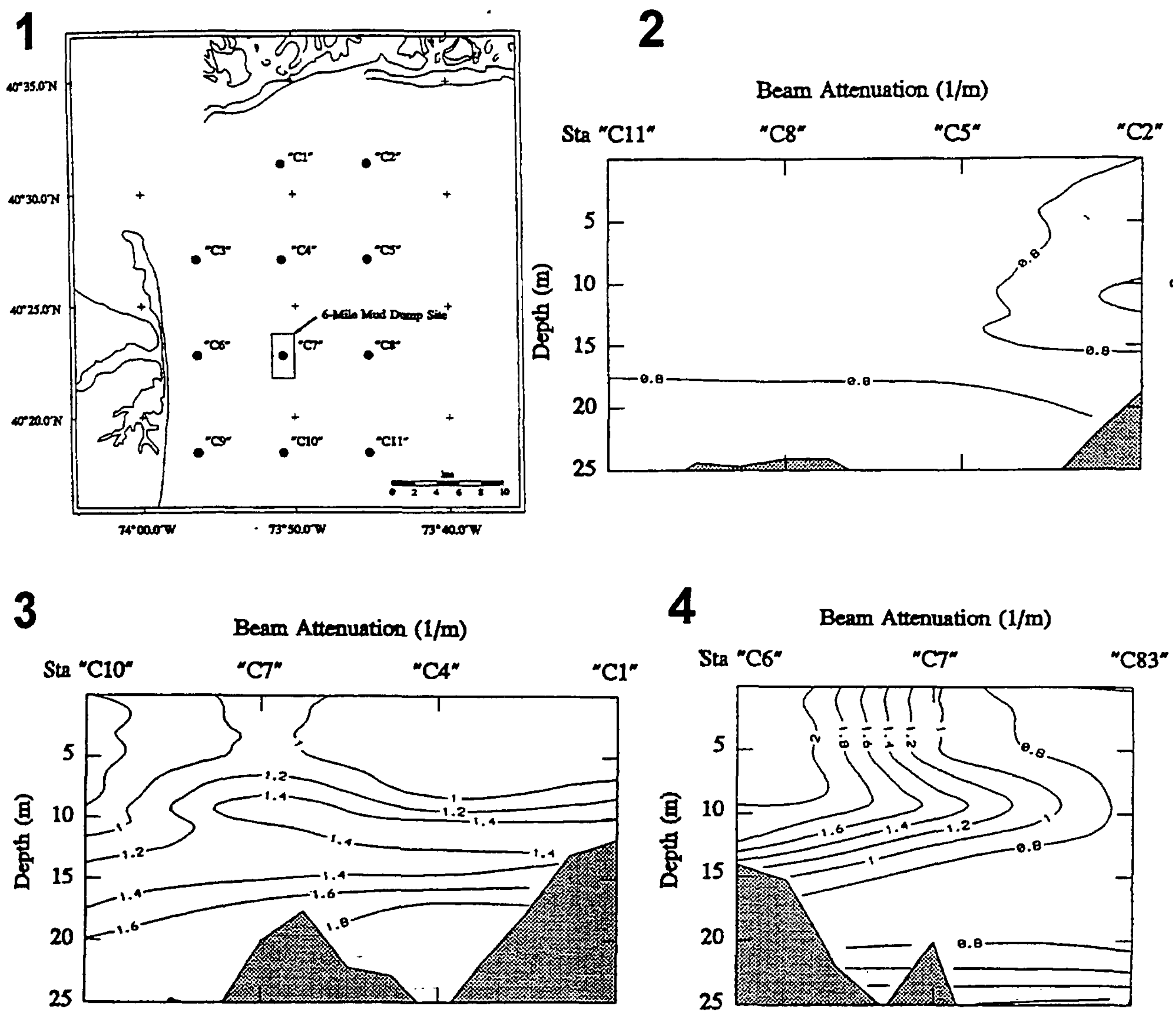


Figure 3-50. Vertical sections of beam attenuation (a measure of water clarity) for the Study Area and MDS in June 1993 (from Dragos and Peven 1994). Panel 1 shows the location of the hydrographic stations sampled. The lowest beam attenuation (clearest water) is along the eastern most side of the MDS (Panel 2). Slightly higher beam attenuation (less clear water) was found in the center of the Study Area (Panel 3). A plume of higher turbidity water emanated from the New Jersey Coast (Panel 4).

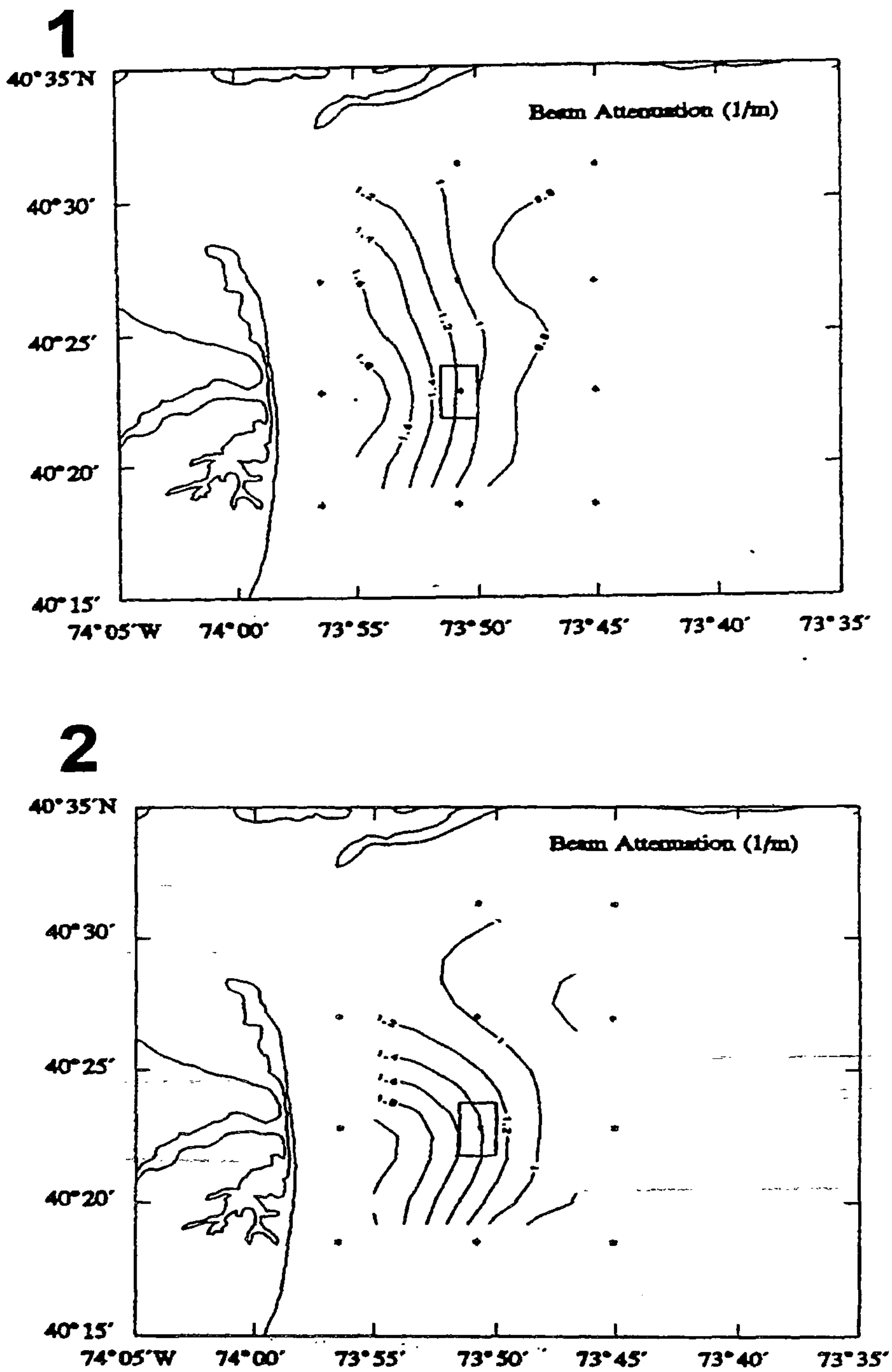
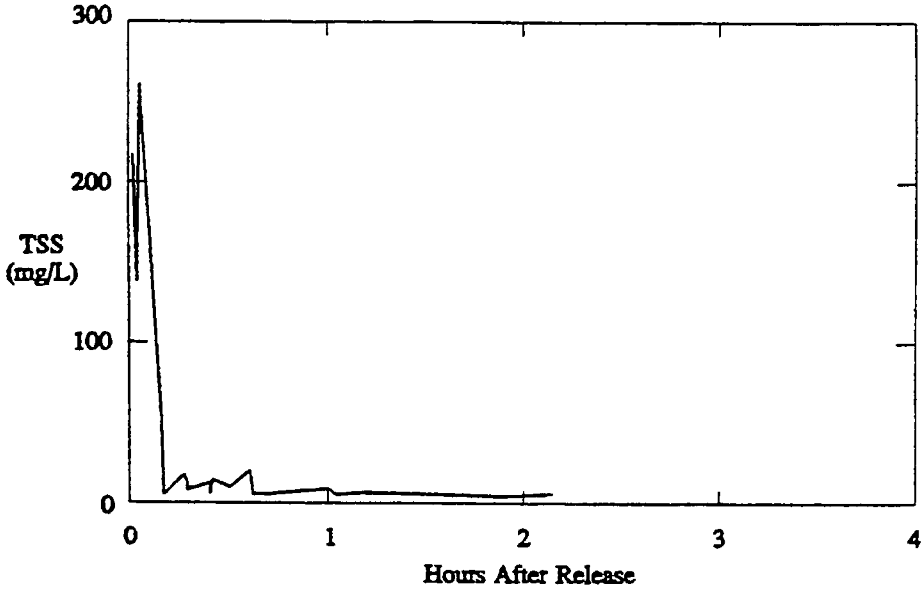


Figure 3-51. Horizontal contours of beam attenuation at 2 m (Panel 1) and 8 m (Panel 2) depths in the Study Area in June 1993 (from Dragos and Peven 1994). Surface water shows increasing water clarity in the offshore direction. The water clarity at 8 m also shows an offshore gradient of increasing water clarity.

1



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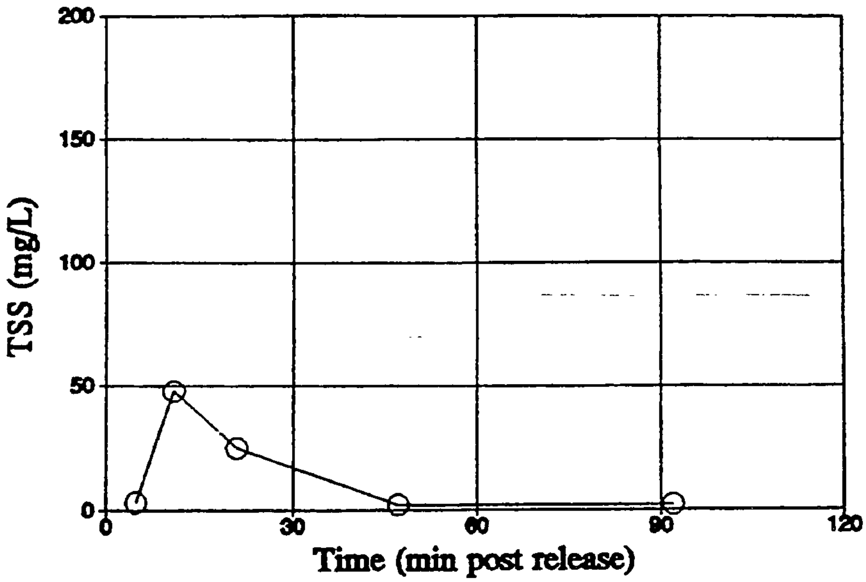

Figure 3-52. Dissipation of total suspended solids (TSS) concentrations of dredged material plumes surveyed in the MDS in (Panel 1) June of 1992 [from Dragos and Lewis (1993)] and (Panel 2) June of 1993 [from Dragos and Peven (1994)].

Moving sewage sludge disposal from the 12-Mile Site to the 106-Mile Site in 1986-1987 measurably improved both the water and sediment quality of the inner Bight (Studholme *et al.*, 1995). Data collected between 1987 and 1989 to evaluate the response of the Bight to reductions in sewage sludge loading showed that summer water column dissolved oxygen levels in previously impacted areas rose after the 12-Mile Site was closed. In particular, measurements of dissolved oxygen in bottom waters of the inner Bight demonstrated rapid recovery of DO to values above 4 mg/l from 1986 through 1988 (minimum values in 1989 were about 2.5 mg/l). This compared to values below 0.5 mg/l at the previously most heavily impacted station during the summer months from 1983 through 1985 (Mountain and Arlen, 1995).

Dissolved oxygen levels measured by EPA Region 2 in the coastal waters (original data from EPA Region 2 STORET database) off New Jersey and New York (to depths of 40 m) between May and October from 1985 through 1994 also show DO concentrations consistently above 2 mg/l (data from EPA Region 2 environmental database). Of the 3,888 data points included in an area extending eastward from the shores of New Jersey to 73° 38'W Longitude and bounded by Latitude 39° 55'N (near Seaside, NJ) and 40 33' 36"N (near Atlantic Beach, Nassau County, NY), only 26 (0.7%) were less than 2 mg/l. These low values were measured in the early to mid 1980s. Only 102 (2.6%) of the samples were less than 3 mg/l. Within the entire data set, dissolved oxygen levels from depths below 12 m were consistently lower than for surface waters, ranging between 3 and 10 mg/l. No trends towards lower DO as depth increased were evident in this data set. Further, DO levels below 2 mg/l were not measured after 1988.

3.3.10.4 Nutrients

The two major nutrients essential for primary production in the ocean are phosphorous and nitrogen. Other major nutrients, notably silicon, as well as many micronutrients and metals, are also necessary for plant growth and may enhance or retard production based on local conditions. Most aquatic and marine systems, however, are dominated by the availability or unavailability of phosphorous and nitrogen, usually present in water and taken up by plants as phosphate and nitrate.

Globally, the major source of phosphorous is land drainage, with the ocean acting as vast reservoir of these nutrients. Nitrogen compounds also enter the sea from land runoff, but a large proportion also enters the marine environment through the atmosphere. Marine algae require sufficient quantities of both phosphorous and nitrogen in order to grow and reproduce. The vast majority of these algae are microscopic phytoplankton that live in the surface of coastal waters which are rich in nutrients and receive sufficient light for primary production (i.e., plant growth).

As phytoplankton species populations and communities grow, they assimilate the nutrients from their environment and deplete the local supply of nitrogen and phosphorous. The ratio at which phytoplankton uptake nitrogen and phosphorous is 16:1, and the ratio that these nutrients naturally exist in the sea is about 15:1 (Redfield, 1958). The consequence of these two ratios is that most marine systems are *nitrogen limited.* In the immediate vicinity of a single phytoplankton cell, if all of the available nitrogen is exhausted, growth ceases, even if ample supplies of phosphorus and other nutrients (e.g., silicon for diatom phytoplankton) are available. Equivalent limitations can be created if other essential nutrients or minerals or vitamins become unavailable by biotic or abiotic processes. Usually, however, nitrogen is the limiting nutrient.

On a population and community-wide scale, the depletion of nitrogen in surface waters means that the numbers of phytoplankton cells reach a *steady state*. The community gets no larger, and no new phytoplankton cells grow or develop until nitrogen becomes available to them through (1) death and decomposition of other phytoplankton, (2) release of nutrients from the sediments or from ocean waters below the photic zone, or (3) addition of nitrogen sources from the land or atmosphere.

In the waters of the New York Bight and at the Study Area, the major concern is nutrient over-enrichment from land-based nitrogen sources. Over-enrichment from land-based nitrogen allows the area's phytoplankton communities to grow unchecked during the summer, leading to eutrophication and depletion of oxygen in the water column and other deleterious effects. The great majority of nitrogen entering the Bight and Study Area originates from sewage discharges that enter the area through the Hudson River plume. In the early 1980s, Malone (1984) calculated that sewage-nitrogen supports an average of 54% of new production in the Hudson river plume during the spring bloom March-May period, 121% during the June-October stratification period, and 221% during the November-February winter period. Malone calculated that, on an annual basis, sewage-nitrogen increases baseline phytoplankton production by approximately 30%. HydroQual (1989a) recently affirmed that the nutrient flux of the Study Area is dominated by the Hudson River plume.

The biological reactivity of nutrients, seasonal physical structure of the water column, currents and wind conditions, and remobilization from sediments all affect the distribution and concentrations of nutrients in the water column (Stoddard *et al.*, 1986). The dominant factor affecting nutrients in the Study Area is the flux associated with the Hudson River outflow (Stanford and Young, 1988). This flux dominates the loading of nutrients to the inner Bight (HydroQual, 1989a; Stoddard *et al.*, 1986). Stoddard *et al.* (1986) summarized data from over 3,000 stations occupied between 1973 and 1981 in the greater New York Bight. This summary indicates that nutrients in the Bight typically show a winter maximum (period of lowest productivity) and summer minima. The amplitude of this cycle decreases seaward. Primary production is highest in the spring with a summer minima and secondary fall maxima. Most of the productivity occurs in the surface waters with decomposition of organic matter occurring in the bottom waters.

Generally, nutrient enrichment in the offshore coastal waters of New Jersey routinely causes elevated phytoplankton levels (HydroQual, 1989b). Stoddard *et al.* (1986) indicate that the enrichment could increase primary productivity by as much as 30%. Annual monitoring of the coastal waters off the eastern seaboard by EPA Region 3 clearly shows the effect of coastal outflows on chlorophyll enrichment (EPA Region 3, 1992a) and decreasing levels with increasing distance offshore including coastal New Jersey (Figure 3-53). Such enhancements are generally confined to the surface waters as the source of nutrient for phytoplankton growth are added above the seasonal pycnocline and density stratification limits exchange of nutrient rich bottom waters with surface waters. Under typical conditions, this same phenomena limits the availability of nutrients regenerated in the sediments from reaching the light-rich surface layer, thereby limiting the impact of sediment regeneration on coastal productivity during the summer months (Kelly, 1993;1995; Kelly and Turner, 1995).

In the past 10 years, nutrient loading to the Bight has decreased resulting in improved water quality. Evidence of this is the increase in dissolved oxygen levels in the Bight waters. Disposal of dredged material in the Study Area remains, as in the past, a minor source of nutrients to the Bight (see Section 3.2.1). Continued dredged material disposal in the Study Area is not expected to significantly affect the concentrations of nutrients in the Bight or the response of phytoplankton.

3.3.10.5 Contaminants

Contaminant concentrations in the water column of the inner New York Bight are generally low (Hanson and Quinn, 1983) and do not exceed marine water quality criteria. The low total suspended solids content (TSS) in the waters of this offshore region causes most contaminants to be present in the dissolved phase (EPA, 1992b; EPA Region 2, 1991). Recent data also show that the concentrations of metals (and by extension organic contaminants) in the water column decrease offshore from the mouth of the Harbor (Figures 3-54a and b).

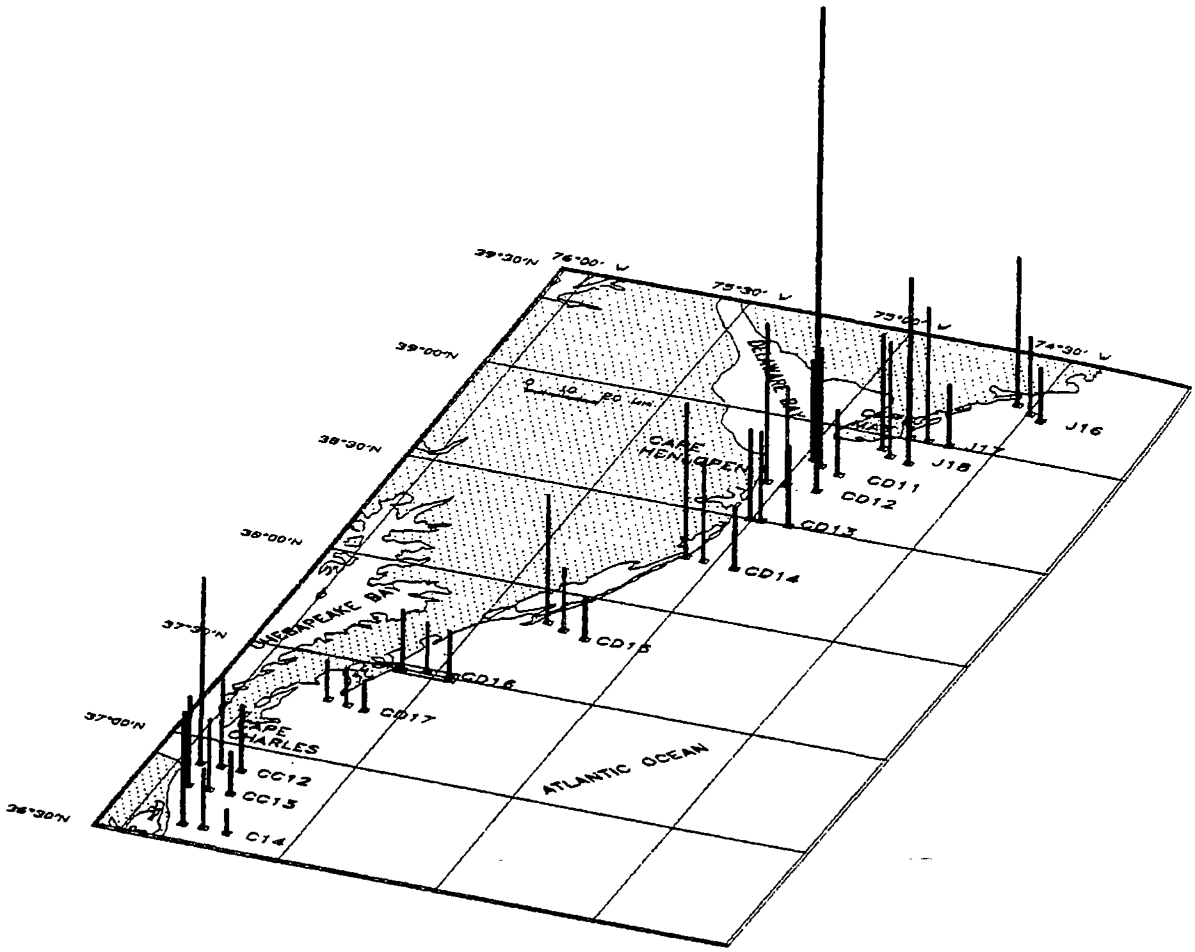

Figure 3-53. Spatial distribution of chlorophyll *a* in surface waters in the Mid-Atlantic Bight from New Jersey to Virginia Beach, VA from 1989 through 1992 (EPA Region 3, 1992a). Average summer concentrations show a consistent decreasing gradient in the offshore direction.

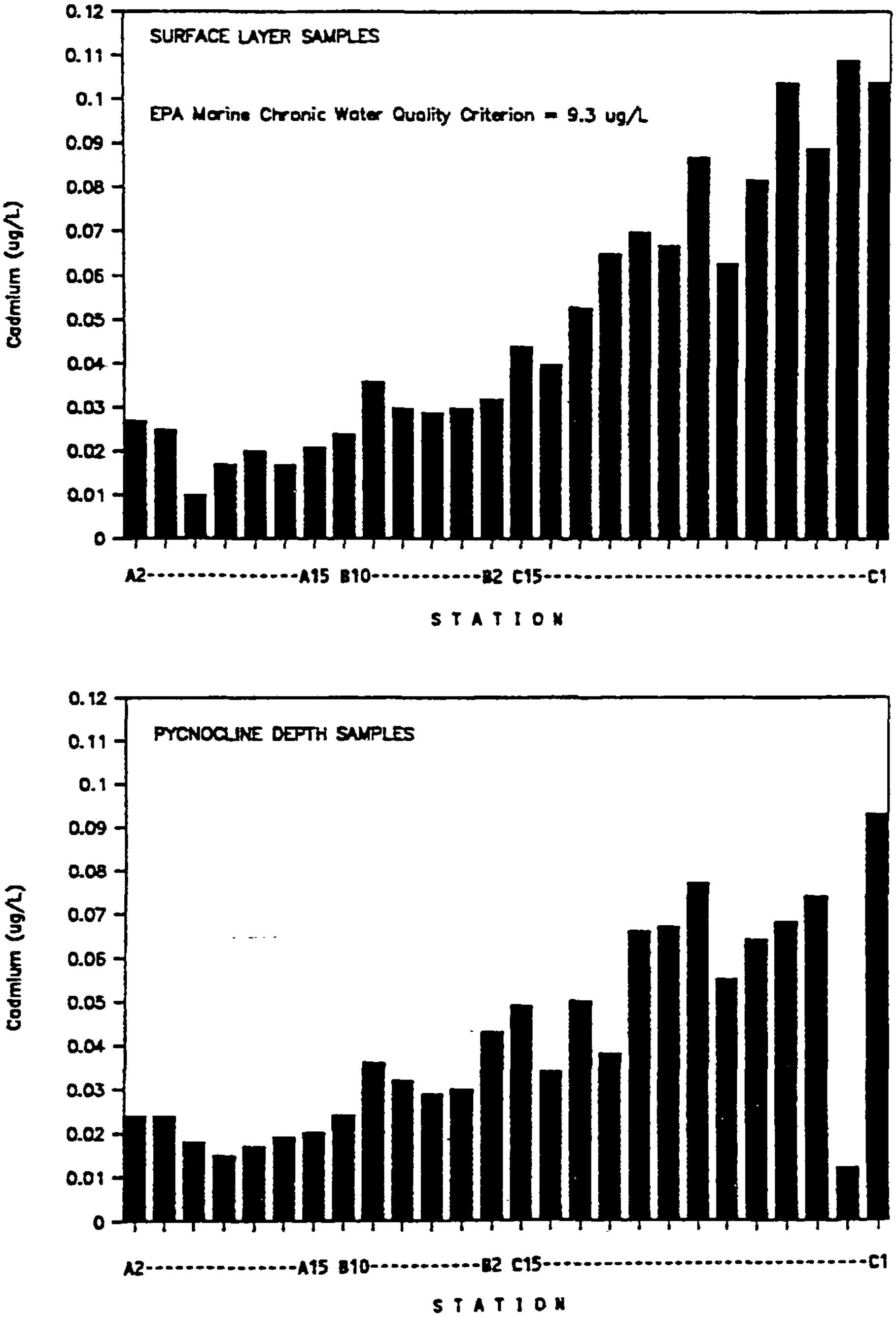

Figure 3-54a. Total recoverable cadmium concentrations in the surface and mid-depth water of the New York Bight in July 1988 (from HydroQual, 1989b). Stations A2 to A14 are along the outer boundaries of New York Bight; Stations B10 to B15 are along the boundaries of the New York Bight Apex; Stations C15 through C1 form a transect from the Apex into inner New York Harbor; Stations C10 through C15 are in the Study Area.

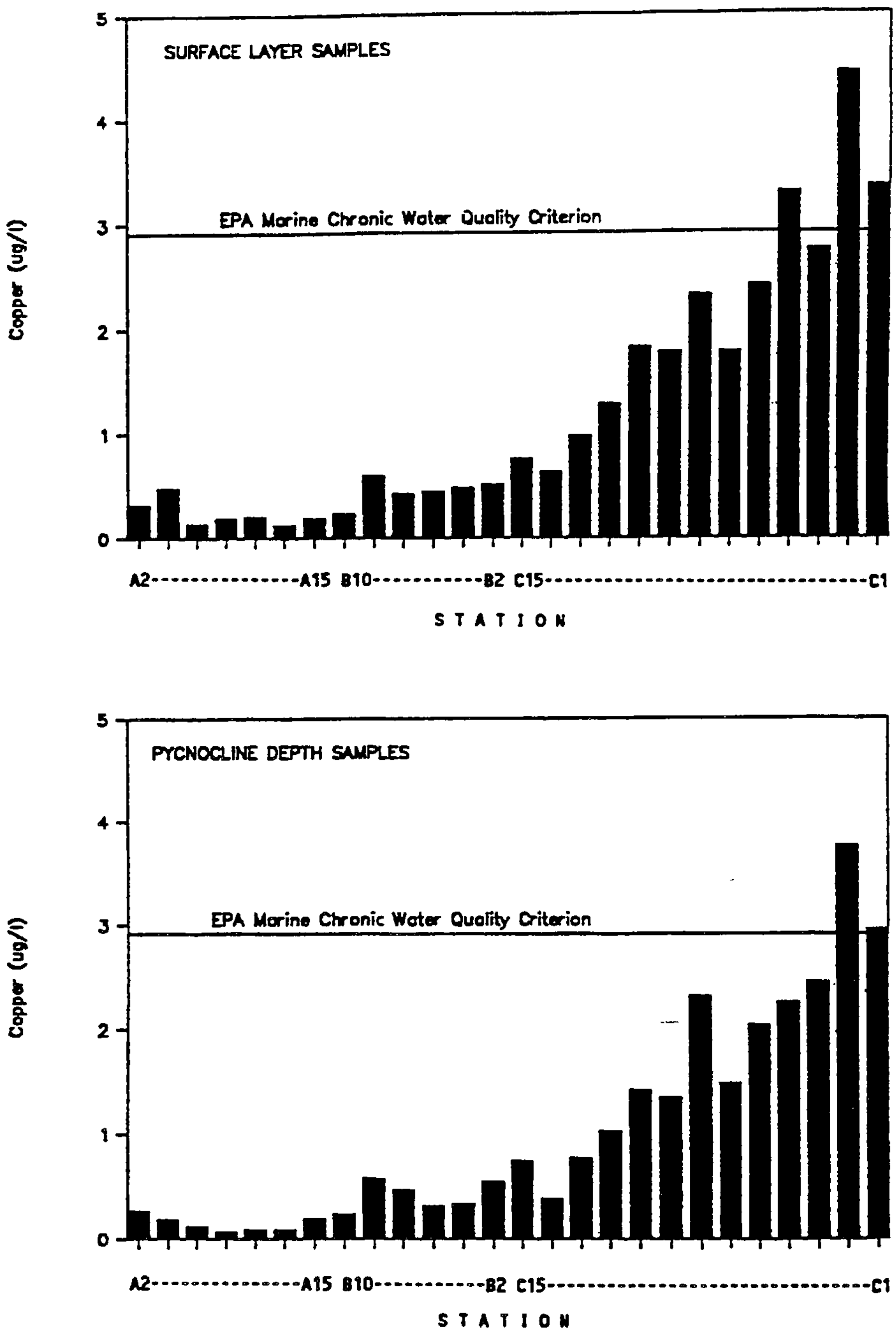

Figure 3-54b. Total recoverable copper concentrations in surface and mid-depth water of the New York Bight in July 1988 (from HydroQual, 1989b). Stations A2 to A14 are along the outer boundaries of the New York Bight; Stations B10 to B15 are along the boundaries of the New York Bight Apex; Stations C15 through C1 form a transect from the Apex into inner New York Harbor; Stations C10 through C15 are in the Study Area.

The decreasing offshore gradient (EPA Region 2, 1991; EPA Region 3, 1992a; HydroQual, 1989b; EPA, 1992b; Hanson and Quinn, 1983; Klinkhammer and Bender, 1981) directly reflects dilution of the contaminant concentrations in the Hudson River plume with seawater from the Bight region. Variations in this gradient may occur as the flow of the river changes and in response to other climatological factors that affect the mixing and transport regimes of the inner bight. The seasonal stratification of the water column also affects the vertical distribution of contaminants. For example, metals concentrations in surface waters are consistently higher than in waters from below the pycnocline. This reflects both the influence of the Hudson River outflow on the surface waters of the Bight and natural geochemical processes that transport metals through the water column. Repeated sampling of the water column in the vicinity of the MDS (Table 3-11) shows that metal concentrations in this area are low and reasonably constant. Thus, while the concentrations of contaminants in the Bight Apex and Study Area can range widely, their spatial and temporal distributions are reasonably predictable.

Table 3-11. Representative recent total metal concentrations measured in the water column of the New York Bight Apex and MDS. Concentrations are in ppb ($\mu g/l$).

Year/ Location	Ag_T	As_T	Cd_T	Cu_T	Ni_T	Hg_T	Pb_T	Zn_T
1988/ Bight Apex[a]	NA	NA	0.034 - 0.087	0.39 - 2.3	0.35 - 1.9	0.0011 - 0.010	0.045 - 0.87	1.7 - 9.3
1991/ Bight Apex[b]	0.0004 - 0.012	1.4 - 1.7	0.025 - 0.087	0.37 - 0.70	0.25 - 0.29	0.005 - 0.009	0.046 - 0.11	1.0 - 2.0
1992/ MDS[c]	NA	NA	NA	0.33 - 0.51	0.30 - 0.39	NA	NA	NA

[a]EPA, 1992b: Surface concentrations were higher than subsurface samples
[b]EPA, 1991: Single depth only; samples from January
[c]Dragos and Lewis, 1993

HydroQual (1989b) summarized water column PCB concentrations as falling in the range of 0.33 to 0.6 ppb in the late 1970s, but suggested that the levels might be high due to analytical artifacts. The measured background concentration of dioxin in the water column of the MDS is extremely low (<0.013 ng/l or <1/100th of one pptr) (Dragos and Peven, 1994). Further, Bopp *et al.* (1995) indicate the DDT concentrations in water column particulate matter are low and can be traced to atmospheric inputs rather than dredged material from the MDS.

The influence of dredged material disposal on Bight water quality is minimal. Recent time series sampling of dredged material plumes at the MDS have demonstrated that contaminant concentrations in the disposal plume immediately following disposal may briefly exceed water quality criteria. However, in these cases, the values quickly (<1 hour) return to background levels (Figure 3-55), well within the initial mixing period allowed under the ocean disposal regulations (Dragos and Lewis, 1993; Dragos and Peven, 1994). All observations of post-discharge water-column contaminant levels show localized, short-duration periods (<3 h) of elevated concentration.

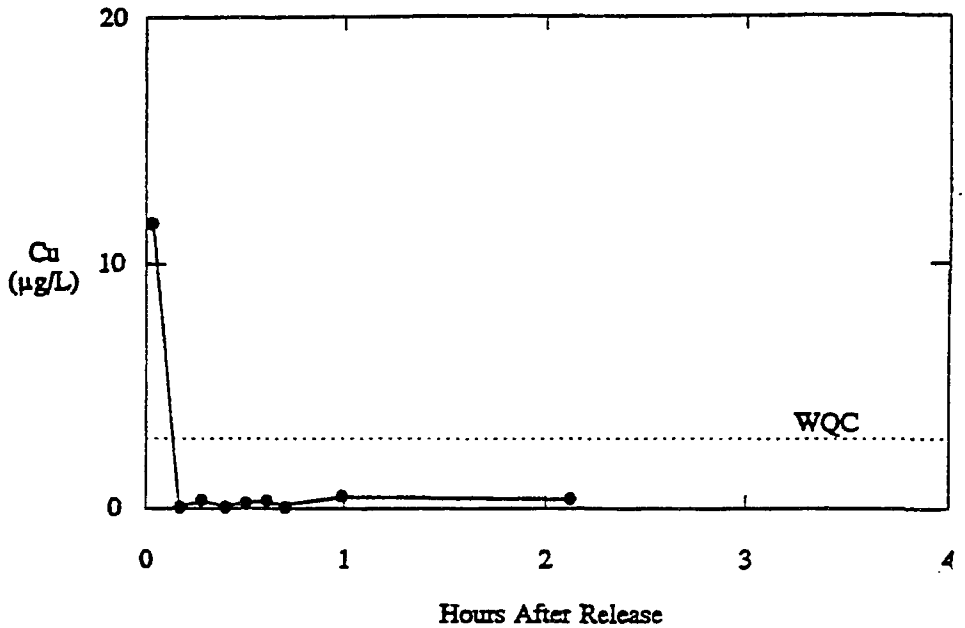

Figure 3-55a. Dissipation of contaminants after dredged material disposal. Time series show rapid decrease in copper following disposal in the MDS in June of 1992 (from Dragos and Lewis, 1993).

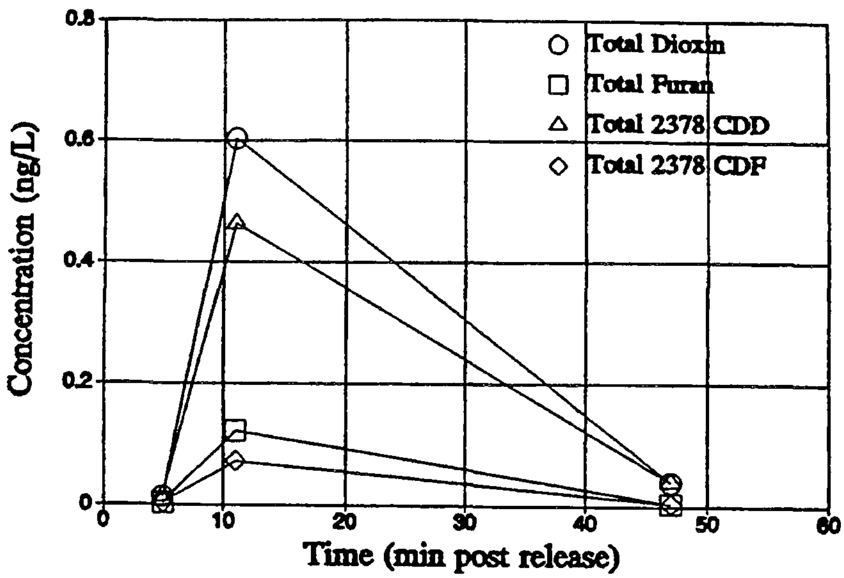

Figure 3-55b. Dissipation of contaminants after dredged material disposal. Time series show rapid decrease in dioxin concentration following disposal in June of 1993 (from Dragos and Peven, 1994).

3.4 Biological Environment

Understanding the inter- and intra-relationships of the affected biological environment is necessary before effective decision making can take place with regard to dredged material management in the New York Bight Apex. Similar to most other dredged material sites around the United States, the primary impacts of concern at the MDS and Study Area are those related to the benthic environment. In general, water column impacts are minimal and short-lived.

As discussed in Section 3.3.10, water quality in the Study Area/MDS is good and meets applicable marine water quality criteria. Contaminants of concern which are detected in the water column are at low concentrations and/or are associated with suspended sediment resulting from the Hudson River outflow or dredged material disposal events. By all measures, background exposure for pelagic organisms to anthropogenic contaminants in the Study Area and MDS is low (refer to Section 3.3.10.5).

The information in Section 3.4 characterizes the present benthic biological environment at the MDS and Study Area. The benthic environment is the portion of the ecosystem most likely to be affected by current dredged material disposal and management and by the possible remediation of bottom areas found to be degraded by historic disposal activities. Section 3.4 primarily focuses on the current condition of benthic infauna and epifauna and recreational and commercially important fish and shellfish — the two main ecological and socioeconomic categories of concern within the Study Area. Particular attention is paid to the possible effects bioaccumulation and toxicity found in the surface sediments of the Study Area, including the potential for transfer of bioavailable contaminants to higher trophic levels.

SEIS Chapter 3 Sections Characterizing Elements of the Biological Community

- Plankton Community (Section 3.4.1)
- Benthic Invertebrates (Section 3.4.2)
- Fish and Shellfish (Section 3.4.3)
- Marine and Coastal Birds (Section 3.4.4)
- Marine Mammals (Section 3.4.5)
- Other Concerns (Section 3.4.6)

The biological environment in the New York Bight Apex can be divided into two components: (1) the water column or pelagic system and (2) the benthic system associated with the seafloor.

Water Column/Pelagic System. Communities that inhabit the water column over the Mud Dump Site and the Study Area range from innumerable species of phytoplankton and zooplankton, to schools of fish and squid, to occasional marine mammals and reptiles. In general, pelagic organism distribution is determined by temperature, water currents, light penetration, and food/nutrient availability. The dynamics of these factors and the resulting regional and local distribution of pelagic organisms in the New York Bight Apex varies through the course of a typical year. However, all available data on the water-column environment indicate that pelagic organisms of the MDS and Study Area are more affected, both positively and negatively, by large-scale coastal processes rather than by existing benthic conditions or management of the MDS. The exceptions are semi-demersal fishes (e.g., silver hake) whose distributions are loosely correlated to bottom type. These fish and others are discussed further in Section 3.4.3.

Benthic System. The benthic biological system is composed of infauna and epifauna. Infauna are organisms such as worms and clams that live within the sediments. Epifauna are organisms such as crabs, lobsters, and mussels that live on the sediment surface or attached to hard substrates (e.g., rocks and reefs), or demersal fish which are strongly associated with the bottom. In the Study Area, distinct areas of sand and sandy mud sediments predominate, with distinctive infaunal and epifaunal communities associated with each sediment type. Most species comprising the infaunal communities are small burrowing or tube-dwelling organisms that live in very close association with the sediment. These organisms are often important prey for large epifauna and finfish.

Benthic infauna of the Study Area are generally well known, having been sampled and analyzed by numerous studies. Motile sediment epifauna (crabs, lobster and bottom fish) are somewhat less well known, as the data for these organisms are primarily from fishery statistics collected and compiled by State and Federal agencies. Least known, in the quantitative sense, are the epifauna that are attached or otherwise strongly associated with the rocks, reefs and other hard substrates in the Study Area. These hard-substrate organisms are found only in the relatively few (and understudied) hard substrate areas of the Mud Dump Site and Study Area.

3.4.1 Plankton Community [40 CFR Section 228.6(a)(9)]

Plankton are small free-floating organisms that primarily drift with ocean currents, in contrast to fish and marine mammals that actively swim. Although most plankton are microscopic and short-lived, they play an important role in the ocean as the base of the food chain for all of the ocean's larger herbivores and carnivores. Plankton also have key ecosystem roles in the distribution, transfer, and recycling of nutrients and minerals in the ocean. The major processes that control plankton distribution, particularly phytoplankton distribution, are water currents, temperature, nutrients, and light penetration.

The New York Bight is characterized by temperature extremes that result in a mixed water column during the winter and a stratified water column in the summer. These distinct seasonal differences are responsible for the seasonal changes in phytoplankton abundance (Yentsch, 1977). During the winter, when the water column is cold and vertically homogenous, nutrients in the bottom waters are mixed into the surface waters which have become depleted during the previous summer months. In the spring, the redistribution of nutrients and increasing daylight periods produce phytoplankton blooms, followed shortly afterwards by increases in the local zooplankton populations that graze on the phytoplankton. Correspondingly, in the fall and early winter, nutrients in the upper zones of the water column are depleted, photoperiod shortens, and the plankton abundance decreases throughout the Bight (see Figure 3-56).

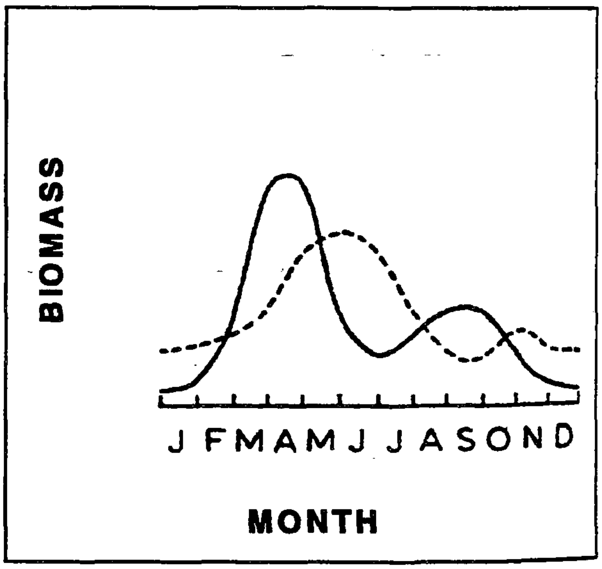

Figure 3-56. Seasonal cycles of phytoplankton (solid line) and zooplankton (dashed line) community biomass in the North Atlantic (modified from Parsons *et al.*, 1977).

The following summary of phytoplankton and zooplankton distribution in the New York Bight and the New York Bight Apex is based on studies conducted in the late 1960s to early 1970s, as described by Malone (1977).

3.4.1.1 Phytoplankton

Malone (1977) lists 36 species of phytoplankton as abundant in the New York Bight Apex during the course of a typical year. Total phytoplankton densities in the apex are highest in July and lowest in November, with diatoms dominating in cold weather months and chlorophytes dominating in the warm weather months. In July, the chlorophyte, *Nannochloris atomus,* is dominant with the largest abundance at the mouth of the Hudson River and the southern shore of western Long Island.

Nuisance Species **[40 CFR Section 228.6(a)(10)].** Nuisance algae in the waters of the New York Bight can include a number of phytoplankton species that can cause "red tide" outbreaks in shellfish and fish, discoloration of water, and other undesirable effects (Anderson, 1994). There are no documented incidents of dredged material disposal causing a bloom of nuisance algae at any open water disposal sites in U.S. waters.

HydroQual (1989b) conducted a study which included a review of nuisance algae in the greater New York Bight, and summarized reported red, green, and brown tides in the coastal regions. As with blooms in other coastal regions, nuisance algae blooms in the Bight are generally confined in coastal lagoons and embayments that are subject to eutrophication and restricted exchange with low-nutrient ocean water. When information is available on these outbreaks, it is most often qualitative and generally includes only a description of water color (i.e., greenish, yellowish brown). The furthest offshore reports of nuisance algae blooms in the Bight are about three miles (4-5 km) offshore (Table C-1 in HydroQual, 1989b).

The nuisance algal species most frequently identified in the coastal waters of the Bight are *Gymnodinium* sp., *Katodinium rotundum* and *Prorocentrum redfieldi*, and *Nannochloris* sp. Other species that are common to temperate waters that may occur in the area include *Ceratium longipes, Gyodinium spirale, Dinophysis* spp., and *Protoperidinium* (HydroQual, 1989b).

Nuisance algae blooms occur primarily in the summer (May through October) when coastal waters are warm and the photoperiod is long. Anderson and Keafer (1995) evaluated the distribution of the red tide species *Alexandrium* and the factors that can affect bloom outbreaks and concluded that the locus of red tide outbreaks is primarily in the shallow embayments. Anderson and Keafer (1995) also concluded that blooms of the toxic *Alexandrium* species are driven by event-scale variability (i.e., wind and rainfall/runoff variability), which plays a significant role in the yearly response of this organism. More specifically, localized blooms are largest when physical forcing functions in the system are weak and embayment flushing is reduced. These observations and conclusions are generally supported by the reported timing, distribution, and abundance of nuisance algae in the coastal New York Bight, conditions that are not typically found in the offshore waters of the Bight. In general, the potential for nuisance algae blooms in the Study Area have been significantly reduced since the mid 1980s. Nutrient loading to the Bight has been significantly reduced (see Section 3.2.1) with the cessation of sewage sludge disposal, increased treatment of permitted sewage discharges, and increased control of runoff in the New York/New Jersey metropolitan area. Dredged material is not a significant contributor of nutrient loading in the Bight (Section 3.2.1).

3.4.1.2 Zooplankton

Malone (1977) found that very few comprehensive studies have been conducted on zooplankton in the New York Bight. In general, zooplankton populations in the inner New York Bight are dominated by four genera of copepods: *Oithona, Paracalanus, Pseudocalanus,* and *Centropages. Oithona* and *Pseudocalanus* are abundant year round, whereas *Centropages* and *Paracalanus* are seasonally abundant.

Other categories of zooplankton that are abundant seasonally or at low densities throughout the year include, chaetognaths, bivalve larvae, tunicates, and siphonophores. Chaetognaths are present throughout the year, with peak abundances in near-bottom water during May through July. Bivalve larvae populations peak in the inner Bight in January through March, and again in August through November. Tunicates are most abundant in the fall. Siphonophores are abundant during all seasons, except for winter. In general, inner Bight zooplankton abundance peaks approximately one month after the inner Bight phytoplankton communities.

Ichthyoplankton and Other Meroplankton. Fish and shellfish eggs and larvae (ichthyoplankton and meroplankton) comprise a large component of the zooplankton community in the New York Bight and are directly related to the presence and health of the area's fish and shellfish stock. As can be expected, ichthyoplankton and meroplankton abundance is directly linked to the spawning cycles of the adult populations. Since most fish and shellfish spawn in the Bight between the spring and summer (with peak `pawning in the spring), egg abundance during this period is relatively high. The transition period from egg to fish larvae varies by species. However, in general, fish and shellfish larvae abundance peaks in the Bight during the late spring (NOAA, 1988b). Fish larvae feed on copepods, which are herbivors, which links fish stocks to phytoplankton production. Even though this linkage is present, NOAA (1988b) concluded that standing stocks of fish are rarely related to the abundance of zooplankton and phytoplankton prey.

Ichthyoplankton and other meroplankton can be herbivorous, carnivorous, or omnivorous; some species subsist entirely on their larval yolk sacs (lecithotrophic) until they reach juveniles stages. Ichthyoplankton typically feed on smaller zooplankton, particularly copepods, such as *Calanus finmarchicus* and *Pseudocalanus minutus* (NOAA, 1988b). Because copepods are herbivores[4] that feed on phytoplankton, adult year classes of fish stocks are indirectly linked to their Year-0 regional phytoplankton productivity (NOAA, 1988b).

3.4.2 Benthic Invertebrates [40 CFR Sections 228.6(a)(2) and 228.6(a)(9); 228.10(b)(2), 228.10(b)(3), and 228.10(b)(5)]

Most benthic invertebrates of the Study Area are small-bodied infaunal species, which quickly respond to changes in physical and chemical conditions. In contrast, some larger sized epifauna (e.g., lobsters and crabs) are generally more motile, migratory, and resilient to local or small scale physical and chemical changes because of their habitat range, feeding behavior, or biology.

As discussed in Section 3.2.1, benthic infaunal communities of the Study Area may have been adversely affected in the past by dredged material disposal, historical disposal of other wastes (e.g., sewage sludge), and pollutant discharges through the Hudson River plume and from coastal New Jersey and Long Island. However, conditions in the Study Area could not be strongly correlated to any of these sources. While disposal of dredged material has caused direct mortality of individual organisms by burial (this will be discussed in Section 3.4.2.4), it also is important to recognize that this disposal has caused persistent long-term changes to sediment character in the Study Area, which, in turn, has affected recruitment and recolonization of infaunal communities.

[4] Some copepod species are omnivores (e.g., *Acartia* sp.)

Recent data from the Study Area[5], indicate there are two generally distinct infaunal communities composed of different species of small bivalves (clams), polychaetes (worms), echinoderms (sand dollars), and crustaceans (amphipods). The major habitat features of the two benthic communities (referred to as Community Groups "A" and "B," and discussed in detail in Section 3.4.2.2) appear to be water depth and sediment grain size. The mean total abundance of the benthic infauna ranges from 4,325 to 128,233 m^2 and the mean total number of species per station ranges from 11.0 to 34.7 species (Battelle, 1996a). While there are non biological measures and lines of evidence to qualify some areas of the Study Area as impacted by anthropogenic activities (see Section 3.3.9) and labeled as "degraded," data on the two infaunal communities do not definitively show that either community is adversely affected by sediment quality. Both infaunal communities are generally abundant and have relatively rich species diversity.

Utility of Benthic Invertebrate Communities for Environmental Monitoring

Of the many aquatic communities that can be studied in conjunction with environmental monitoring, benthic invertebrates are particularly useful for evaluating anthropogenic impacts. As stated by Bilyard (1987), study of the benthos affords a monitoring program with relatively easily obtained quantitative data, the variability of which can be estimated. Because many benthic invertebrates are not highly migratory, the data are site-specific. This is important in assessing impacts caused by specific types of disturbances. Additionally, many benthic community constituents are very sensitive to anthropogenic impacts (Thomas, 1993; Conlan, 1994). The benthos also represents an important biological community that interacts not only with communities in the overlying waters via food chains (e.g., Steimle *et al.*, 1994), but also with the physical environment, especially in the case of infaunal communities (e.g., Rhoads and Boyer, 1982).

A useful method for understanding the present infaunal communities of the Study Area is to compare data collected by recent and historical studies. By characterizing the previously existing infaunal communities to that of the recent communities, one can correlate the approximate type and degree of community responses to physical and chemical changes that have occurred in the Study Area benthos. Unfortunately, direct quantitative comparisons between historical studies and current studies of the Study Area are not possible because of substantial differences in the focus of the past studies, the variety of sampling and analytical methods used, and the availability of original data (as opposed to available data summaries).

Many of the historical studies focused on Bight-wide and Bight Apex infaunal communities and typically included very few stations within the borders of this SEIS's Study Area. However, despite these differences, the historical studies allow general, qualitative comparisons to be made that are useful for understanding how the current infaunal communities in the Study Area developed.

[5] **Note to Readers:** The Battelle (1996a) study of infaunal communities was limited to samples obtained from the approx. 23-nmi^2 rectangular box that encompasses the current MDS (Subarea 1 in Figure 3-3). After the infauna sampling of this 23-nmi^2 box was conducted for the Battelle study, the Study Area for this SEIS was enlarged by the addition of a 7-nmi^2 rectangular box (Subarea 2) to the northwest. All references to the Study Area in Section 3.4.2 of this SEIS refer to only the original 23 nmi^2 SE box.

3.4.2.1 Studies of Infaunal Communities in the New York Bight Conducted Before 1990

Prior to 1960, most studies conducted within the New York Bight were concerned with inshore environments and are not directly relevant to the MDS (Pearce *et al.*, 1981). In the late 1960s, intensive studies of the New York Bight began, largely under the sponsorship of NOAA/NMFS. These studies continued into the 1970s and 1980s and, although not an integrated monitoring program, provided insights into historical patterns of abundance, diversity, and taxonomic dominance within the infaunal communities of the Bight.

Data Comparability Problem Among Infaunal Community Studies

Substantial methodological differences among the various studies conducted in the Bight [summarized in Wilber and Will (1994)] preclude direct comparisons of the data from many of the studies. For example, during studies conducted prior to 1979, sediment samples were rinsed over 1.0 mm-mesh sieves, whereas during most studies conducted after 1979, samples were rinsed over 0.5 mm-mesh sieves. The use of smaller mesh sieves typically results in the retention of more infaunal animals (and probably more species) than the use of larger mesh sieves. Also, samples obtained during most studies conducted before 1994 were collected by using 0.1-m^2 Smith MacIntyre or modified Van Veen grab samplers. During surveys conducted in 1994, 0.04-m^2 Young-modified Van Veen samplers were used. Finally, since most of the studies conducted in the Bight focus on the entire New York Bight or the New York Bight Apex, they do not tend to have enough stations within the boundaries of the MDS/Study Area to provide a precise characterization of the area.

NMFS studies completed between 1968 and 1971 (summarized in Pearce *et al.*, 1981) concluded that disposal of sewage sludge and dredged material had impacted habitat quality in the Bight Apex, and that an area in the center of the Christiaensen Basin was "devoid of benthic macrofaunal species." Stations with reduced numbers of infauna also were found where there were high levels of chemical contaminants.

During the Marine EcoSystems Analysis (MESA) Program conducted by NOAA from 1973 to 1976, benthic samples were collected from a grid of 65 stations in the New York Bight Apex; six of these were located within the boundaries of the present SEIS Study Area. The MESA studies led to the conclusion that species diversity was very low in areas of highly organic sediments. These sediments were generally thought to be heavily impacted by sewage sludge and dredged materials deposited in the Bight. Most of this region of reduced diversity was located in the Christiaensen Basin, but extended westward to include the northeastern portion of the Study Area. Pearce *et al.* (1976) also reported that amphipods were absent from these carbon-rich sediments, although certain deposit-feeding, "pollution-tolerant" species were present.

Caracciolo and Steimle (1983) used the same MESA data set to construct contour diagrams showing the distributions of various sedimentary and infaunal characteristics within the Bight. These contour diagrams implied that the entire MDS area had moderately low species diversity and low infauna abundance, features often interpreted as evidence of an impacted benthic environment. Among the species reported to occur at relatively high densities in the MDS/Study Area were the polychaetes *Nephtys incisa*, *Prionospio steenstrupi*, and *Pherusa*, and the nutclam *Nucula proxima*. The sand dollar *Echinarachnius parma* and the amphipod *Pseudunciola obliquua* were not abundant in the area. Based on these observations, Caracciolo and Steimle concluded that the infaunal communities in the vicinity of the sewage-sludge and dredged-material disposal sites were adversely altered.

Four stations that were part of the Northeast Monitoring Program (NEMP) conducted by NOAA from the late 1970s through the mid 1980s were located within the Study Area (Reid *et al.*, 1982). Reid *et al.* (1991) included data from only one station (Station 4), which is located in the northwestern corner of the Study Area and provides some degree of historical reference for that area. Reid *et al.* reported that during the period from 1979 to 1985 there was no consistent pattern of taxonomic dominance, and infaunal abundance varied temporally. Reid *et al.* concluded that the fauna at this station was variable but not altered compared to that of the sewage dumpsite. They also remarked that the infauna variability might have been related to the substantial sediment heterogeneity observed in the area.

In the late 1980s, the NMFS designed and implemented a study to monitor habitat changes within the Bight in response to the cessation of sewage sludge disposal at the 12-Mile Site. Two sets of stations were incorporated into the design (Studholme *et al.,* 1995). Broadscale stations provided for Bight-wide coverage and replicate stations focused on monitoring the response in the Christiaensen Basin close to the sewage disposal site. Three of the broadscale stations were located within the Study Area, but data collected from them have not been presented in summary reports on the infauna (Reid *et al.,* 1991;1995). Analysis of infauna data from the replicate stations revealed that some attributes of the benthos responded to the cessation of sludge disposal, whereas others did not (Reid *et al.,* 1995). Significant increases in the numbers of species, numbers of amphipod species, and numbers of amphipod individuals at the station closest to the sludge disposal site (NY6) were detected following the transfer of sewage sludge disposal to the 106-Mile Site. Furthermore, an expected decrease in the abundance of an opportunistic polychaete worm *Capitella* [often considered an indicator of organically enriched sediments (Pearson and Rosenberg, 1978)] was detected. Even though these changes implied improved habitat conditions, several other measures of benthic conditions (e.g., biomass of certain species such as the worms *Pherusa affinis* and *Nephtys incisa*) did not increase in the Christiaensen Basin following phaseout of sludge disposal (Reid *et al.,* 1995). While Reid *et al.,* (1995) suggested that there was some indication that recovery of the benthos in the vicinity of the 12-Mile Site had started, they drew no conclusions that were specifically related to the MDS.

Mud Dump Site Infaunal Community Before 1990

Based on studies conducted before 1990, the MDS infaunal communities were characterized as:

- Having low infaunal species diversity and abundance, and
- Consisting of a single community type that was associated with fine, highly organic, contaminant-laden sediments.

The original site-designation EIS (EPA, 1982) characterized the MDS as having "low absolute numbers of individuals" of infaunal animals as a result of disposal activities. This conclusion was reached, at least in part, because of the historical generalizations of the area provided by Pearce *et al.* (1976) and Caracciolo and Steimle (1983) that were based on limited sampling in the vicinity of the site. The EIS also assessed the effects of dredged-material disposal on the benthos by analyzing two sets of unpublished data. Each of the two sets included data from about 8 to 10 stations that were within the present boundaries of the Study Area. The analysis and subsequent presentation of these data sets was restricted to infaunal species associated with "fine-grained sediments with high organic carbon content" (EPA Region 2, 1982). The first data set was derived from samples collected by the Virginia Institute of Marine Science during surveys of the New York Bight conducted between 1973 and 1976. The EIS reported that the highest densities of the species that were analyzed occurred along the axis of the Hudson Shelf Valley extending northward between the MDS and the sewage sludge disposal site. One species, the nutclam *Nucula proxima,* was abundant along the eastern boundary of the Study Area. The second data set was taken from the results of surveys conducted at the MDS in 1979 by EPA and Interstate Electronics Corporation. From this analysis, the EIS reported that low species density occurred within the boundaries of the MDS and extended north and south of the site. Densities increased to the west and east of the site and were highest in the Hudson Shelf Valley and Christiaensen Basin. Based on these two studies, the EIS concluded that there was temporal consistency in the distribution of dominant taxa and the effects of dredged-material disposal were generally restricted to the MDS.

3.4.2.2 Characterization of the Study Area Based on Studies Conducted After 1990

In August 1992, EPA conducted a rapid bioassessment of the benthic resources at several areas in the New York Bight Apex that were being considered as replacement sites for the MDS (Battelle, 1993). This survey used trawls to collect qualitative data on epibenthic crustaceans and grab samples for a qualitative analysis of the infauna. Trawls were also used to collect fish for analyses of the relationship between fish diets and the benthos. Three trawl transects, along each of which three infaunal grab stations were placed, were located in the southwest part of the Study Area. Two additional trawl transects were located south of the southern boundary of the Study Area. The study concluded that the area encompassing the southern part of the Study Area had a *Nucula proxima-Nephtys incisa* infaunal community at most stations and that amphipods were not among the dominant taxa. Thus, the community type found in the southern part of the Study Area was characteristic of that found in fine-grained sediment areas.

High-resolution sampling of the Study Area conducted in October 1994 (Battelle, 1996a) revealed several major differences relative to the historical picture of the MDS area. Perhaps the most striking result of this study was that the infaunal community in the Study Area was biologically heterogeneous and, in general, was abundant and diverse. Several biological features showed considerable variability on relatively large (i.e., among-stations), as well as relatively small (i.e., within-station) scales. Total infaunal abundance among stations varied from slightly more than 4,000 to more than 128,000 individuals/m^2 (Figure 3-57). Annelids and molluscs were the dominant major taxa, respectively representing about 71% and 18% of all individuals collected in the Study Area. The range of total species per station ranged from about 11 to 35 (Figure 3-57). Of these species, 62% were annelid worms, 17% were crustaceans, and 11% were molluscs. Species diversity per station, as measured by the Shannon-Weiner index (*H'*), ranged from very low (mean values <1.0) to moderate (mean values between 3.0 and 3.5; Figure 3-57).

Delineation of Infaunal Community Groups A and B. In addition to varying in numerical properties, the infaunal communities within the Study Area also differed substantially in composition. The strongest evidence for this observation was provided by the Bray-Curtis similarity analysis that revealed two primary infaunal communities (termed Group A and Group B; Figure 3-58) that bore little taxonomic resemblance to each other.

Infaunal Community Group A. The general biological features of Group A (Table 3-12; Figure 3-59) were high infauna abundance, moderate numbers of species per sample, and moderate species diversity. Dominant taxa included the nutclam *Nucula proxima* and the polychaetes *Prionospio steenstrupi* and *Pherusa* (Figure 3-60). Other polychaetes also were prevalent. Abundances of the polychaete *Polygordius*, the sand dollar *Echinarachnius parma*, and the amphipod *Pseudunciola obliquua* were low. Though variable, chemical contaminant levels, as indicated by the number of ER-L exceedances (see Section 3.3.9.3), were high (Table 3-12) at Group A stations. Group A samples were collected at 22 stations that were located in two noncontiguous areas of the Study Area (Figure 3-61). One set of Group A stations was located along the west-central boundary of the Study Area; the second set was located along the eastern half of the Study Area and included stations in the eastern part of the MDS. In general, Group A samples were collected from

> **Infaunal Community at the Mud Dump Site and Study Area**
>
> Based on the October 1994 study, the MDS and Study Area infaunal communities can be characterized as:
> - Having a high degree of spatial heterogeneity;
> - Consisting of a community type "Group A" that is (1) associated with relatively deep, muddy sediments of high organic carbon and high chemical contaminant content, and (2) consisting of a community that is generally abundant and relatively species rich; and
> - Consisting of a community type "Group B" that is (1) associated with relatively shallow, sandy sediments of low organic carbon and low chemical contaminant content, and (2) consisting of a community that is generally abundant and relatively species rich.

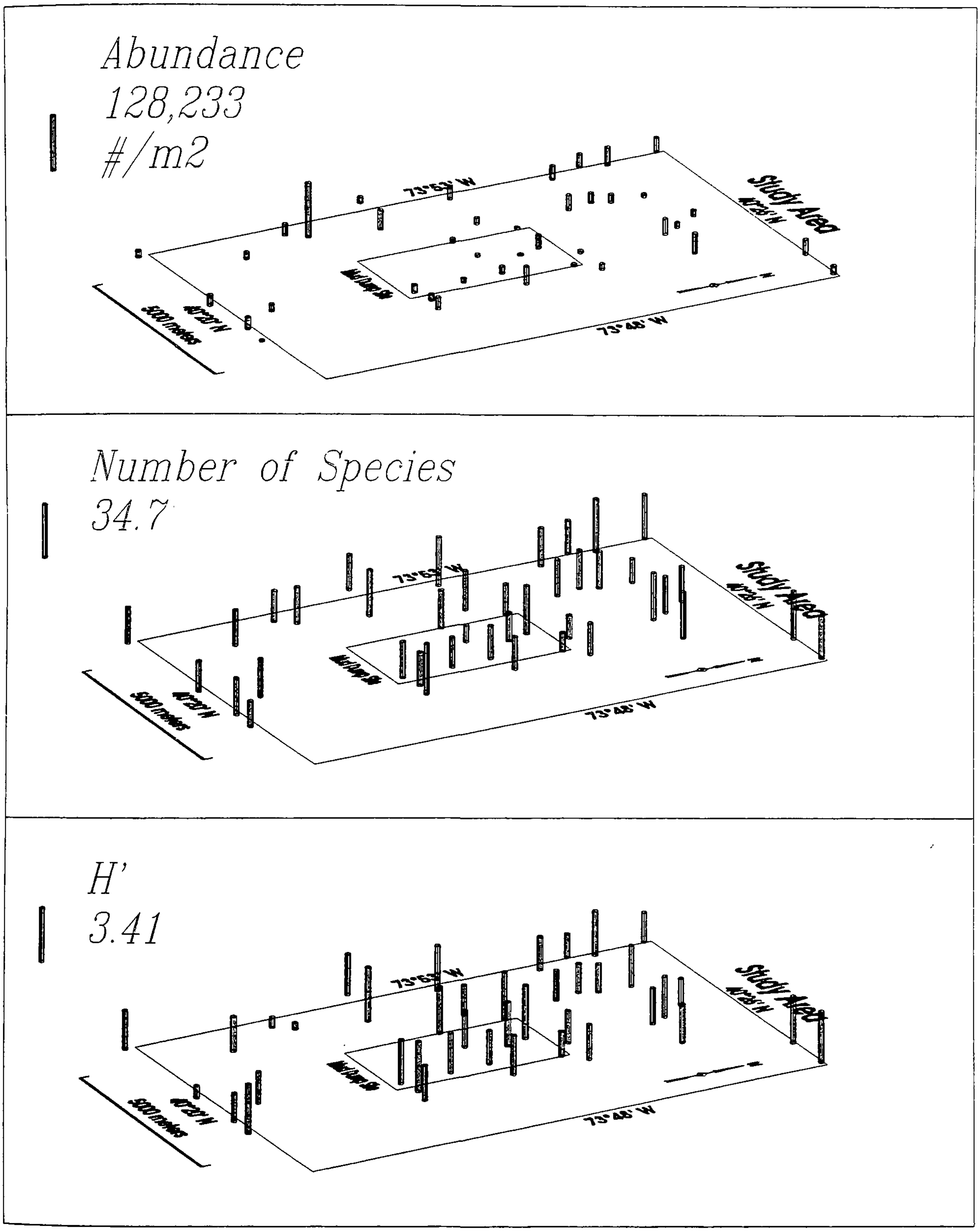

Figure 3-57. Geographic distribution of mean total infaunal abundance, numbers of species per replicate, and species diversity per replicate in the October 1994 Study Area (Subarea 1) (from Battelle, 1996a).

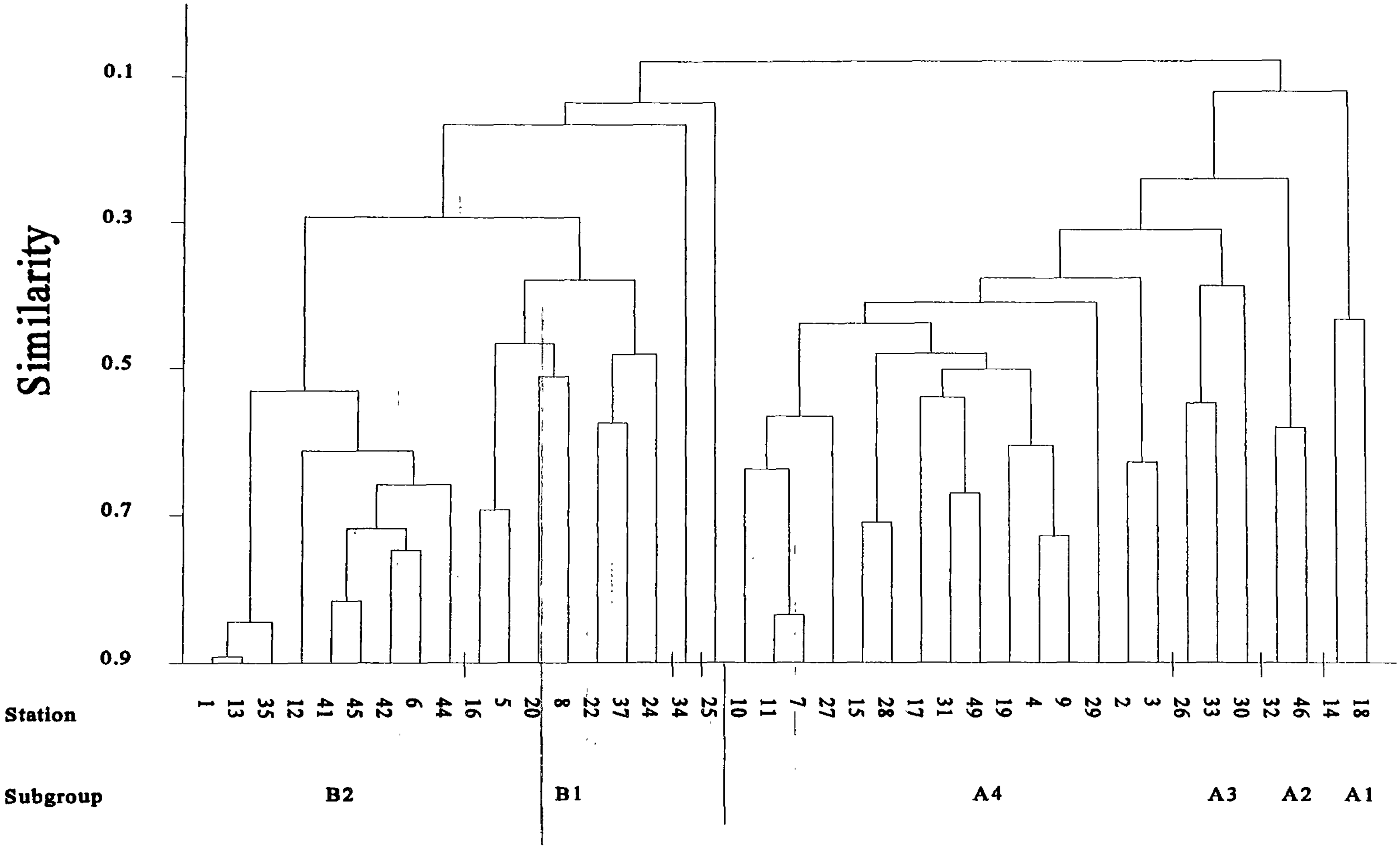

Figure 3-58. Dendrogram resulting from clustering of stations based on Bray-Curtis similarity (from Battelle 1996a).

Table 3-12. General geophysical and biological properties of the two main cluster groups resulting from Bray-Curtis similarity analysis (from Battelle 1996a). The mean (± standard deviation) for each value are provided for each group.

Cluster Group	Geophysical Properties				Biological Properties				
	Depth (m)	Mud (%)	Sand (%)	TOC (%)	*Ampelisca* Survival (%)	Total Abundance (#/m²)	Species (#/Sample)	Species Diversity (H')	Faunal Characteristics
A	27 (±4)	42 (±29)	58 (±29)	1.4 (±1.0)	33 (±36)	25,489 (±13,870)	25 (±6)	2.6 (±0.5)	*Nucula, Prionospio*, and *Pherusa* dominant; *Monticellina, Polydora quadrilobata, Cossura*, and *Phoronis* common; amphipods moderately, common.
B	20 (±4)	3 (±5)	97 (±5)	0.04 (±0.12)	68 (±29)	24,753 (±27,612)	23 (±4)	2.0 (±0.7)	*Polygordius*, and *Echinarachnius* dominant; *Pseudunciola, Prionospio*, and oligochaetes common; amphipods common.

relatively deep areas, and were mostly composed of muddy sediment with high organic content (Table 3-12; Figure 3-62).

Infaunal Community Group B. The general biological features of Group B (Table 3-12; Figure 3-59) were high infaunal abundance, moderate numbers of species per sample, and moderately low species diversity. Dominant taxa included the polychaete, *Polygordius*, the sand dollar, *Echinarachnius parma*, and the amphipod, *Pseudunciola obliquua* (Figure 3-63). Also common was the polychaete *Prionospio steenstrupi*, although it was much less abundant at Group B stations than it was at Group A stations. Chemical contaminant levels, as indicated by the number of ER-L exceedances, at Group B stations were low (Table 3-12).

Group B samples were collected at 18 stations that were located in relatively shallow waters, with sandy sediments that had very low organic content (Table 3-12; Figure 3-62). Stations comprising Group B were located in a band that extended from the northwest corner of the Study Area, through the center of the Study Area (including the western side of the MDS), to the southern boundary of the Study Area (Figure 3-61). The grouping of these stations into a relatively contiguous north-south band through the Study Area is coincident with the top of the historic disposal mound and natural sediment in the southern part of the Study Area. The southwestern corner of the MDS, a region that had a considerable area of fine sediments (Figure 3-16) and had recently received capped dredged material, was not sampled in October 1994. Because of the strong association between infauna cluster groups and sedimentary characteristics, the infauna of the southwestern part of the MDS might be expected to be more similar to that of Group B than that of Group A once deposited sands are recolonized.

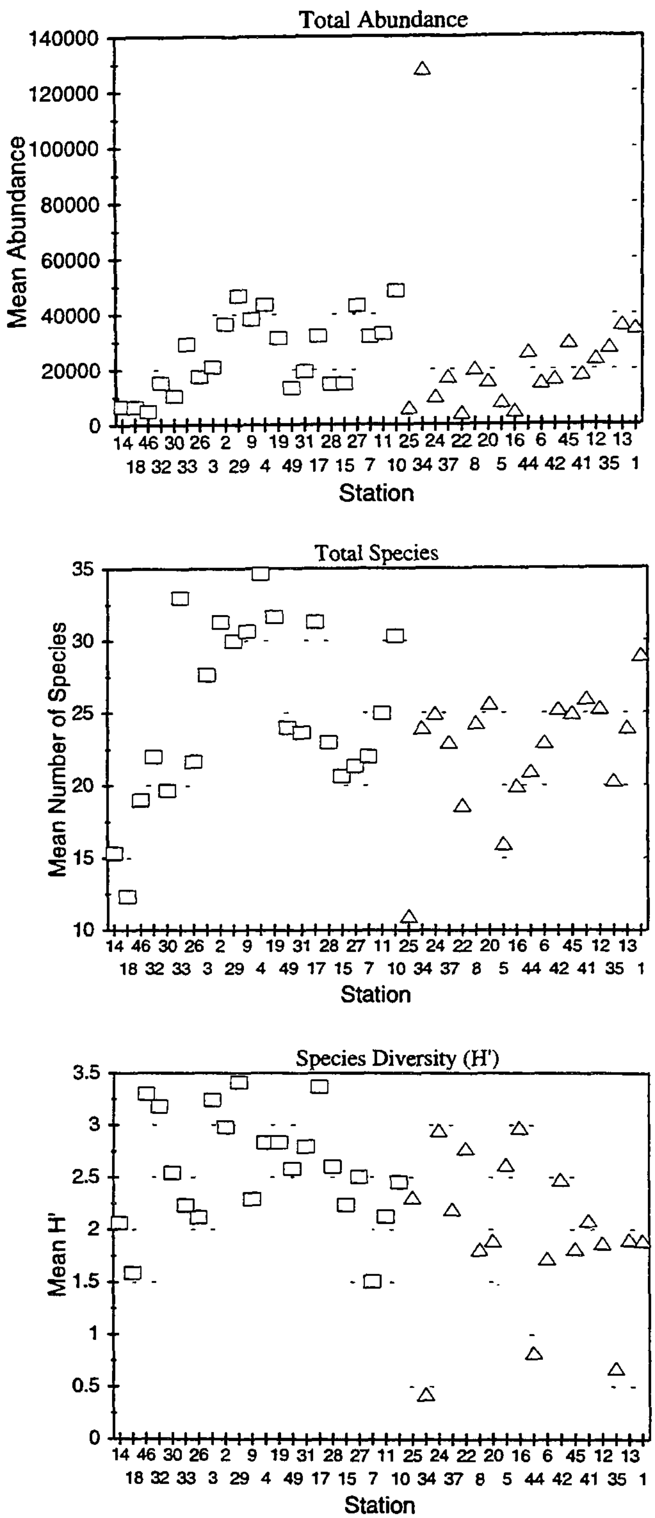

Figure 3-59. Mean total infaunal abundance (number/m^2), numbers of species, and species diversity in the October 1994 Study Area (Subarea 1) (from Battelle 1996a). Stations are arranged by cluster group. (□: Cluster Group A; △: Cluster Group B).

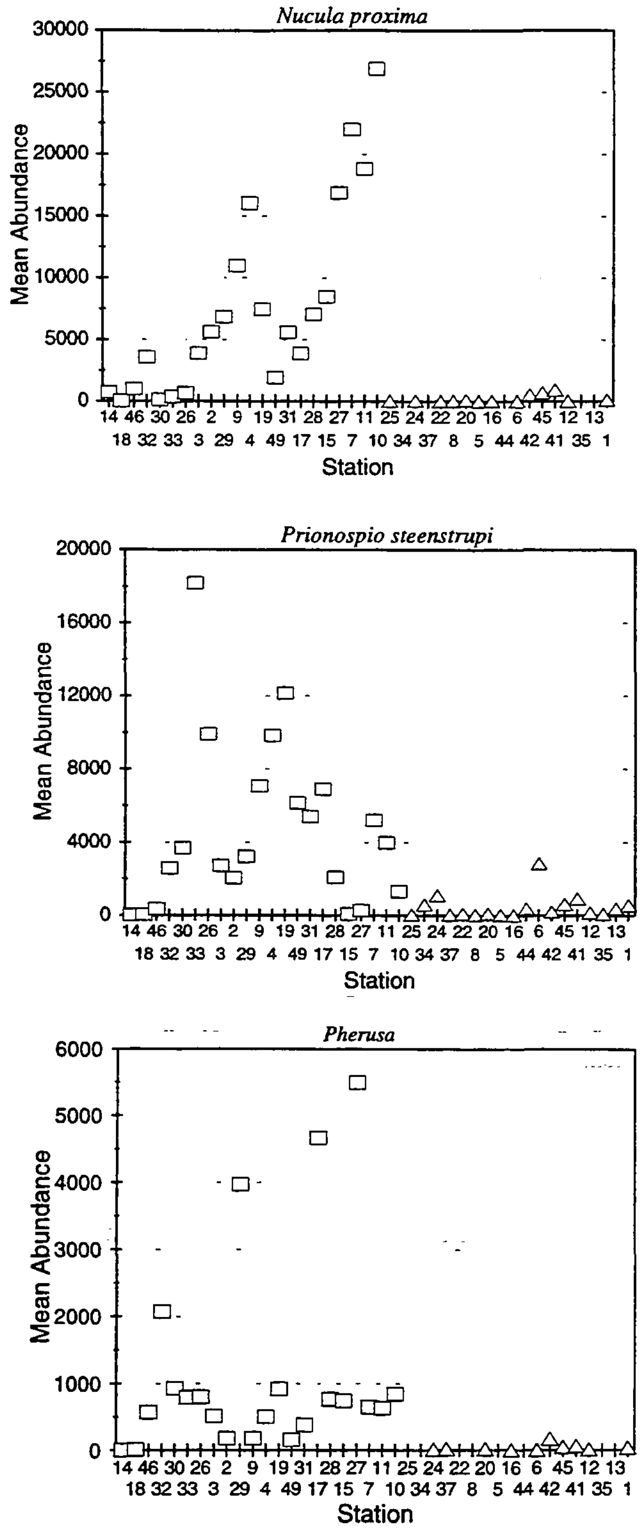

Figure 3-60. Mean abundance (number/m²) of *nucula proxima*, *prionospio steenstrupi*, and *Pherusa* in the October 1994 Study Area (Subarea 1) (from Battelle 1996a). Stations are arranged by cluster group. (□: Cluster Group A; △: Cluster Group B).

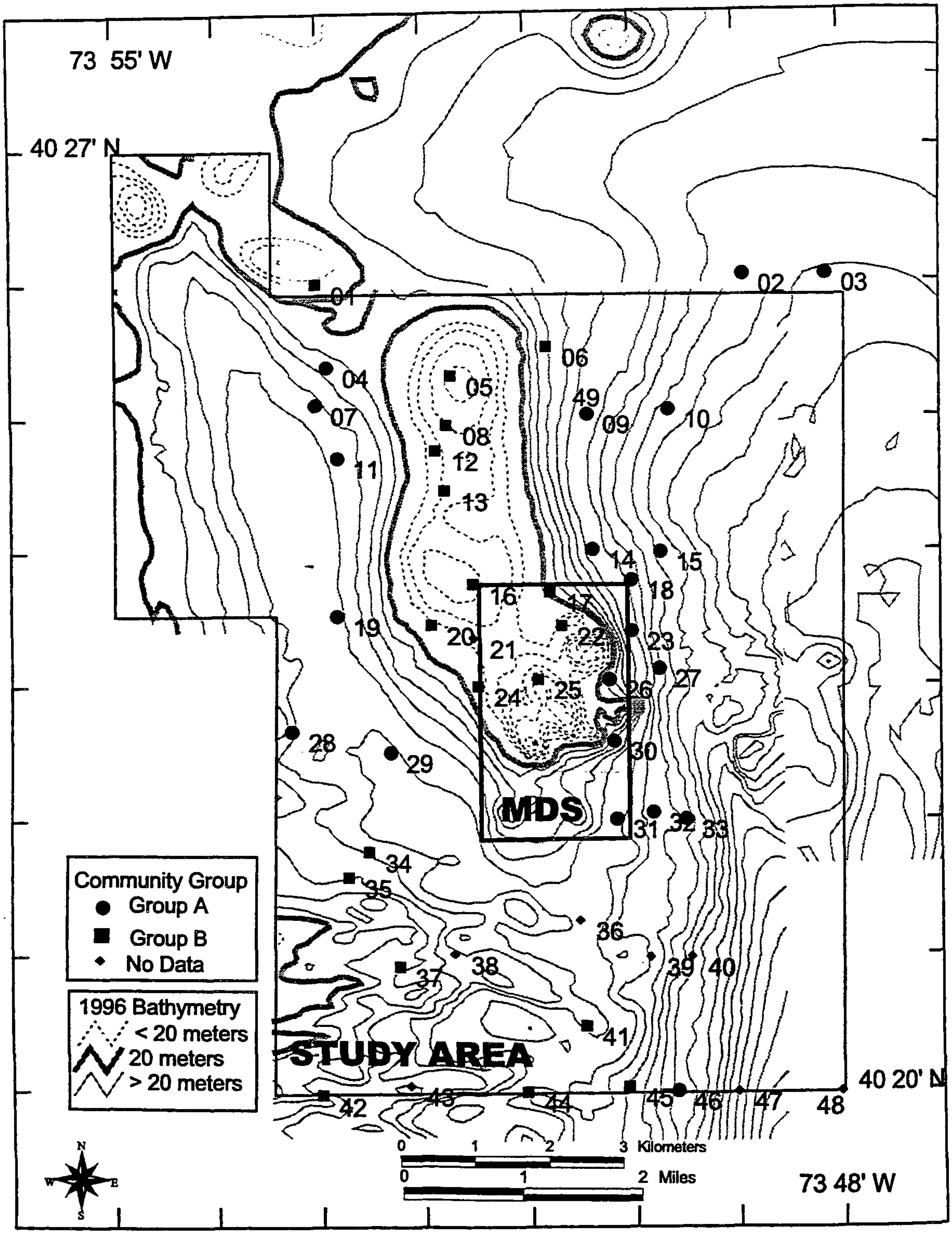

Figure 3-61. **Locations of cluster groups within the October 1994 Study Area (Subarea 1) (Battelle 1996a).** (●: Cluster Group A; ■: Cluster Group B; •: no data)

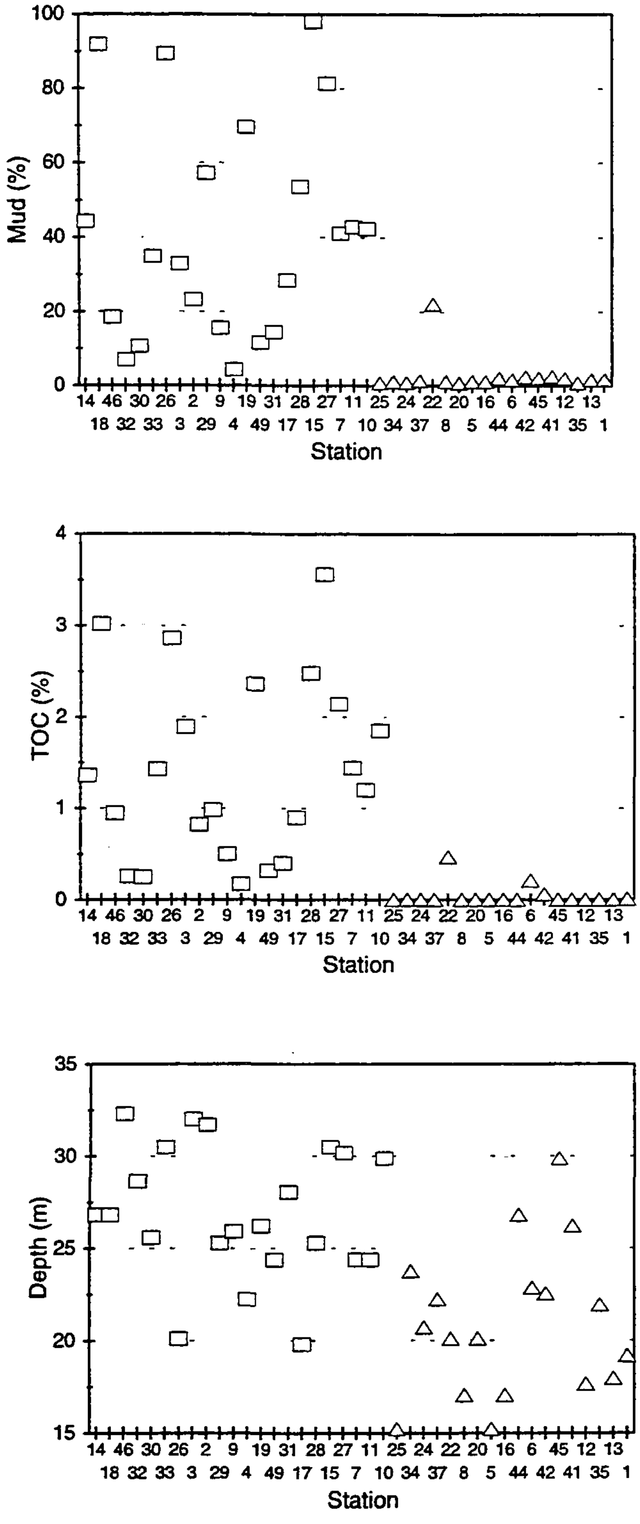

Figure 3-62. Mud (%), TOC (%), and water depth (m) at stations included in the infaunal analyses. Stations are arranged by cluster group. (□: Cluster Group A; △: Cluster Group B).

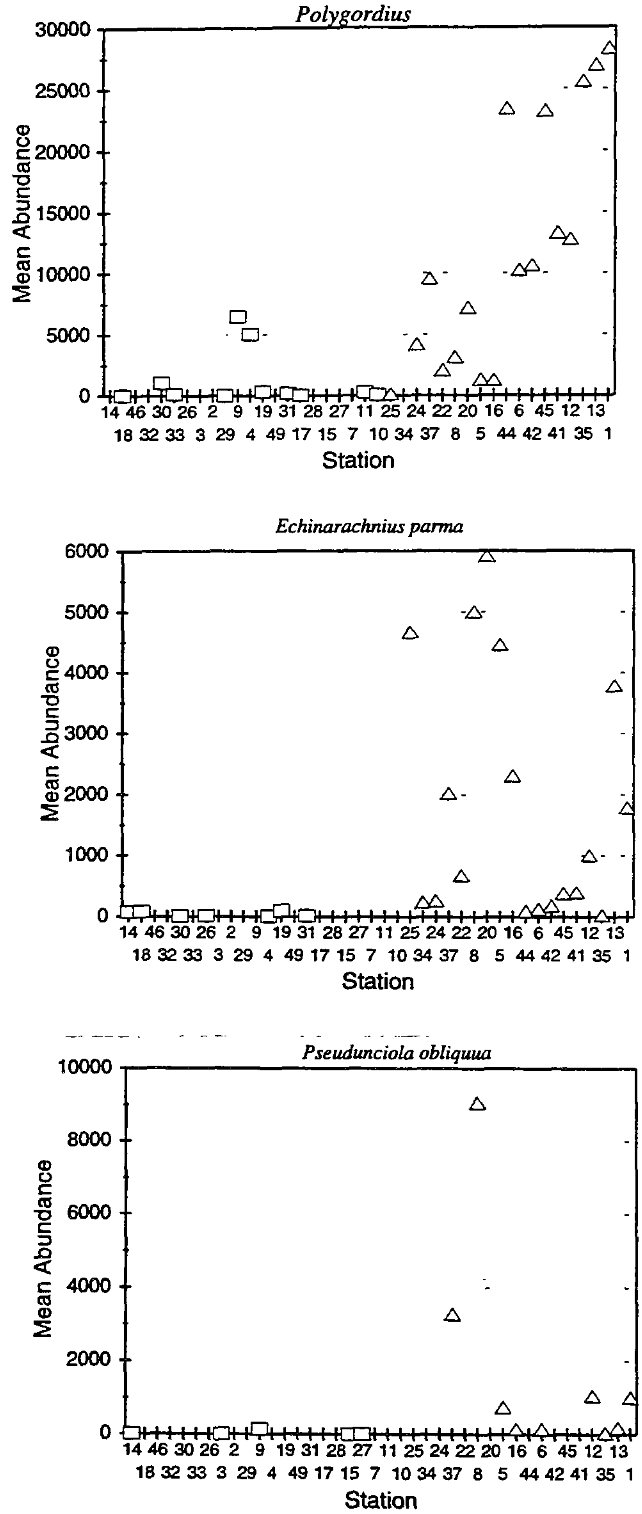

Figure 3-63. Mean abundance (number/m²) of *Polygordius*, *Echinarachnius parma*, and *Pseudunciola obliquua* in the Study Area. Stations are arranged by cluster group. (□: Cluster Group A; △: Cluster Group B).

3.4.2.3 Comparison of Study Area Benthic Infaunal Communities Before and After 1990

The data gathered from the recent studies provide an image of the Study Area (see text box at beginning of next section) that differs with historical characterizations. Most obvious is the finding that the infaunal communities in the region, while heterogeneous, can be classified into two distinct community patterns. Consequently, historical generalizations that the MDS had low infaunal diversity and abundance and was associated with contaminated fine sediments (Pearce *et al.*, 1976; Caracciolo and Steimle, 1983), probably were not entirely accurate, although, there was some evidence, which was not fully recognized at the time, that the area was heterogeneous. The 1982 EIS mentioned a region to the north and south of the MDS boundaries, but presumably still within the Study Area, that consisted of sandy, low-organic sediments (EPA, 1982). Although the 1982 EIS did not characterize the community inhabiting this sandy region, it mentioned that the low densities of the indicator species (i.e., those associated with fine-grained, high-organic sediments) in that area were probably because those species were not typically found in sandy sediments. Furthermore, grain-size data taken from Table B-2 and B-3 in the EIS revealed a band of sandy sediments extending southward from the northwest corner of the Study Area along the western boundary of the MDS to the southern part of the Study Area (EPA Region 2, 1982), a pattern that is strikingly similar to that found in October 1994. Later, Reid *et al.* (1991) described a community in the northwestern part of the Study Area that consisted primarily of animals associated with sandy sediments. Thus, some historical evidence suggests that the community patterns found in 1994 may have been present, at least in some form, for at least 20 years, but were only made clear by the intensive sampling performed in 1994.

3.4.2.4 Are the Study Area Infaunal Communities Impacted?

The 1982 EIS conclusion that the area chosen for the MDS had been adversely affected by dredged material disposal is based on the presumption that species found where chemical contaminants are high are "pollution tolerant," whereas taxa not found in such areas are "pollution sensitive." Such judgements have been made by simple comparisons of the distributions of various infaunal species to those of organic and contaminant content (e.g., Pearce *et al.*, 1976; Caracciolo and Steimle, 1983; Weisberg *et al.*, 1996) and by the use of multivariate statistical techniques (Walker *et al.*, 1979; Chang *et al.*, 1992). There are two problems with this approach: (1) there is a strong positive relationship between the sedimentary mud fraction and organic content and contaminant load, and (2) the absence of a species from contaminated areas is assumed to mean that there was a contaminant-related effect. Attempts to separate the effects of sediment texture from contaminant loads were made by constructing various sedimentary strata (Walker *et al.*, 1979; Chang *et al.*, 1992) followed by multivariate analyses. Hypothetically, these techniques

Differences in Infaunal Community Distribution within the Study Area

Previous studies that used distributional comparisons concluded that the nutclam *Nucula proxima* and the polychaetes *Prionospio steenstrupi* and *Pherusa affinis*, among others, were insensitive to contaminants. Because these (Group B) species characterized the infaunal community found in muddy, contaminant-laden sediments in the Study Area in 1994, it might be concluded that this community was a result of the presence of the contaminants.

Previous similar comparisons concluded that the sand dollar *Echinarachnius parma* and the amphipod *Pseudunciola obliquua*, among others, were sensitive to contaminants. Because these (Group B) species characterized the infaunal community found in sandy, relatively contaminant-free sediments in the Study Area in 1994, it might be concluded that this community was a result of the absence of the contaminants.

Alternatively however, it can be hypothesized that community Group A and B distributions are governed by factors other than the contaminant levels found in the sediments of the Study Area. Group A species may simply have strong affinities for muddy sediments, inhabit regions of the Study Area where these sediments are found, and are unaffected by the relatively high contaminant levels found in these areas. Correspondingly, Group B species may have affinities for sandy sediments and not muddy sediments areas, regardless of their contaminant levels. If either hypothesis is true, categorizing portions of the Study Area as degraded on the basis of infaunal distribution data alone cannot be supported.

would permit the classification of taxa according to contaminant sensitivity or tolerance. However, they do not alleviate the second problem. Hypotheses other than sedimentary contaminant load could explain the absence of species from an area. For example, many studies [including the October 1994 MDS study by Battelle (1996a)] have noticed that the distributions of some taxa are strongly associated with sediment texture, although this relationship may not necessarily be one of cause and effect [see Snelgrove and Butman (1994)]. In the case of the Study Area and other regions in the New York Bight, so-called sensitive species typically have been associated with sandy, but not muddy, sediments. Therefore, the absence of such taxa from contaminant-laden sediments, which are typically muddy, may be related to sediment texture, not contaminant load. Furthermore, biological interactions such as predation (e.g., Commito and Ambrose, 1985; Ambrose, 1991; Wilson, 1990) or competition (e.g., Hughes, 1985; Wilson, 1990) may offer alternative explanations for the distribution of species. The potential importance of such interactions has not been considered in most studies of infaunal communities in the Bight. Without direct supporting evidence, it is misleading to conclude that the distributions of infaunal species in the New York Bight, including the Study Area, can be explained primarily by the distributions of sedimentary organic content or contaminant load. Therefore, it cannot be definitively concluded that either the Group A or Group B community type found in the Study Area was the result of contaminated sediment.

3.4.3 Fish and Shellfish of the Study Area

The New York Bight is considered a transitional region for many species of fish and shellfish. This region is occupied by many fish species, few of which are considered year-round residents. Most fish species in the Bight are transient and are classified as either summer or winter residents because they migrate through the area on a seasonal basis. These migrations are in response to the dramatic variations in water temperature in the New York Bight, on both temporal and spatial scales. Temporal variations in the inshore region of the New York Bight range from boreal-zone conditions in the winter to tropic zone conditions in the summer (refer to Section 3.3.3). Wide-ranging conditions such as these cause the New York Bight to be a seasonal habitat for many commercially and recreationally valuable fish species (Grosslein and Azarovitz, 1982). Conversely, the same conditions are ideal for only a few year-round resident species.

The Bight is an import economic resource for both commercial and recreational/sport fishermen. Economic data from the area encompassing the inner Bight indicate that in 1993 commercial fishermen harvested 148 million lbs of fish and shellfish worth over $24 million. This volume included about 50 species (NEFSC, 1995a). In addition to commercial fishing, NMFS (1995) reports that in 1994 there were almost two million marine recreational anglers in New York and New Jersey. As of 1993, economic impact data on the New Jersey sport fishing industry shows almost 9 thousand jobs and total revenues of $703 million for this industry (ASA, 1995). The economic value of the industry was estimated at $343 million. Fishing activity in the New York Bight and within the Study Area is clearly of significant socio-economic importance and is examined in detail in this section of the SEIS to provide a comprehensive understanding of the regional commercial and recreational fishing industries and how they might be affected by placement of dredged material. Further socioeconomic information on commercial and recreational fishing and catch value is contained in Section 3.5.1.2.

Important fish and shellfish in the Study Area are evaluated relative to (1) the seasonal distributions, spawning habits, habitat preferences, and food habits of fish and shellfish in the Bight, (2) the overall health and ecological importance of these stocks, and (3) how changes in dredged material placement might impact the end-users of these stocks, including human beings.

As previously described, the New York Bight is a prominent feature of the Northwest Atlantic Ocean and is often referred to as a part of the Middle Atlantic Bight (south of Cape Cod to Cape Hatteras). The New

York Bight extends seaward between 150 and 180 km to the edge of the continental shelf (Gross, 1976), and is bounded by land to the north and west and influenced by the Gulf Stream to the south and east. The southern coast of Long Island, New York is the northern boundary; the coast of New Jersey is the western boundary. The latitude and longitude boundaries of the New York Bight correspond with National Marine Fisheries Service (NMFS) commercial Statistical Areas 612 - 616 (Figure 3-64).

The New York Bight Apex is a smaller region within the New York Bight that shares the boundaries of NMFS commercial Statistical Area 612, as illustrated in Figure 3-64. The Apex includes the Study Area and is the focus of the fish and shellfish resources discussion in this Chapter. In some cases, if data or information are not available for the Bight Apex, data from the New York Bight or a larger geographic area (i.e., Southern New England or Middle Atlantic Bight) are used to evaluate the resident fish and shellfish communities, as appropriate to the SEIS goals.

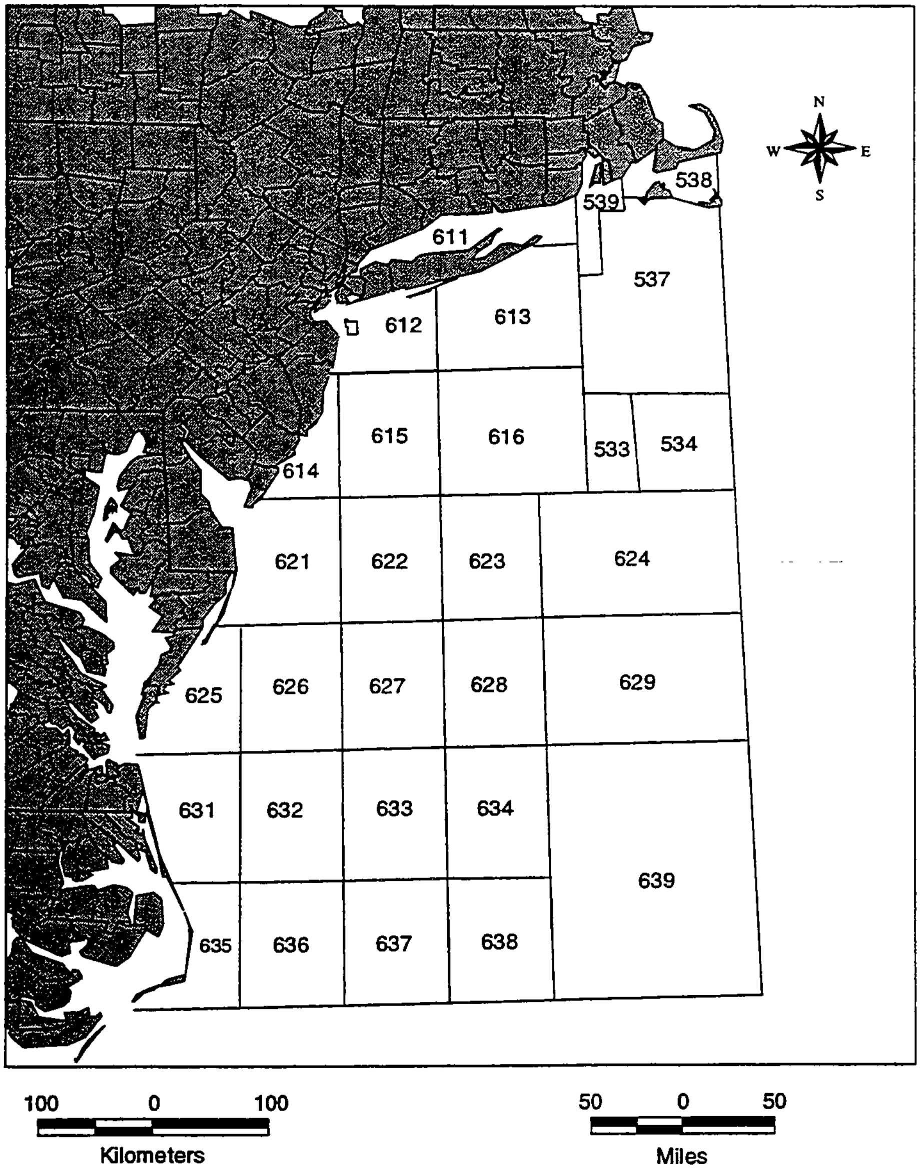

Figure 3-64. National Marine Fisheries Service commercial fisheries statistical areas, Cape Cod to Cape Hatteras.

Data Sources Used in SEIS Section 3.4.3 to Characterize Fish and Shellfish Resources in the Study Area

To comprehensively describe the fish and shellfish that occupy the Study Area, field studies and other data sources were reviewed. Data on fish and shellfish were obtained from five major sources, plus personal communication with scientists at relevant federal and state laboratories. The data sources include commercial catch statistics, recreational catch statistics, federal laboratory resource trawl surveys, New Jersey Department of Environmental Protection (NJDEP) resource trawl surveys, and peer-reviewed journal and federal laboratory scientific literature.

Commercial Catch Statistics. Commercial catch data are reported by the National Marine Fisheries Service (NMFS) port agents when fish and shellfish are landed at port. The catches are reported by pre-defined Statistical Areas. Statistical Area 612 (Figure 3-64) encompasses the Study Area and covers about 90% of the New York Bight Apex. The value and volume of fish and shellfish caught in this statistical area provides information on their relative importance to the commercial fishing industry.

Recreational Catch Statistics. The NMFS annually publishes reports on recreational fishing along the eastern coast of the United States (example: NMFS, 1995). These publicly available data are summarized by state and region and do not identify the discrete locations within a region where the fish were caught. Consequently, these "coarse" data were augmented for this SEIS by information provided by anglers during telephone interviews.

Federal Resource Trawl Survey. The NMFS Northeast Fisheries Science Center (NEFSC) also conducts bottom trawl surveys along the east coast of the United States from Cape Hatteras north during the spring, fall, and summer. Sampling is conducted within strata bounded by depth zones in the Atlantic Ocean (Figure 3-65). Feeding habits data from fish collected in offshore (i.e., Strata 1) and inshore (i.e., Strata 8-14) strata were used to describe the prey selected by fish likely to be found in the Study Area.

State Resource Trawl Surveys. The New Jersey Department of Environmental Protection (NJDEP) conducts trawl surveys throughout the year of fish inhabiting nearshore areas from Sandy Hook, NJ to Cape Henlopen, DE. Surveys are conducted annually during January, April, June, August, and October and date back to 1988. Sampling is conducted within strata whose boundaries are approximated by depth contours (30, 60, 90 m) and longitudinal lines. Each strata is comprised of several sampling blocks that are 2° latitude in width and 2.5° longitude in height. The outermost Strata 14, is bounded on the east by the 73°50′ and the west by the 73°56′ longitudinal lines. The eastern boundary passes directly through the middle of the MDS as illustrated in Figure 3-66. Data from Strata 13, which is shoreward of 14, were also evaluated. Figure 3-67 shows the NJDEP sampling strata and blocks for Strata 13 and 14, with the Study Area overlain for comparison. Data from these strata are used to characterize the fish and shellfish likely to be found within the Study Area. In comparison to NMFS resource trawl surveys and commercial catch data, the NJDEP resource trawl survey data provide the finer scale fish community information.

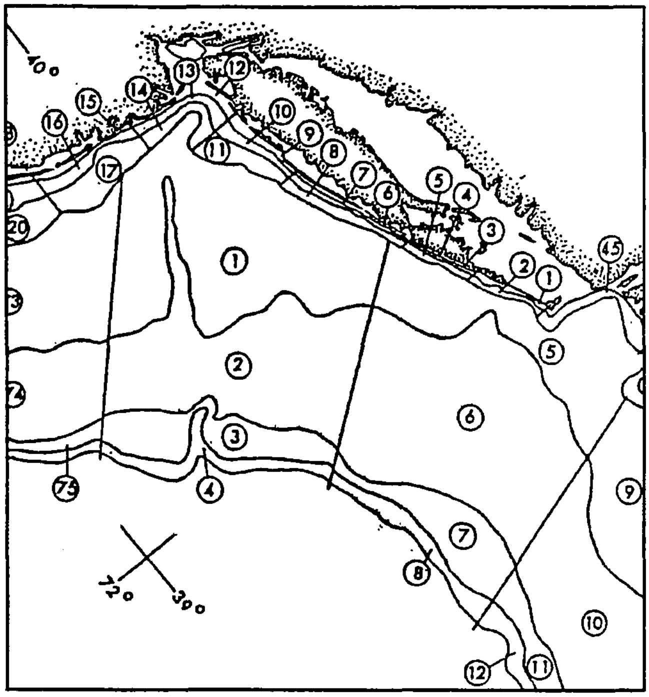

Figure 3-65. National Marine Fisheries Service bottom trawl survey strata in the vicinity of the Study Area.

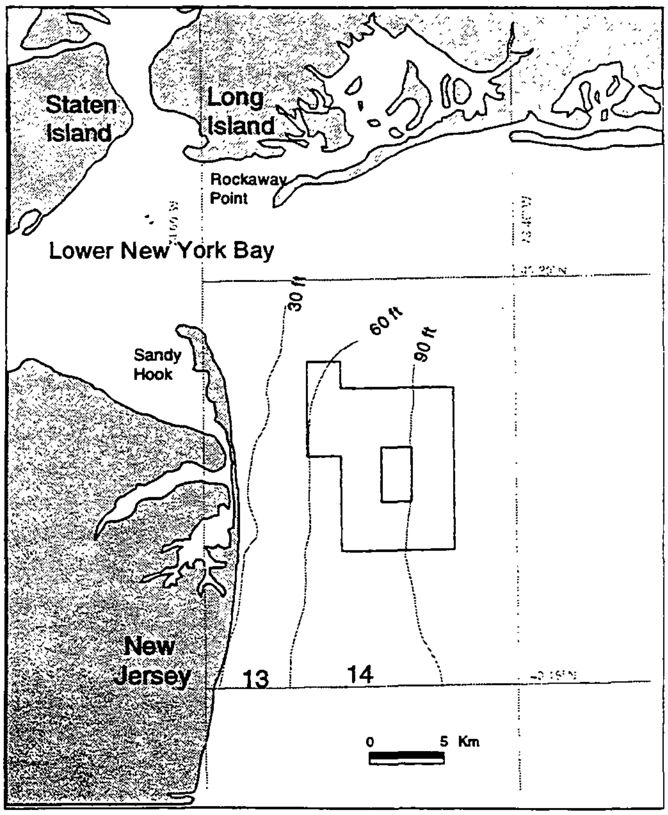

Figure 3-66. New Jersey Department of Environmental Protection fisheries trawl survey sampling Strata Nos. 13 and 14.

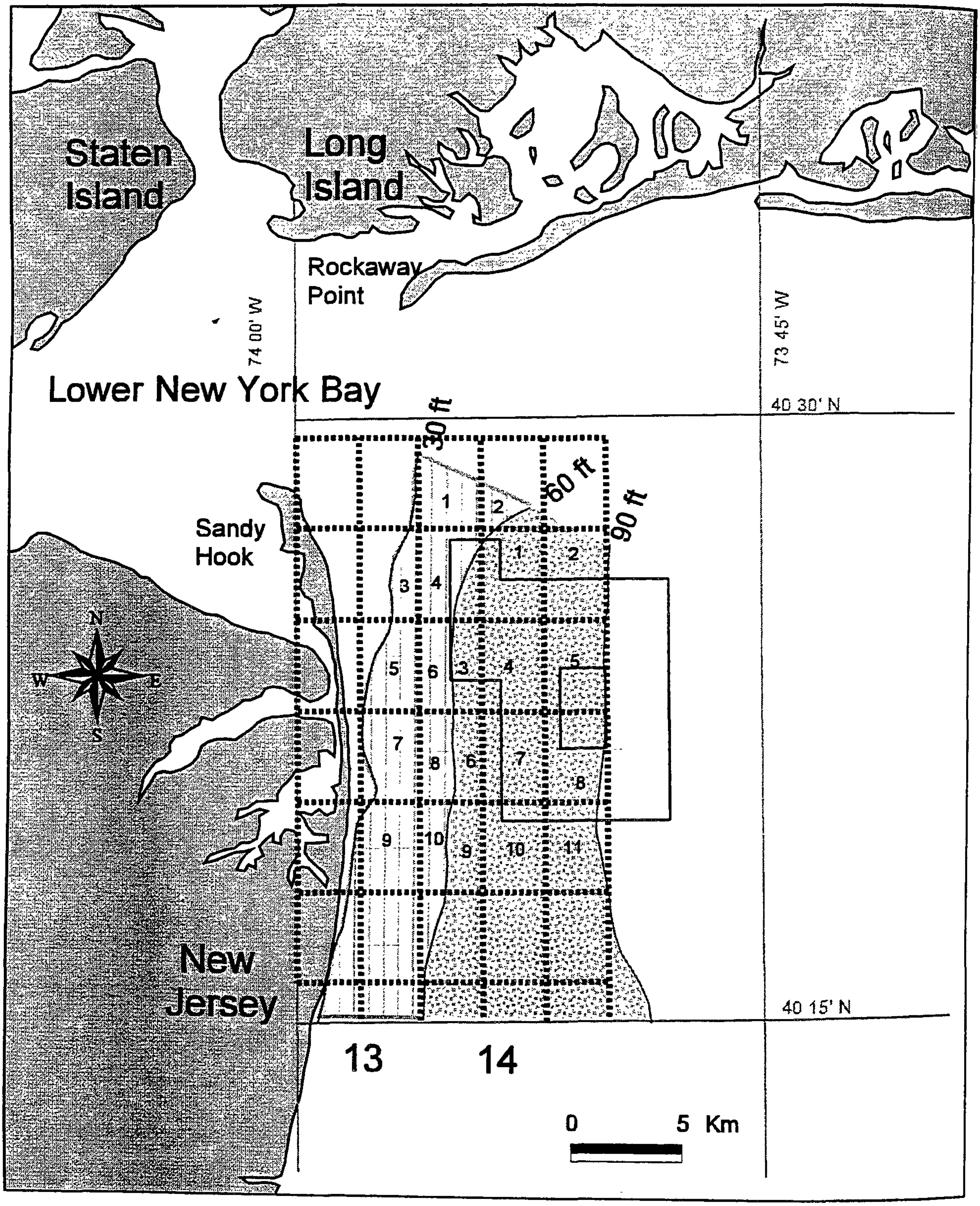

Figure 3-67. **New Jersey Department of Environmental Protection fisheries sampling Strata No. 14 and blocks nearest the Study Area.**

Species of Fish and Shellfish Found in the Study Area. Over 300 species of fish and shellfish are permanent or migratory residents in the Middle Atlantic Bight (Conner *et al.*, 1979). Of these, approximately 36 species, as listed in Tables 3-13 and 3-14, are considered commercially, recreationally, and ecologically important[6] within the New York Bight based on (1) a species list presented in Wilk *et al.* (1992) collected during a study of the 12-Mile Dump Site and (2) consultation with Federal and state personnel familiar with fish and shellfish of economic and ecological importance that are found in or near the Study Area.

> The following three key factors were used to characterize fish and shellfish of the Study Area:
>
> - Spatial and Temporal Distribution
> - Spawning Strategies
> - Food and Habitat Requirements
>
> These factors provide important information about each species that can be used to predict potential effects associated with remediation of the HARS.

Tables 3-13 and 3-14 classify fish and shellfish, respectively, according to their primary importance in the Study Area (i.e., commercial, recreational or ecological significance) and their habitat. The importance of commercially or recreationally harvested fish and shellfish is self evident — these species are human food sources and are either consumed by the anglers or sold for direct (e.g., fish market) or indirect (e.g. processed into fish meal) consumption. The fish and shellfish classified as ecologically significant in this SEIS are either known major prey of commercial or recreational species in the Bight region, or have been determined by scientists to be integral components of the general ecosystem around the Study Area (S.Wilk, NMFS, pers. comm., 1995). In general, fish species, including those in the Study Area, are classified according to their habitat — demersal or pelagic. Demersal fish species make up the largest percentage of fish species found in the Study Area. These 21 species spend most of their lifecycle on or near the bottom. The seven pelagic fish species reside and feed within the water column of the Study Area at some time during the year. Three anadromous fish species (which live in the ocean and spawn in freshwater) commonly found within the Study Area are discussed with the pelagic fish.

3.4.3.1 Spatial and Temporal Distribution of Fish in the Study Area

Characterization of the seasonal distribution of fish communities in and near the Study Area are drawn primarily from NJ DEP resource trawl surveys in Strata 14 for 1993-1995 (refer to Figure 3-67). Data from Strata 13, which is shoreward of the Study Area, are discussed in comparison to Strata 14. Comparisons of peak periods of abundance to relative differences in catch weights between Strata 14 and 13 provide information on the temporal occurance of the species in the Study Area and their relative abundance.

Appendix A of this SEIS contains summaries of two major sets of Study Area fish resource data. NMFS commercial catch data are presented in Figure A-1. NJDEP relative monthly abundance data are presented in Figure A-2. The graphs of the NMFS data show species that are targeted seasonally by the commercial fishing industry. In general, commercial catches are based on seasonal abundance of the target species and the fishers' effort to catch individual species, the later of which is driven by the market values (the

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[6] The classification of 12 fish and the horseshoe crab as ecologically significant does not exclude the ecological significance of other fish and shellfish discussed in this SEIS, nor the ecological significance of the other species of fish and shellfish that have been documented in the region of the SEIS Study Area. All organisms present in the Study Area, including man, contribute to the regional environment and ecology. The 36 species discussed in Section 3.4.3 have been determined during the development of this SEIS to be those of concern and/or those potentially affected by placement of dredged material in the Study Area.

Table 3-13. Fish inhabiting the Study Area and the New York Bight.

Fish Species—Common & Scientific Names	Classification/Regional Significance	Regional Frequency
Demersal Species (21)		
Silver hake *(Merluccius bilinearis)*	Commercial	Common
Yellowtail flounder *(Pleuronectes ferrugineus)*	Commercial	Infrequent
Red hake *(Urophycis chuss)*	Commercial, Recreational	Common
Scup *(Stenotomus chrysops)*	Commercial, Recreational	Common
Summer flounder *(Paralichthys dentatus)*	Commercial, Recreational	Common
Winter flounder *(Pleuronectes americanus)*	Commercial, Recreational	Common
Tautog *(Tautoga onitis)*	Commercial, Recreational	Common
Cod *(Gadus morhua)*	Commercial, Recreational	Rare
Black sea bass *(Centropristis striata)*	Recreational	Common
Little skate *(Raja erinacea)*	Ecological	Very Common
Windowpane flounder *(Scophthalmus aquosus)*	Ecological	Common
Fourspot flounder *(Paralichthys oblongus)*	Ecological	Common
Ocean pout *(Macrozoarces americanus)*	Ecological	Common
Cunner *(Tautogolabrus adspersus)*	Ecological	Common
Spiny dogfish *(Squalus acanthias)*	Ecological	Common
Spotted hake *(Urophycis regius)*	Ecological	Common
Northern searobin *(Prionotus carolinus)*	Ecological	Common
Striped searobin *(Prionotus evolans)*	Ecological	Common
Gulf Stream flounder *(Citharichthys arctifrons)*	Ecological	Infrequent
Sea raven *(Hemitripterus americanus)*	Ecological	Rare
Longhorn sculpin *(Myoxocephalus octodecimspinosus)*	Ecological	Rare
Pelagic Species (4)		
Butterfish *(Peprilus triacanthus)*	Commercial	Common
Atlantic herring *(Clupea harengus)*	Commercial	Common
Bluefish *(Pomatomus saltatrix)*	Recreational, Commercial	Common
Weakfish *(Cynosion regalis)*	Recreational	Common
Pelagic/Anadromous Species (3)		
American shad *(Alosa sapidissima)*	Commercial	Common
Alewife *(Pomolobus pseudoharengus)*	Commercial	Common
Striped bass *(Morone saxatilis)*	Recreational	Common

Source: S. Wilk, NMFS, pers. comm., 1995; B. Halgren, NJDEP, pers. comm., 1995.

Table 3-14. Shellfish in the Study Area and New York Bight.

Shellfish Species—Common & Scientific Names	Classification\Regional Significance	Regional Frequency
Pelagic Species (2)		
Long-finned squid *(Loligo pealei)*	Commercial	Common
Short-finned squid *(Illex illecebrosus)*	Commercial	Infrequent
Benthic Species (6)		
Rock crab *(Cancer irroratus)*	Commercial	Very Common
Jonah crab *(Cancer borealis)*	Commercial	Infrequent
American lobster *(Homarus americanus)*	Commercial	Common
Surf clam *(Spisula solidissima)*	Commercial	Very Common
Sea scallop *(Placopecten magellanicus)*	Commercial	Infrequent
Horseshoe crab *(Limulus polyphemus)*	Commercial, Ecological	Common

Source: S. Wilk, NMFS, pers. comm., 1995; B. Halgren, NJDEP, pers. comm., 1995.

industry does not fish species that cannot be sold). The NMFS data are valuable primarily because they quantify the amount of fish harvested from the statistical area encompassing the Study Area. However, these data do not show the socioeconomic value of fish primarily targeted by recreational fishermen, or the ecological importance of fish that are not harvested or are discarded at sea (i.e., unrecorded bycatch).

The NJDEP data in Figure A-2 of Appendix A quantify State fish resources, regardless of whether the species are targeted by commercial or recreational fishermen. The NJDEP data has been generated from scientific trawls of State offshore waters; the data is not a calculation of total catch weights from a particular strata. The data evaluators and authors of this SEIS determined that the NJDEP data was particularly useful for evaluating commercial fishing in the Study Area because the NJDEP data are at a finer scale than the NMFS data which include more non-Study Area habitat.

Evaluated together, the NMFS data in Figure A-1 and the NJDEP data in Figure A-2 provide an overview of fish species composition and distribution of the Study Area region. The two data sets also show the relative importance of specific species to the coastal New Jersey commercial fishing industry.

3.4.3.1.1 Commercially Important Fish Distribution

Thirteen species of commercially important fish are found in or near the Study Area.

Demersal Species

All of the demersal species (except for yellowtail flounder) that are commercially important are also

Commercially Important Fish Species, in Decreasing Order of Commercial Catch Volume and Landed Value for NMFS Subarea 612 (1993)

Species	Volume (1,000 lbs)	Value ($)
Summer flounder	842	1,218,496
Bluefish	794	263,915
Silver hake	787	385,974
Red hake	331	155,288
Winter flounder	282	299,061
Atlantic herring	190	9,689
Tautog	117	107,327
Scup	93	44,511
Butterfish	66	48,221
Cod	42	52,111
Yellowtail flounder	40	62,689
American shad	37	24,597

targeted by the recreational anglers in the Study Area. Many of the eight demersal species (silver hake, summer flounder, red hake, winter flounder, scup, tautog, yellowtail flounder, and cod) are caught throughout the year in NJDEP Strata 14. However, catches of each species peak at various times of the year. Species most abundant in January are silver hake, red hake, and cod. These species are often referred to as cold-water or winter species. Warm-water or summer demersal species (i.e., species most abundant between June and October) include winter flounder, summer flounder, tautog and scup.

Comparison Between NJDEP Strata 13 and 14. All of the demersal species, except for yellowtail flounder and cod, which are rare in the New York Bight, are caught in both Strata 13 and 14. A comparison of the catch weights in Strata 13 versus 14 show that five of the demersal species (silver hake, red hake, winter flounder, scup, cod, and yellowtail flounder) are more prevalent in Strata 14. Summer flounder and tautog are the only species that are more common in Strata 13. The differences in tautog catch weights in these two strata are insignificant because tautog are rarely caught in bottom trawls because they prefer hard-bottom habitats (i.e., rock, reefs, wrecks) that are not effectively sampled with the bottom trawl fishing gear used by the NJDEP.

For most species, the period of peak abundance in Strata 14 coincides with the period of peak abundance in Strata 13. The one exception to this is summer flounder, which has the highest catch weights in August in Strata 13 and October in Strata 14. This difference may be attributable to the concentrations of summer flounder the in shallower water of Strata 13 from late spring to early autumn and the offshore migrations through Strata 14 in the fall (NOAA, 1995a).

Pelagic Species

Five pelagic species are commercially important — butterfish, Atlantic herring, bluefish, American shad, and alewife. In comparison to demersal species, these pelagic species are highly migratory and pass through the Study Area at various times of the year. Butterfish are warm-season fish (Bigelow and Schroeder, 1953) that migrate through the Study Area in late May or early June from deep warm waters off the continental shelf toward inshore waters.

During the winter, primarily in January and February, herring moves through the Study Area while migrating south (D. Stevenson, pers. comm., 1996). This is confirmed by NJDEP data which indicate that Atlantic herring have been collected near the Study Area in January. Herring move offshore, out of the Study Area, in April as they begin their migration northward.

In the spring, alewife move through the Study Area on their northerly migration from southern Atlantic waters, where they overwinter, to the Hudson River for spawning. Alewife are abundant in the Study Area in April (G. Shepherd, pers. comm., 1996).

Like alewife, American shad spawn in freshwater rivers and pass through the Study Area during the spawning season on their way to and from the Hudson River. American shad are most prevalent in the Study Area in June (G. Shepherd, pers. comm., 1996).

Bluefish also migrate through the Study Area during the summer months, with peak abundance in June. Bluefish are prolific in coastal and offshore waters from the Chesapeake Bay to Maine during the summer, before migrating south in the fall (M. Terceiro, pers. comm., 1996).

Comparison Between NJDEP Strata 13 and 14. In general, more pelagic species are caught in Strata 14 than in Strata 13 throughout the year. For some species, however, the peak period of abundance in Strata 13 and 14 do not coincide. For example, more alewife and American shad are caught in January in Strata

13 than in any other month. This is not consistent with the period of peak catches in Strata 14. The highest catches of these two species in Strata 14 are in the second quarter (April - June) of the year. This difference may be due to the migratory behavior of these fish species (which is based on water temperature and other environmental factors).

3.4.3.1.2 Recreationally Important Fish Distribution

The ten recreationally important (seven are also commercially important) fish species are discussed in this section. In 1994, these ten species comprised 80% of the total number and total weight of fish harvested (brought ashore in whole form) by New York and New Jersey anglers.

Demersal Species

All recreationally important demersal species (except for black sea bass) are also important to the commercial fishing industry. In 1994, black sea bass catches (1.5 million) by recreational anglers were second only to summer flounder catches (3.1 million). Catches of black sea bass by NJDEP (mostly in October) do not accurately reflect the relative abundance of black sea bass because of the habitat in which this species resides. Black sea bass prefer hard-bottom substrates (e.g., rocky outcrops, reefs, wrecks) which cannot be effectively sampled by trawl gear. However, hook and line recreational anglers successfully fish black sea bass in these habitats.

Pelagic Species

Three pelagic species that migrate through the Study Area are recreationally important — bluefish, weakfish, and striped bass. Of these, bluefish is the most frequently caught by recreational anglers; it is also commercially important as described previously.

In general, weakfish migrate inshore during the spring and offshore during the fall (G. Shepherd, pers. comm., 1996). Migration patterns are related to spawning which occurs in estuaries from April to June. Weakfish migrate out of the New York Bight estuaries after spawning and remain in the Bight from spring through the fall where they undergo localized coastal migrations. Although annual peaks in abundance near the Study Area may fluctuate due to these local migrations, weakfish catches generally peak in October near the Study Area. These differences in peak times may be due to the onset of offshore migration in October to overwintering areas.

There are three distinct populations of striped bass that may periodically occupy the environment in and around the Study Area (G. Shepherd, pers. comm., 1996). The first population of striped bass spawn in the Hudson River and tend to remain in the New York Bight all year. Separate populations spawn in the Chesapeake Bay and Delaware River. After spawning, these two distinct populations pass through the New York Bight during northerly migrations in the spring and southerly migrations (from the north) in the fall.[7] All three striped bass populations are caught as they migrate through the Study Area. Catches of striped bass are caught near the Study Area from the spring through the fall.

3.4.3.1.3 Ecologically Important Fish Distribution

As previously defined, fish classified as ecologically significant in this SEIS are either known major prey of commercial or recreational species in the Bight region, or have been determined by scientists to be integral components of the general ecosystem around the Study Area (S. Wilk, pers. comm., 1995). These

[7] Note that not all striped bass migrate to southern locales. Sex, age, water temperature, and food availability are some of the factors that influence their movements.

species may have relatively large abundances, but are not targeted by commercial or recreational fishermen. The twelve ecologically significant fish species listed in Table 3-13 are demersal. No pelagic species have been identified by fishery resource managers as being ecologically important in the Bight.

Of the twelve ecologically important species, little skate is the most common (i.e., highest commercial catch weight) of these species. Skate (non-species specific) are frequently caught as bycatch (T. Helser, pers. comm., 1996). Longhorn sculpin and sea raven are the least common of these species. Most of the species are prevalent between April and September and, with a few exceptions, are more prevalent in Strata 14 than Strata 13. Windowpane and the searobins (striped and northern) have higher catches in Strata 13. Spiny dogfish are ubiquitous; they are caught in equal amounts in both strata.

3.4.3.2 Spatial and Temporal Distribution of Shellfish in the Study Area

Shellfish described in this section are either benthic epifauna or infauna. Squid, a pelagic macroinvertebrate, is also included in this section. All of the shellfish species (Table 3-14) are commercially important for either domestic or foreign markets. Many species are also prey items for demersal fish species found in or near the Study Area.

Some Study Area shellfish migrate through the region in response to changes in water temperature. Others do not exhibit any significant seasonal migration. Characterization of the seasonal distribution of fish communities in and near the Study Area are drawn primarily from NJ DEP resource trawl surveys in Strata 13 and 14 for 1993-1995 (refer to Figure 3-66) and commercial catches recorded by NMFS in Statistical Area 612 (refer to Figure 3-64) for 1993[8]. Data from Strata 13 and 14 are compared to commercial catch data to identify temporal distributions and the relative abundances. Appendix A includes figures displaying quarterly catches by NJDEP and commercial fishermen.

Shellfish in Decreasing Order of Commercial Catch Volume and Landed Value for NMFS Subarea 612.

Species	Volume (1,000 lbs)	Value ($)
Surf clam	53,485	3,901,399
Sea scallop	1607	1,181,810
American lobster	948	3,377,561
Long-finned squid	518	313,605
Rock crab	66	68,404
Horseshoe crab	661	70
Short-finned squid	No data available	
Jonah crab	No data available	

Squid. Squid are pelagic macroinvertebrates that spend most of their life in the water column. These organisms are highly migratory and the most mobile of the shellfish discussed in this SEIS. Because of their mobility in the water column, they are often caught in trawls with pelagic fish, such as butterfish.

The long-finned squid, *Loligo pealei*, exhibit seasonal migrations. They migrate offshore to canyon mouths along the continental shelf in the winter and inshore on the shelf in the late spring (Lange and Sissenwine, 1980; Macy, 1982). Spring inshore migrations occur in April in the Long Island area. Based on trawl surveys by NJDEP, catches of *L. pealei* become more abundant in August in Strata 13 and 14. During this time they may be very abundant in or near the Study Area.

[8] Although NJDEP collects shellfish during its sampling operations, the gear used is not efficient for sampling shellfish, and does not provide an accurate representation of abundance. Peak periods of abundance based on NJDEP data are different from peaks based on commercial catch data. For many species, catches by NJDEP precede periods of peak commercial shellfish catches. This may be related to the locations of NJDEP sampling areas, which are often in areas inshore of commercial fishing activity, and the migratory behavior of many of these species.

In comparison to *L. pealei,* the short-finned squid, *Illex illecebrosus,* undertake long-distance seasonal migrations and are associated with cooler water temperatures. During the spring, juvenile *I. illecebrosus* migrate northward (from spawning areas in the south Atlantic) along the edge of the continental shelf. The adults then migrate inshore to feed and, by summer, have become dispersed across the continental shelf. Peak abundance of *I. illecebrosus* in the New York Bight occurs during this time. In the fall, *I. illecebrosus* migrate back offshore, to the shelf-slope convergence zone in waters of greater than 185 m, and south to spawning grounds. Because the continental shelf and slope waters are their primary habitat, *I. illecebrosus* are not as abundant as *L. pealei* in the Study Area and New York Bight (Hendrickson *et al.*, 1996).

Rock Crab. Distributions of rock crab are apparently controlled by seasonal cooling and warming (Stehlik *et al.*, 1991). In the New York Bight and the Study Area region, rock crabs move inshore in the fall and remain until the spring when they migrate offshore (Stehlik *et al.*, 1991). Migrations occur across the continental shelf. Sampling by NJDEP indicate that rock crabs are collected near the Study Area in the spring and early summer (April in Strata 13; June in Strata 14) before they migrate offshore. Commercial fishermen harvest rock crabs between July and September when they are further offshore on the continental shelf.

The results of sampling by trawls indicate that females may bury into the sediment more than males. Burial appears to occur during daylight hours when they are inactive (Stehlik *et al.*, 1991). Therefore, this species may be more susceptible to burial during daylight hours, a possible issue of concern for dredged material managers.

Jonah Crab. Jonah crabs are less abundant and conduct less extensive migrations in the New York Bight than rock crabs (Stehlik, 1993). Jonah crab migrations extend from the outer edges of the continental shelf in the winter to the central portions of the shelf in the summer (Stehlik *et al.*, 1991). Notably, Jonah crab and rock crabs are in the Bight at different times of the year. As mentioned above, rock crab abundance is highest between April and June. According to NJDEP trawl surveys, abundance of Jonah crab is highest in June and August. There are no commercial catches of Jonah crab in the Study Area.

Lobster. Lobster is probably the second most motile of the shellfish addressed by this SEIS. Seasonal distribution of lobsters is directly influenced by water temperature. Lobsters migrate inshore to shallow waters in the New York Bight in the spring and summer to spawn and migrate offshore in early winter (Uzmann *et al.*, 1977). However, not all lobsters migrate inshore to spawn. There are two populations of lobsters in the Study Area region: (1) an offshore population that either conducts extensive migrations from the continental shelf to inshore waters to spawn or does not migrate inshore and spawns on the continental shelf, and (2) an inshore population that conducts localized inshore migrations (Uzmann *et al.*, 1977).

Generally, individual lobsters migrate at different times (i.e., there are no simultaneous mass migrations that periodically occur as with the Caribbean spiny lobster). Lobster tend to congregate in submarine canyons during the winter and early spring as evidenced by the concentration of the lobster fishery (Cobb and Phillips, 1980). In addition to onshore/offshore migrations, lobsters move laterally east or west along the outer shelf and upper continental slope. Near the Study Area, lobsters are present year round, but more lobster are collected by NJDEP in January. The lobsters caught by the NJDEP most likely belong to the inshore population, since the offshore population is not found in the Study Area in January. Catches by commercial lobstermen are highest between July and September before the organism migrates offshore.

Surf Clam. The surf clam is a sedentary mollusc which spends most of its life buried in the substrate of the ocean floor (Ropes and Merrill, 1973). The surf clam only buries to a depth equal to its shell length to allow its short siphon to extend above the sediment (Ropes, 1980). Burrowing is inhibited in high water temperatures and low dissolved oxygen levels. Because this species is sedentary, it is vulnerable to year-round fishing activity. Although trawl survey data from NJDEP indicate that the species is more prevalent between April and June, this species is caught by commercial fishermen year round.

Sea Scallop. Sea scallops, like surf clams, are relatively sedentary. According to NJDEP, sea scallops are present in the Study Area region from April to June. However, commercial catches peak between July and September. Commercial catches of sea scallops near the Study Area are approximately 5% of the volume of surf clam catches.

Horseshoe Crab. Horseshoe crabs undergo a seasonal onshore-offshore migration (Shuster, 1950). During cold weather months, horseshoe crabs are found on the continental shelf (Shuster, 1979). Catches have been reported in water depths of 30 - 60 m (Shuster, 1960; Shuster, 1979). Because the animals are poikilothermal (Frankel, 1960) they bury into sediments for protection against low water temperatures. Triggered by the warming water temperatures in the spring, horseshoe crabs migrate inshore to sandy beaches to spawn. They begin to migrate offshore at the end of the spawning season (Shuster, 1950). The largest NJDEP collections of horseshoe crabs are in October as they migrate offshore following spawning. This corresponds with commercial catches of horseshoe crabs near the Study Area.

3.4.3.3 Spawning Strategies of Fish and Shellfish in the Study Area

Understanding spawning strategies is important to identifying potential impacts to the reproductive success and subsequent population growth of shellfish species. Spawning strategies are characterized by the type of eggs produced (i.e., demersal, pelagic) and the spawning periods. Both of these are major factors in reproductive success. Environmental conditions influence the number of eggs that hatch and the success of larvae that grow into adults. The predominant environmental condition in this regard at the Study Area is seasonal water temperature.

Most fish species spawn either demersal or planktonic eggs that hatch into larvae in 1 day to 6 weeks, depending on the species, time of year, and water temperature (W. Morse, pers. comm., 1996). *Loligo pealei* is the only shellfish discussed in this SEIS that spawns demersal eggs. Demersal eggs are laid on or buried in the bottom sediment. They remain on the bottom until the larvae hatch. Very often, demersal eggs are sticky and adhere to surfaces (e.g., rocks) until larvae are hatched. Because these surfaces may be located on the ocean floor, the reproductive success rate of fish that produce demersal eggs (Table 3-15) may be lower, due to burial of eggs, than fish that produce planktonic eggs. Demersal eggs placed in shallow-water areas are also at risk from disturbances to the substrate to which they are attached. In the Study Area, these benthic disturbances include occasional storm resuspension of sediment and, within the disposal site boundaries, placement of dredged material.

Most of the fish species listed in Table 3-15 and the shellfish listed in Table 3-16 (except for *Loligo pealie*) and discussed here spawn planktonic eggs. Planktonic eggs float in the water column and are often referred to as buoyant. Buoyancy of eggs varies among different species and the eggs may or may not contain an oil globule. Oil globules cause eggs to be more buoyant (i.e., specific gravity is reduced), especially if the oil globule is large in comparison to the size of the egg. Neutrally buoyant eggs have a specific gravity close to that of seawater, thus are more readily mixed deeper into the water column by waves and other turbulence. Most planktonic eggs are found in the upper 40-50 m of the water column and are frequently collected during plankton sampling. Eggs with oil globules are usually located in the upper 15 m of the water column, closer to the surface than other planktonic eggs.

Table 3-15. Egg type and characteristics of fish species that occupy the New York Bight.

Fish Species [d = demersal; p = pelagic]	Egg Characteristics
Winter flounder *(Pleuronectes americanus)*[d]	demersal eggs: sticky, deposited on sandy bottoms in estuaries
Atlantic herring *(Clupea harengus)*[p]	demersal eggs: sticky, adhere to ocean bottom sediments
Sea raven *(Hemitripterus americanus)*[d]	demersal eggs: sticky, may adhere to ocean sponges
Longhorn sculpin *(Myoxocephalus octodecimspinosus)*[d]	demersal eggs: sticky, lose stickiness after 24 hours, then lay on ocean bottom
Little skate *(Raja erinacea)*[d]	demersal eggs: partially buried in sandy ocean sediments
Ocean pout *(Macrozoarces americanus)*[d]	demersal eggs: egg masses deposited on ocean bottom among rocks and stones
Silver hake *(Merluccius bilinearis)*[d]	planktonic eggs:[1] contains oil globule
Bluefish *(Pomatomus saltatrix)*[p]	planktonic eggs:[1] contains oil globule
Summer flounder *(Paralichthys dentatus)*[d]	planktonic eggs: contains oil globule
Scup *(Stenotomus chrysops)*[d]	planktonic eggs: contains oil globule
Red hake *(Urophycis chuss)*[d]	planktonic eggs: contains oil globule
Butterfish *(Peprilus triacanthus)*[p]	planktonic eggs: contains oil globule
Black sea bass *(Centropristis striata)*[d]	planktonic eggs: contains oil globule
Windowpane flounder *(Scophthalmus aquosus)*[d]	planktonic eggs: contains oil globule
Fourspot flounder *(Paralichthys oblongus)*[d]	planktonic eggs: contains oil globule
Spotted hake *(Urophycis regius)*[d]	planktonic eggs: contains oil globule
Northern searobin *(Prionotus carolinus)*[d]	planktonic eggs: contains oil globule
Striped searobin *(Prionotus evolans)*[d]	planktonic eggs: contains oil globule
Cod *(Gadus morhua)*[d]	planktonic eggs: no oil globule
Yellowtail flounder *(Pleuronectes ferrugineus)*[d]	planktonic eggs: no oil globule
Tautog *(Tautoga onitis)*[d]	planktonic eggs: no oil globule
Weakfish *(Cynosion regalis)*[p]	planktonic eggs: no oil globule
Gulf Stream flounder *(Citharichthys arctifrons)*[d]	planktonic eggs: no oil globule
Cunner *(Tautogolabrus adspersus)*[d]	planktonic eggs: no oil globule
Spiny dogfish *(Squalus acanthias)* [d]	live birth
American shad *(Alosa sapidissima)* [2]	demersal eggs: not sticky
Striped bass *(Morone saxatilis)* [3]	planktonic eggs: contains oil-globule
Alewife *(Pomolobus pseudoharengus)* [2]	demersal eggs: indiscriminant adhesion on stones

[1]These eggs are more buoyant than other planktonic eggs listed in the table.
[2]Anadromous fish, spawns in fresh water
[3]Anadromous fish, spawns in brackish water or fresh water
Sources: Bigelow and Schroeder, 1953; P. Berrien, pers. comm., 1996.

Table 3-16. Egg type and characteristics of shellfish species that occupy the New York Bight.

Shellfish Species	Egg Characteristics
Long-finned squid *(Loligo pealei)*	demersal eggs; deposited in clusters
Short-finned squid *(Illex illecebrosus)*	unknown, egg characteristic data are inconclusive
Rock crab *(Cancer irroratus)*	eggs carried by female until hatched
Horseshoe crab *(Limulus polyphemus)*	eggs buried in sand on beaches, intertidal areas
Jonah crab *(Cancer borealis)*	eggs carried by female until hatched
American lobster *(Homarus americanus)*	eggs carried by female until hatched
Surf clam *(Spisula solidissima)*	planktonic eggs
Sea scallop *(Placopecten magellanicus)*	planktonic eggs

Sources: S. Murawski, pers. comm., 1996; M. Dawson, pers. comm., 1996; L. Stehlik, pers. comm., 1996; L. Hendrickson, pers. comm., 1996.

Although eggs may be found in the surface layer, they do not remain there for extended periods of time because of detrimental effects from ultraviolet light on the eggs (P. Berrien, pers. comm., 1996). In addition, sea-surface turbulence causes eggs to be mixed down into the water column. Because surface waters of the ocean are relatively turbulent, planktonic eggs are usually mixed into the water column to some degree. This mixing usually does not cause detrimental effects to the eggs (W. Morse, pers. comm., 1996).

The spawning period as well as the type of egg (Tables 3-17 and 3-18) should be considered in determining possible impacts of dredged material to fish and shellfish in the MDS and Study Area. During spawning periods, fish and shellfish are physiologically stressed because energy is focused on reproduction. Some fisheries are closed during spawning periods to protect the spawning females and the future fish stocks, (e.g., harvesting of egg-bearing lobster females is not allowed). Spawning periods for demersal and pelagic fish species are illustrated in Figures 3-68 and 3-69, respectively. Spawning periods of shellfish are illustrated in Figure 3-70. These figures also include the quarterly distribution of fish and shellfish in the Study Area. Fish and shellfish whose spawning periods coincide with periods of prevalence in the Study Area may be more vulnerable to potential impacts during placement of dredged material, especially if demersal eggs are spawned. However, it should be noted that spawning during these periods can occur over a wide geographic area (south of Cape Cod to northern New Jersey) that includes the Study Area. This is especially true for fish and squid which are widely distributed. In the following text, spawning and quarterly distribution in and near the Study Area are compared to identify potential periods when species are vulnerable.

3.4.3.3.1 Demersal Fish Spawning Strategies

All 21 demersal species listed in Table 3-13 produce either planktonic or demersal eggs (Table 3-15).

Demersal Eggs. Five of the 21 demersal species listed in Table 3-13 produce demersal eggs. Of these species, winter flounder is the only commercially important species. Notably, winter flounder migrate to estuaries to spawn, while the other four demersal species (sea raven, longhorn sculpin, little skate, and ocean pout) spawn offshore, laying their eggs on the bottom or on objects resting on the ocean floor. Eggs from these species are vulnerable to burial by dredged material or effects from resuspended sediments (e.g., from storm events).

Planktonic Eggs. Sixteen demersal species produce planktonic eggs. The most buoyant eggs (large oil globule in relation to egg size) are produced by the commercially important silver hake. Because of their large oil globule, silver hake eggs are found near the air/water interface in the upper surface layers of the ocean. Black sea bass, summer flounder, scup, and red hake, all of which are valuable to the recreational fishery, produce eggs that contain an oil globule. The eggs of these recreationally important species and the eggs of the remaining demersal species (windowpane flounder, fourspot flounder, spotted hake, northern and striped searobin, cod, yellowtail, tautog, and cunner), however, are consistently found deeper in the water column than silver hake eggs. Because planktonic eggs drift in the water column, and disposal events at the MDS are infrequent and impact the water column for only short periods, planktonic eggs are much less likely to be impacted by dredged material placement than demersal eggs.

Demersal Fish Spawning vs. Peak Abundance Periods at the Study Area (Figure 3-68). Cod, winter flounder, longhorn sculpin, and spiny dogfish spawn in the first two quarters of the year. The spawning periods of cunner, silver hake, gulfstream flounder, northern searobin, and windowpane flounder begin in early spring and continue into the late fall. Late spring - summer spawners include two commercial and recreational species (tautog and scup), one commercial species (yellowtail flounder), one recreational species (black sea bass), and two ecological species (striped searobin and fourspot flounder). Summer

Table 3-17. Primary and secondary prey species of fish occupying the Study Area.

Fish Species	General Prey Characterization	Primary Prey Species	Secondary Prey Species	Typical Prey Habitat
Cod *(Gadus morhua)*	clams, crabs, mussels, fish	*Arctica islandica* *Cancer irroratus* *Cancer borealis* Decapod crab *Clupea harengus* *Ammodytes* sp. *Urophycis chuss* *Raja* sp. Pleuronectiformes		sand, gravel, water column
Yellowtail flounder *(Pleuronectes ferrugineus)*	worms, shrimp	Polychaeta Amphipoda	epibenthic crustaceans Pisces	mud, sand
Summer flounder *(Paralichthys dentatus)*	fish (scup), squid, rock crabs, shrimp, bivalve molluscs, polychaetes	*Loligo* sp. *Stenotomus chrysops* Pisces Gammaridae *Etrumeus teres*	epibenthic crustaceans Pisces	sand, near-bottom water column
Winter flounder *(Pleuronectes americanus)*	small crabs, annelid worms, bivalves	*Ceriantheopsis americanus* *Pherusa affinis* *Nephtys* sp. *Cancer irroratus* *Asabellides oculata* *Scoletoma* sp. Polychaetes	*Nucula proxima* Anthozoa Sipunculida Crustaceans	mud, sand
Windowpane flounder *(Scophthalmus aquosus)*	mysids, planktonic shrimp, epibenthic shrimp	Gammaridea Mysidacea *Crangon septemspinosa* *Ammodytes* sp. Decapoda shrimp	Pisces miscellaneous worms	sand
Fourspot flounder *(Paralichthys oblongus)*	small fish, squid, crabs, shrimp, molluscs, annelids	Pisces (e.g., *Merluccius bilinearis)* Cephalopoda (e.g., *Loligo* sp.) Decapoda shrimp Pandalidae Mysidacea		near-bottom water column
Gulf Stream flounder *(Citharichthys arctifrons)*	worms, sand dollars, fish	Polychaete Amphipoda Decapoda crustacean Echinodermata Pisces (e.g., Gadidae)		sand, near-bottom water column

Table 3-17. Primary and secondary prey species of fish occupying the Study Area.

Fish Species	General Prey Characterization	Primary Prey Species	Secondary Prey Species	Typical Prey Habitat
Little skate ***(Raja erinacea)***	sand shrimp, amphipod	Caprellidae Gammaridae Decapoda crab Polychaete *Crangon septemspinosa* Decapoda shrimp Crustacea *Cancer irroratus* *Ammodytes* sp.	Pisces Anthozoa	sand, epizoic
Ocean pout ***(Macrozoarces americanus)***	sand dollars, shrimp, crabs, and possibly sea stars	*Echinarachnius parma* Echinoidea Amphipoda Decapoda Aphroditidae	Pisces brittle star Polychaete	sand, rocks
Cunner ***(Tautogolabrus adspersus)***	mussels, worms, epibenthic shrimp,	*Mytilus edulis* *Crangon septemspinosa* Polychaete Decapoda crab	*Echinarachnius parma*	rocks, sand
Spiny dogfish ***(Squalus acanthias)***	small fish, ctenophores	Ctenophora Pisces (Scombridae)	Molluscs epibenthic crustaceans Pisces (e.g., *Peprilus triacanthus*)	water column
Scup ***(Stenotomus chrysops)***	crustaceans, worms, molluscs, vegetable debris	Polychaeta Bivalvia Amphipoda		sand, rock
Silver hake ***(Merluccius bilinearis)***	fish, crustaceans, squid	*Ammodytes* sp. *Scomber scombrus* *Merluccius bilineris* *Crangon septemspinosa* Mysidacea Decapoda shrimp Pandalidae	*Peprilus triacanthus*	sand, water column

Table 3-17. Primary and secondary prey species of fish occupying the Study Area.

Fish Species	General Prey Characterization	Primary Prey Species	Secondary Prey Species	Typical Prey Habitat
Red hake ***(Urophycis chuss)***	shrimp, worms, fish, amphipods, crabs	*Crangon septemspinosa* *Dichelopandalus leptocerus* *Cancer irroratus* *Pherusa affinis* *Nephtys incisa* Polychaeta Amphipoda Decapod shrimp Pandalidae *Ammodytes* sp.	Pisces	sand, mud
Spotted hake ***(Urophycis regius)***	shrimp, crabs, amphipods	Pandalidae *Merluccius bilinearis* Pisces Decopoda shrimp Decapoda Euphausiidae Amphipoda		sand, near-bottom water column
Black sea bass ***(Centropristis striata)***	crabs, squid, mussels	Decapoda *Cancer* sp. Cephalopoda	*Mytilus edulis*	sand, water column
Tautog ***(Tautoga onitis)***	mussels, crabs, sand dollars	*Mytilus edulis* *Cancer* sp. *Echinarachnius parma*		rocks, sand
Northern sea robin ***(Prionotus carolinus)***	crabs, worms, epibenthic shrimp, fish	Polychaete *Cancer irroratus* *Crangon septemspinosa* Pisces		mud, sand, water column
Striped sea robin ***(Prionotus evolans)***	crabs, epibenthic shrimp	Decapoda *Cancer irroratus* *Crangon septemspinosa*		mud, sand
Sea raven ***(Hemitripterus americanus)***	shrimp, crabs, fish (cunner, ray)	*Cancer irroratus* *Tautogolabrus adspersus* Pisces *Raja erinacea* *Crangon septemspinosa* *Dichelopandalus leptocerus*		mud, sand rocks, water column

Table 3-17. Primary and secondary prey species of fish occupying the Study Area.

Fish Species	General Prey Characterization	Primary Prey Species	Secondary Prey Species	Typical Prey Habitat
Longhorn sculpin ***(Myoxocephalus octodecimspinosus)***	crabs, epibenthic shrimp, worms, fish fry (e.g., alewives, cunners, eels, herring, mackerel, silver hake, sculpin)	*Cancer irroratus* *Dichelopandalus leptocerus* *Crangon septemspinosa* *Cancer* sp.	polychaete Pisces	mud, sand
Butterfish ***(Peprilus triacanthus)***	copepods, small fish, polychaete, gammarid amphipod, crabs, bivalves	Tomopteridae Copepod Decapoda Axiidae		sand, water column
Atlantic herring ***(Clupea harengus)***	Copepods, euphausiids, pterodpods	Amphipoda Chaetognatha		water column, sand
Bluefish ***(Pomatomus saltatrix)***	fish (e.g., windowpane flounder, anchovy) shrimp, squid, crabs, mysids, annelid worms	*Anchoa mitchilli* Pisces Amphipoda Decapod crab *Scophthalmus aquosus* Gammaridea Engraulidae	Cephalopoda	water column, sand
American shad ***(Alosa sapidissima)***	zooplankton (large copepods, mysids, euphausiids), *Meganyctiphanes norvegica,* fish larvae (e.g., silver hake)	Euphausiacea *Merluccius bilinearis*	copepods	water column
Weakfish ***(Cynosion regalis)***	fish (e.g., anchovy), shrimp, squid, crabs, worms, clams	Fish (e.g., *Anchoa mitchilli*) Engraulidae Cephalopoda		water column
Striped bass ***(Morone saxatilis)***	fish (e.g., red hake), crabs, shrimp, squid, clams	*Brevoortia tyrannus* *Urophycis chuss*		water column
Alewife ***(Pomolobus pseudoharengus)***	fish (e.g., sand lance), cyclopoid copepods, cladocerans	Ammodytes sp.		water column, sand

Sources: NEFSC, 1995b; Steimle *et al.*, 1994; Steimle, 1994; Steimle and Terranova, 1991; Michaels *et al.*, 1986; Bowman and Michaels, 1984; Steimle and Ogren, 1982; Langton and Bowman, 1980; Carraciola and Steimle, 1983; Battelle, 1996a; E. Ruff, pers. comm., 1996; Fauchald, 1977; Shepherd *et al.*, 1986; Wigley, 1960.

Table 3-18. Primary and secondary prey species of shellfish occupying the Study Area.

Shellfish Species	General Prey Characterization	Primary Prey Species	Secondary Prey Species	Typical Prey Habitat
Long-finned squid ***(Loligo pealei)***	crustaceans (e.g., euphausiid shrimp), small fish (e.g., butterfish, anchovy), other squid	*Peprilus triacanthus* Engraulidae Euphausiid *Meganictiphanes* sp. *Pandalus borealis* *Crangon* sp. Copepods Sagitta Anomura Stomatopod Pisces		water column
Short-finned squid ***(Illex illecebrosus)***	crustaceans (euphausiids, with small quantities of hyperiid amphipods), and fish, other squid	Euphausiid Amphipod *Meganictiphanes norvegica* Myctophidae Meluceidei (e.g., *Merluccius bilinearis)* shrimp Pisces Chaetognatha		water column
Rock crab ***(Cancer irroratus)***	Molluscs, crustaceans, polychaetes, fish	Cephalopoda *Pherusa affinis* Amphipoda *Cancer* sp. Anomural/Brachyura	algae *Nucula proxima* *Cerastoderma pinnulatum* *Ensis directus*	silt, sand
Horseshoe crab ***(Limulus polyphemus)***	small bivalves (e.g. blue mussel) and worms	*Gemma gemma* *Mytilus edulis* Polychaetes		sand
Jonah crab ***(Cancer borealis)***	Molluscs, crustaceans, worms, fish	*Nucula proxima* *Cerastoderma pinnulatum Pitar morrhuanus* *Pherusa affinis* Amphipoda Paguridae *Cancer* sp.	algae Nephtyidae Panaeidae/Caridae *Echinarachnius parma* Anomura/Brachyur a Crustacea	silt, sand
American lobster ***(Homarus americanus)***	invertebrates, fish (living and dead), small quantities of marine plants	Pisces *Cancer irroratus* *Pherusa affinis*		silt, sand
Surf clam ***(Spisula solidissima)***	phytoplankton	diatoms		water column
Sea scallop ***(Placopecten magellanicus)***	phytoplankton	diatoms organic detritus		water column

Sources: Michaels *et al.*, 1986; Stehlik, 1993; M. Dawson, pers. comm., 1996; Steimle, 1994; S. Murawski, pers. comm., 1996; Vovk and Khvichiya, 1980; Froerman, 1983.

Figure 3-68. Quarterly distribution of demersal fish inhabiting the Study Area (bars) and corresponding spawning periods (asterisks). Bar thickness indicates relative population size during calendar periods that the species inhabit the Study Area.

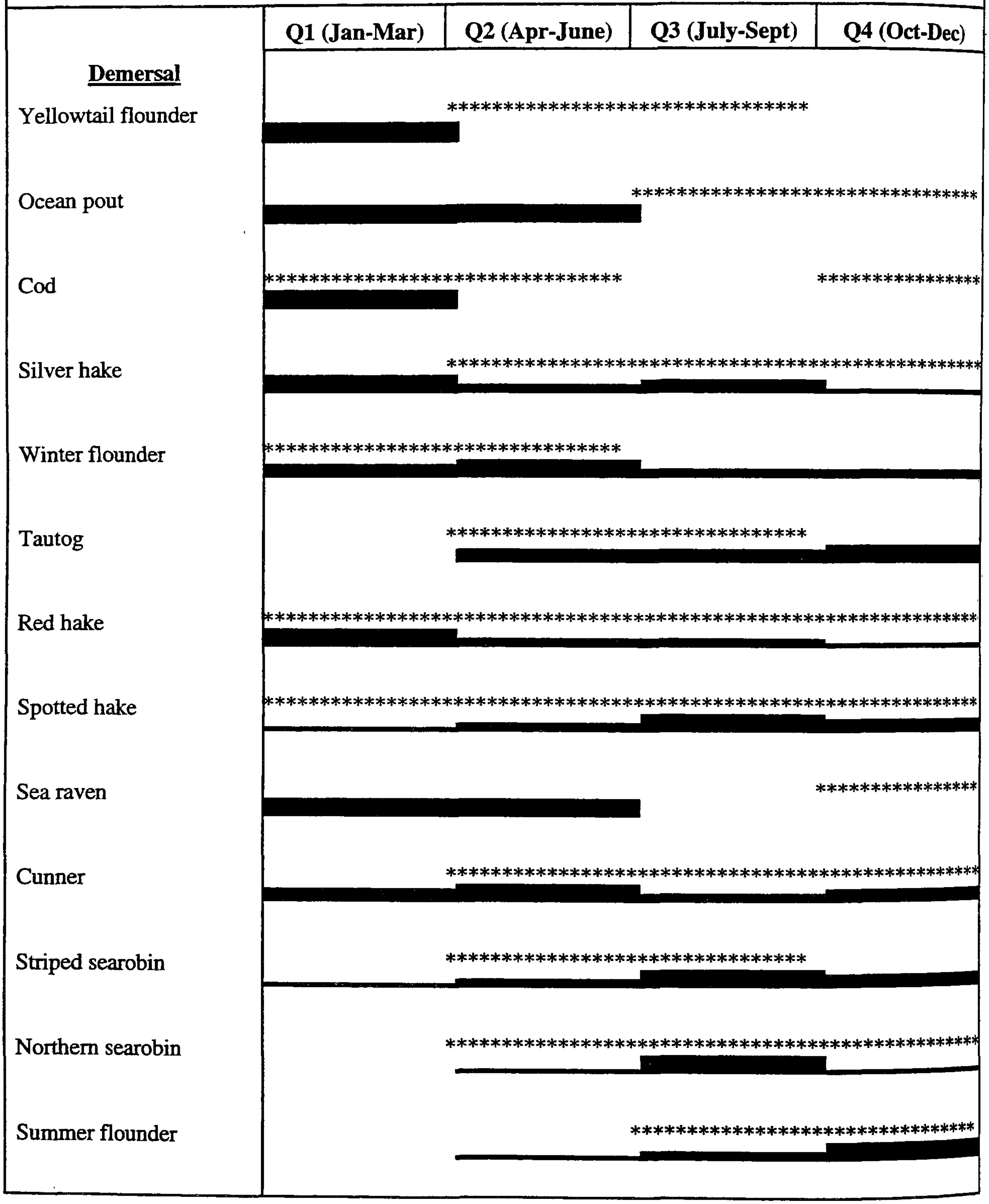
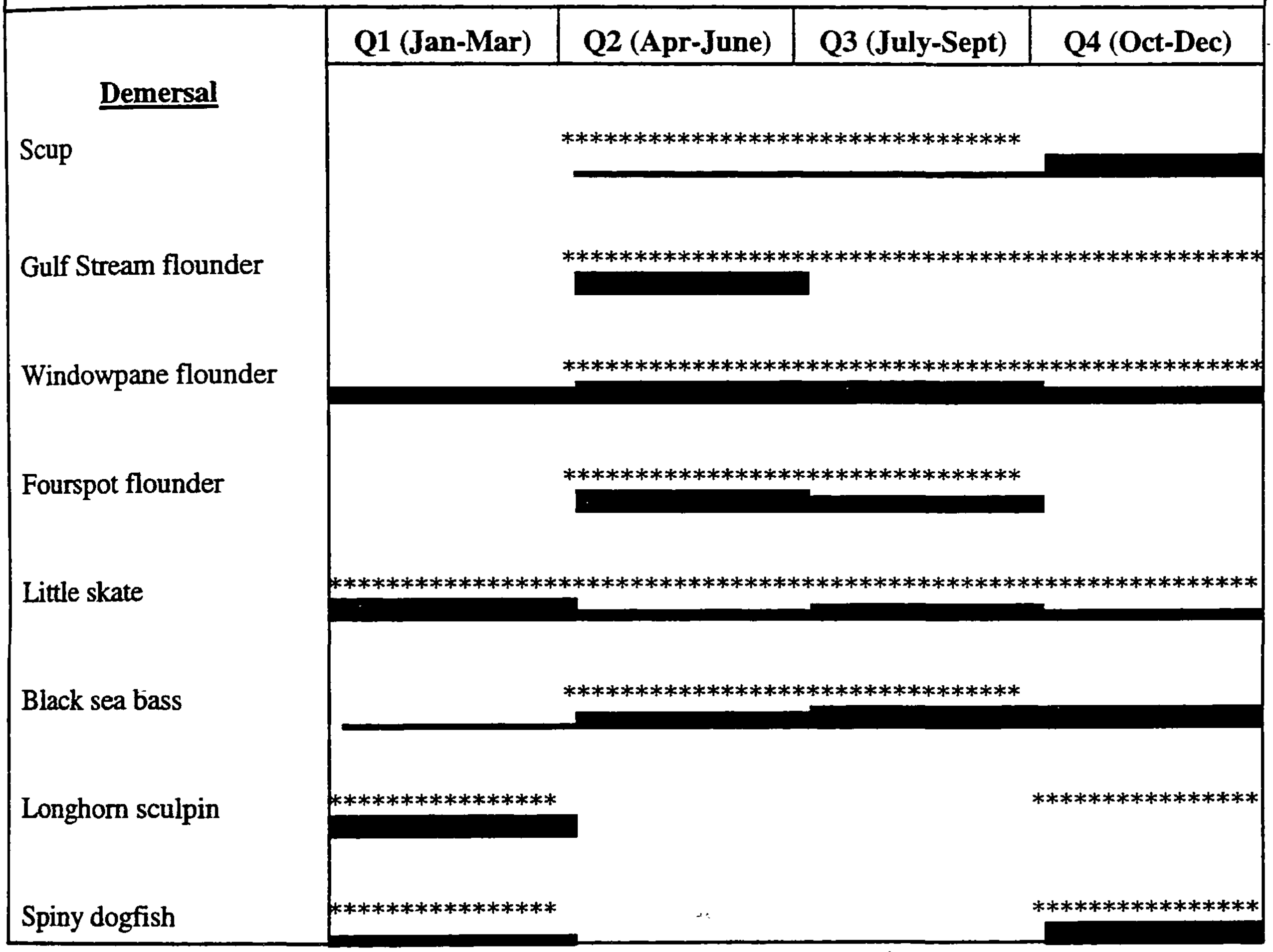
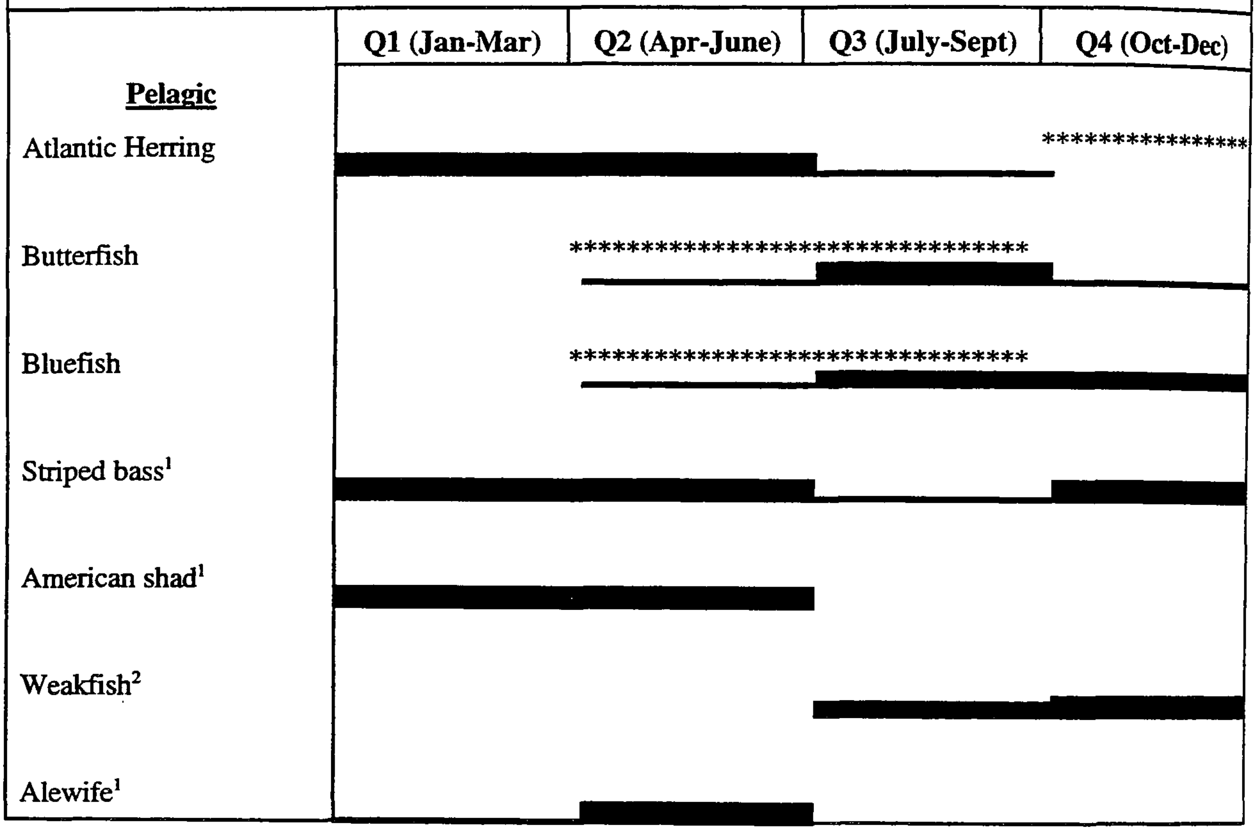


Figure 3-68. Quarterly distribution of demersal fish inhabiting the Study Area (bars) and corresponding spawning periods (asterisks). Bar thickness indicates relative population size during calendar periods that the species inhabit the Study Area.



Sources: Smith, 1985; Eklund, 1988; Colton *et al.*, 1979.

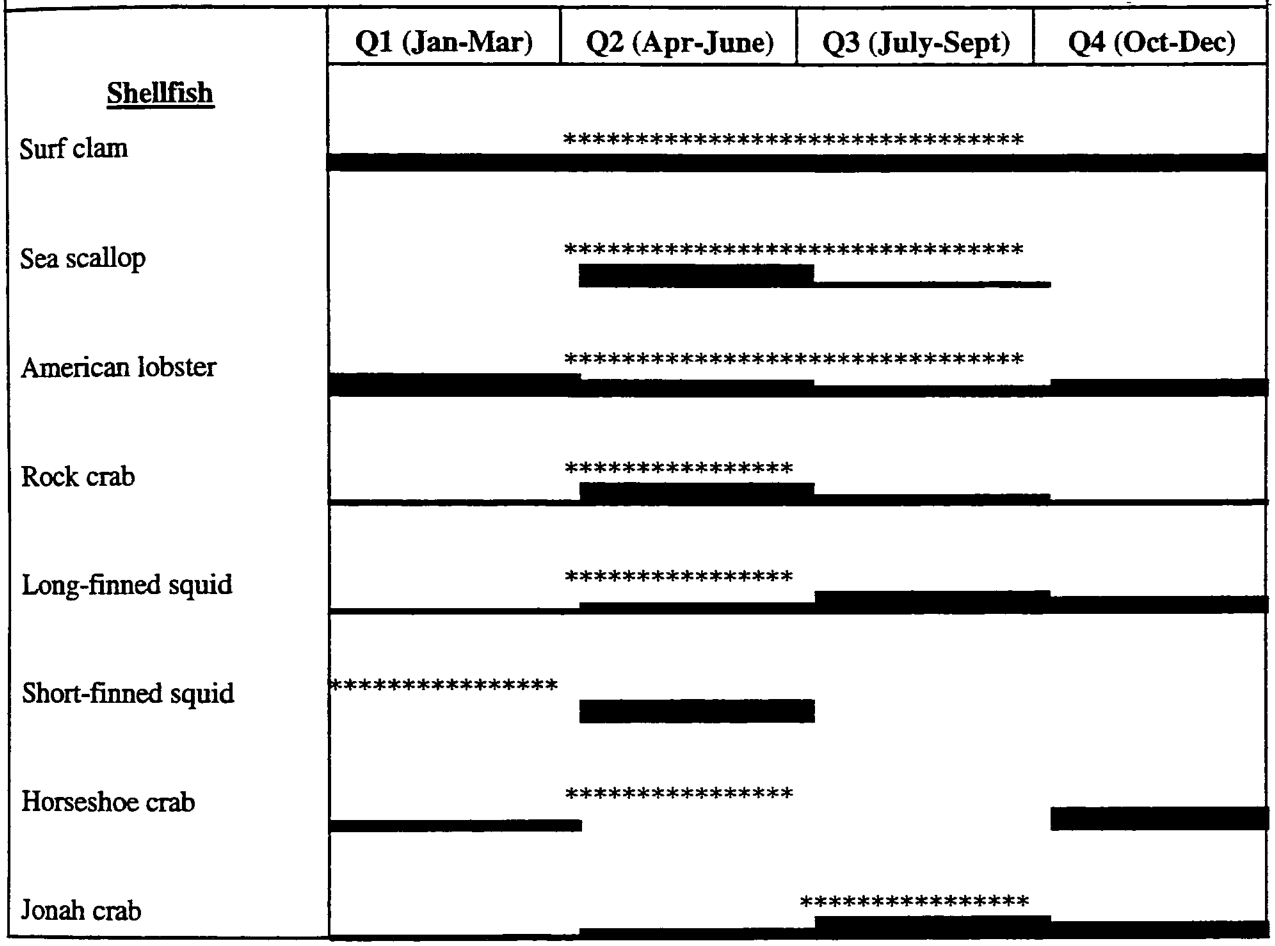
Figure 3-69. Quarterly distribution of pelagic fish inhabiting the Study Area (bars) and corresponding spawning periods (asterisks). Bar thickness indicates relative population size during calendar periods that the species inhabit the Study Area.



[1] These species are anadromous and do not spawn in the ocean.
Source: Smith, 1985; G. Shepherd, pers. comm., 1996; M. Terceiro, pers. comm., 1996.

[2]This species spawns in estuaries.

Figure 3-70. Quarterly distribution of shellfish inhabiting the Study Area (bars) and corresponding spawning periods (asterisks). Bar thickness indicates relative population size during calendar periods that the species inhabit the Study Area.



Sources: Smith, 1985; Murawski, pers. comm., 1996; NOAA, 1995; M. Dawson, pers. comm., 1996; J. Weinberg, pers. comm., 1996.

flounder and ocean pout spawn in late summer through early winter. Sea raven spawn during the last quarter of the year. Spotted hake, little skate, and red hake spawn throughout the year.

A key feature for evaluating the fish species of concern is to determine when the fish are most abundant at or near the Study Area and whether the fish are spawning during this period of peak Study Area-abundance. An overlap of a fish species spawning period with peak abundance at the Study Area would create greater cause for concern about impacts compared to a species that spawn far from the Study Area. Fish species for which there is no overlap in the spawning period and peak abundance period are yellowtail, ocean pout, silver hake, tautog, sea raven, and scup. All of these, except for ocean pout and sea raven, produce planktonic eggs. The regional populations of ocean pout and sea raven most likely deposit their demersal eggs at locations away from the Study Area because the peak abundances in the Study Area do not coincide with spawning periods. There is overlap between spawning period and peak abundance for the remaining fifteen species. For example, peak catches of longhorn sculpin and little skate in the NJDEP Strata 14 occur during the spawning period. Thus, it is possible that longhorn sculpin and little skate spawn when in peak abundance near the Study Area.

Demersal fish species with corresponding peak abundance and spawning periods in or near the Study Area

- Cod.
- Winter flounder
- Red hake
- Spotted hake
- Cunner
- Striped searobin
- Northern searobin
- Spiny dogfish
- Summer flounder.
- Gulfstream flounder
- Windowpane flounder
- Fourspot flounder
- Little skate
- Black sea bass
- Longhorn sculpin

3.4.3.3.2 Pelagic Fish Spawning Strategies

Demersal Eggs. Atlantic herring is the only major pelagic species of the Study Area (discussed in this SEIS) that produces demersal, sticky eggs that adhere to ocean bottom sediments. However, the likelihood of significant spawning in the Study Area is low because the southernmost known location for spawning is Nantucket Shoals (NOAA, 1995d).

Planktonic Eggs. Four pelagic fish species that are found in and near the Study Area produce planktonic eggs. One of the species (striped bass) demersal eggs are anadromous and spawns in fresh water. Therefore, there is no concern that conditions or impacts at the MDS will affect the spawning behavior or hatching success of these species. The eggs of bluefish and butterfish (both contain an oil globule) and weakfish (does not contain an oil globule) remain in the water column until they hatch; potential impacts from placement of dredged material in the MDS or Study Area is very remote.

Pelagic Fish Spawning vs. Peak Abundance Periods in the Study Area (Figure 3-69). As discussed in the preceding section, a key feature for evaluating the fish species of concern is determining when the fish are most abundant at or near the Study Area and whether the fish are spawning during this period of peak abundance. An overlap of pelagic fish spawning periods with peak abundance periods at the Study Area may subject a species to impacts from placement of dredged material compared to species that spawn far from the Study Area. Atlantic herring, a commercial pelagic species, does not appear to spawn at the Study Area. Herring spawn inshore during the last quarter of the year; while it is most abundant in offshore waters of the Study Area from January to June; they move inshore in April prior to spawning. Contrary to Atlantic herring, the late spring and summer spawning periods of bluefish (recreational and commercial species) and butterfish (commercial species), both of which produce pelagic eggs, coincide with periods of peak abundance (July-September). The three anadromous species (striped bass, American shad, and alewife) and one estuarine spawning species (weakfish) are not relevant to this discussion because they do not spawn in the ocean.

3.4.3.3.3 Shellfish Spawning Strategies

As mentioned previously, most of the shellfish discussed in this SEIS spawn planktonic eggs, except for *Loligo pealei* and *Illex illecebrosus*, for which no data are available. As discussed for fish in the previous section, a key feature for evaluating possible impacts to shellfish species is to identify the period when the shellfish are most abundant in the Study Area and whether the shellfish are spawning during the peak abundance period. An overlap of shellfish spawning periods with peak abundance periods may subject the species to impacts from placement of dredged material compared to species that spawn outside the Study Area. Shellfish require specific consideration because even motile shellfish are far less motile than fish; shellfish such as crabs and lobsters can undertake migrations to spawning grounds. Sessile shellfish species are sedentary with limited to nonexistent migrations during their lifecycles, thus, spawning occurs wherever the organisms are throughout the year.

Loligo* and *Illex Squid. Both *Loligo pealei* and *Illex illecebrosus* are annual semelparous species that are capable of spawning at any time during the year. Recent studies on ageing indicate that, in general, *L. pealei* spawn during the winter (NEFSC, 1994). Previous studies had indicated that *L. pealei* spawned in spring and fall (NEFSC, 1994). Because *L. pealei* has the potential for spawning year round, they could deposit eggs on the ocean floor near or in the Study Area at any time during the year. However, it is most likely for spawning to occur in the winter, when this squid species is outside of the Study Area (Figure 3-70).

I. illecebrosus is thought to spawn throughout the year, but primarily during the winter after the adults migrate offshore (migration starts in the fall) and head south to the warm waters of the Atlantic Ocean off the southern U.S. coast. Secondary spawning events have occurred in the Atlantic Ocean off the northern U.S. coast during the summer (Lange, 1981). Because the primary spawning grounds are south of the New York Bight (specifically, south of Cape Hatteras; Rowell and Trites, 1985) and secondary spawning is at great depths in waters offshore of the northeastern U.S. (Lange and Sissenwine, 1980), it is highly unlikely that *I. illecebrosus* will deposit eggs in or near the Study Area. There are no conclusive data on the type of eggs spawned by *I. illecebrosus* or the specific geographic spawning locations (L. Hendrickson, pers. comm., 1996).

Rock crab. After spawning rock crabs carry their eggs until they hatch (Krouse, 1972). Because this species is abundant near the Study Area during the spawning period (Figure 3-70), it is possible that the egg-carrying females that bury themselves in sediment could be buried by placement of dredged material.

Jonah Crab. The spawning period for the Jonah crab does coincide with its period of peak abundance in or near the Study Area (Figure 3-70). Therefore it is likely that the crab would spawn in the region of the Study Area.

Lobster. Individual lobsters spawn every other summer. Eggs are carried by the female until they hatch (Cobb and Phillips, 1980). As mentioned above, lobster migrate to warmer inshore waters during the spring to early summer to spawn. The offshore lobster may undergo extensive migrations in comparison to the coastal/inshore population to reach warmer water which is conducive to extrusion of eggs, molting, and subsequent mating (Uzmann *et al.*, 1977). However, some offshore lobster populations may migrate shorter distances or not migrate at all to spawn. The spawning period of the lobsters occurs at a time when they are least abundant at the Study Area (Figure 3-70).

Surf Clam. The number of spawning periods that a surf clam undergoes is influenced by water temperature. In general, there are two spawning periods: one major (Mid-July to early August) and one minor (mid-October to early November; Ropes, 1980). In years or areas with cooler water temperatures, only the major spawning period may occur. In the New York Bight area, spawning can potentially occur from spring to early fall (Figure 3-70). As mentioned previously, the surf clam is a sedentary species which spends most of its life buried in the surface sediments of the benthos. Surf clams are harvested by commercial fishermen in the Study Area region year round, so it is possible that these species may be affected by placement of dredged material, especially during their spawning periods.

Sea Scallop. Sea scallops in the area of the Study Area exhibit biannual spawning in the spring and early fall (Kirkley and DuPaul, 1991). The spring spawning is the more dominant event and may correspond with the period of peak abundance near the Study Area (Figure 3-70). The planktonic eggs remain in the water column until they hatch into larvae and settle into the sediment for a development period.

Horseshoe Crab. In May and June, horseshoe crabs migrate inshore to sandy beaches where they mate and spawn, burying egg masses in the sand (Rudloe, 1981). This shoreline spawning will not be affected by disposal operations at the Study Area.

3.4.3.4 Food and Habitat Requirements of Fish and Shellfish in the Study Area

The type of sediment habitat available to demersal fish species and shellfish (except for squid which is pelagic) significantly affects their survival and abundance. In contrast, sediment type is not as important for pelagic fish species and squid, which spend most of their life cycle in the water column. For demersal species, the seafloor serves two major purposes: protection from predators and a source of food. For example, sandy sediments provide excellent protection to species that bury into the sediment (e.g., flounder) and the nooks and crannies of hard substrate, rocks, rubble, and wreckage provide habitat that small fish can hide in as protection against larger species. The physical characteristics of the sediment (e.g. amount of sand, gravel, mud, roughness and relief) generally establish specific prey species available to fish and shellfish (e.g., benthic infauna in muddy and sandy areas, species attached to hard substrate in rock or other hard-bottom areas, or fish living in the water column immediately above the sediment/water interface).

There are several major sediment types in the Study Area. These can be broadly classified as sandy, sandy mud, muddy, and hard-bottom sediments. The location and extent of these major sediment types are depicted schematically in Figure 3-71. Detailed characterizations of these areas can be found in Section 3.3.2. Briefly, these major sediment types are characterized as follows:

- *Sandy sediments (0-10% fines)*: These sediments are nearly devoid of fine grained particles and may range from fine sands to coarse sand or small gravel. This type of sediment covers approximately 30% of the Study Area. These sediments are found in the southern one-third of the Study Area and in a

Summary of Shellfish Spawning vs. Peak Study Area Abundance Periods
(refer to Figure 3-70)

- The squid *Loligo pealei* may spawn in the Study Area when abundance is at less-than-peak levels.
- Lobster in the Study Area spawn when abundance is at less-than-peak levels.
- The squid *I. illecebrosus* and horseshoe crabs spawn outside the Study Area.
- Surf clam and sea scallop populations (relatively sedentary species) are present in the Study Area and spawn from spring through the fall.
- Jonah and rock crabs (relatively motile compared to surf clams and sea scallops) are at peak abundance in the Study Area during their spawning period.
- **Conclusion:** Rock crab, surf clam, and sea scallop populations are most likely to be affected by dredged material disposal activities in the Study Area.

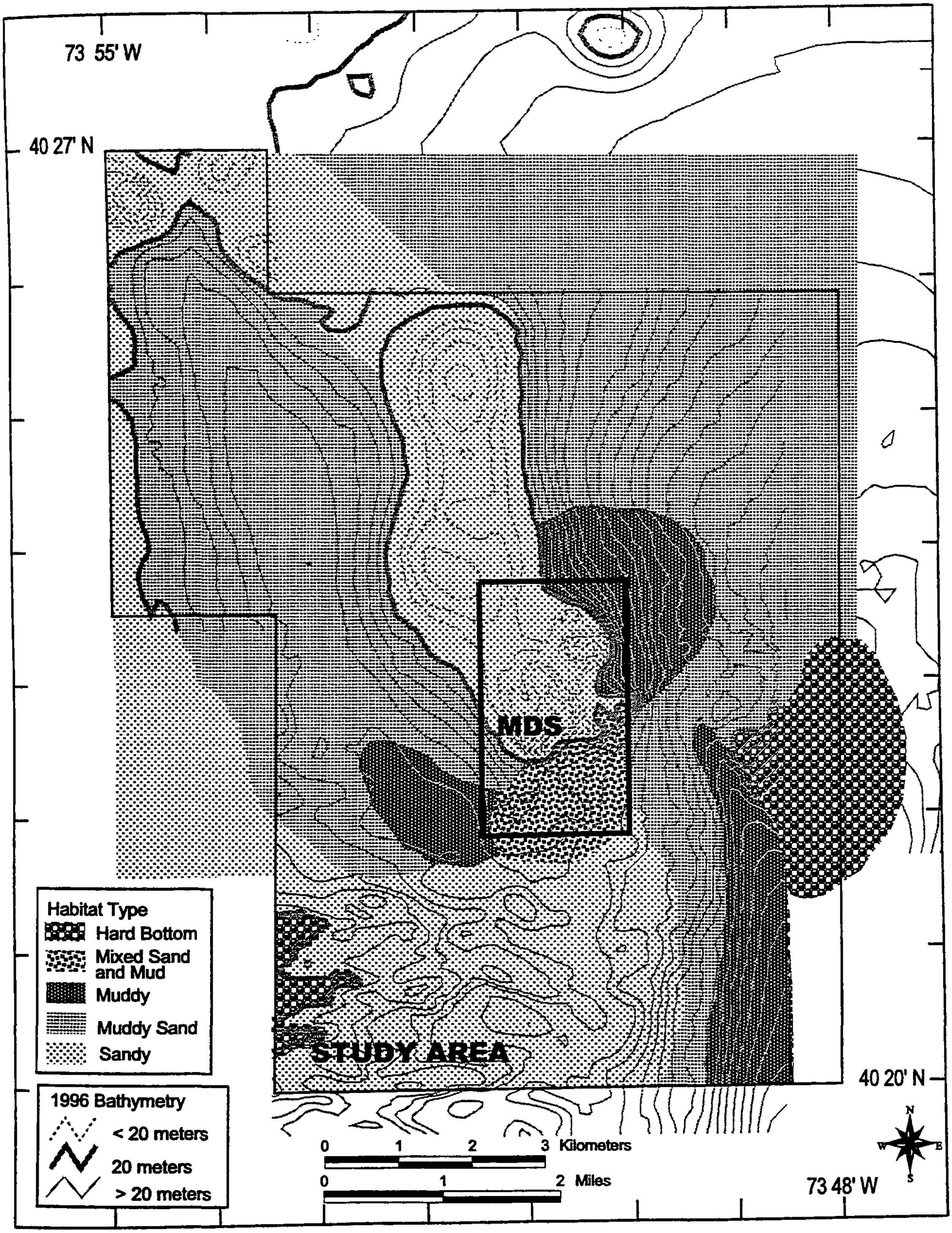


Figure 3-71. Schematic diagram of location and extent of the four major surface sediment categories in the Study Area.

band extending north and south through the central portion of the Study Area. The sediments in this latter area are predominately associated with the historic and present dredged material disposal mounds.

- *Sandy-mud sediments (10-40% fines):* This type of substrate is the most predominant sediment in the Study Area, covering approximately 40% of the area. These sediments are found in two areas (1) along the entire eastern portion of the Study Area from the northern to the southern boundary and (2) within the shallow basin west of the historic disposal mounds.

- *Muddy sediments (40-100% fines):* These sediments are restricted to relatively small zones located in and near the MDS. This sediment type covers 10 to 15% of the Study Area. The muddy sediments are generally restricted to the southern half of the MDS, although some areas extend slightly beyond the northeast and southwest corners of the MDS. The texture of these sediments is prone to change due to ongoing dredged material disposal in the MDS. The new materials can range from muds to sand depending on the most recent disposal projects and management activities.

- *Hard-bottom:* Areas with hard-bottom characteristics comprise approximately 15% of the Study Area. These regions are scattered throughout the Study Area and are characterized by rock, rubble, rough relief, and wreckage. Rough bottom areas with hillocks covered by sand are most prevalent in the southwest section of the Study Area known as the Shrewsbury Rocks. Rubble is found in the central eastern section of the Study Area and is primarily associated with the former Cellar Dirt Site. Gravel is only found in the shallow depths of the oldest portion of the historic disposal mound (northern most section of Subarea 2). Shipwrecks and obstructions are found in several locations in the Study Area but are most concentrated in the northern and western regions. (See Section 3.5.7 for additional information).

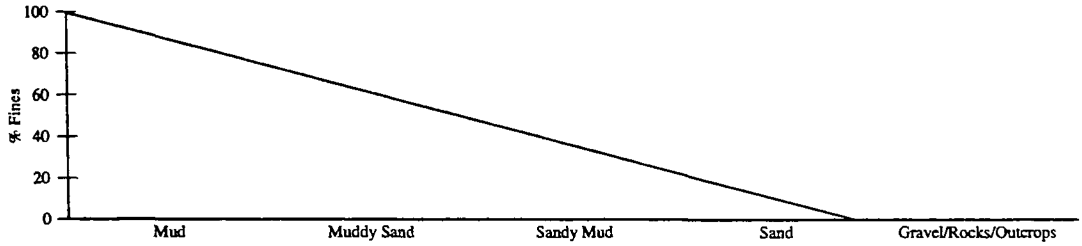
Note that within the areas comprising each of these major sediment types, smaller areas of each sediment type can be found. This provides a cascading scale of interlaced sediment types in the area, providing a broad range of interlinked habitat types for fish that inhabit the region.

Consistent with the sediment types in the Study Area, the demersal fish species that occur in the Bight include those that prefer sandy sediments or a combination of sand and mud (Figure 3-72). For example, flounder species, which prefer sand to mud sand sediments, can be found throughout the Study Area. Because flounder bury themselves in the sand when disturbed, they avoid areas that contain hard substrate (rocks) and very soft muds (Bigelow and Schroeder, 1953) which prevent or inhibit their ability to burrow. Other species that rest and forage on the bottom, such as little skate and longhorn sculpin, survive equally well in areas with sand or muddy sediments. Only one species, spotted hake, is primarily supported by and prefers muddy sediment (T. Azarovitz, pers. comm., 1996). Other species are found on mud sediments as well as sand or hard substrates. These include species such as silver hake, longhorn sculpin, and little skate. At least one species, the spiny dogfish, does not demonstrate a preference for specific sediment types and is found throughout the area.

Shellfish found in the Study Area are associated with many sediment types, ranging from mud (e.g., horseshoe crab) to gravel (e.g., rock crab). Some species may have an affinity to more than one sediment type. For example, horseshoe crabs are found in muddy and sandy environments.

Hard substrates provide protective areas for fish (juveniles or adults), a substrate for growth of epibenthic invertebrates (e.g., blue mussels), and a range of macro and micro habitat that can support numerous individual fish and their prey species. These bottom types often provide disproportionate amounts of habitat and forage area relative to the other sediment types. Species such as cunner, tautog, and black sea

Figure 3-72. Sediment preferences of fish and shellfish that occupy the Study Area.
(See Figure 3-71 for spatial distribution of sediment texture in the Study Area).



COMMON SPECIES LIKELY FOUND WITHIN THE STUDY AREA

Mud	**Muddy Sand**	**Sandy Mud**	**Sand**	**Gravel/Rocks/Outcrops**
Spiny dogfish	Spiny dogfish	Spiny dogfish	Spiny dogfish	Spiny dogfish
Spotted hake	Winter flounder	Yellowtail flounder	Winter flounder	Winter flounder
Silver hake	Horseshoe crab	Jonah crab	Scup	Scup
Red hake	Sea scallop		Yellowtail flounder	Black sea bass
Fourspot flounder			Silver hake	Silver hake
Longhorn sculpin			Summer flounder	Tautog
Windowpane flounder			Red hake	Cunner
Little skate			Cod	Cod
Horseshoe crab			Ocean pout	Ocean pout
			Longhorn sculpin	Longhorn sculpin
			Black sea bass	Little skate
			Fourspot flounder	Sea raven
			Sea raven	American lobster
			Northern sea robin	Surf clam
			Striped sea robin	Rock crab
			Little skate	Jonah crab
			Windowpane flounder	
			Gulfstream flounder	
			Surf clam	
			Rock crab	
			Jonah crab	
			Horseshoe crab	
			Sea scallop	

Sources: Bigelow and Schroeder, 1953; T. Azarovitz, pers. comm., 1996; Langton *et al.*, 1994; M. Dawson, pers. comm., 1996; S. Murawski, pers. comm., 1996; and Stehlik *et al.*, 1991.

bass are known to dominate hard substrate habitats (Bigelow and Schroeder, 1953). Ocean pout have been collected on hard substrates, even though the species prefers sand habitat. Other typical species found in hard-bottom areas include tautog and black sea bass (Bigelow and Schroeder, 1953). Gravel, while only found in small patches in the northwestern portion of the Study Area, can serve as an alternate substrate for cod, winter flounder, silver hake, and scup.

The diverse sediment types in the Study Area clearly support a variety of fish and shellfish species, many of which can forage and survive across several types of substrate. Thus, the intermixing of these substrates at a variety of spatial scales likely maximize the ability for many of these species to survive and flourish in the area. The following section discusses specific food (prey) requirements of the most important fish and shellfish species in the Study Area and relates these to specific prey organisms in the various sediment types.

3.4.3.4.1 Fish—Food and Habitats

Generally, the physical features of a fish (e.g., mouth size, type of teeth, fast/slow swimmer) establish the type of organisms on which fish prey. Typically, pelagic fish prey on small organisms found in the water column (plankton, copepods, euphausiids, and mysids) and other pelagic fish. The prey of demersal fish depend largely on the habitats with which the fish is associated.

To understand the interaction of fish, prey species, and substrate in the Study Area, thus establishing the significance of the various sediment types to the fisheries of the Study Area, prey species preferred by the fish of the area were identified. Two data sources were used to identify preferred prey for each fish species, scientific literature and information contained in the NMFS, Northeast Fisheries Science Center data base (NEFSC, 1995b). Prey species were categorized as primary or secondary prey (Table 3-17). Recent data from benthic invertebrate studies within the Study Area (Battelle, 1992a; 1996a) were then used to predict where prey (listed in the table) are located within the Study Area and determine the sediment (substrate) associated with that area. In general, the prey species and associated habitats in the Study Area correspond with published literature on prey habitat interactions.

> **Criteria for Determining Primary and Secondary Prey Categories for Fish in the Study Area**
>
> **NEFSC Database:** The NEFSC database contains quantitative measurements of stomach contents of fish collected in the New York Bight. Primary and secondary prey species were determined from the fractional contribution each identifiable species made to the entire set of prey species. All species that fell within the top 80% were categorized as primary prey. Secondary prey included the remaining 20%. These categories provide additional information about the prey found the Study Area.
>
> **Published Literature Sources:** Published literature with interpretive evaluation based on best scientific judgement provided a second source for determining prey categories. Prey species that comprised a major portion of the diet, based on the percentage, were categorized as primary prey. Key infauna species that were a minor component of the diet were also categorized.

The following section is organized by predator habitat type (multi-habitat, sand, mud, and hard-bottom). Discussions within each section focus on the fish (predator) species groups and the major prey species.

Multi-Habitat Fish

Species discussed in this section forage over a range of sediment types, including mud, sand, and gravel.

> **Multi-Habitat Fish Species in the Study Area**
>
> - Winter flounder
> - Silver hake
> - Cod
> - Windowpane flounder
> - Little skate
> - Sea raven
> - Red hake
> - Fourspot flounder
> - Spiny dogfish
> - Longhorn sculpin
> - Ocean pout

Winter Flounder. Winter flounder, with its relatively sedentary lifestyle and a small mouth, feeds on prey found in or on the sediment in which it lives. It is found on muddy-sand and sandy sediments both of which are found throughout the Study Area. The winter flounder diet consists of several species of polychaete worms, *Pherusa affinis*, *Asabellides oculata,* and *Nephtys* sp., and *Cancer irroratus* (rock crab), which are characteristic of muddy sediments in the Study Area (Battelle, 1996a). Note, however, that Caracciolo and Steimle (1983) state that *Cancer irroratus* is typically associated with sandy environments. In a 1995 survey of the Study Area, *Cancer irroratus* was only collected in silty sediments[9] (Battelle, 1996a). *Ceriantheopsis americanus* (tube anenome) appears to be a preferred prey of winter flounder and is found in all sediment types of the Study Area, except for gravel.

Silver and Red Hake. Silver hake, although classified as a demersal fish species, swims independent of depth or sediment type (Bigelow and Schroeder, 1953). The species' association with sand, gravel, or mud sediments are limited to the times when they are on the bottom as juveniles and when spawning. Silver hake is a voracious cannibalistic piscivore that preys primarily on mackerel (a demersal fish species) and smaller fish of its own species. The fish prey may be pursued over all sediment types. Silver hake feed also on sand lance, which, not surprisingly, are found in sand sediments. Juvenile silver hake feed on crustaceans (Bigelow and Schroeder, 1953), such as mysids (epibenthic shrimp), and *Crangon septemspinosa* (epibenthic shrimp) both of which are typically found in sandy sediments. Mysids have been identified in samples from the Study Area (Battelle, 1992a).

Red hake prefers soft sediments (mud), but it is found on sandy sediments as well. The diet of red hake is primarily composed of many different families of crustaceans, except for molluscs or echinoderms (Bigelow & Schroeder, 1953). As sluggish swimmers, red hake pursue sand lance and epibenthic crustaceans (e.g., amphipods, crabs, and shrimp) in sandy environments. Amphipods have been identified in samples from the Study Area (Battelle, 1992a). In muddy environments at the Study Area, red hake probably feed on *Cancer irroratus, Pherusa affinis,* and *Nephtys incisa* (Battelle, 1996a). Red hake (like spotted hake) also feed on *Dichelopandalus leptocerus* (pandalid shrimp), which are typically found on sediments with high organic content (Wigley, 1960)

Cod. Although cod spend most of their time on the bottom; cod do not root in the bottom sediments for prey (Bigelow and Schroeder, 1953). Cod primarily pursue and feed on fish in the water column, such as herring (a pelagic fish), but they will also forage the bottom for other demersal species, such as skates, flounder, and sand lance (NEFSC, 1995b). When feeding on benthic invertebrates, cod prefer molluscs, such as ocean quahog (NEFSC, 1995b). (Ocean quahog is a commercially harvested species fished heavily in sandy bottom areas of the southern New Jersey-Delmarva Peninsula area.)

Fourspot and Windowpane Flounder. Fourspot and windowpane flounder, like summer flounder, are found in both sand and mud environments. Fourspot flounder is very similar to summer flounder. It is a large mouth flounder that feeds on mobile prey in the water column, such as small fish (silver hake) and squid (NEFSC, 1995b). When it forages near the bottom, it consumes epibenthic prey, such as pandalid and mysid shrimp, both of which have been identified in samples from the Study Area (Battelle, 1992a). The diet of windowpane flounder includes mysid shrimp, small fish (e.g., sand lance), and gammarids (found in the Study Area) in sandy environments (Bigelow and Schroeder, 1953).

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[9] The sampling referred to was conducted in the Study Area using a grab sampler, which is not effective for sampling mobile shellfish. The absence of *Cancer* when sampling sandy sediments may be an artifact of sampling, and not related to distribution of *Cancer.*

Spiny Dogfish. Spiny dogfish are voracious eaters that travel across all sediment types in pursuit of fish (e.g., mackerel), their preferred prey. Dogfish are also one of the few fish that eat ctenophores (Bigelow and Schroeder, 1953). NEFSC (1995b) data indicate that they feed on ctenophores in areas near the Study Area. Prey that are of secondary importance include molluscs and epibenthic crustaceans such as decapod crab (e.g., *Cancer* sp.) and shrimp. *Cancer* crabs are found on mud sediments throughout the Study Area.

Little Skate. Amphipods, decapod shrimp, and polychaete worms are the primary prey of little skate. When foraging in sand sediments within the Study Area, little skate are probably feeding on *Crangon septemspinosa* (NEFSC, 1995b). Other little skate prey items are polychaete worms, which are abundant in mud and sand environments in the Study Area, and *Cancer irroratus,* which primarily inhabit sandy sediments. Little skate are also known to inhabit rocky ledges, where they may forage for epizoic caprellidae (NEFSC, 1995b). The southwest portion of the Study Area has some rough bottom (rocks covered by sand) habitat; a pseudo ledge environment exists in the eastern portion of the Study Area in the debris field of the old Cellar Dirt Site.

Sculpins. Longhorn sculpins stay near the bottom on mud, sand, and pebble substrates, and forage for prey from these substrates. A preferred prey, *Cancer irroratus* (NEFSC, 1995b), which is found in the Study Area (Battelle, 1996a), is eaten by sculpin on mud or sand bottoms. Longhorn sculpins in sandy sediments in the Study Area may be attracted by resident *Crangon septemspinosa.* Polychaetes, which are a minor prey, may be found in either mud or sandy sediments in the Study Area. Longhorn sculpins also pursue fish fry, such as pipefish, which it most likely catches in the mouths of rivers (Bigelow and Schroeder, 1953).

Sea raven, which are also in the sculpin family, have larger teeth than the longhorn sculpin and are found on similar substrates (i.e., hard sand and pebbles). Although they are not found on sticky mud, they do appear to have a preference for clay (Bigelow and Schroeder, 1953). On pebbly substrates, which are found in northwest corner of the Study Area, sea raven may pursue tautog (Bigelow and Schroeder, 1953). Similarly, sea raven may hunt *Cancer irroratus* or *Crangon septemspinosa* found on sandy sediments (NEFSC, 1995b).

Ocean Pout. Ocean pout spend most of their time hiding among stones (Bigelow and Schroeder, 1953). The primary prey of ocean pout is sand dollars, which is located in abundance on sand substrates throughout the Study Area. When on rocky substrates, ocean pout probably feed on aphroditidae worms (E. Ruff, pers. comm., 1996).

Sandy Habitat Fish

Four species of demersal fish prefer sandy environments exclusively. Sand bottoms are predominately found in 30% of the Study Area; sandy-mud bottoms represent 40% of the Study Area (refer to Section 3.3.2 and Figure 3-71). Prey items identified in the stomachs of fish species that forage on sand bottoms are described below.

Fish Found on Sand and Sandy Mud Substrates in the Study Area

- Scup
- Northern sea robin
- Striped sea robin
- Yellowtail flounder
- Gulfstream flounder
- Summer flounder

Yellowtail Flounder. Yellowtail is a relatively sedentary small-mouthed flounder, like winter flounder. Prey are limited to polychaetes and small crustaceans (e.g., amphipods) (NEFSC, 1995b), many of which are found in sand environments in the Study Area.

Scup. Scup rarely leave the bottom in search of food (Bigelow and Schroeder, 1953). Scup primarily feed on polychaete worms (NEFSC, 1995b), which are found throughout the Study Area in sand and silt environments. Other prey include amphipods and small bivalves, both of which are common to sandy sediments.

Gulfstream Flounder. Although there are no data specific to the New York Bight or Study Area on gulfstream flounder, general feeding information indicate a preference for echinoderms (i.e., sand dollars) and polychaetes, which are located in the sandy sediments of the Study Area. The gulfstream flounder is also known to prey on other fish (Michaels *et al.*, 1986).

Summer Flounder. Summer flounder is a predacious large mouthed flounder with a diverse diet that reflects its adaptation to pursue prey in the water column and feed on benthic invertebrates. Data indicate that summer flounder caught near the Study Area feed primarily on pelagic prey in the water column, such as fish (round herring) and cephalopods (squid) (NEFSC, 1995b). Other prey eaten by summer flounder include gammarids that are found on sandy environments in the Study Area (Battelle, 1996a).

Sea Robins. Sea robins are voracious fish that feed indiscriminately on many prey, including shrimp, crab, worms, and fish (Bigelow and Schroeder, 1953). As with the gulfstream flounder, there are no New York Bight or Study Area specific data on sea robins. Prey species listed in Table 3-17 were identified in sea robins collected throughout the northwest Atlantic Ocean as reported by Michaels *et al.* (1986). Although some of the prey species (e.g., *Cancer irroratus*) have been identified in the Study Area, they are not typical of the sandy sediments usually associated with sea robin habitat.

Muddy Habitat Fish

Muddy sediments cover approximately 10% of the Study Area (refer to Section 3.3.2 and Figure 3-71).

Spotted hake is the only demersal species discussed in this SEIS that is caught exclusively on muddy, muddy-sand sediments (T. Azarovitz, pers. comm., 1996). The spotted hake diet consists of pelagic (e.g., fish and euphausiids) and benthic (e.g., amphipods and shrimp) prey (NEFSC, 1995b). Spotted hake, like red hake, forage for *Dichelopandalus leptocerus* which is motile and can be found on many sediment types.

Hard Substrate (Gravel/Rocks/Outcrops) Habitat Fish

Hard bottom habitats support numerous species, many of which are also found on other substrates. Hard bottom substrates cover approximately 15% of the Study Area and are predominant in the southeast corner and vicinity of cellar dirt site. (Refer to Section 3.3.2 and Figure 3-71). Gravel and pebbles serve as alternate habitat substrates for seven demersal species listed in the text box. These species are also found on other substrates, as mentioned in previous discussions. Only three demersal species, black sea bass, tautog, and cunner, prefer hard substrates, specifically rocks and outcroppings.

Fish Found on Hard-Bottom Habitats in the Study Area

- Tautog
- Cunner
- Black sea bass

Fish Found on Gravel and Pebbles Substrates in the Study Area

- Silver hake
- Cod
- Little skate
- Sea raven
- Longhorn sculpin
- Winter flounder
- Ocean pout
- Spiney dogfish
- Scup

Tautog and black sea bass are sought on hard substrates in the Study Area by both commercial and recreational fisheries. Tautog primarily feed on blue mussels, but are classified as opportunistic benthic omnivores that select crabs (*Cancer* sp.) and sand dollars for food as frequently as mussels (Steimle and Ogren, 1982). Blue mussels are frequently found attached to hard substrates. Although a few blue mussels were found in the Study Area (Battelle, 1996a), mussels have not been reported as common in literature that characterizes invertebrates in offshore areas of the New York Bight. Substrate condition is critical for supporting mussel populations. Olla *et al.* (1974) stated that changes in substrates that support 1- to 2-yr old mussels could lead to a high probability of stress for the tautog population. The key prey of black sea bass, which are often collected with tautog, is *Cancer* sp. Although *Cancer* crabs (*C. irroratus* or *C. borealis*) were only collected from silty sediments in the Study Area (see previous footnote), they are associated most often with sandy sediment (Caracciolo and Steimle, 1983). In addition, *Cancer* crab is also found on gravel and rocky sediments (Jeffries, 1966; Krouse, 1980). Blue mussels and squid, a pelagic invertebrate, are eaten also.

Cunner, which is in the same family as tautog, is often found with tautog in rocky substrates, and is known to feed on small blue mussels. Additionally, cunners feed on *Crangon septemspinosa* and decapod crabs. *Crangon septemspinosa* is typically associated with sandy sediments, which are found throughout the Study Area.

Pelagic Habitat Fish

The pelagic species discussed in this section, with the exception of butterfish, do not exhibit a preference for bottom types found in the Study Area.

Butterfish. Although a pelagic species, butterfish are often associated with sandy sediments where they feed on benthic invertebrates, such as polychaete worms, shrimp, small crabs, and small molluscs (Bowman and Michaels, 1984).

Herrings. The herrings (Atlantic herring, alewife, and American shad) are plankton feeders that primarily feed on various species of copepods, shrimp, amphipods. For example, Atlantic herring feed on euphausiid shrimp, whereas shad feed on mysid shrimp (Bigelow and Schroeder, 1953). American shad will feed near the bottom on amphipods and will occasionally eat small fish (e.g., silver hake). Alewife will feed on diatoms and small fish to supplement its normal diet. Data from surveys near the Study Area indicate that alewife caught in this area feed on sand lance (NEFSC, 1995b). Unlike shad and alewife, herring is not normally a fish eater (Bigelow and Schroeder, 1953). Although not mentioned in Bigelow and Schroeder, chaetognaths appear to be a major component of the diet, especially for herring in the area near the Study Area (NEFSC, 1995b).

Bluefish. Bigelow and Schroeder (1953) describe bluefish as the "most ferocious and bloodthirsty fish in the sea." Bluefish are piscivores that feed on many species of fish and squid (i.e., cephalopods). Anchovy and windowpane flounder are prey species that have been identified in bluefish collected near the Study Area (NEFSC, 1995b). Occasionally bluefish will feed on crustaceans. Notably, small bluefish feed on copepods, amphipods, and small crabs (Bigelow and Schroeder, 1953). There is no evidence that bluefish, a migratory species, exhibits any preference to bottom types in the Study Area.

Weakfish. Adult weakfish feed primarily on other fish. Juvenile weakfish preferentially feed on shrimp and other small crustaceans (Bigelow and Schroeder, 1953). Anchovy is a fish species eaten by adult weakfish caught in the New York Bight Apex (NEFSC, 1995b).

Striped bass. Striped bass are voracious and opportunistic, feeding on small fish and several species of invertebrates (Bigelow and Schroeder, 1953). Red hake and Atlantic herring are two fish species that are consumed in the area near the Study Area (NEFSC, 1995b).

3.4.3.4.2 Shellfish—Food and Habitats

As previously discussed, most shellfish are closely associated with the sediment. Because most shellfish are relatively sedentary, sediment type is critical to survival because it provides a food source, protection, and habitat for the life of the organism. As such, food items are obtained from the sediment (e.g., benthic or epibenthic species), or are filtered from the water that passes above the bottom sediments. The exception is squid, which feeds on pelagic prey. Because of the strong sediment preferences of the non-pelagic shellfish in or near the Study Area (Figure 3-72), distribution of these organisms, when present, is determined by the sediment types of the Study Area (Figure 3-71).

Specific food items of each species are presented in Table 3-18. The following text describes shellfish habitat and food preferences in detail.

Multi-Habitat Shellfish

Loligo* and *Illex Squid. There is no evidence that *Loligo pealei* and *Illex illecebrosus* have an affinity for one substrate type over another. Once hatched from eggs laid on the bottom, the juveniles and adults spend their short lifespan in the water column. Juvenile squid feed on euphausiids and small crustaceans. In general, as squid mature, pelagic prey comprises a larger percent of the diet. Fish (e.g., butterfish) are a major component of the diet in the adult squid (Lange and Sissenwine, 1980). Adult squid are opportunistic predators, feeding on whatever fish are available within a specific size range (Dave, 1992). Crustaceans and other squid are also consumed by adult squid. Squid are not only predators; they serve as prey for fish and mammals as well.

Juvenile *I. illecebrosus* predominately feed on chaetognaths and a variety of crustaceans (Froerman, 1983). Prey of adult *I. illecebrosus*, in decreasing order of importance, include euphausiids, fish, and squid (Michaels *et al.*, 1986; Froerman, 1983). Fish prey of *I. illecebrosus* include silver hake, myctophids, cod, haddock, herring, and flounder (Squires, 1957; Bigelow and Schroeder, 1953). Silver hake is reported to be the most common fish prey species of *Illex* (Dave, 1992). *Illex* most likely feed on these prey when they are in the vicinity of the Study Area in the summer. Some of the fish prey of *I. illecebrosus* are associated with specific sediment types, as described previously.

The relative importance of prey in the diet of *Loligo pealei* varies with the size of the individual (Macy, 1982). The major prey of juvenile *L. pealei* is copepods, with euphausiids being of less importance (Vovk and Khvichiya, 1980). As the juveniles grow, mesozooplankton (e.g., copepods) consumption decreases and macroplankton (euphausiid and *Sagitta*) consumption increases. When *L. pealei* reach 7 to 10 cm, their diet switches to young crabs, Anomora, Stomatopoda, shrimp, and polychaetes (Vovk and Khvichiya, 1980). The diet of larger (>13cm) squid (e.g., *I. illecebrosus*) is dominated by small fish and smaller squid (Vovk and Khvichiya, 1980; Macy, 1982). Fish prey of adult *L. pealei* include myctophids, anchovy, scup, butterfish, and herrings (Michaels *et al.*, 1986; Lange and Sissenwine, 1980). These prey, like *L. pealei*, are not strongly associated with one sediment type.

Horseshoe Crab. Horseshoe crabs can be found in either sand or mud. Horseshoe crabs bury their eggs in sandy sediments on coastal beaches, but are found in mud environments in offshore areas. The sand or mud environment where non-spawning horseshoe crabs are found provide prey. Horseshoe crabs dig into the sediment in search of marine worms and shellfish, which are their primary prey. Prey species include, *Nereis* (sand worm), *Cerebratulus* (sand ribbon worm), *Gemma* and *Macoma* (duck clams), *Ensis* (razor clam), and *Mya* (soft-shelled clam). Although these prey may be associated with sand and mud environments, extensive feeding occurs during the breeding season (spring) when the crabs are found in intertidal sand and mud flats. Thus, most feeding will occur outside of the Study Area.

Sand/Gravel Habitat Shellfish

Sea Scallop. Sea scallops are most often associated with sandy sediments, which are found in the northwest and southern area of the Study Area; however, prey are obtained from the water column that passes by them. Because sea scallops are relatively sessile, they must adapt to fluctuations in food supply. Diatoms, including *Prorocentrum, Thalassiosira* sp., and *Dinophysis*, are the predominant prey of sea scallops. Other prey identified in the stomachs of sea scallops include several species of algae, pollen grains, silicoflagellate strew, ciliates, bacteria, and detritus (Shumway *et al.*, 1987). Thus, changes to sediment type in the Study Area as a result dredged material placement will not affect prey of sea scallops, but may affect sea scallop populations if there is a significant change in grain size.

Rock Crab. Investigations of rock crab distributions indicate that the preferred sediments from Georges Bank to Cape Hatteras are sand and sand/gravel (Uchupi, 1963; Schlee, 1973). Sandy areas are found in the northeast region of the Study Area. Gravel substrates are located in the northwest quadrant of the Study Area. Other studies conducted in Maine and Canada have found individuals on rocky (Scarratt and Lowe, 1972) and muddy (Krouse, 1980) sediments. *C. irroratus*, like many crabs, are scavengers (Stehlik, 1993) that compete with other crabs for food. Migrations of *C. irroratus* inshore in the fall and offshore in the spring may occur to avoid competition for food with other crabs, such as the blue crab (*Callinectes sapidus*) and northern lady crab *(Ovalipes oscillatus)*, both of which are dormant in the winter (Stehlik *et al.*, 1991). Recent studies on diets of rock crabs in the New York Bight indicate that *Pherusa affinis* comprised the largest volume of the rock crab's stomach contents. This prey is most often associated with mud sediments. The remainder of the diet included molluscs, and fish (Stehlik, 1993), of which molluscs is the most strongly associated with a specific sediment type.

Jonah Crab. *C. irroratus*, like many crabs, are scavengers (Stehlik, 1993) that compete with other crabs for food. Recent studies on the diet of Jonah crab in the New York Bight indicate a similarity in prey with *C. irroratus* even though the two species may be found in different habitats. Jonah crabs are most frequently found in silty sand (Uchupi, 1963; Schlee, 1973), although they are also collected on gravel and rock substrates (Jeffries, 1966; Krouse, 1980), compared to *C. irroratus* which does not have a preference for silty sand or rock. Polychaetes, many of which are found in sand environments, are the most frequently eaten prey and contributed the largest percentage to the stomach volume (Stehlik, 1993). Other components of the Jonah crab's diet include *Pherusa affinis* and *Nucula proxima*, the latter of which was found by Stehlik (1993) to comprise 12% of the diet. *P. affinis* and *N. proxima* are most often associated with muddy habitats, which are located in the southern portion of the Study Area (Battelle, 1996a).

Surf Clam. Abundance of the surf clam is strongly associated with coarse sediments (Pearce *et al.*, 1981). Investigators indicated that catches of surf clams from gravel sediments were significantly higher than catches in sand (2-2.5 times) and silt-clay (3-5.5 times). However, it is unclear if larvae selectively settle on gravel sediments (Pearce *et al.*, 1981). Gravel sediments are rare in the Study Area and are only found in the northwest area. The gravel sediments where surf clams are most often found do not serve as a food source. Surf clams are filter feeders that draw in water through siphons to trap prey. As the water is drawn in, food particles are collected and ingested by the clam. Ropes (1980) reports that surf clams feed predominantly on several species of diatoms, including *Amphiprora constricta* and *Tintinnus*.

Hard Substrate (Rocks/Cobbles/Outcrops) Habitat Shellfish

Lobster. Lobster prefer rocky and cobbled areas (Cobb and Phillips, 1980) but use a variety of benthic substrates as habitat (including dredged material clumps). The Study Area contains rocky cobbled areas in the eastern and southern portion of the site. Lobsters use burrows or crevices for protection. Inshore and offshore stocks of lobsters are not preferential in their choice of habitat (Cobb and Phillips, 1980). Juvenile and adult lobsters occupy habitats of mud/silt, mud/rock, sand/rock and bedrock/rock (Thomas, 1968). The most common habitat is rocks or boulders on a sandy substrate. The preferred topography is rugged with a gradient from 0° to 70° (Cobb and Phillips, 1980). Some species of fish may occupy the same shelter as lobsters or live within close proximity (Cobb and Phillips, 1980). Another common habitat of offshore lobsters is the mud-clay base or submarine canyon clay wall. In either substrate the lobsters dig into the substrate (i.e., burrow) or make a tunnel or bowl-shaped depression to hide in.

Lobster feed on prey that may be inside or attached to the rocky or cobbled areas where the lobster resides. Cobb and Phillips (1980) report that lobsters are omnivorous feeders and predators. Prey include bottom invertebrates such as crabs, polychaetes, mussels, periwinkles, sea urchins and starfish (Ennis, 1973). Crabs (e.g., rock crab) appear to be the preferred prey (Cobb and Phillips, 1980), however, lobsters are opportunistic feeders whose diet shifts based on the availability of prey. During summer molting periods, lobsters appear to selectively feed on more sea stars and sea urchins than during other times of the year (Cobb and Phillips, 1980). Although lobsters may be habitat dependent, their omniverous feeding habits allow them to be adaptable to changes in prey availability.

3.4.4 Marine and Coastal Birds [Section 228.6(a)(9)]

The coast of the Atlantic Ocean supports a large number of resident and migratory marine and coastal birds (MMS, 1991). Thousands of marine and coastal birds migrate through the New York Bight annually. These birds are documented when they stop at Federally protected areas such as national wildlife refuges (e.g., Jamaica Bay Wildlife Refuge) and national parks (see Section 3.5.9) in the New York Bight (GNRA NPS, 1996). In addition, New York and New Jersey record and monitor birds that are on either Federal or state endangered or threatened species lists. Table 3-19 lists coastal and marine birds with special status that have been recorded in New York or New Jersey, and might possibly be affected by current conditions or future dredged material management activities in the Study Area. These birds are classified by their marine habitat as pelagic, shorebirds, waterfowl, colonial water birds, raptors, and marsh birds.

EPA has conducted an informal consultation with the U.S. Fish and Wildlife service (U.S. Fish and Wildlife Service Letter dated April 6, 1995) for endangered species under its jurisdiction within the Study Area (including marine and coastal birds). This informal consultation was concluded on July 28, 1995.

3.4.4.1 Pelagic Birds

The Atlantic coast, including the Study Area, supports many species of pelagic birds. These birds do not come near the coast, except when breeding, and most breed outside of the New York/New Jersey area, and therefore very unlikely to be affected by activities in the Study Area. An example of a pelagic bird that probably visits the Study Area is the common loon *(Gavia immer)*, which is listed as uncommon or rare (depending on the season) in the Jamaica Bay Wildlife Refuge in New York (Davis, 1994).

3.4.4.2 Shorebirds

Shorebirds inhabit open beaches, tidal flats, and marshes. Although the majority of shore birds that occur along the Atlantic coast are migratory, they do not travel as far from land as pelagic birds (MMS, 1991). Shorebirds are either colonial or solitary in nesting habitat, and some species breed in upland areas. Examples of shore birds include the willet, piping plover, and the phalarope (e.g., Wilson's, northern, red).

Table 3-19. Coastal and marine birds in New York and New Jersey listed as endangered, threatened, or of special concern [adapted from NNTC (1994) and Davis (1994)].

Species	Classification	Season	Federal Status	NY State Status [1]	NJ State Status
Common Loon *(Gavia immer)*	Pelagic	spring, late fall	--	Special Concern	--
Great Blue Heron *(Arden herodias)*	Coastal wader	late fall	--	--	Threatened
Little Blue Heron *(Egretta caerulea)*	Coastal wader	spring - early fall	--	--	Endangered
Yellow-crowned Night-heron (Nycticorax violaceus)	Coastal wader	spring - early fall	--	--	Threatened
Bald eagle *(Haliaeetus leucocephalus)*	Raptor	summer - winter	Endangered	Endangered	Endangered
Northern harrier *(Circus cyaneus)*	Raptor	early fall - winter	--	Threatened	Endangered
Osprey *(Pandion haliaetus)*	Raptor	spring and early-late fall	--	Endangered	Endangered
Peregrine Falcon *(Falco peregrinus)*	Raptor	early fall	Endangered	Endangered	Endangered
Piping plover *(Charadrius melodus)*	Shore	spring- early fall	Threatened	Endangered	Endangered
Common tern *(Sterna hirundo)*	Colonial waterbird	spring - early fall	--	Threatened	--
Roseate tern *(Sterna dougallii)*	Colonial waterbird	spring - early fall	Endangered	Endangered	Endangered
Black tern *(Chlidonias niger)*	Colonial waterbird	spring - early fall	--	Special concern	--
Least tern *(Sterna antillum)*	Colonial waterbird	spring - summer	--	Endangered	Endangered

[1]Season with the highest annual abundance as recorded at the Gateway National Recreation Area in New York. All of these protected species are classified as uncommon (1 to 9 individuals recorded annually) or rare (only one or a few individuals recorded).
[2]Breeding status only.

The willet is commonly found in New York from the spring through early fall (GNRA NPS, 1996). The piping plover is Federally listed as endangered. [Additional information on the piping plover can be found in Section 2.2 Battelle (1997a).] Because the willet and piping plover are closely associated with the shoreline, it is unlikely that they will visit the Study Area (G. Haas, pers. comm., 1996). The phalarope, however, may travel some distance from the shore since it feeds in upwelling areas (G. Haas, pers. comm., 1996) and may visit the Study Area.

3.4.4.3 Waterfowl

The preferred habitat of waterfowl includes coastal oceanic waters, bays, sounds, estuaries, lagoons, and tidal wetlands (MMS, 1991). Waterfowl, as with shorebirds, are migratory and breed within inland regions. Waterfowl that are recorded at the Gateway National Recreation Area include American black duck (*Anas rubripes*), harlequin duck *(Histrionicus histrionicus)*, Canada goose *(Branta canadensis)*, and scoters [*e.g.*, black scoter *(Melanitta nigra)*] (Davis, 1994; MMS, 1991; D. Pence, pers. comm., 1995). Other species that occupy the area include the red-breasted merganser (*mergus serrator*) and oldsquaw (*Claugula nyemallo*). Any of these species could potentially be sighted in the Study Area.

3.4.4.4 Colonial Water Birds

This category comprises many coastal birds, including wading birds which walk through the water searching for prey. Colonial water birds are characterized by the colonies of nests that they build along the coasts. Wading birds occur in all Atlantic coastal states, but prefer tidal creeks, ponds, marshes, mangrove flats, and similar shallow water habitats. Examples of colonial water birds reported at the Jamaica Bay Wildlife Refuge that may be sighted in the Study Area include the roseate tern (endangered), brown pelican *(Pelecanus occidentalis)*, great blue heron *(Ardea herodias)*, black-crowned night heron *(Nycticorax violaceus)*, great egret *(Casmerodius albus)*, snowy egret *(Egretta thula)*, glossy ibis *(Plegadis falcinellus)*, American oyster catcher *(Haematopus palliatus)*, and least tern *(Sterna antillarum)* (Davis, 1994).

3.4.4.5 Raptors

Raptors hunt for food while in flight; many species hunt for food along the coast. The northern harrier *(Circus cyaneus)*, osprey *(Pandion haliaetus)*, peregrine falcon, bald eagle, and the short-eared owl *(Asio flammeus)* are raptors that are listed at the Jamaica Bay Wildlife Refuge (Davis, 1994) and that might visit the Study Area while hunting for food (USFWS, 1995a;b). Currently, the primary threat to these birds is human disturbance of nesting birds.

3.4.4.6 Marsh Birds

Marsh birds are found in shallow estuaries where they feed and breed. The king rail *(Rallus elegans)* and the black rail *(Laterallus jamaicensis)* are marsh birds that are of special concern in the New York/New Jersey area (NNTC, 1994). Because of the preferred coastal and inland habitat of these two species, it is unlikely that they will be observed in the Study Area.

3.4.5 Marine Mammals and Reptiles [Section 228.6(a)(9)]

The majority of cetaceans and turtles in the western North Atlantic Ocean are found in continental shelf waters (Kenney and Winn, 1986). Data collected over more than 10 years indicate that the New York Bight, in comparison to other areas of the United States, has one of the highest diversities of marine mammals and sea turtles even though the resident, nonmigratory populations are relatively low (Sadove and Cardinale, 1993).

Twenty-eight species of marine mammals and five species of turtles have been sighted in the New York Bight over the past several years (Sadove and Cardinale, 1993). Six species of the marine mammals and one turtle species are classified as rare, or their abundance in the New York Bight is unknown because of unconfirmed or no live sightings. These species include the blue whale *(Balaenoptera musculus)*, beluga whale *(Delphinapterus leucas)*, dense-beaked whale *(Mesoplodon densirostris)*, true's beaked whale *(Mesoplodon mirus)*, gulf stream beaked whale *(Mesoplodon europeaus)*, goose-beaked whale *(Ziphius cavirostris)*, and hawksbill turtle *(Eretomochelys imbricata)*. The remaining 22 species of marine mammals and four species of turtles are listed in Table 3-20. Two species of whales and two species of turtles identified as endangered or threatened inhabit the Study Area during a portion of their life cycle. These species, humpback whale, fin whale, loggerhead turtle, and Kemp's Ridley turtle, are discussed in Battelle (1997a).

Of the 26 species, five cetaceans, four pinnipeds, and three turtles have been sighted in the Bight Area. These species are briefly discussed in the following sections.

3.4.5.1 Cetaceans (Whales, Dolphins, Porpoises)

The most frequently observed cetaceans in the inner New York Bight are fin, humpback, and pygmy sperm whales, and saddleback dolphins. There have been live sightings of each of these species, except for the pygmy sperm whale, in the inner New York Bight. Although there have not been live sightings of the pygmy sperm whale, stranding data indicate that this species visits the inner New York Bight. The following text provides a brief summary of the life history of each species. A more detailed description of the life history of the fin and humpback whales can be found in Battelle (1997a).

Endangered or Threatened Cetaceans

Fin Whale. Fin whales *(Balaenoptera physalus)* are present in all the major oceans of the world from the Arctic to the tropics (Evans, 1987) and are the most abundant baleen whale in the New York Bight (Sadove and Cardinale, 1993). They are long and slender, growing to a maximum size of about 27 m and 73,000 kg (Minasian *et al.*, 1984). They are considered to be one of the fastest great whales, with speed in excess of 20 knots (Leatherwood *et al.*, 1976). Because of their high cruising speed, fin whales were not harvested commercially in large numbers until other, easier to catch species such as right whales were depleted and whalers developed high-speed boats (Leatherwood *et al.*, 1976). However, more than 700,000 fin whales were harvested world-wide in the twentieth century (NMFS, 1994), resulting in this species being listed as endangered in 1970. Fin whales are the most abundant and frequently sighted of the endangered great whales that visit coastal waters of the northeastern United States. As such, this species may be observed in the Study Area (NMFS, 1996).

Fin whales are found in feeding aggregations of more than 20 individuals in the summer in the New York Bight. Their diet consists of fish (e.g., sand lance, herring, mackerel), squid, and zooplankton. The New York Bight population is estimated at 400 animals, with estimates of 800 animals reported at specific times during the year (Sadove and Cardinale, 1993).

Humpback Whale. The unique feature of humpback whales *(Megaptera novaeangliae)* that distinguishes them from all other baleen whales is their extremely long flippers that may be 5 m long or about ⅓ of their total body length; the total body length reaches 18 m. Humpback whales were an important commercial species throughout most of their range, including Long Island and New England waters, until early in the twentieth century (Allen, 1916), when commercial harvesting resulted in severely depleted populations. Today, humpback whales, which are Federally listed as endangered, occur in all the oceans of the world, except possibly the Arctic (NMFS, 1991). They are regularly sighted in the New York Bight (most of

Table 3-20. Marine mammals and sea turtles in the New York Bight [adapted from Sadove and Cardinale, 1993].

Common Name	Scientific Name	Federal Status	Sighting Frequency	Sighting Periods
		Cetaceans (whales, dolphins, porpoises)		
Fin whale	*Balaenoptera physalus*	Endangered	Abundant	January - March
Minke whale	*Balaenoptera acutorostrata*	Protected	Abundant	year-round
Sei whale	*Balaenoptera borealis*	Endangered	Abundant	July - August
Humpback whale	*Megaptera novaeangliae*	Endangered	Common	June - Sept.; Dec.- Jan.
Northern Right whale	*Eubalaena glacialis*	Endangered	Rare	March - June
Sperm whale	*Physeter catodon*	Endangered	Common	May - June; October
Pygmy Sperm whale	*Kogia breviceps*	Protected	Increasing	June - August
Atlantic Bottlenose dolphin	*Tursiops truncatus*	Protected	Abundant	June - September
Common/Saddleback dolphin	*Delphinus delphis*	Protected	Abundant	March - June
Striped dolphin	*Stenella coeruleoalba*	Protected	Abundant	February - May
Atlantic Spotted dolphin	*Stenella plagiodon/attenuata*	Protected	Abundant	May - August
Harbor porpoise	*Phocoena phocoena*	Endangered	Increasing	December - June
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Protected	Abundant	year-round
White Beaked dolphin	*Lagenorhynchus albirostris*	Protected	Abundant	December - May
Long-Finned pilot whale	*Globicephala melaena*	Protected	Abundant	year-round
Killer whale	*Orcinus orca*	Protected	Rare	August - February
Grampus	*Grampus griseus*	Protected	Abundant	year-round
		Pinnipeds (seals)		
Harbor seal	*Phoca vitulina*	Protected	Abundant	November - May
Harp seal	*Phoca groenlandica*	Protected	Increasing	November - May
Ringed seal	*Phoca hispida*	Protected	Unknown	January - April
Gray seal	*Haliochoerus grypus*	Protected	Common	January - March
Hooded seal	*Cystophora cristata*	Protected	Unknown	January - April
		Reptiles (turtles)		
Kemp's Ridley turtle	*Lepidochelys kempi*	Endangered	Abundant	June - October
Loggerhead turtle	*Carretta carreta*	Protected	Abundant	May - October
Green Sea turtle	*Chelonia mydas*	Endangered	Common	June - October
Leatherback turtle	*Dermochelys coricea*	Endangered	Abundant	May - November

[1]Abundant>common>increasing>rare.
[2]Based on strandings, which generally occur in the summer months (OORF, pers. comm., 1996).

these whales are non-reproducing juveniles), and are one of the baleen species regularly observed in shallow water; therefore, it is possible that this species may be observed near the Study Area (NMFS, 1996).

Humpback whales feed opportunistically on a wide variety of species of pelagic crustaceans and small fish. A favorite food of humpbacks is the sand lance *(Ammodytes americanus)*, although they also feed on commercially important fish, such as herring *(Clupea harengus)*, mackerel *(Scomber scombrus)*, and squid *(Illex illecebrosus)* (Overholtz and Nicolas, 1979; Whitehead and Glass, 1985; Whitehead, 1987; Piatt *et al.*, 1989; NMFS, 1991). Although there are no specific population estimates for the New York Bight, the population of humpbacks in the western North Atlantic is estimated at 900 animals (Sadove and Cardinale, 1993)

Non-Endangered or Non-Threatened Cetaceans

Harbor Porpoise. The harbor porpoise *(Phocoena phocoena)*, which has been proposed for listing (Witte, R. EPA Region 2 Endangered Species Coordinator) is the smallest cetacean (maximum total length of 1.5 m) in the western North Atlantic Ocean (Leatherwood *et al.*, 1976), where its distribution is restricted to the continental shelf (Katona *et al.*, 1993). As the common name implies, the harbor porpoise is found primarily near shore, in shallow waters and in bays and harbors (Gaskin, 1984). Sightings of this species in the New York Bight 10-15 years ago were very rare. Recently, however, sightings have increased (Sadove and Cardinale, 1993). Harbor porpoises are observed alone or in large groups when in the open ocean, swimming "quietly" at the surface (Leatherwood *et al.*, 1976). Because of their near shore, shallow water distribution, it is unlikely that the harbor porpoise will be observed in the Study Area which is 2.8 nmi from shore at its western most boundary.

There are no direct feeding observation data on harbor porpoises because of the difficulty of observing this small-sized cetacean at sea. Gaskin (1992), however, reports that harbor porpoises belonging to the Gulf of Maine population (which includes those observed in the New York Bight) feed on pelagic schooling fish, such as herring and mackerel, and occasionally when in deeper water, feed on hake, squid, and octopus.

As noted in EPA's April 4, 1996 letter to the NMFS, current information indicates that this species is not known to interact with dredging and discharge operations. Rather, the major impact on harbor porpoise populations is gill net fishing. Accordingly, EPA indicated that it would not include the species in its BA. NMFS concurred with the approach on May 8, 1996.

Pygmy Sperm Whale. The pygmy sperm whale *(Kogia breviceps)* grows to at least 3.4 m in length. They are characterized by "a crescent shaped bracket mark", often referred to as a false gill, located in the same position where a fish's gill slits would be located (Leatherwood *et al.*, 1976). This species is distributed offshore (Sadove and Cardinale, 1993), and there have been few live sightings. However, stranded pygmy sperm whales have been found in the New York Bight (MMSC, pers. comm., 1996). In fact, recent increases in strandings along the coast of the New York Bight have resulted in the pygmy sperm whale being classified as one of the top five species of marine mammals found stranded in this region (Sadove and Cardinale, 1993; MMSC pers. comm., 1996). The offshore distribution, few live inshore sightings, yet increased strandings, make it unclear how often pygmy sperm whales visit the Study Area. Further, a New York Bight population estimate is not available.

Pygmy sperm whales have not been observed feeding. Squid, however, has been found in the stomachs of stranded animals in the New York Bight (Sadove and Cardinale, 1993).

Saddleback Dolphin. The saddleback dolphin *(Delphinus delphis)*, which reaches a maximum total length of 2.6 m, has a distinctive hourglass or crisscross pattern of tan or yellowish tan on its sides (Leatherwood *et al.*, 1976). This species, also known as the common dolphin, is often sighted in herds of thousands and is very active (Leatherwood *et al.*, 1976). They are distributed throughout the temperate, subtropical, and tropical waters of the western North Atlantic Ocean. The saddleback dolphin is found along the south shore of Long Island in waters of deeper than 10 m (Sadove and Cardinale, 1993). Depths at the Study Area are between 14 to 42 m (see Section 3.1); thus, animals that frequent the southern shore of Long Island could move south into the Study Area.

Saddleback dolphins feed on squid and fish (e.g., herring, mackerel). Population estimates for the New York Bight range from 5,000 to 10,000 animals.

3.4.5.2 Pinnipeds

All pinnipeds found in the New York Bight — ringed seal (*Phoca hispida*), harbor seal *(Phoca vitulina)*, harp seal *(Phoca groenlandica)*, gray seal *(Haliochoerus grypus)*, and hooded seal *(Cystophora cristata)* — are Federally protected, but none are listed as endangered or threatened in the United States or Canada. The harbor seal is the most abundant pinniped on the east coast of the United States. Because the harp, gray, and hooded seals (known as the ice seals) are restricted primarily to Canadian waters, very little is known about their distribution in U.S. waters. As the Canadian stocks grow, it appears that the distribution of these three pinnipeds is moving south (Katona *et al.,* 1993). The number of strandings and sightings have increased recently. Within the last five years, strandings of these four species (plus the ringed seal, *Phoca hispida*) have comprised a majority of all strandings in this region (OORF, pers. comm., 1996).

The most common pinnipeds in the New York Bight are the harbor and gray seals. Harbor seals have been reported in the Long Island region year round, with the highest abundance of animals occurring from November through May. Mostly pup and juvenile gray seals are observed seasonally. Gray seals have been sighted along the coast within the Bight, and are often sighted with harbor seals (Sadove and Cardinale, 1993). As true seals (i.e., phocids), the distribution of harbor, harp, gray, and hooded seals is limited primarily to nearshore waters. However, these seals are unlikely to visit the Study Area or be affected by placement of Material for Remediation at the HARS.

Gray seals have been observed feeding on cod when sighted along the coast. Harbor seals also have been observed feeding on cod, in addition to herring, mackerel, squid, flounder, green crabs, mussels, and whiting (Sadove and Cardinale, 1993). The New York Bight harbor seal population estimate is 1800 individuals. Harp seals are estimated at 100 in this region. Population estimates for the gray and hooded seals are not available (Sadove and Cardinale, 1993)

3.4.5.3 Reptiles (Turtles)

Sea turtles are highly migratory and are found throughout the world's oceans (NOAA, 1995e). The coastal waters of New York (i.e., inner New York Bight) provide an important habitat for juvenile Kemp's ridley, green, and loggerhead turtles (Morreale and Standora, 1993) and adult-sized leatherbacks. All of the species discussed in this section are Federally listed as endangered or threatened. More detailed information on the Kemp's ridley and loggerhead turtles can be found in Battelle (1997a).

Kemp's Ridley Turtle. The Kemp's ridley sea turtle *(Lepidochelys kempi)* is the smallest of the sea turtles (NRC, 1990), and the most endangered sea turtle in the world (Carr and Mortimer, 1980). This turtle is found mainly in the Gulf of Mexico (Hildebrand, 1982); however, juveniles migrate north along the Atlantic seaboard during the summer. Most of the turtles that visit the New York Bight are juveniles, averaging 25-30 cm in length (NMFS, 1988; NOAA, 1991). More ridley turtles are observed in the coastal waters of New York and southern Massachusetts than anywhere else in the northeast (Lazell, 1980;

Morreale and Standora, 1992). Important habitats in the New York Bight include Long Island Sound, Block Island Sound, Gardiners Bay, Jamaica Bay, lower New York harbor, and portions of Peconic Estuary and Great South Bay (Sadove and Cardinale, 1993). This species' predominance in the New York Bight indicates that it may inhabit part of the Study Area during the summer and fall (NMFS, 1996).

In the New York Bight, where crustaceans represent more than 80% of the diet, nearly all feeding takes place on or near the bottom in shallow water (Morreale and Standora, 1992;1993; Burke *et al.*, 1994). Young ridleys consume several species of crabs, including (in order of decreasing preference) spider crabs, lady crabs, and rock crabs (Morreale and Standora, 1992;1993). Seasonal population estimates for the New York Bight range from 100 to 300 individuals.

Loggerhead Turtle. The loggerhead sea turtle (*Caretta caretta*) is listed as threatened throughout its range under the Endangered Species Act (USFWS, 1986). It is the most common and seasonally abundant turtle in inshore coastal waters of the Atlantic (NMFS & USFWS, 1991). Sub-adult loggerhead turtles migrate northward in the spring and become abundant in coastal waters off New York where they are encountered in Long Island Sound, New York Harbor-Raritan Bay, and along the south coast of Long Island during the summer (Henwood, 1987; Keinath *et al.*, 1987; Morreale *et al.*, 1989; Shoop and Kenney, 1992). The loggerhead has two distribution patterns — one group of mainly juveniles is found in bays and the Long Island Sound; the second group is more oceanic, and is generally found along the south shore of Long Island and up to 40 miles offshore (Sadove and Cardinale, 1993). This second group of loggerhead turtles, found along the south shore of Long Island, may regularly inhabit or travel through the Study Area (NMFS, 1996).

The dominant prey of the loggerhead turtle is the spider crab, but other crabs (horseshoe, green, and portunid) are consumed as well (Sadove and Cardinale, 1993). Abundance estimates of loggerheads along the U.S. Atlantic coast are difficult to make due to the short time turtles spend on the surface where they can be spotted from a plane or boat. Existing data indicate that approximately 800 animals are in the New York Bight during the summer and fall each year (Sadove and Cardinale, 1993).

Leatherback Turtle. The leatherback turtle *(Dermochelys coricea)* is the largest and most distinctive of the living sea turtles and is listed as endangered throughout its range (USFWS, 1986). Leatherbacks reach a length of 150-170 cm SLCL (straight line carapace length; large outstretched front flippers may span 270 cm in an adult) and a weight of 500 to 900 kg. Leatherbacks are more widely distributed as adults, as compared to other sea turtles, in temperate and boreal waters throughout the world. Their wide distribution is directly related to endothermy, which allows them to survive and feed in colder temperate waters than other sea turtles can tolerate. (Friar *et al.*, 1972, Standora *et al.*, 1984). Leatherback turtles are the second most common turtle along the eastern seaboard of the United States and the most common north of the 42°N latitude. Long Island Sound supports one of the largest populations on the Atlantic coast during the summer and early fall (Lazell, 1980; Shoop and Kenney, 1992). They are found also along the south shore of Long Island (Sadove and Cardinale, 1993).

Adults migrate extensively throughout the Atlantic basin in search of jellyfish and other gelatinous zooplankton, such as salps, ctenophores, and siphonophores (Limpus, 1984). Although leatherback turtles are pelagic feeders, they can dive to considerable depths (extending 400 m, with an average of 60 m) in search of food (Eckert *et al.*, 1986;1989). During the summer, they move into fairly shallow coastal waters (but rarely into bays), apparently following their preferred jellyfish prey. Because of the leatherback's feeding habits, it is unlikely that this turtle will be found in the Study Area (NMFS, 1996). Because they are a largely oceanic, pelagic species, estimates of their population status and trends have been difficult to obtain. Rough population estimates indicate 500-800 animals per year in the New York Bight.

3.4.6 Other Factors for the Biological Community

Important fishery resource species of the New York Bight that derive a substantial portion of their diet from the benthos (modified after Boesch, 1982)	
Invertebrates	
American Lobster	Jonah Crab
Rock Crab	Surf Clam
Fish	
Red Hake	Summer Flounder
Silver Hake	Winter Flounder
Haddock	Windowpane Flounder
Scup	Yellowtail Flounder
Black Sea Bass	Tautog

Many commercially and recreational important fish and shellfish species in the New York Bight feed primarily on benthic animals (see side box). The intimate connection between fishery resources and benthic habitats of the Study Area raises two issues. As described earlier in Section 3.4.2.2, sediments within the Study Area can be classified into two basic regimes; one a sandy, low TOC, low chemical content regime; and the other a muddy, high TOC, chemically rich regime. The first fish-resource benthic-habitat concern arises if benthic organisms living in one of the sedimentary regimes in the Study Area have more dietary importance to fish or shellfish than the benthic organisms living in the other regime. If this case exists, alteration to this dietarily-important habitat could effect the fishery resources in the area. The second resource/habitat concern relates to the potential for trophic transfer of contaminants from the sediment to endangered or threatened species or to humans. Examination of both concerns requires a brief review of general trophic relationships between fishery resources and the benthos, and of the expected relationships between predators and prey in the Study Area.

3.4.6.1 Predator-Prey Interactions in the Study Area

Trophic Relationships. In shallow-water marine habitats, the transfer of energy from the primary producers (plants) to primary and secondary consumers (animals) rarely occurs along a simple pathway, or food chain. Most frequently energy transfer occurs via complex pathways that involve consumers using many sources of food. The first step along the trophic pathways that constitute a marine food web is the conversion of energy (e.g., solar or chemical energy) into products (i.e., organic compounds) that can be stored and used by plants and animals. This conversion is accomplished by primary producers, typically microscopic or large plants or bacteria. Oceanic ecosystems depend primarily on phytoplankton for primary production; coastal and estuarine ecosystems usually rely on detritus which is the degradation products and associated microbiota from large vascular plants (sea and marsh grasses) and macroalgae. Both phytoplankton and detrital primary production probably are important in the Bight. This is particularly true for the benthos which is dependent primarily on detritus. Primary consumers, generally small animals (herbivores), usually ingest these organic compounds by consuming the primary producers directly. The complexity of the food web increases with the presence of many predator-prey relationships among secondary consumers (i.e., primary carnivores) who feed on the primary consumers and are in turn fed upon by tertiary consumers (i.e., secondary carnivores). The uppermost level of the food web is occupied by animals that do not usually become the prey of other animals. These animals, often called top carnivores, include many marine mammals, large sharks or other large fish, and humans. Often this level is considered the "end" of the food web, but in reality another level exists, that of the decomposers. As animals from any trophic level die, their bodies are consumed by various scavengers or may be converted to detritus and supply energy to bacteria, thus regenerating the trophic cycle.

A generalized example of such a complex pathway, or food web, in the Study Area is diagramed in Figure 3-73. Within the Study Area, the most important source of energy input to the benthos is likely via phytoplankton production, although other sources may include organic carbon input from the Hudson River, coastal dischargers, and the disposal of organically-enriched sediments at the MDS. Using phytoplankton production as the base of the food web, energy is transferred directly to the benthos through consumption of phytoplankton by infaunal filter-feeders, or indirectly primarily via the consumption of detritus by infaunal surface and subsurface deposit feeders. The link to upper trophic levels occurs by consumption of infaunal organisms by bottom feeders such as bottom-feeding fish and epibenthic crustaceans. These latter consumers are in turn eaten by higher-level carnivores, such as piscivorous fish, which subsequently may be consumed by mammals.

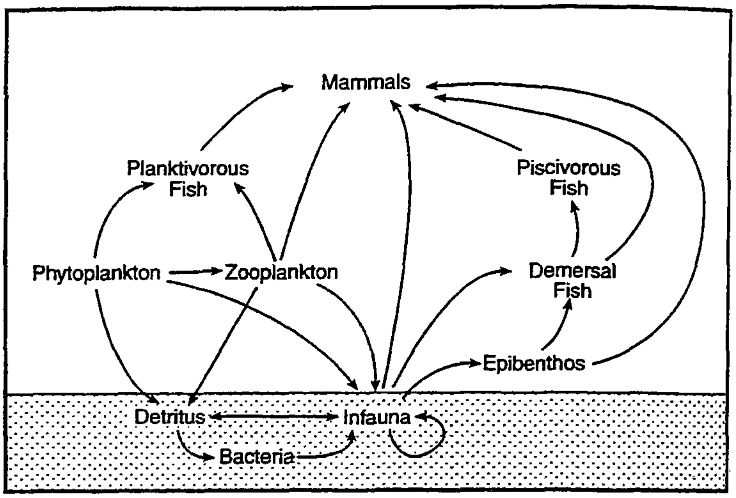

Figure 3-73. Generalized marine food chain model.

To examine how the two major sediment regimes found in the Study Area can affect food sources of fishery-resource species, it is necessary to identify prey organisms and the sediment type in which they occur. This permits potential contaminant transfer pathways from the sediments through the various trophic levels to humans to be evaluated. For this SEIS, the predator-prey relationships of several bottom-feeding fish species found in the Study Area were examined. The primary prey of the bottom feeders shown in Figure 3-74 (tautog, windowpane flounder, red hake, winter flounder, and lobster) consists of a variety of infaunal and epifaunal or epibenthic animals. These infaunal and epifaunal animals are the main link from the primary producers to the upper levels of the food web (see side box). The pathway from the sandy, low organic, low chemical sediments through the food web to humans is illustrated by the predator-prey interactions of tautog, windowpane flounder, and red hake. The trophic pathway of the windowpane flounder (Figure 3-74) can be summarized as

Feeding modes and trophic roles of the benthos of the Study Area. Examples of food items are included within parentheses.

Mode	Action	Role
Filter-Feeders	Remove particles from the water column	Primary Consumers (phytoplankton), Secondary Consumers (zooplankton)
Deposit-Feeders	Remove particles from surface or within sediments	Primary Consumers (detritus), Secondary Consumers (bacteria, meiofauna)
Carnivore/Browsers	Capture whole or browse parts of animals	Tertiary or Higher Level Consumers (infauna)

- The windowpane flounder feeds on amphipods, the sand lance, and epibenthic crustaceans,
- The bluefish feeds on the windowpane flounder, and
- Humans catch and consume the bluefish

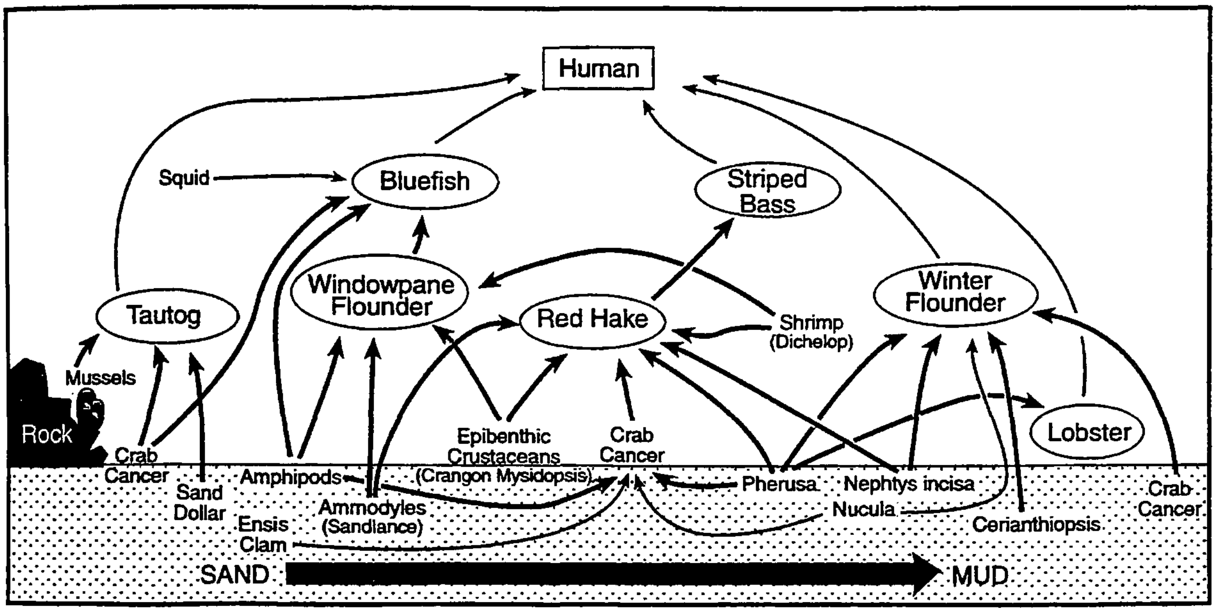

Figure 3-74. Representative trophic transfers in the Study Area.

In contrast to the windowpane flounder, the winter flounder is one of the few fish species that feeds primarily on animals inhabiting the muddy, high organic, chemically-enriched sediments of the Study Area. Its trophic pathway (Figure 3-74) can be summarized as

- The winter flounder eats mud-dwelling polychaete worms (*Nephtys incisa* and *Pherusa*) and the tube-dwelling sea anemone (*Cerianthiopsis*),
- The winter flounder also feeds on another mud dweller, the nut clam *Nucula proxima*, but the clam is only of secondary dietary importance to the flounder,
- Humans catch and eat the winter flounder.

The red hake is one fish species that derives its diet from both sedimentary regimes found in the Study Area. Its trophic pathway (Figure 3-74) can be summarized as

- The red hake feeds on prey from muddy sediments, including the polychaete worms *Nephtys incisa* and *Pherusa*,
- The red hake also feeds on organisms from sandy sediments, including epibenthic crustaceans and the sand lance, *Ammodytes*,
- Striped bass consume the red hake,
- Humans catch and eat striped bass.

The tautog is one fish that feeds on hard-bottom animals, primarily mussels, but also eats sand dollars, which inhabit clean sands, and decapod crabs such as *Cancer*, which live on semiconsolidated sediments of either regime (Figure 3-74).

Although the above predator-prey examples presented in this section show fish feeding on prey from both sedimentary regimes and hard-bottoms found in the Study Area, prey from sandy habitats appear to show more widespread importance in the diets of the main fishery resource species in the area (Table 3-21). Boesch (1982) presented a similar observation and concluded that many mud-dwelling species are not

Table 3-21. Dietary importance of key benthic species found in each benthic habitat type in the Study Area (modified after Boesch, 1982).
Primary dietary items are indicated by ■ , secondary items by □.

Prey Species	Resource Species (see Key below)										
	AL	RC	WPF	WF	RH	SH	BSB	TA	CU	OP	LS
	Sandy Sediments										
Sand Dollar								■	□	■	
Sand Shrimp			■		■	■			■		■
Amphipods			■		■					■	■
Polychaetes			□		■					□	
Epibenthic crustaceans			■		■	■	■			■	■
Jackknife Clam		□									
Rock Crab		■					■	■	■		■
Sand Lance			■		■	■					■
	Muddy Sediments										
Nut clam		□		□							
Pherusa	■	■		■	■						
Nephtys incisa				■	■						
Polychaetes				■	■						
Tube Sea Anemone				■							
Rock Crab	■	■		■							■
	Hard Bottoms										
Mussels							□	■	■		
Rock Crab	■	■						■	■		
Polychaetes							■			■	

Key: AL, American Lobster; RC, Rock Crab; WPF, Windowpane Flounder; WF, Winter Flounder; RH, Red hake; SH, Silver Hake; BSB, Black Sea Bass; TA, Tautog; CU, Cunner; OP, Ocean Pout; LS, Little Skate.

important dietary items. He offered possible explanations for the exclusion of mud-inhabiting species from most diets, including strong predator avoidance behaviors (tube sea anemones), a burrowing lifestyle (several polychaetes), and thick shells (nut clam). However, the information presented in Table 3-21 shows that these taxa may be important in the diets of predators that may be able to forage relatively deeply in the sediments or that can crush shells.

The scenarios presented in this section integrate information presented in Section 3.4.2.2 on infaunal communities in the Study Area and Section 3.4.3.4 that discusses the diets of key fish and shellfish species. Understanding the complex predator-prey interactions that occur among the organisms of the Study Area, and the role specific benthic habitat types play in them helps to illuminate the potential transfer of contaminants from the sediments to high-level consumers, especially humans. These transfers and trophic interactions are considered in the next section (Section 3.4.6.2). Further, understanding the trophic interactions from both a food resource perspective and contaminant transfer through the trophic system will enable better evaluation of the potential impacts of alterations to the sediments that might occur under the alternatives being considered in this SEIS.

3.4.6.2 Bioaccumulation and Trophic Transfer of Environmental Contaminants

A major mechanism by which sediments containing elevated levels of contaminants can impact living resources is by adverse bioaccumulation through trophic transfer. This section considers information relevant to contaminant bioaccumulation and trophic transfer in the Study Area.

General Concepts of Bioaccumulation. Bioaccumulation is defined as the uptake and retention of a contaminant from all possible external sources (water, food, substrate, air) (Brungs and Mount, 1978; Spacie and Hamelink, 1985). While bioaccumulation of a contaminant by an organism in the field or in the laboratory may or may not result in detrimental impacts to the organism, it can be an indicator that a population of the same or similar organisms, or of higher trophic-level organisms that prey on the contaminated organisms, or both, may be potentially at risk of impact.

In general, contaminant bioaccumulation is the link between exposure and effects, and can provide useful insights about potential routes and extent of pollutant exposure, ecological effects, and human-health risks (Lee *et al.*, 1989). The difficulty of evaluating bioaccumulation is that the detection and measurement of a bioaccumulated contaminant in an organism cannot be equated directly to a degree of harm or impact that the organism will experience due to the contaminant exposure. While research has shown that sublethal accumulation of contaminants in organisms, whether polychaetes, fish, or people, can result in detrimental effects to the organism, the environmental or human-health consequences of low levels of bioaccumulative contaminants is much less clear.

The following text discusses the pathways by which contaminants, known or suspected of being present in the sediments of the Study Area, may potentially bioaccumulate. An understanding of these contaminant pathways is essential for evaluating the pathway components related to (1) dredged material management at the Mud Dump Site and (2) historical dredged material and other disposal activities in the Study Area, and (3) other contaminant sources to the region. Even though contaminant bioaccumulation in the Study Area in and of itself has not been proven to relate to significant ecological effects, it is treated within this SEIS as having potential for causing harm and is therefore of concern.

Bioaccumulation Pathways. In aquatic environments, contaminants are bioavailable only if they are in a form that can be transferred into an organism, usually through its skin, gill epithelium, gut epithelium, or other cell membrane (Newman and Jagoe, 1994). Nearly always, contaminants in solution in the water are much more bioavailable than those bound to sediment particles or present in food (Neff, 1984). Most bioaccumulative contaminants of concern (e.g., PCBs, DDTs, dioxins) are hydrophobic and strongly bound to sediment particles (i.e., they dissolve in water at only ultra-low concentrations, if at all). Some of these sediment particles are suspended in the water column by natural processes such as river outflow or resuspended by currents and storm events; others are suspended by man's activity (e.g., dredged material disposal events, fish trawling, underwater mining, etc.).

For bioaccumulation to occur, the rate of uptake must be greater than the rate of loss of the contaminant from the organism. Highly soluble contaminants, such as ammonia and some inorganic ions, often occur in bioavailable forms in the environment and rapidly penetrate the tissues of aquatic organisms. However, when at sublethal concentrations, these contaminants are not retained and are lost just as rapidly from the tissues by diffusion or active transport. As a result, their concentrations in tissues are equal to or lower than their concentrations in the ambient medium. For other contaminants, organisms' metabolic processes regulate contaminant levels independent of concentrations in the ambient medium (Chapman *et al.*, 1996). This is especially true for many metals. Still other bioavailable contaminants are taken up rapidly, but are transformed and excreted rapidly; these contaminants are not bioaccumulative.

For bioaccumulative contaminants, when exposed to a relatively constant concentration of the contaminant (through water, food, sediments), the rate of active plus passive loss of the contaminant in an organism increases to equal the rate of uptake. At this point, a "steady state" or "equilibrium" is reached.

Several methods and models have been developed to predict steady-state tissue concentrations in organisms for the concentrations of the contaminants in water or sediment. The simplest models use empirically derived Bioconcentration Factors (BCF) for water concentrations and the Biota-Sediment Accumulation Factors (BSAF) for sediment concentrations.

$$BCF = C_T/C_W$$

Where: C_T = the contaminant concentration in an organism's tissues
C_W = the concentration in water

$$BSAF = C_L/C_{OC}$$

Where: C_L = the contaminant concentration in an organism's lipids
C_{OC} = contaminant concentration associated with the organic carbon fraction of the sediment

Also for nonpolar compounds the BCF can be determined by the regression

$$\text{Log BCF} = a \text{ Log } K_{ow} + b$$

Where: K_{ow} = octanol/water partition coefficient

With sufficient empirical data on the organism and environment being investigated, the above accumulation factors can be used to predict steady-state residue[10] concentrations of bioaccumulative contaminants.

A component of bioaccumulation is biomagnification. Biomagnification is the transfer of a chemical through trophic levels resulting in elevated concentrations with increasing trophic levels (Connell, 1989;

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[10] Steady-state residue: Sum of the uptake rate constants of the contaminant from all environmental compartments accessible to the organism to the sum of release rate constants by active and passive mechanisms from the organism.

Gobas *et al.*, 1993). Recent studies have shown that very few chemicals biomagnify in aquatic environments (e.g., LeBlanc, 1995). Generally, even though higher trophic levels have higher contaminant concentrations relative to lower trophic levels, the increase can be explained in many cases by the relative increase in lipid content as trophic level increases or by decreased chemical elimination efficiencies of higher trophic level organisms (LeBlanc, 1995).

Trophic Position Relative to Contaminant Bioaccumulation. The interrelationships between the potential contaminant sources, bioaccumulation, and trophic transfer are shown schematically in Figure 3-75 which represents the major transfer paths of contaminants through the trophic transfer, but greatly simplifies the complex and overlapping web of interactions present in most environments, thus is illustrative only.

In Figure 3-75, there are five major pathways for chemical entry into organisms (1) water, (2) particles (detrital or resuspended), (3) bulk sediment, (4) the interstitial water of the sediments, and (5) grazing (herbivorous or carnivorous). The importance of each pathway depends in large measure on the life history of the organism and bioavailability of the contaminant. For example, benthic infaunal and epifaunal organisms are in close and immediate contact with bottom sediments and are more likely to be exposed to contaminants through the bulk sediment and pore water route. For these organisms, feeding mode (i.e., filter or deposit) will also influence the initial entry pathway (resuspended particulates and detrital particles) and dictate the exposure to contaminants. Because these organisms are nonmigratory, they can be chronically exposed to local concentrations of contaminants in the sediments.

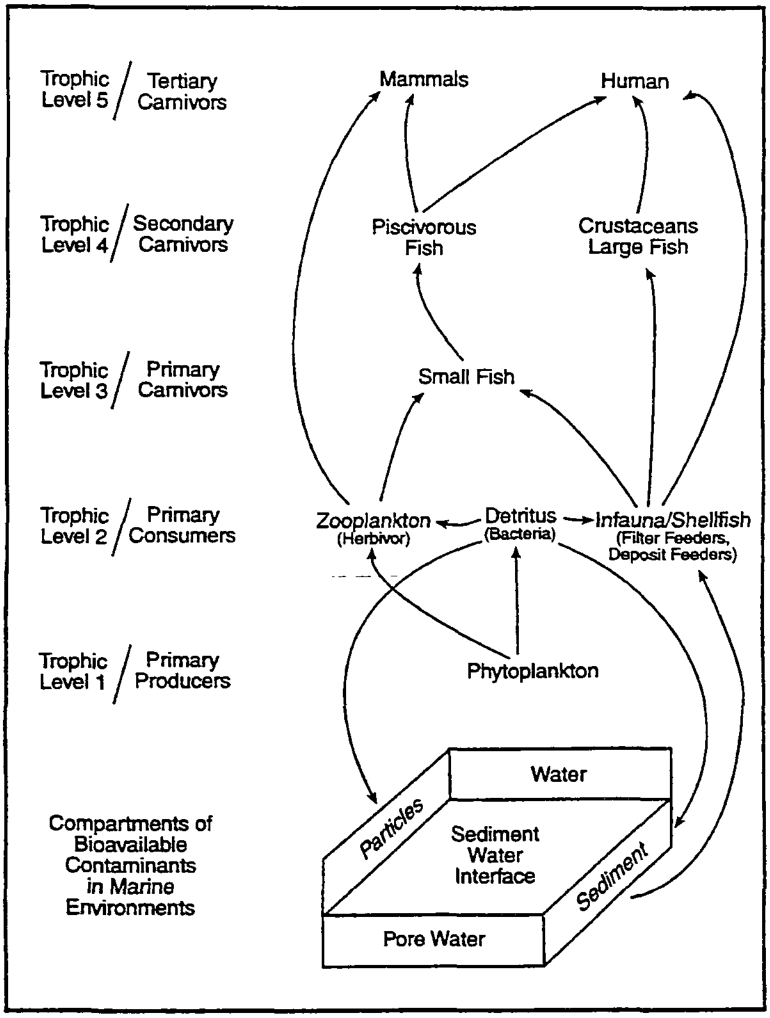


Figure 3-75. Schematic representation of major pathways of contaminant entry into the food web and trophic transfer pathways. Many marine mammals, such as the right whale, are trophic level 3 consumers. Humans are actually omnivorous, feeding at several trophic levels.

Demersal species that live on the bottom may be exposed through sediment and food pathways depending on the trophic level (e.g., primary or secondary carnivores) that they occupy. These organisms are more motile than benthic infauna and can encounter varying levels of contaminants through different prey species and feeding ranges. Further removed from the sediment environment that contains most of the bioaccumulative contaminants are the pelagic organisms. Pelagic organisms (e.g., bluefish) generally prey on other pelagic organisms. Thus, these organisms are primarily exposed to contaminants present in the water column and their water-column food. Additionally, because many pelagic fish transit across large coastal areas, they may be exposed to widely different types and levels of contaminants throughout their life cycle. This situation makes evaluating and linking pelagic-organism contaminant bioaccumulation from specific sites exceedingly difficult.

Grazing occurs at all trophic levels. Herbivorous organisms graze on primary producers (e.g., plankton) and plant detritus. These primary consumers can include zooplankton and filter feeding benthic species (e.g., bivalves) as well as higher organisms such as whales (Battelle, 1997a). Small and large fish and crustaceans graze on zooplankton and benthic infauna and are in turn grazed by larger fish. The ultimate trophic level of grazers includes the carnivorous fish, some marine mammals, and man.

As described previously, steady state or equilibrium concentrations of contaminants in the organism develop on the basis of the propensity of the chemical to partition from the water and be retained within the organism. Generally, bioaccumulation of highly hydrophobic organic chemical contaminants increases in this order (LeBlanc, 1995):

primary producers → invertebrates → fish

This order is driven primarily by the increase in lipid content and the decrease in effectiveness of diffusion from an organism as size increases. As a result, species and chemical-specific differences may affect the bioaccumulation of chemicals in the organisms.

Recent concepts (e.g., LeBlanc, 1995) suggest that the level of a contaminant in an organism is driven more by its food source. Such concepts, while beginning to provide estimates of expected levels of contaminants in fish and from other information, must still be refined and validated before broad applications of the concept can be made.

Exposure to Contaminants. Water-column organisms encountering a dredged material plume may be exposed to elevated concentrations of dissolved and particulate materials from the dredged material for short periods (i.e., <1 h) before the plume is diluted to background concentrations (Dragos and Lewis, 1993; Dragos and Peven, 1994). These post-disposal exposure periods are too short for water-column organisms to bioaccumulate hydrophobic organic contaminants (log $K_{ow} \geq 3.5$), including the contaminants of environmental concern, such as PCBs, polycyclic aromatic hydrocarbons (PAHs), and chlorinated industrial and agricultural contaminants (61 FR 51195-51203 Sept. 30, 1996). Thus, the level of contaminants in pelagic organisms found in the Study Area reflects longer-term exposure, which may occur in a variety of habitats depending on the life history and migratory patterns of the organism.

Infaunal organisms are more likely than epifauna to directly bioaccumulate contaminants from sediments and can affect the health of these organisms and potentially the larger ecological community (Boese and Lee, 1992). Further, as discussed previously Section 3.4.6.1, benthic organisms are food items for predators and, when contaminated, are potential pathways for sediment-associated pollutants to move to higher trophic levels. Human health may be affected directly by consumption of contaminated sediment-dwelling invertebrates or indirectly through consumption of fish that are contaminated through trophic transfer (Boese and Lee, 1992).

Exposure to Contaminants in the Study Area. The primary exposure pathways of contaminants in the Study Area and surrounding areas are through (1) exposure of near-bottom pelagic and demersal organisms to particles and resuspended sediment and (2) exposure of infauna and epifauna to bottom sediments. Because there are multiple sources of contaminants to this area, it is difficult to identify and separate which of these sources are most significant in establishing exposure levels. Further, mobile organisms (e.g., lobster, flounder, migratory commercial and recreational fish) range over large areas (including, but not limited to the Study Area) that can have major differences in chemical concentrations. Other contaminant sources such as atmospheric inputs and transport into the region in association with the Hudson River Plume may, in addition to dredged material disposal, influence contaminant levels in water, particles, and surface sediment of the region through transport and deposition processes.

The influence of non-local sediment sources on the level of contaminants in the Bight areas can be understood from the recently completed Port of Newark/Port Elizabeth dredged material capping project (SAIC, 1995d). Under this project, dioxin levels in polychaete worms collected from sediments in the project and reference areas were measured prior to disposal and after capping. The dioxin levels in the organisms collected after disposal and capping were similar to levels measured in the area before the capping effort, even though the cap had no detectable dioxin (SAIC, 1995d; 1995e). Dioxin levels in worm tissues collected in 1995 were slightly higher than in April 1994 with average concentrations at stations off the cap slightly above on-cap stations (SAIC 1996c). Present understanding of pathways and bioaccumulation potentials suggest other, possibly distant, sources (e.g., deposition of Hudson River plume particles or resuspension of sediment with higher contaminant concentrations from nearby areas) caused the increase (SAIC 1996c). Further, the information suggests that local sediments are not an important source for the dioxin in these organisms. Thus, while the remediation and restoration options being considered under this SEIS (refer to Sections 2.3 and 2.4) should theoretically result in decreases in sediment concentrations and body burden of chemicals that can bioaccumulate in organisms, other contaminant sources to the area likely overwhelm the ability to detect any decreases in bioaccumulation as a result of remediation activities. This is particularly true for recreational and commercial fish and shellfish species that migrate through the New York Bight on a seasonal basis and are exposed to contaminant sources outside of the Study Area.

3.4.6.2.1 Contaminants in Polychaete Worms from the Study Area

As discussed above, the concentrations of bioaccumulative contaminants in the water, sediments, and infauna food sources, in concert with contaminant partitioning in the organisms' lipids, generally determine the levels of contaminants in succeeding trophic levels. Valuable information about probable sources of contaminants to the marine food chain in the Study Area can be elucidated by understanding the relationships among sediment contaminants, infaunal prey, and infauna predators. In the following text, a key pathway of contamination to living resources (i.e., fish and shellfish) was examined by sampling and analyzing polychaete worms living in the Study Area and nearby areas of the inner Bight (Battelle, 1996b;1997b). As discussed in Section 3.4.3.4, polychaete worms are major prey items of many fish and shellfish (Refer to Tables 3-17 and 3-18). The contaminant body burden of these worms (both concentrations and spatial distributions) helps to identify those chemicals and sediment areas most likely to impact New York Bight living resources that are of ecological or socio-economic importance.

Metals: Metals concentrations in polychaetes collected from throughout the Study Area were consistent among samples collected between 1991 and 1994 (Table 3-22). Further, these recent data are similar to levels reported in polychaetes collected from the area in 1983-1985. The major difference between samples collected in 1991 and 1994 are slightly higher values of Cd, Cr, Ni, and Pb in mixed species from 1991 relative to the 1994. The causes are not clear as the 1990 and 1991 samples were held live aboard the sampling vessels and allowed to depurate, thereby lowering the measured contaminant concentrations. Results for the other samples reported in Table 3-22 were obtained from sampled organisms that were not depurated. Thus, these samples have some gut-associated sediments that contribute to the measured concentrations (Battelle, 1996b;1997b). However, it is believed that undepurated organisms better represent the exposure to contaminants to the next trophic level from these prey species.

Table 3-22. Range in metal concentrations in polychaetes collected from the Study Area.
Units are on a parts-per-million wet weight basis.

Source and Sample Data	Steimle, *et al.* (1994)[1,2] 1983 - 1985	Charles and Muramato (1991) Collected October 1990						McFarland *et al.*, (1994) August 1991		Battelle (1993) [1,3] August 1992	Battelle (1997b)[3] Oct 1994	Battelle (1997b)[3] May 1995
Location	East of Hudson Shelf Valley	Referenc e Area	MDS		East of MDS	Study Area (South)	Study Area (West)	Reference Area		New York Bight	Study Area	Bight Apex (outside Study Area)
Metal			(North)	(South)				Mixed species	*Nephtys*			
Ag	0.10	ND	<1.2	ND	ND	<1.1	<1.4	NA	NA	0.22	0.05 - 0.34	0.09 - 0.25
As	2.78	5.4	2.6 - 3.8	3.2 - 6.8	1.3 - 5.6	4.6 - 7.6	2.2 - 6.8	NA	NA	8.4	1.9 - 6.1	2.8 - 11.4
Cd	0.30	0.12	<0.12	<0.12	<0.12	<0.2	<0.2	0.54±0.01	0.62±0.03	0.13	0.04 - 0.16	0.04 - 0.32
Cr	4.12	0.8	1.4 - 2.6	1.2 - 3.2	1.0 -1.2	0.8 - 1.6	1.2 -2.4	26.8±1.3	1.5±0.39	1.9	0.16 - 3.4	0.11 - 2.7
Cu	5.3	3.3	3.2 - 7.6	1 - 5.2	1 - 3.2	0.8 - 5	1 - 7.4	8.3±0.1	3.69±0.17	5.4	1.2 - 7.6	0.7 - 5.7
Fe	NA	124	290 - 846	180 - 800	147 - 310	60 - 740	120 - 1000	NA	NA	NA	56 - 1200	NA
Hg	0.092	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	0.048±0.002	0.11	0.03	0 - 0.06	0.01 - 0.04
Ni	0.96	ND	0.8 - 1.2	<1.2	0.8 - 1	<0.9	<0.96	19.0±1	1.19±0.25	1.2	0.31 - 1.8	0 - 1.3
Pb	2.1	0.7	1.6 - 3.8	0.7 - 3.2	0.36 - 1.1	0.4 - 2.4	0.8 - 3.4	10.2±2	0.085±0.02	2.0	0.75 - 6.2	0.2 - 4.3
Se	1.3	NA	0.8 - 1.2	1 - 2	1.4 - 1.6	0.6 - 1.4	0.8 - 2	NA	NA	NA	0.66 - 2.1	NA
Zn	38	28	20 - 34	22 - 38	25 - 28	22 -38	13.4 - 39	20±0.7	35.2±0.4	42	15.6 - 30.4	13.0 - 29.4

[1] Converted from dry to wet weight using assumed 80% water content.
[2] Samples processed using stainless steel tools; potential contamination of samples.
[3] Undepurated samples

Most of the metals concentrations reported in polychaetes from the Study Area are relatively constant with differences among stations falling within a factor of 2 to 6 (Battelle, 1997b). Regions of distinctly high and low concentrations are not evident in the data from the Study Area (Figure 3-76). Because most of the samples with sufficient biomass for the chemical analysis were obtained from stations that had relatively high mud content, the data shown in Figure 3-76 primarily represent locations that tend to have higher chemical concentrations in the sediment.

Metals levels in polychaetes from the Study Area were similar to those in samples collected from outside the Study Area but still within the Bight Apex (Battelle, 1997b). Thus, metals levels in the polychaetes can be considered to relatively invariant over broad regions of the inner Bight.

Organic Compounds: Total PAH concentrations in polychaetes from the Study Area ranged between 140 and 1,200 ppb wet weight; concentrations between 4 and 520 ppb wet weight were measured in the Bight Apex (Table 3-23). Total PAH concentrations in polychaetes from east and south of the Study Area were lower than those measured in samples collected north of the Study Area. Generally, total PAH concentrations in the Study Area were significantly higher than those from the Apex (Battelle, 1997b), especially compared to levels in samples collected to the east and south of the Study Area, which had total PAH levels of 33 ± 25 (n = 9) ppb wet weight. Polychaetes from the six stations north of the Study Area averaged 246 ± 158 ppb total PAH, which fall in the lower range of the total PAH levels observed for the Study Area.

Other organic compounds in polychaete worms from the Study Area include PCBs (Figure 3-77). Total PCBs in these organisms ranged from 40 to 180 ppb (wet weight). PCB concentrations in samples from outside the Study Area have been reported as high as 440 ppb (Battelle, 1993). However, the use of different methods among the studies to quantify of the PCB levels (i.e., as Arclor mixtures or the sum of congeners) may account for differences of about two fold (NOAA, 1996). Data obtained using directly comparable methods clearly show higher PCB levels in polychaetes from the Study Area relative to Apex areas to the east and south (Battelle, 1996b). As observed in the PAH data, total PCB concentrations in polychaete samples from north of the Study Area were generally higher than in samples from the east and south of the Study Area (65 ± 20; [n = 6] versus 31 ± 10 [n = 9], respectively), and were also at the lower end of the concentration range of samples from the Study Area.

Residues of pesticides in polychaetes from Study Area are generally low (Table 3-23). Chlordane and DDE residues were less than 11 ppb wet weight at the MDS reference site (McFarland *et al.*, 1994). Total DDT concentrations ranged from 16 to 43 ppb wet weight in samples collected from throughout the Study Area in 1991 and 13 to 45 ppb for samples collected from the same area in 1994 (Battelle, 1997b). Spatially, the total DDT distribution was similar to the other organic chemicals (Figure 3-78).

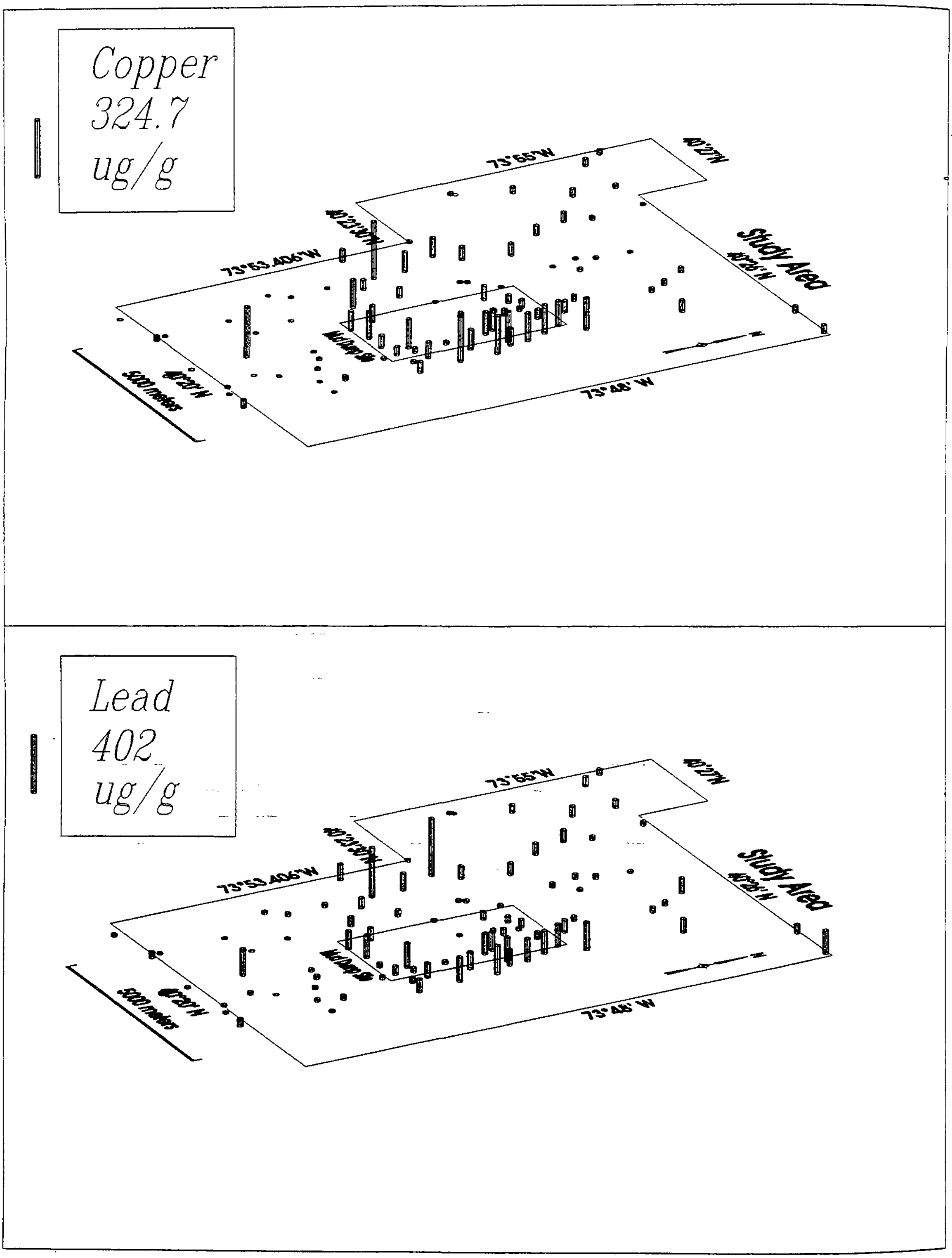


Figure 3-76. Distribution of copper and lead in polychaete tissues collected in and near the Study Area. Stations located outside the Study Area are from the May 1995 Bight Apex sample collection (Battelle, 1996b; 1997b).

Table 3-23. Organic contaminant concentrations (ppb wet weight) in polychaete samples from the Study Area.

Compound Class	Concentrations	Reference
PCB_t	440[2,3]	2 Battelle (1993) (7); Samples collected in August 1992 3 Results converted from dry weight using 80% water content; PCB as Arclor 1254
	156 ± 19[5]	5 McFarland *et al.* (1994) MDS Reference area, August 1991, mixed polychaetes
	71 ± 5[6]	6 McFarland *et al.* (1994) MDS Reference area, August 1991, *Nephtys* only
	43 - 179[9]	9 Battelle (1997b) October 1994 (n = 19)
	14 - 110[10]	10 Battelle (1997b) May 1995 (n =17)
PAH_t	600[2,3] 141 - 1,210[9] 4 - 520[10]	See above
DDT/DDE	20 - 29 (MDS N)[4] 16 - 22 (MDS S) 16 - 43 (MDS E) 16 - 23 (Study Area S) 16 - 29 (Study Area W)	4 Charles and Muramato (1991); as 4,4'DDE
	<3.3 (DDE)[5] 5.4 (DDE)[6]	
	12.6 - 45[9]	
	2 - 36[10]	
Tributyltin	7.9 - 54[9]	See above
Total organotins	19 - 87[9]	

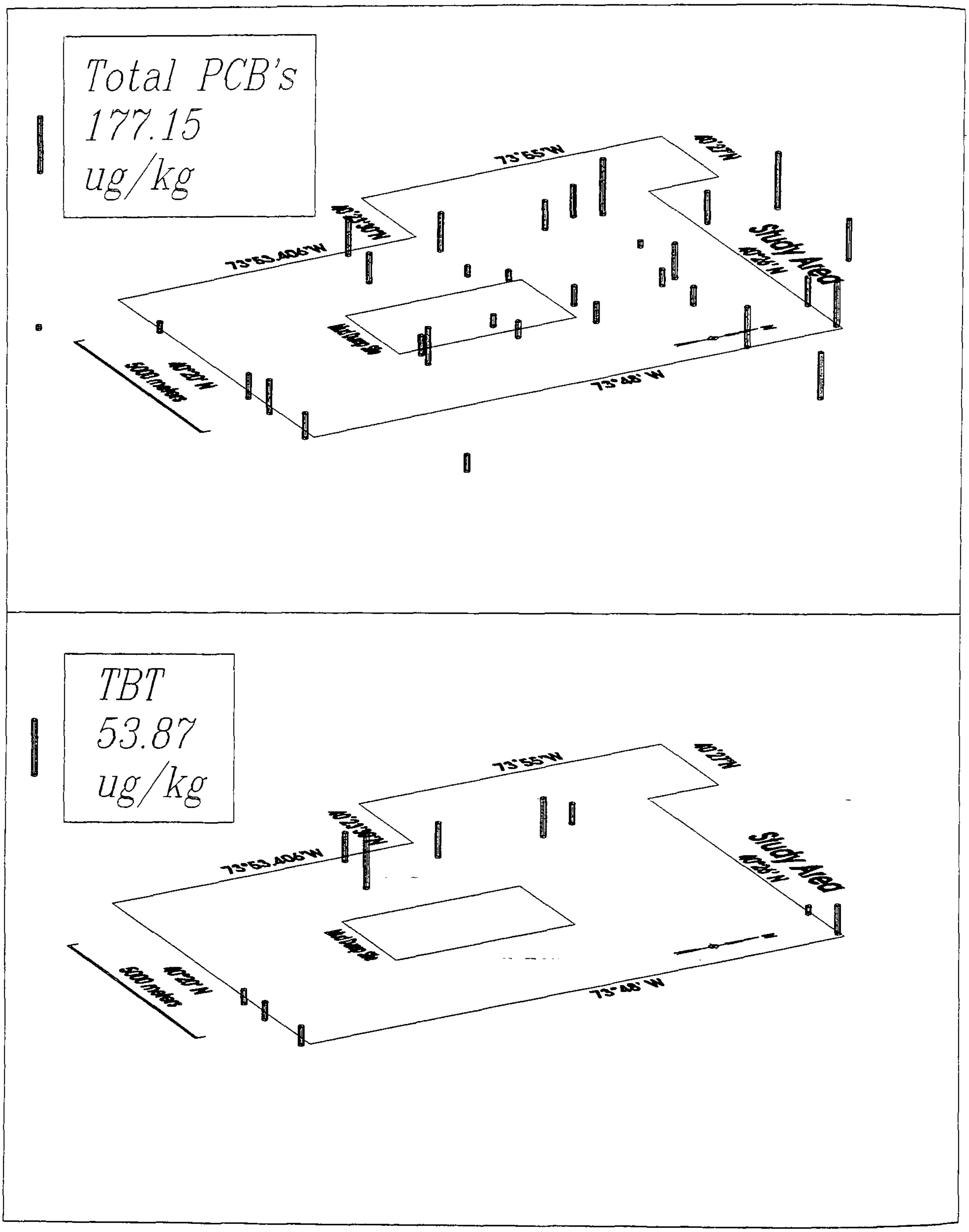


Figure 3-77. Representative distributions of total PCB and total organotins in polychaete worms collected from the Study Area. Stations located outside the Study Area are from the May 1995 Bight Apex sample collection (Battelle, 1997b).

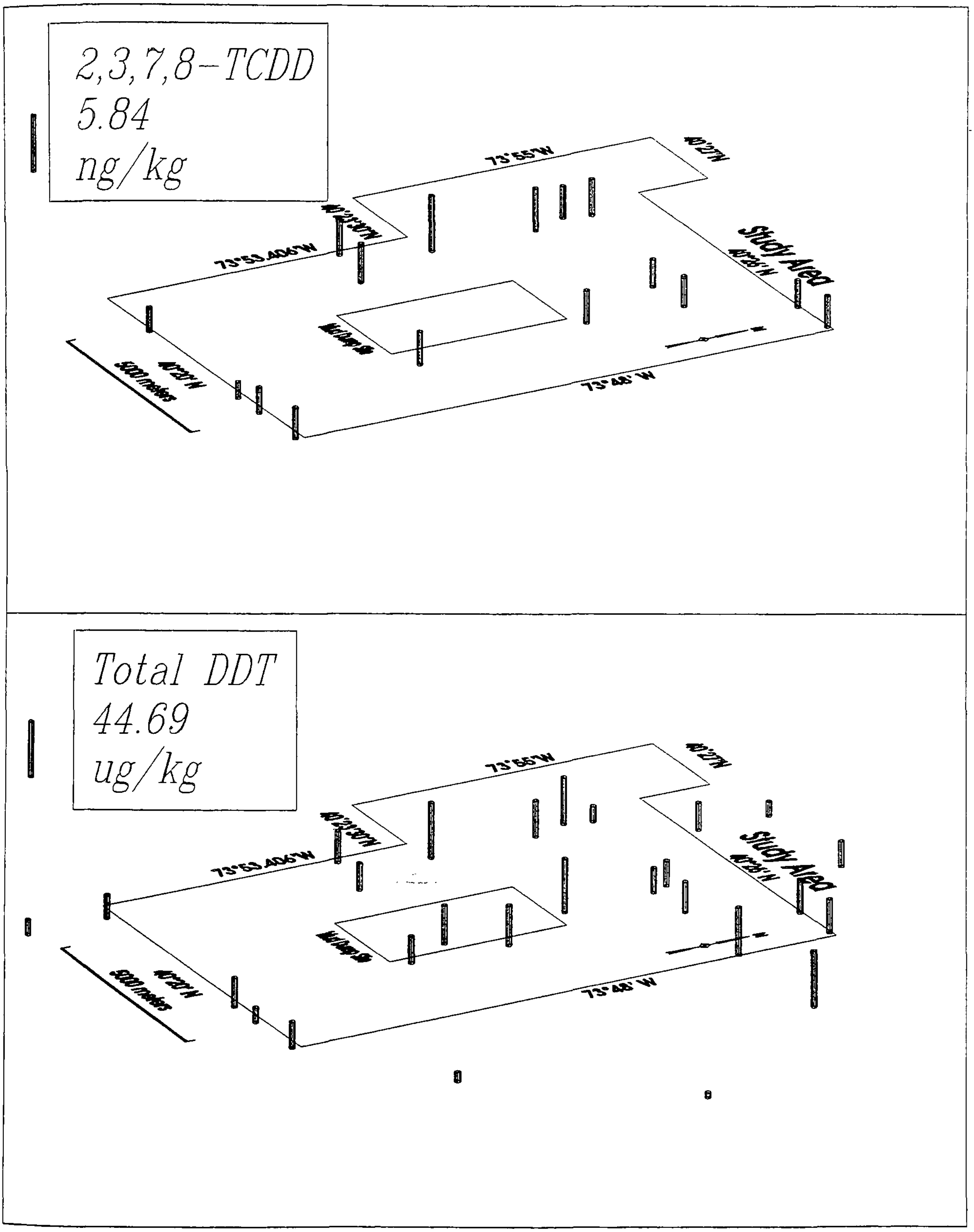


Figure 3-78. Representative distributions of dioxin (2,3,7,8-TCDD) and total DDT in polychaete worms collected from the Study Area. Stations located outside the Study Area are from the May 1995 Bight Apex sample collection (Battelle, 1996b; 1997b).

Total DDT concentrations in the polychaete samples from areas to the east and south of the Study Area averaged 2.2 ± 1.6 ppb wet weight (Battelle, 1997b) and are consistently lower than measured in samples from the Study Area. Total DDT levels in the stations to the north of the Study Area were at the lower end of the concentration range from the Study Area. The mean concentration for samples from north of the Study Area was 15.9 ± 8 ppb versus a range of 12 to 45 ppb in the Study Area.

The set of organic contaminant data from the Study Area show regions of distinctly higher or lower concentrations in polychaetes were not clearly evident (Figures 3-77 and 3-78) in the Study Area. However, two areas on the flanks of the historic dredged material mound appear to have slightly higher concentrations for some contaminants (e.g., total DDT, total PCB, total PAH) relative to the other locations (Battelle, 1997b). These areas with slightly elevated contaminant concentrations are in water depths of 15 to 16 m on the east side of the basin west of the dredged material mound and also in the northeastern corner of the Study Area.

Dioxin and Furans: Most dioxin and furan concentrations in polychaetes collected from throughout the Study Area were low (Table 3-24). In 1991, the highest reported 2,3,7,8-TCDD concentrations in the MDS ranged from 3.5 to 9 pptr wet weight . In 1994, the highest value measured was 5.8 pptr. Most samples collected in 1994 fell within the range from 3 to 5.8 pptr. The lowest values were found at two locations on the southern boundary of the Study Area (Figure 3-78). Results from 1995 (SAIC 1996d) were similar but with slightly higher levels in the worms from the cap. Sources external to the MDS are believed to cause this response.

Although the polychaete samples collected from the Study Area in 1994 were associated with sediments that have the highest dioxin levels in the Study Area, the dioxin levels were not substantially higher than those observed in samples from the Port Elizabeth capping project and from the MDS reference area sampled in August of 1991. There are no clear indications of hot spots for dioxin in polychaetes from the Study Area (i.e., >10 pptr 2,3,7,8-TCDD). Further, post-cap monitoring of the Port of Elizabeth project found similar dioxin levels in polychaetes collected from the sand cap and reference areas, and from the pre- and post-disposal periods. The fact that dioxin and furan levels are relatively similar (<2 fold differences) across regions, within and outside the Study Area and the MDS, and across time suggests that resident polychaetes are either not responding to the levels in the sediments or are being exposed via routes that provide a more uniform and constant supply.

3.4.6.2.2 Contaminant Bioaccumulation in Polychaetes from the Study Area

The relationship between contaminant concentrations in the polychaetes and sediments were examined to determine any characteristic patterns and to identify contaminants most likely to bioaccumulate into significant prey species (Battelle, 1997b). These studies showed that there are three general response patterns by polychaetes to sediment contamination in this region:

1. Infauna tissue contamination is low and does not correspond to sediment levels.
2. Infauna tissue contamination mirrors sediment contamination levels.
3. Infauna tissue contamination is above that of sediment levels.

Table 3-24. Dioxin results for polychaete tissues collected in the Study Area in the early 1990s. Units are parts per trillion (pptr) wet weight.

Location	2,3,7,8-TCDD	2,3,7,8-TCDF	Data Source
1990 North of Study Area	4.4		Pruell *et al.* (1990)
Reference	2.5	NA	Charles and Muramato (1991)
MDS North	3.9 - 8.1	NA	(Samples collected October 1990 precapping; separated by taxa for analysis)
MDS South	4.3 - 6.2	NA	
MDS East	3.6 - 9.0	NA	
Study Area South	2.7 - 4.1	NA	
Study Area West	4.5 - 8.0	NA	
North Reference	1.4 - 2.1	1.5 - 1.8	SAIC (1992)
South Reference	0.7 - 2.0	1.2 - 2.1	(Samples collected 1992; composites at each of three stations)
MDS	0.61 - 0.95	1.4 - 1.8	
1994; North Reference (n = 2)	1.2 - 3.0	<1.2 - 1.7	SAIC (1995d)
1994; South Reference (n = 1)	1.5	1.5	(Composite samples of polychaetes; dominated by predator type; collected May 1994 after completion of dredged material capping operations in 1994)
Sand cap Newark Bay Dredging Project (n = 1 composite derived from 10 stations)	2.2	2.5	
MDS (n = 3)	2.7 - 3.0	<4.8	
1995; On Cap (n = 3)	3.5	0.9 - 2.1	SAIC 1996c (composit samples dominated by *Arabellidae*, a predator; off cap species were dominated by *Arabellidae* and *Nereididae* (a detritovor)
1995; Off Cap (n = 3)	3.2 - 4.1	1.8 - 3.1	
Reference (n = 3)	<1.9 - 2.2	0.7 - 1.0	
Polychaetes misc.	<1.7 ± 0.2	3.1 ± 0.20	McFarland *et al.* (1994)
Nephtys	<2.0 ± 0.2	2.3 ± 0.26	(composites collected from the MDS Reference Site August 1991)
Study Area n = 16	1.8 - 5.8	1.9 - 5.6	Battelle (1997b) (Undepurated composite samples from throughout Study Area and MDS in October 1994)

Response Pattern 1: Tissue Contaminant Levels Low and Unrelated to Sediment Levels. Response Pattern 1 is believed to include contaminants that are regulated by organisms, and thus do not bioaccumulate. The metals Ag, Cd, Cu and Zn are included in this group. This finding is consistent with the conclusions of Brown and Neff (1993) and Chapman *et al.* (1996) that metals, in general, do not biomagnify in organisms. Battelle (1997b) showed that Response Pattern 1 also holds for total PAH contamination in the polychaetes, but this may be due to the fact that PAHs in muddy New York Bight sediments have low bioavailability or are metabolized rapidly in polychaete tissues.

Response Pattern 2: Contaminant Levels Mirrors Sediment Contamination. Response Pattern 2 includes contaminants that increase in polychaete tissues in proportion to contamination in the sediments, and appear to be neither regulated nor bioaccumulated by the organisms. Contaminants in this group included metals As, Cr, Hg, Ni, Sb, Sn, and organic compounds such as dioxins, furans, and low and high molecular weight PAHs.

Response Pattern 3: Contaminant Bioaccumulation. Response Pattern 3 includes contaminants that clearly bioaccumulate in polychaetes, such as PCBs.

The Battelle (1997b) studies indicate that only a few chemicals bioaccumulate from the sediments to polychaetes in the Study Area and the New York Bight Apex. Chemicals that do bioaccumulate include those that have high ($>10^6$) octanol water partition coefficients (i.e., propensity to associate with lipid material). In contrast to predictions of high bioaccumulation factors, the Battelle (1997b) study found that dioxin and furan did not appear to bioaccumulate in the polychaetes from the Study Area. This is consistent with findings of McFarland *et al.* (1994) who did not observe bioaccumulation in organisms sampled from the area, and concluded that these compounds are only transferred between trophic levels. Shrock *et al.* (1996) also found low bioaccumulation factors (BAF = 0.14 for 2,3,7,8 TCDD and 0.21 for 2,3,7,8, TCDF) for lipid and TOC normalized dioxin and furans in 28-day bioaccumulation tests conducted across wide range of contaminant levels sediments with *Nephtys incisa.*

Overall, the chemicals of greatest concern from a bioaccumulation perspective are PCBs. This does not, however, nullify concerns about other chemicals, particularly those classified into Response Pattern 2 which have high concentrations in the Study Area relative to surrounding areas in the Bight Apex. More specific information about tissue contaminant levels and specific toxicological responses by individual organisms, communities, and populations in the area is required to definitively determine impact.

3.5 Socio-economic Environment [40 CFR Sections 228.6(a)(8) and (11)]

The New York-New Jersey metropolitan area has a population of over 8 million. Another 11 million people reside in counties that border the metro area, the waters of the New York Bight, the lower Hudson River, and eastern Long Island Sound (1994, USBC). The socio-economic activities of this high density population has been and continues to be inextricably linked to the waterways and shoreline facilities of the Port of New York and New Jersey, and the natural and manmade resources of the New York Bight and adjacent waters.

This section of the SEIS presents information on the socioeconomic environment of the Study Area of the Mud Dump Site, including commercial and recreational fisheries (Section 3.5.1), mariculture (Section 3.5.2), shipping (Section 3.5.3), military usage (Section 3.5.4), mineral or energy development (Section 3.5.5), recreational activities (Section 3.5.6), cultural and historic areas (Section 3.5.7), other uses of the Study Area (Section 3.5.8), and areas of special concern (Section 3.5.9).

3.5.1 Commercial and Recreational Fisheries

Commercially and recreationally important fish and shellfish in the New York Bight and in the Study Area are natural resources of significant socioeconomic value to the metropolitan population. The ecology and location of specific fish and shellfish resources were presented and discussed in Section 3.4. Sections 3.5.1 and 3.5.2 which follow present information on chemical contaminants found in Study Area fish and shellfish (human health issue) and catch data for the commercial and recreational fishing sectors (economic and social issue).

3.5.1.1 Chemical Contaminants in Fish and Shellfish

Recent (within the past 10 years) data on chemical contaminants in fish, shellfish, and other organisms collected in the Study Area or nearby areas (New York Bight Apex, Hudson Shelf Valley) are not sufficient to systematically and statistically define spatial or temporal trends in contaminant concentrations. However, the data are sufficient to qualitatively characterize the level of contaminants in many of the important fish and shellfish species harvested in the area. In the following subsections, contaminant data in fish and shellfish are compared to available human health consumption guidelines and action levels as well as bioaccumulation potentials.

In the following discussion, metals, organic compounds, and dioxin are considered under separate sections. Within each section, information on the key fish and shellfish (e.g., lobster) are discussed independently.

3.5.1.1.1 Metals in Fish and Shellfish

Although metals data have been reported for recreational and commercially important species in the area for over 20 years, only a few comprehensive, high-quality data sets have been published. Information within some published data sets indicate that some samples were inappropriately processed for metals analysis (e.g., use of stainless steel dissection tools and homogenization vessels), resulting in potential sample contamination and corrupt laboratory results for metals such as Fe, Cr, and Ni.

Ranges in metals concentrations in the tissues of fish and shellfish collected in the Study Area from the early 1970s through mid 1990s are presented in Tables 3-25a and b. The concentrations of individual metals measured in these organisms are generally similar across species, although concentrations vary widely among the metals. For example, cadmium concentrations are generally less than 0.4 ppm (μg/g) wet weight in the majority of the species with most values falling below 0.1 ppm (μg/g) wet weight.

Table 3-25a. Range in metal concentrations in organisms collected in the late 1970s through 1995 from the New York Bight, Bight Apex, and Hudson Shelf Valley. Units are on a parts-per-million ($\mu g/g$) wet weight basis for composite samples (n) or individual organisms.

Metal	Sea Scallop	Rock Crab				Shrimp		Mollusks	*Nucula* sp. [3]
	NYB APEX[1] n = 2	NYB[1] n = 5	MDS[2] n = 5-8	MDS REF[2] n = 4	NYB[3] n = 1	MDS n = 2	NYB n = 8	MDS Reference Site[4]	MDS Reference Site[4,5]
Ag	<0.07	0.16 - 0.38	0.79	0.24	1	0.6 and 0.6	0.4 -0.6	NA	NA
As	NA	NA	NA	NA	8.5	1.8 and 2.3	1.8 - 2.9	NA	NA
Cd	0.11 - 0.20	<0.17	<0.1	<0.1	1.2	0.9 and 0.13	0.2 - 0.36	0.62 ± 0.028	1.0
Cr	0.20 - 0.31	0.5 - 1.3	0.5	<0.4	0.5	0.3 and 1.2	0.16 - 0.70	0.82 ± 0.5	1.3
Cu	0.12 - 0.19	3.2 - 8.9	14.8	25.4	47	15 and 20	13 - 21	3.1 ± 0.16	6.8
Hg	0.02 - 0.04	NA	0.19	NA	0.08	0.035 and 0.044	0.014 - 0.034	0.32	0.0.038
Ni	<0.13	<0.55	NA	NA	1.7	0.22 and 0.7	0.15 - 0.43	0.70 ± 0.14	1.46
Pb	<0.4	<1.0	<1.3	<1.0	0.15	0.15 and 0.36	0.016 - 0.13	2.66 ± 0.28	0.67
Zn	0.02 - 0.04	29 - 52	32	NA	57	16 and 17	13 - 17	13.7 ± 0.08	2.42

[1]Reid *et al.* (1982); composite samples from through out Study Area and adjoining areas.
[2]Greig *et al.* (1977); pooled organisms collected in 1971 and 1972.
[3]Battelle (1993); seven samples collected in August 1992.
[4]McFarland *et al.* (1994); samples collected from MDS reference site area in August 1991.
[5]The data in this column are converted to wet weight from the dry weight concentration in McFarland *et al.* (1994).

Table 3-25b. Range in metal concentrations in organisms collected in the late 1970s through 1995 from the New York Bight, Bight Apex, and Hudson Shelf Valley. Units are on a part-per-million (μg/g) wet weight basis for composite samples (n) or individual organisms.

Metal	Winter flounder	Window pane flounder			Red Hake[1]
	Study Area[1] n = 7	Study Area[1] n = 7	MDS[2] n = NA	NYB[2] n = NA	Study Area n = NA
Ag	<0.1	<0.1	<0.1	<0.1	<0.11
As	NA	NA	1.4	2.8	NA
Cd	<0.1	<0.08 - 0.23	<0.1	<0.1	<0.11
Cr	<.13 - 1.4	<0.2 - 0.55	<0.5	<0.5	0.1 - 0.76
Cu	0.14 - 0.34	0.15 - 0.31	1	NA	0.1 - 0.31
Hg	0.03 - 0.12	0.02 - 0.09	0.15	0.27	0.04 - 0.09
Ni	<0.12 - 0.28	<0.21	NA	NA	0.22
Pb	<0.6	<0.6	<0.5	<0.5	<0.7
Se	NA	NA	NA	NA	NA
Zn	1.4 - 6.4	1.4 - 6.8	4.6	5.1	0.77 - 2.6

[1]Reid *et al.* (1982) composite samples from throughout the Study Area.
[2]Greig and Wenzloff (1977) pooled organisms collected in 1971 and 1972.

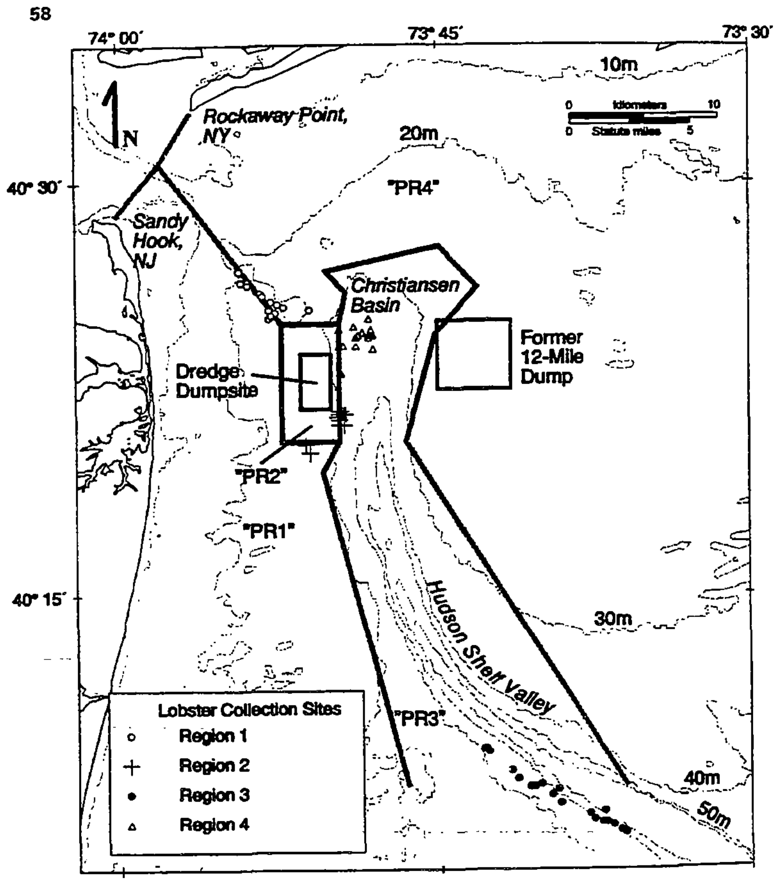
Mollusks and the bivalve *Nucula* sp. have slightly higher concentrations (approximately 0.5 to 1 ppm wet weight). Similarly, mercury concentrations in the organisms listed in Tables 3-25a and b are generally less than 0.3 ppm (μg/g wet weight) with most reported values under 0.1 ppm. Mollusks have the highest mercury concentrations (approximately 0.3 ppm wet weight). The windowpane flounder data set, although limited, suggests mercury levels were lower in 1982 than in 1972. It can not be determined whether the differences in the data reflect true decreases in concentration or are due to improvements in analytical techniques.

Across most organisms, zinc concentrations are consistently higher than the other eight metals (Tables 3-25a and b); the highest concentrations (30 to 60 ppm wet weight) are found in rock crab. Zinc concentrations of less than 10 ppm wet weight are found in flounder and red hake, with very low values (<0.04 ppm wet weight) reported for sea scallops in the early 1980s. Metals levels in rock crabs collected from within the MDS in 1972 (Greig and Wenzloff, 1977) were generally within a factor of two of the concentrations measured at a reference site, and were not considered to be elevated within the MDS.

Limited data obtained from organisms sampled in 1992 suggest that recent concentrations are not greatly different from this earlier data (Tables 3-25a and b). Metals concentrations in shrimp from a reference area and the MDS in August 1992 (Battelle, 1993) were low and fell within a similar concentration range, suggesting that metal levels in organisms recently collected from outside the MDS are similar to those within the MDS.

Metals concentrations in four recreational fish species collected in the New York Bight Apex in 1993 (NOAA, 1995a) are consistently low (Table 3-26) and within the range of metal concentrations found in uncontaminated finfish (NOAA, 1995a). The concentration of metals in the fluke collected in this NOAA sampling are also similar to the historical values for winter flounder collected in 1972 and 1980 (compare Tables 3-25a and b and Table 3-26). Spatial trends were not evident in the 1993 data (NOAA, 1995a).

Metals levels in the two flounder species collected from the Study Area in 1992 are similar to those measured in winter flounder collected from other coastal areas [e.g. from Massachusetts Bay in 1993 and 1994 (Hillman and Peven, 1995); Hillman *et al.*, (1994)]. Moreover, metals levels in the flounder tissue collected from the New York Bight in the 1980s are similar to the recent results from the New York Bight and Massachusetts Bay.



Locations of 1993 NOAA lobster collections.

***Lobster*:** An extensive set of metals measurements in lobster from the New York Bight Apex was recently completed by EPA, USACE, and NOAA (NOAA, 1996). In this study, lobsters were obtained from local lobstermen who fished at known locations in the New York Bight Apex.

Four areas were sampled: (1) northwest of the Study Area (considered to be influenced by the Hudson River Plume), (2) northeast of the Study Area in the western parts of the Christiaensen Basin (near the MDS and former 12-Mile Site), (3) south and southeast of the MDS (southeastern Study Area), and (4) in the Hudson Shelf Valley several kilometers to the southeast of the Study Area. Sample collections were completed in June, July, August, and October. Composite samples (5 animals per composite) were prepared for lobster muscle and hepatopancreas and concentrations of ten metals in each composite sample were determined. Metals concentrations in the lobster muscle tissue were found to be uniformly low with Ag, Cd, Ni, Pb, and total Hg less than 0.5 ppm (μg/g) wet weight (Table 3-27) with Pb being undetectable in most samples. The highest value for Hg in an individual composite was 0.5 ppm. Copper, Cr, and As were all less that 8 ppm; Zinc was less than 30 ppm.

Metals in the hepatic tissue were generally higher than in the muscle (except for Hg which was slightly lower). Concentrations of Hg were less than 0.25 ppm; Ag, Cr, Ni, and Pb were less than 1.5 ppm. Cadmium concentrations in the hepatic tissue were consistently less than 10 ppm, As was less than 14 ppm, and Zn less than 66 ppm. Copper concentrations ranged from 111 to 580 ppm wet weight. The

Table 3-26. Concentrations of contaminants in the flesh of recreational fish collected in the New York Bight Apex in 1993. Metals are in parts per million (wet weight); organic compounds are in parts per billion (wet weight); dioxin is in parts per trillion (wet weight). Range is derived from composite samples each prepared with three fish of the same species. (NOAA, 1995a)

Contaminant	Bluefish	Fluke	Sea Bass	Tautog
Ag	0.030 - 0.057	0.011 - 0.034	0.022 - 0.044	0.017 - 0.048
As	0.25 - 0.63	1.46 - 2.34	2.23 - 5.32	0.82 - 1.27
Cd	0.085 - 0.27	0.082 - 0.19	0.079 - 0.21	0.089 - 0.14
Cr	0.13 - 0.73	0.074 - 0.26	0.11 - 0.81	0.068 - 0.41
Cu	0.21 - 0.64	0.17 - 0.44	0.21 - 0.65	0.21 - 0.51
Hg	0.066 - 0.14	0.022 - 0.049	0.033 - 0.074	0.045 - 0.12
Ni	0.089 - 0.36	0.054 - 0.23	0.083 - 0.41	0.050 - 0.26
Pb	0.12 - 0.45	0.079 - 0.26	0.13 - 0.50	0.10 - 0.32
Zn	8.3 - 23.0	2.5 - 4.8	3.1 - 6.2	2.9 - 6.3
PCB_t	212 - 568	25.9 - 43.0	44.4 - 137	41.1 - 116
DDT_t	101 - 269	5.4 - 11.3	10.4 - 41.5	7.5 - 31.3
$Chlordane_t$	23 - 64	4.1 - 5.5	4.1 - 12	4.1 - 12

high copper concentrations are typical for this organism which uses phythalocyanine, a natural copper binding compound, in its metabolic system (NOAA, 1996). As in the case of the lobster muscle, several metals (most notably Pb) were not detected in several composites.

The range in metal concentrations in each of the composite samples were similar within tissue type across all areas sampled and sampling periods (Table 3-27). The concentration ranges for several metals (Ag, Cd, Ni, Pb) measured in the muscle tissue in 1993 appear to be lower than reported for a limited set of samples obtained in this area in 1981 (Reid *et al.*, 1982) (Table 3-27). The concentrations of other metals appear to be about the same between these two periods, although Hg and Cr may be slightly higher in the 1993 sampling. NOAA also indicates that the metals levels in these lobster are similar to those measured in lobster collected from submarine canyons on the outer continental shelf as part of the 106-Mile Site monitoring program in the early 1990s.

Metals levels in tissue and hepatopancreas samples from the sampled areas were not significantly different among the sample composites from the areas closest to the Hudson River Plume and MDS (NOAA, 1996). Higher concentrations were found in both the hepatic and muscle tissues obtained in the Hudson Shelf Valley (NOAA, 1996). No correlation of the measured contaminant levels to the relative location of the MDS or other possible contaminant sources could be verified.

Table 3-27. Concentrations of metals in muscle and hepatopancreas of lobster collected in the New York Bight Apex in parts per million (wet weight). Range is derived from individual composite samples.

Metal	Muscle					Hepatopancreas			
	Reid *et al.* (1982)	NOAA (1996)[1] June through October 1994				NOAA (1996)[1] June through October 1994			
	Study Area n = 6[2]	Hudson River Plume n = 12	Southeast Study Area n = 7[3]	Northeast Study Area n = 12	Hudson Shelf Valley n = 17	Hudson River Plume n = 12	Southeast Study Area n = 7	Northeast Study Area n = 12	Hudson Shelf Valley n = 17
Ag	0.1 - 0.7	0.087 - 0.31	0.13 -0.22	0.071 - 0.25	0.08 - 0.29	0.097 - 1.1	0.28 - 0.95	0.32 - 1.04	0.13 - 1.25
As	NA	2.3 - 4.5	2.8 - 5.0	2.5 - 4.4	3.9 - 8.0	4.8 - 7.7	4.3 - 9.3	3.8 - 7.5	5.9 - 13.9
Cd	<.05 - 0.15	0.001 - 0.003	0.001- 0.002	0.001 - 0.003	0.001 -0.008	1.4 - 5.0	1.5 - 2.6	1.6 - 2.9	1.2 - 9.6
Cr	<.1 - 0.52	0.15 - 1.4	0.23 - 1.5	0.10 - 0.82	0.18 - 1.1	0.24 - 1.27	0.25 - 1.4	0.15 - 0.52	0.16 - 0.76
Cu	2.3 - 9.5	2.3 - 5.9	3.2 - 4.1	2.9 - 5.3	1.9 - 6.8	194 - 567	137 - 446	257 - 516	112 - 580
Hg	0.04 - 0.15	0.10 - 0.49	0.12 - 0.31	0.048 - 0.18	0.051 - 0.38	0.054 - 0.19	0.091 - 0.23	0.054 - 0.18	0.045 - 0.25
Ni	0.08 - 0.46	<.06 - 0.016	<.010 - 0.048	<.06 - 0.010	<.006 - 0.29	0.20 - 0.49	0.06 - 0.30	0.055 - 0.43	0.11 - 0.56
Pb	0.2 - 0.6	<.004 - 0.058	<.004 - 0.035	<.004 - 0.084	<.004 - 0.061	0.016 - 0.15	<.004 - 0.15	0.021 - 0.43	<.004 - 0.20
Zn	5.8 - 18	15.3 - 19.9	16.0 - 19.9	14.4 - 17.6	14.6 - 28.4	18.2 - 59.0	16.8 - 52.6	16.7 - 60.0	18.0 - 66.5

[1]Values are the range from individual composite samples each comprised of tissue from five different lobsters.
[2]n = number of composite samples in the range.
[3]Samples in August and October were not obtained due to movement of lobster fishing further offshore.

Comparison of metals levels in lobster composites collected within the past 2 to 3 years from the Bight Apex and Massachusetts Bay reveals similar metal levels in muscle and hepatic tissues. Mercury levels in lobster muscle tissue from outer Boston Harbor and Massachusetts Bay ranged from 0.1 to 0.3 ppm wet weight and averaged less than 0.1 ppm (Hillman and Peven, 1995). These values are well within the concentration range observed in the Bight Apex. Metals in lobster hepatopancreas from Massachusetts Bay were slightly lower than those from the New York Bight except for Ag which was slightly higher. Concentrations ranges in the 1994 Massachusetts Bay samples in ppm wet weight were 0.01 - 0.1 for Pb; 0.4 to 0.1 for Hg; 0.15 - 0.24 for Ni; 1 - 4 for Ag; 2 -4 for Cd; 0.03 to 0.32 for Cr; 33 to 124 for Cu; and 15 to 21 for Zn.

3.5.1.1.2 Organic Compounds in Fish and Shellfish

A large set of organic contaminant data for several fish and shellfish species collected in and near the Study Area became available in 1995 and 1996. These data are summarized below.

Fish: Total PCB concentrations in four recreation species — bluefish, fluke, sea bass, and tautog — reported by NOAA (1995a) (Table 3-26) were readily detectable but at widely different concentrations among the sampled species. The highest concentrations (low hundreds of ppb wet weight) were found in the bluefish. Fluke and sea bass had PCB concentrations in the low ppb wet weight range. Relative concentrations of total DDT and total chlordane were similar in these species, although at much lower levels (Table 3-26). Further, NOAA (1995a) notes that contaminant concentrations in bluefish samples from the MDS were not different from those collected from locations outside of the MDS. The local and seasonal migrations of these fish make it impossible to correlate tissue data with contaminants known to occur in the Study Area and MDS. In particular, it is well known that bluefish (a pelagic species) transit the Study Area seasonally and likely pick up the their contaminant loads in coastal habitats such as the estuaries and harbors where they reside most of the time, and not in the Study Area.

Coastal New Jersey striped bass, which are primarily pelagic, migrate between warmer southern waters in the winter and Hudson River in the summer, had mean total PCB concentrations as high as 3.5 ppm in the early 1980s. Striped bass collected from the New York Harbor area from the late 1970s through the late 1980s had PCB concentrations that were less than 2 ppm (HydroQual, 1989b). Further, PCB data from striped bass in the New York Harbor show a continuous decline in the lipid normalized PCB level between 1978 and the early 1990s (Figure 3-79) (EPA, 1993).

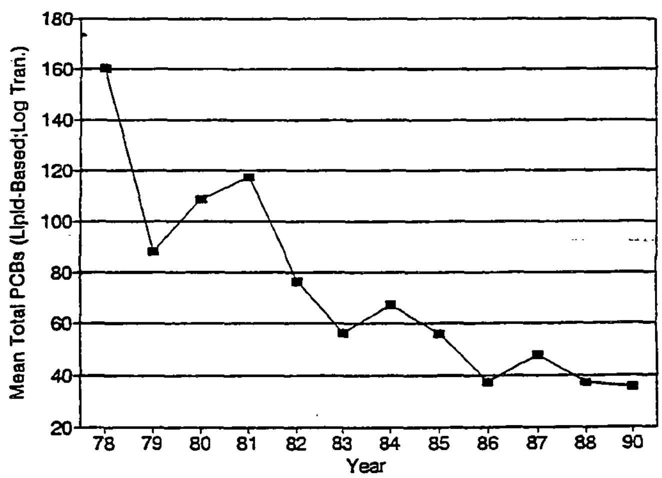


Figure 3-79. Trend in PCB contamination in striped bass from the lower Hudson River between 1978 and 1990 (EPA, 1993).

PCB concentrations in the winter flounder sampled in 1982 were 200 to 330 ppb wet weight (Table 3-28). PCB levels in flounder liver were between 400-900 ppb wet weight in the mid-1980s (Draxler *et al.*, 1991) and higher than in the edible tissues as is typically observed in this species. Historic data on PCB levels in 224 composite samples of bluefish collected from the New York Bight in 1985 did not show any exceedance of the 2 ppm wet weight FDA Action Limit (HydroQual,

Table 3-28. Ranges in organic contaminants (parts-per-billion wet weight) in organisms collected from the New York Bight Apex and Hudson Shelf Valley.

Contaminant	Sea Scallop	Rock Crab	Red Hake	Winter Flounder	Windowpane Flounder	Shrimp	Mollusks
PCB_t	30[1] n = 1	90 - 110 n = 3[1]	100[1] n = 2	210 - 330[1] n = NA	106 - 210[1] n = 4	140; 160[2] (MDS) 90 - 260 (Bight)	27 ±10 *Mercenaria mercenaria*[3] 110 ±60 Mixed mollusks[3] 100 ±32 *Nucula* sp[4] 191 *Yoldia limatula*[4] 27±11 *Mercenaria* sp.[4]
PAH_t	NA	95 - 700	273; 389	28 - 228	35 - 494	13; 31 (MDS) 3 - 7 (Bight)	Concentrations ranged from 1.5 ppb indeno[1,2,3-c,d] pyrene in *C. lacteus* to 239 ppb benzo[*k*] flouranthene in *Nucula* sp., substantially below the ppm levels observed in organisms from contaminated areas[4]
DDE/DDT	NA	NA	NA	NA	NA	NA	DDE 5.7±2.2 *Nucula* sp.[4] 11 *Yoldia limatula*[4] 1.6±0.04 *Mercenaria* sp.[4] 5.3±0.2 Molusca[4] DDT <0.42 *Nucula* sp.[4]

[1]Reid *et al.* (1982); for composite samples (n) collected in 1980; PCB as Arclor 1254.
[2]Battelle (1993); Samples collected in August 1992.
[3]McFarland *et al.* (1994); MDS Reference area, August 1991, a) Mercenaria mercinaria, b) Mixed mollusks.
[4]McFarland *et al.* (1994).

1989b). Draxler *et al.* (1991) found that contaminant levels in flounder collected after cessation of sewage sludge disposal at the 12-Mile Site decreased rapidly, suggesting that the sewage sludge disposal was a major source of these contaminants in the area.

PAH concentrations in the bluefish, fluke, sea bass, and tautog reported in NOAA (1995a) (Table 3-26) were largely undetected. Data summarized in HydroQual (1989b) indicate that DDT in flounder were at least 1000x less than the FDA action levels. Note that these generally low organic contaminant levels were obtained at a time when surface sediments in the region of the Study Area likely had higher contaminant concentrations from the then active 12-Mile Sewage Sludge Disposal Site.

Historically, organic contaminants in other species collected from the vicinity of the Study Area were also low (see Table 3-28). PAH concentrations in benthic organisms (bivalves, mollusca) collected from the Mud Dump Site Reference Station in August 1991 were in the low ppb (wet weight) range (Table 3-28) and well below levels observed in organisms from highly contaminated sites (McFarland *et al.*, 1994). Similarly, McFarland *et al.* (1994) found that pesticide concentrations in benthic organisms collected in 1991 ranged from 0.37 to 10.7 ppb. DDE and DDT in molluscs were reported as less than 11 ppb wet weight and PCB concentrations in sea scallop, rock crab, and mollusks were less than 100 ppb wet weight (Table 3-28).

***Lobster*:** Organic contaminant concentrations in lobster from the New York Bight Apex were recently reported in NOAA (1996). This study found that organic contaminant concentrations in the lobster muscle were generally low (Table 3-29). The maximum total PCB concentrations, as the sum of 18 PCB congeners ($\sum_{18}$PCB) in the muscle, were 220 ppb wet weight and ranged as low as 60 ppb wet weight. Total DDT and total chlordanes in the muscle tissue ranged from 20 to 35 ppb wet weight. High molecular weight PAHs (HMWPAH) were generally less than 490 ppb; low molecular weight PAHs (LMWPAH) were generally not detectable (<64 ppb wet weight).

In contrast to the lobster muscle, total PCB levels in the hepatic tissue were substantially higher and ranged from 1.8 to 7.4 ppm wet weight (1,800 to 7,400 ppb) across individual sample composites. PCB levels in lobster hepatopancreas collected in 1982 were between 700-1,400 ppb wet weight (Draxler *et al.*, 1991). Hepatic PCB values in lobster collected from other northeast United States coastal environments have been consistently measured at less than 1 ppm wet weight (Hillman and Peven, 1995; Hillman *et al.*, 1994).

Total DDT concentrations in the hepatic tissue was as high as 1,420 ppb wet weight, but were more generally near 800 to 900 ppb wet weight (Table 3-29). Total chlordane concentrations did not exceed 360 ppb wet weight as mean concentrations for a sampling area for any of the sampling periods. HMWPAH concentrations were less than 2.6 ppm; LMWPAH were not detectable except in October when concentrations were detectable at approximately 190 ppb.

The 1993 total PCB ($\sum_{18}$PCB) concentrations in muscle and hepatic tissue of lobsters from the Hudson Shelf Valley were consistently lower than those from the three areas near the MDS. This spatial trend was consistent throughout the four sample collection periods. The three areas located nearest the MDS and Hudson River Plume had consistently uniform concentrations of total PCB, DDT, and PAH (NOAA, 1996). PCB concentrations in the hepatic tissue from the Bight Apex were equivalent to or higher than those in lobster from the rest of the New York Bight. These later values are consistently lower than those measured in the Georges Bank/Gulf of Maine region (NOAA, 1996).

Table 3-29. Recent concentrations of organic contaminants in muscle and hepatopancreas of lobster collected in the New York Bight Apex [parts per billion (wet weight) except for dioxin and furan which are in parts per trillion (wet weight)]. These data represent the range in the individual composite samples obtained for four surveys in each area. Chlordane$_t$, DDT$_t$, HMWPAH, and LMWPAH represent the range in the mean concentration for each area by survey.

Contaminant Muscle **Hepatopancreas**
Reid *et al.* (1982) NOAA (1996)
June through October 1994 NOAA (1996)
June through October 1994
Throughout Area
n = 5[1] Hudson River
Plume
n = 12 Southeast Study
Area
n = 8[2] Northeast Study
Area
n =13 Hudson Shelf Valley
n = 17 Hudson River
Plume
n = 12 Southeast Study
Area
n = 8 [2] Northeast Study
Area
n = 13 Hudson Shelf
Valley
n = 17

PCB$_t$[3]	240 - 1,100	64 - 89	64 - 78	77 -220	62 - 88	2790 - 7380	2745 - 4090	2340 - 4860	1840 - 3870
DDT$_t$[2,4]	NA	19 - 29	21; 23	20 - 32	21 - 35	750 - 1150	880; 900	800 - 1420	610 - 825
Chlordane$_t$[2,4]	NA	20 - 23	20; 21	20 -31	20 -32	190 - 360	240; 300	190 - 340	150 - 240
2,3,7,8-TCDD	NA	<1.8	<1.8	<1.8	<1.8	73 - 160	78 - 131	70 -173	31 - 65
Dioxin/Furan TEQ[5]	NA	<8.7	<9.6	<8.7	<8.8	122 - 239	139 - 205	121 - 266	63 - 124
2,3,7,8-TCDF	NA	<3.2	<3.2	<3.2	<3.2	130 - 210	140 - 175	160 - 220	95 - 140
HMWPAH[2,4,6]	311 - 510	480 - 490	480	480	480	1100 - 2620	1020; 1210	520 - 1310	480 - 1260
LMWPAH[2,4,6]		64	64	64	64	64 - 190	64; 73	64	62 - 90

[1]n = number of site mean concentrations reported.
[2]Samples in August and October were not obtained due to the movement of the lobster fishing offshore; two survey means reported.
[3]Sum of 18 congeners.
[4]Range in the mean concentrations of composite samples (unequal number of composites per mean) for the period from June to October 1994 (four surveys).
[5]Reported as toxic equivalents.
[6]High molecular weight PAH and low molecular weight PAHs.

For the hepatic tissue, total chlordane was highest at locations nearest the Hudson River Plume and lowest in the Georges Bank/Gulf of Maine region. Spatial distributions of total DDT in the hepatic tissue was less predictable, although lobster collected in the area to the northeast of the Study Area had the highest concentrations (NOAA, 1996). PAH's were highest in the areas to the north and northeast of the Study Area.

3.5.1.1.3 Dioxins and Furans in Fish and Shellfish
Recent data for commercial and recreational fish species collected in the New York Bight Apex (NOAA, 1995a) indicate that dioxin/furan levels in these organisms is generally low (Table 3-30). Reported total dioxin concentrations are consistently less than the 10 pptr (wet weight) concern level established for dredged materials testing in the New York harbor area. The concentrations of the most toxic dioxin and furan congeners (2,3,7,8-TCDD and 2,3,7,8-TCDF) in muscle tissues of recreational fish were consistently less than 7 pptr (Table 3-30). The highest 2.3.7.8-TCDD values were in bluefish muscle (3 to 7 pptr); the lowest concentrations (<0.5 pptr) were measured in fluke. TCDD concentrations in the tautog and sea bass were at the lower end of this range (0.6 to 3 pptr). The 2,3,7,8-TCDD and 2,3,7,8-TCDF congener concentrations reported for shellfish species caught in the MDS and Study Area are consistently less than 3 and 6 pptr, respectively (Table 3-30).

Dioxin, as 2,3,7,8-TCDD, concentrations in the muscle tissues of the lobsters collected by NOAA (1996) were found to be less than the 1.8 pptr wet weight method detection limit (Table 3-29). Total dioxin and furan expressed as toxic equivalents were consistently less than 2.0 pptr in the muscle tissues. In contrast, dioxin in the hepatic tissues of lobster collected in 1991 was much higher, and ranged from 31 to 173 pptr. Toxic equivalents ranged from 63 to 266 in these tissues. A close correlation between total PCB concentrations and dioxin levels was also noted in the organisms. Concentrations of both chemical classes were strongly related to the lipid content of the tissues. Thus, the spatial distribution of the dioxin closely parallels that of the PCBs with higher levels measured in lobsters from the Bight Apex than in the rest of the Bight and areas further to the east.

Dioxin concentrations in samples collected 5 to 9 years before the NOAA collection had higher concentrations than those measured in the 1993 collections (NOAA, 1996 and Table 3-30). Dioxin concentrations in hepatic tissues collected some 5 years prior to 1993 (Rappe *et al.*, 1991) were 2 to 4 times higher than those reported in NOAA (1996), and were higher than those reported by Hauge *et al.* (1994) in samples collected about 10 years earlier.

3.5.1.1.4 Contaminant Bioaccumulation Potential in Study Area Organisms [Section 228.10(b)(6)]
Few contaminants found in the study area biomagnify through trophic levels, although several may bioaccumulate in prey species resident within the Study Area (Section 3.4.6.2.2). Concentrations of other chemicals simply increase in tissues in response to higher contaminant levels in the sediments.

To evaluate the potential transfer of bioaccumulatable contaminants across trophic levels, concentrations of certain contaminants were measured in polychaetes in the Study Area and in organisms known to prey on polychaetes in the Study Area.

Table 3-30. Dioxin results in fisheries tissues samples collected in and near the Study Area. Units are parts per trillion wet weight.

Organism	Source	Location	2,3,7,8-TCDD	2,3,7,8-TCDF
Lobster	Rappe *et al.* (1991) (collected circa 1990 near 12-Mile Site, n = 2)	Hepatopancreas	257 & 611	384 & 348
		Meat	6.3 & 4.7	4.1 & 3.5
	Hauge *et al.* (1994) (collected in mid 1980s, n = 19)	Combined hepatic and muscle tissues; Area up to 25 km offshore of New Jersey	40.8±16.5 (0% not detectable)	36.4±16.3 (4% Not detectable)
		Hepatic tissue of individual lobster; nearshore location	170, 410	260, 380
		Meat of individual lobster; nearshore location	<20	<20
	NOAA, 1996 n = 50	Study Area and Hudson Shelf Valley	See Table 3-27	See Table 3-27
Fish	NOAA, 1995a	Study Area and MDS areas	Bluefish: 1.0 to 7.3 Fluke: <0.20 to 0.44 Sea Bass: 0.59 to 1.5 Tautog: 0.7 to 2.95	Bluefish: 3.3 to 10 Fluke: <0.5 Sea Bass: 0.61 to 1.1 Tautog: 1.5 - 4.5
Shrimp	Battelle (1993) (collected in August 1992[1])	MDS (n = 1)	2.8	5.6
		Bight (n=2)	ND and 0.4	2.2 and 4.0
Mollusks	McFarland et al (1994) (August 1991 mixed species)	MDS Reference Area	1.73 ± 0.18	4.33 ± 0.42

[1]Estimated from dry weight using 80% water content

Comparison of Estimated Contaminant Levels in Polychaete Predators to Measured Levels

Contaminant	Measured contaminant concentration in polychaetes (See Section 3.4.6.2.1)		Measured concentrations in polychaete predators in the Study Area (See Section 3.5.1.1)
	Minimum	Maximum	
2,3,7,8-TCDD (pptr ww) Log P = 6.1	1.8	5.8	Lobster meat: <1.8 Lobster Hepatic tissue: 70 to 173
Total DDT (ppb ww) Log P = 5.98	12.6	44.7	Lobster meat: 19 to 32 Lobster Hepatic tissue: 800 to 1,420
Total PCB (ppb ww) Log P = 6.0	43.4	177	Lobster meat: 64 to 220 Lobster hepatic tissue: 2,300 to 4,860 Winter Flounder: 210 to 330 (as Arclor) Red Hake: 100

The measured contaminant concentrations in polychaetes were also used in the general bioaccumulation model of LeBlanc (1995) to calculate estimated contaminant concentrations in organisms that prey on polychaetes in the Study Area. Use of this simple model yielded concentration ranges of 18-59 pptr 2,3,7,8-TCDD, 110-400 ppb Total DDT, and 510-2,065 ppb Total PCB. These predicted levels were substantially higher than the actual measured values, except for lobster hepatic tissue. In addition, for dioxins and furans in particular, two additional studies have found that trophic transfer factors are generally below 1 for higher trophic level species such as lobsters [Pruell, R. personal communication, 1993; Cook, *et al.* (1993)].

3.5.1.1.5 Seafood Contaminant Levels Relative to FDA Advisory Levels

In addition to concerns over the potential trophic transfer and potential affects on the ecology of the Study Area, elevated contaminants levels are of significant socio-economic concern from a food consumption perspective (i.e., are fish and shellfish harvested from the Study Area area safe for human consumption?). However comparison of contaminant levels in Study Area fish tissue to Food and Drug Administration (FDA) action levels provides useful information of potential human-health impact, presented by seafood caught at the Study Area.

The body burden data of fish and shellfish in the New York Bight Apex demonstrate that tissue samples collected within the past 5 years do not exceed the 1 ppm wet weight FDA action levels for methyl mercury (total Hg is <1.0 ppm). However, total PCB levels in lobster hepatic tissue sampled in the Bight Apex in 1993 show consistent exceedance of the FDA 2 ppb guidance level for this class of contaminants (no exceedances were found in lobster muscle tissue). Exceedance of FDA action levels for other compounds (e.g., 300 ppb chlordane), were not observed in the muscle tissue of lobster or other organisms. McFarland *et al.* (1994) found that dieldrin, endrin, and heptachlor concentrations in organisms collected in 1991 were at least two orders of magnitude below applicable FDA action levels of 300 ppb (wet weight). FDA action limits for DDT, DDE, and DDD (5.0 ppm wet weight) also were not exceeded in any fish; levels were at least 20 times below the action limit.

Dioxin levels in fish, shellfish, and muscle tissue of lobster are consistently below the 25 pptr "limited consumption" guidance of the FDA. In contrast, levels of 2,3,7,8-TCDD in all lobster hepatic samples from 1993 exceed the FDA 25 pptr "limited consumption" guidance and 36 of 44 samples exceed the 50 pptr "no consumption guidance" (NOAA, 1996).

In response to the levels of concern presented by these concentrations, the states of New York and New Jersey have issued fish consumption advisories for some fish, crustacea, and shellfish caught in the waters of the New York New Jersey Harbor and Bight areas. Specifically, New York and New Jersey have advised people to limit or avoid consumption of several species of fish (striped bass and blue fish) and crustacea (lobster tomalley) caught in waters of the Harbor/Bight and, in some cases, have prohibited the sale, consumption, and/or harvesting of fish, crustacea, and shellfish due to toxic contamination, especially PCBs and dioxin.

Information on specific species and chemicals are available for the two States.

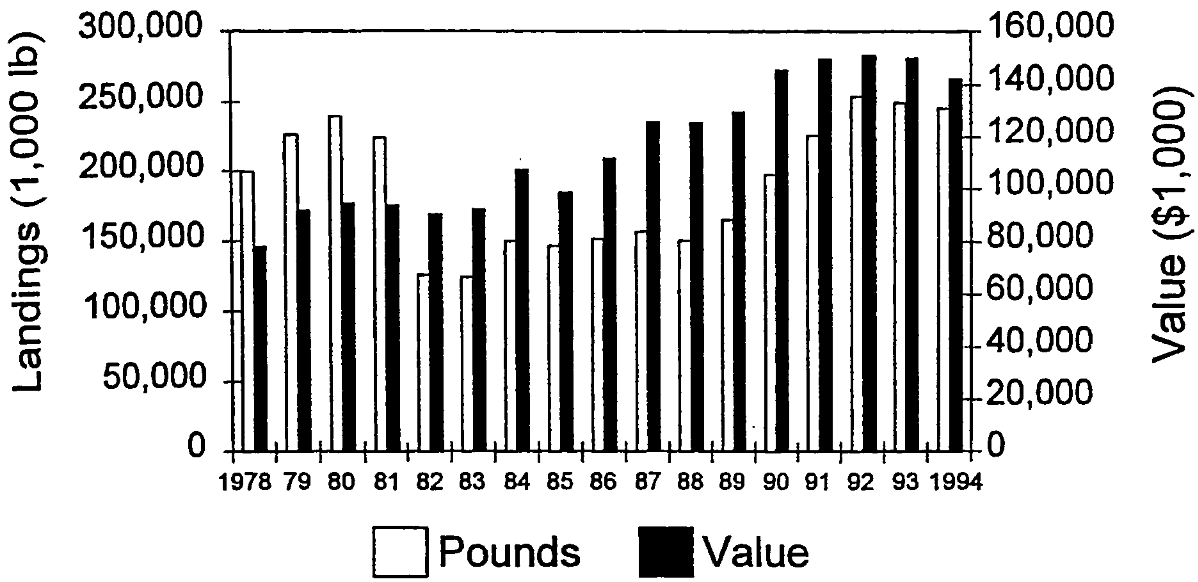
As considered in the preceding sections, PAHs, PCBs, pesticide, and dioxin/furan concentrations are generally low in tissues of fish and shellfish that inhabit Study Area. Levels of these contaminants in the commercial fish are indicative of a relatively clean environment (NOAA, 1995e). Bioaccumulation of relatively few chemicals are evident in the Study Area. Contaminants in polychaetes have the potential to transfer to higher trophic levels, although biomagnification of contaminants in the marine food chain in the area is not clearly evident except in lobster hepatic tissue. With the exception of PCB and dioxin contaminant levels in hepatic tissue of lobster, contaminant levels are consistently less that action levels established by the FDA and other guidance for evaluating the potential for contaminant transfer from sediments to organisms. The role of the sediments in the Study Area and associated benthic infauna as the cause for the high lobster hepatic PCB and dioxin concentrations can not be definitively established given the close proximity of the Study Area to the Hudson River Plume (NOAA, 1996). Regardless, the levels of PCBs and dioxin in the lobster hepatic tissue are of significant concern and are the focus of ongoing fish advisories from the states of New York and New Jersey.

3.5.1.2 Catch Data of Commercially and Recreationally Important Fish and Shellfish in the Study Area

To understand the value of fishing in the Study Area, it is necessary to first understand who fishes which species, where and when the fish are caught, and the size of the catches. The following commercial and recreational fishery information is summarized from recent National Marine Fisheries Service (NMFS) catch statistics and reports, and from information solicited from the regional fishing industry for this SEIS.

Commercial Fishing: The New York Bight contains several major commercial fishing ports in New York (Freeport, Hampton Bay-Shinnecock, and Montauk) and New Jersey (Atlantic City, Belford, and Point Pleasant, Port Belmar/Neptune, Barnegat Inlet, and Port of Cape May). Fish and shellfish landed in New York and New Jersey ports from 1992 to 1994 contributed an average of 16% and 17% of the total marine landings (i.e., catch volume) and value, respectively, in the northeast United States (New Hampshire to Virginia). The volume and value of commercial fish and shellfish landed in New York and New Jersey ports have varied over the past 15 years, from a low of 126 million lbs. and $90 million in 1982 to a high of 254.5 million lbs. and $151 million in 1992 (Figure 3-80). Since the mid-1980s, there has been a gradual increase in landings and value, although a small decrease was observed in 1994.

The commercial fishery statistics collected by NMFS provide reliable information on the amount of commercial catch, its value, and the distribution of species that are landed at New York and New Jersey ports. However, the value of NMFS fishery data for use in this SEIS is limited due to the fact that these data are based on port landings, not catch locations. Thus, while most of the fish and shellfish landed in New York and New Jersey ports were probably caught in the New York Bight (S. Wilk, personal



Source: NOAA 1979, 1981, 1983, 1985, 1987, 1989, 1991, 1993, 1995

Figure 3-80. Commercial fishing data for all New York and New Jersey ocean ports.

communication, 1995), and much of the catch could have been caught in or near the Study Area, catch location can conceivably be anywhere along the eastern United States. This creates a degree of uncertainty to catch data analyses, relative to commercial fishery resources in the Study Area.

NMFS Statistical Subarea 612 is the data region that encompasses the New York Bight Apex and includes the Study Area (refer to Figure 3-64). Table 3-31 presents the landings and value of eighteen commercial fish and shellfish caught in Subarea 612 in 1993 (the most recent data available). The species in Table 3-31 represent eighteen of the more than 35 fish and shellfish species regularly caught in Subarea 612. These eighteen species (discussed in detail in Section 3.4.2) represent 40% of the total catch volume and 43% of the total market value of fish and shellfish caught in 1993.

***Recreational Fishing*:** Recreational or sport fishing is a popular activity in the New York Bight practiced by coastal, noncoastal, and out-of-state anglers (NMFS, 1995). The majority of New York Bight anglers fish from private or rental boats or from party or charter boats.

Table 3-31. Commercial landings and value of selected commercially important fish and shellfish species caught in statistical Subarea 612 in 1993.

Species	Volume (1000s lbs)	Value ($)
Fish		
Summer flounder	842	1,218,496
Bluefish	794	263,915
Silver hake	787	385,974
Red hake	331	155,288
Winter flounder	282	299,061
Atlantic herring	190	9,689
Tautog	117	107,327
Scup	93	44,511
Butterfish	66	48,221
Cod	42	52,111
Yellowtail flounder	40	62,689
American shad	37	24,597
Shellfish		
Surf clam	53,485	3,571,753
Sea scallop	1,607	1,181,810
American lobster	721	2,509,770
Long-finned squid	518	313,605
Rock crab	66	68,404
Horseshoe crab	<1	70
Total of all species	60,019	10,317,291

Source: NEFSC, 1995a

Since 1992, the number of recreational anglers fishing off New York and New Jersey has steadily increased (Table 3-32), as has the total number of fishing trips (Table 3-33). The largest number of participants in both states are coastal residents; however, data indicate that a significant number of residents from other states travel to New Jersey to fish. In fact, the number of out-of-state residents fishing off the coast of New Jersey represents more than 40% of the total anglers in this area. New Jersey is one of the most popular fishing destinations for saltwater fishing in the northeastern United States. More recreational anglers fish off the coast of New Jersey than in any other state from Maine to Virginia (NMFS, 1995).

Table 3-32. Estimated number (in thousands) of recreational anglers fishing off the coasts of New York and New Jersey.

Year	New York				New Jersey			
	Coastal Residents	Non-Coastal Residents	Out of State Residents	Total	Coastal Residents	Non-Coastal Residents	Out of State Residents	Total
1992	466	13	42	521	408	14	336	758
1993	539	13	70	622	583	9	433	1025
1994	693	12	65	770	616	21	477	1113

Source: NMFS, 1995

Table 3-33. Estimated number (in thousands) of recreational angler fishing trips from New York and New Jersey.

Year	New York				New Jersey			
	Coastal Residents	Non-Coastal Residents	Out of State Residents	Total NY Trips	Coastal Residents	Non-Coastal Residents	Out of State Residents	Total NJ Trips
1992	3219	42	148	3409	3300	86	1173	4556
1993	3915	53	222	4189	3766	71	1356	5193
1994	4131	61	188	4380	4022	103	1535	5659

Source: NMFS, 1995

Because most recreational fishing (70%) between Delaware and New York is conducted by boat, recreationally caught fish in the Study Area and adjacent waters may be either resident fish or fish migrating through the area. The top ten species of fish caught by recreational anglers from New York and New Jersey are listed in Table 3-34. These species represent 74% and 72%, respectively, of the total pounds of fish harvested by all recreational fishermen from New York and New Jersey in 1993 and 1994. In addition, these species represent 50% and 44%, respectively, of the total volume of fish caught in 1993 and 1994 in the mid-Atlantic region (New York to Virginia). Of the total recreational catch in mid-Atlantic the New York to Virginia catch represented 115% and 84% of the Connecticut to Maine catch in 1993 and 1994, respectively. Ecological information on the recreational species listed in Table 3-34 is discussed in Section 3.4.

Recreational and Commercial Fishing Areas Within the Study Area: Fishing grounds are wide ranging in the Bight. The Study Area includes four of the most frequently fished areas within the New York Bight (R. Bogan, pers. comm., 1996). These fishing areas, shown in Figure 3-81, have been named by local fishermen and do not appear on navigational charts. Fishing locations (in relation to the current MDS), target species, and fishing seasons are presented in Table 3-35.

Commercial and recreational fishermen target the same fish, but catch them at different levels, primarily due to degree of fishing effort and different gear types. In general, recreational fishermen use hook-and-line; commercial fishermen use trawls. The exception is lobster, which is only caught by commercial fishermen using pots or traps.

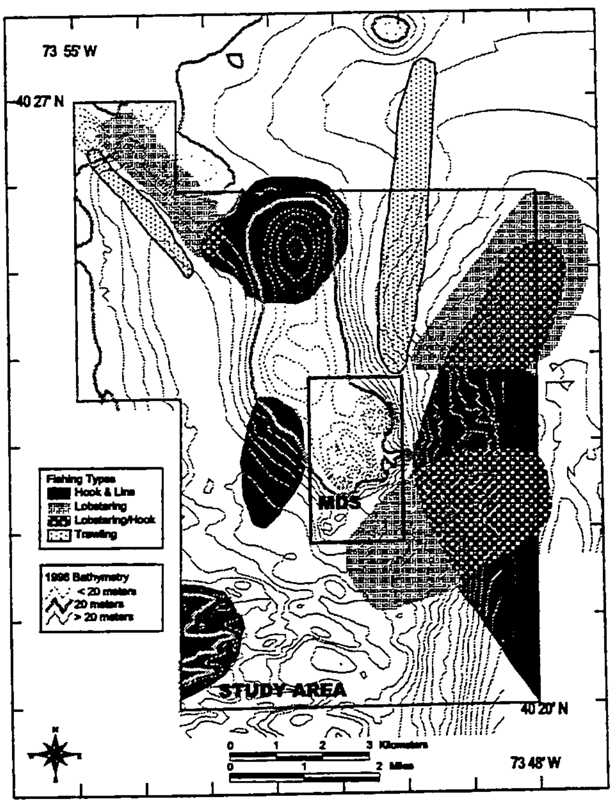


Figure 3-81. Commercial and recreational fishing locations in the Study Area.

Table 3-34. Top 10 recreational fish species, in decreasing order of estimated catch weight[1] (1,000s lbs.), for New York and New Jersey.

Species	Total		New Jersey		New York	
	1993	1994	1993	1994	1993	1994
Summer flounder	6,004	6,488	4,269	3,843	1,735	2,645
Bluefish	7,626	5,269	1,900	1,958	5,726	3,311
Striped bass	2,450	2,413	874	438	1,576	1,975
Black sea bass	3,656	1,734	3,344	1,627	312	107
Winter flounder	1,570	1,104	902	681	668	423
Scup	909	1,058	34	500	875	558
Tautog	3,163	916	1,362	331	1,801	585
Weakfish	313	706	313	706		
Atlantic cod	1,947	181	54		1,893	181
Red Hake	190	118	190	118	-	-
Total	27,828	19,987	13,242	10,202	14,586	9,785

[1]Estimated Catch Weight based on NMFS Catch Type A (fish brought ashore in whole form) and B1(not available in whole form for identification and enumeration by interviewers, includes caught fish used as bait, filleted, given away, discarded dead, etc.). Live fish returned to the sea are not included in the summary data of this table.

Table 3-35. Fishing areas and target species of the Study Area. (Source: Battelle 1996 unpublished survey data from charter boat captains from the NY Bight area)

Fishing Area (Unofficial Name)	Location in Relation to MDS	Fishing Season	Target Species
17-Fathom	East	winter	cod, white hake, red hake
		spring, fall	black sea bass, tautog, lobster
		summer	bluefish, sea bass, lobster
The Farms	Southeast	winter	cod, white hake, red hake
		spring, fall	black sea bass, tautog, lobster
		summer	bluefish, sea bass, lobster
Shrewsbury Rocks	West	winter	white hake, red hake
		spring, fall	black sea bass, tautog, lobster
		summer	scup, bluefish, sea bass, lobster
Scotland Banks	North	winter	white hake, red hake
		spring, fall	black sea bass, tautog, lobster
		summer	scup, bluefish, sea bass, lobster

Lobster is caught by traps from the spring through the late fall in the four areas listed in Table 3-35 and shown in Section 3.5.1.1.1. Lobstermen target their fishing effort at the regional lobster population as it moves offshore in the fall and shoreward in the spring. In general, lobster traps are generally fished in the rocky areas of the Study Area. Trap lines have been observed near the 17-fm line on the southeast side of the Mud Dump Site (in the southern portion of the Study Area) and in the rocky northwestern portion of the Study Area.

Bottomfish trawling is generally conducted in the relatively few flat-bottom portions of the Study Area. Trawl scour marks have been located east of the MDS mound and in the northwest corner of the Subarea 1. Fishermen have also indicated that trawling occurs in the northern portion of Subarea 2.

Hook-and-line fishing is conducted by sport/recreational fishermen in hard-bottom areas containing both rocks and wrecks. The primary fishing grounds are in the northwest and southwest corners of the Study Area.

Several shipwrecks are located in the Study Area. Wrecks above the surface of the sediment are habitat for a number of reef and hard-bottom fish and shellfish species. Most of the identified shipwrecks are located in the north and northwestern regions of the Study Area and in the rocky. The location and features of these shipwrecks, and of other wrecks thought to be buried beneath the sediment by natural sedimentation or dredged material disposal in the area summarized in Section 3.5.7 and in the Cultural Resources Report which is available on request by contacting: Joseph Bergstein, EPA Region 2, tel. 212-637-3890, e-mail bergstein.joseph@epamail.epa.gov.

3.5.2 Fishery Enhancement Structures and Operations

Artificial Reef Structures. Artificial reefs have been constructed by the States of New York and New Jersey on the ocean floor near the Study Area boundaries to create new fishing grounds, habitat for marine fish and shellfish, and underwater dive structures (Table 3-36). The reefs are constructed of natural and recycled material, including rock rubble, brick, culverts, vehicles, concrete debris, concrete ballasted tires, steel-hulled vessels, and obsolete army tanks. Fish and shellfish communities develop on these artificial reefs, which provide hard-bottom habitat. The reefs serve to both enhance existing hard-bottom habitat and replace habitat that has been destroyed by pollution, development, and other alterations to the coastal areas. As the reefs become colonized by shellfish and other invertebrates, the reefs become a source of food as well as shelter for local fish communities.

New York and New Jersey manage a total of 25 (11 in New York, 14 in New Jersey) artificial reefs. However, only three are located near the Study Area (Figure 3-82). Five reefs are located on the southern coast (ocean side) of Long Island and are north and east of the Study Area. One New Jersey reef is located between the New Jersey shore and western boundary of the Study Area. The water depths at this site is less than 20 m. Two other artificial reef sites are well to the south of the Study Area.

Table 3-36. Artificial reef sites located near the Study Area.

Reef Site	Relative Location to SEIS Study Area
Rockaway, NY	approx. 6 nmi north
Atlantic Beach, NY	approx. 6.5 nmi north
McAllister Grounds, NY	approx. 8 nmi north
Fire Island, NY	approx. 14 nmi north
Hempstead Town, NY	approx. 11 nmi north
Sandy Hook , NJ	approx. 1.5 nmi west of Subarea 2
Sea Girt, NJ	approx. 18 nmi southwest
Shark River, NJ	approx. 20 nmi southeast

Source: NYDEC, 1996; NJDEP, 1994.

Mariculture Operations. There are no mariculture operations in or adjacent to the Study Area. The nearest mariculture hatcheries and nurseries for hard clam (*Mercenaraia mercenaria*) culture are in South Oyster Bay and Great South Bay, in New York State waters (D. Barns, NY DEC, pers. comm., April 1996). The nearest of these facilities is about 30 miles from the northeast corner of the Study Area. In New Jersey, hard-clam hatchery facilities are located in the Tuckerton\Little Egg Harbor\West Creek area (J. Flimlin, NJ Sea Grant, pers. comm., April 1996), which is more than 70 miles from the southern border of the Study Area. Both the New York and New Jersey hard-clam hatchery areas are located behind barrier islands, protected from the oceanic environment, and isolated from the proposed HARS by both distance and geologic features. The clam grow-out facilities nearest the Study Area are located in Highlands and Sea Bright, NJ, approximately 3 miles to the west but located on the landward side of Sandy Hook. Thus, it is improbable that these facilities have been affected by the operation of the MDS due to the distance from the site.

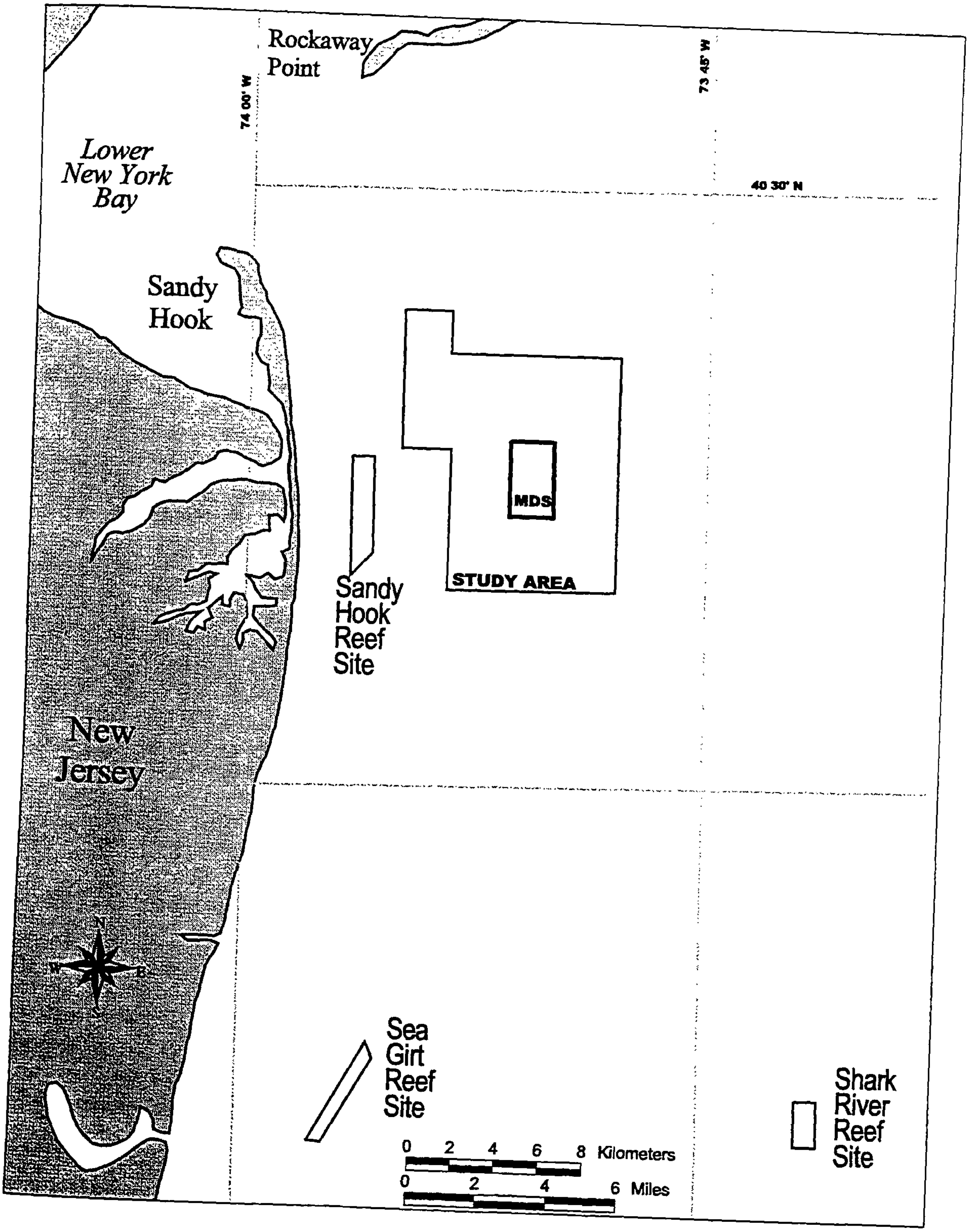


Figure 3-82. Artificial reefs located near the Study Area.

An area industry related to mariculture is clam *relaying*. Relaying operations do not hatch or rear clams for seafood, but they have similar requirements (i.e., high water quality conditions, undisturbed sediments) to those of hard-clam grow-out operations. The process of clam relaying is practiced for both hard and soft calms in the New York and New Jersey waters. Clams are harvested from waters that are polluted with bacteria which exceed State criteria for seafood sales. These clams are harvested by the same means that clams from clean waters are harvested; however, instead of going directly to market, the clams are sent to permitted relay stations located in clean State waters. At the relay stations, the live clams are placed in mesh bags and/or on racks which are then submerged for several days to allow the clams to depurate bacteria that are harmful to humans if ingested. After the appropriate depuration period, the clams are certified as safe for human consumption and sent to market. It should be noted that these relaying operations are designed to depurate the clams of bacteria only and are monitored for the level of bacteria. In general, the clams that come from the relay stations (or clams harvested directly from clean waters), are not monitored or certified as free of other contaminants, such as heavy metals or organic compounds.

The nearest relaying operations to the MDS and Study Area are inside the lower New York-New Jersey Harbor, in Raritan Bay. Both New York and New Jersey have permitted relaying operations in this area. Hard (*Mercenaria mercenaria*) and soft clams (*Mya arenaria*) harvested from nearby polluted waters are transported to relay stations southeast of Staten Island (D. Barns, NY DEC, and J. Flimlin, NJ Sea Grant, pers. comm., 1996). These relay stations are within the inner Harbor, protected from direct influence of the ocean environment, and, like the mariculture operations, isolated by distance and geological features from the MDS.

3.5.3 Shipping [Sections 228.5(a) and 228.6(a)(8)]

As summarized in Section 1.3 of Chapter 1 of this SEIS, the Port of New York and New Jersey is one of the nation's leading ports. In 1994, the Port shipped 126.1 million short tons of cargo, ranking third in the nation, behind the Port of South Louisiana and the Port of Houston (USACE WCSC, 1996). The water- and land-based facilities of the Port of New York and New Jersey are located, designed, and operated to optimize cargo and passenger ship handling of a wide range of vessel capacities, drafts, and types. The large volume of cargo that moves through the port, and its ranking among other regional and national ports, indicates that the Port of New York and New Jersey is well located and competitive with alternate modes of transportation (i.e., rail, truck, air).

The existing MDS and the Study Area are located in a busy ship traffic zone at the mouth of the New York-New Jersey Harbor (Figure 3-83). Dredged material barges and hopper dredges, while required to discharge their loads at precise locations in the MDS, usually need to spend only 3 to 5 minutes at the discharge point. These short discharge periods present low risks of collision or other conflict with cargo or passenger ships entering and exiting the Harbor, or to ships transferring pilots. However, because of the Study Area's location in an active navigation area, dredged material vessels and barges transiting between the dredging sites and the existing MDS contribute to the overall harbor traffic volume. Any increase in vessel traffic increases the chance of a navigational mishap. The further a dredged material barge or vessel must travel, the greater is the risk of collision or some other impact to other ships (EPA Region 2, 1982).

The present MDS is located entirely within the navigation Precautionary Zone at the entrance to the Harbor. The Study Area surrounds the MDS and extends into the Ambrose-to-Barnegat traffic lane, the separation zone of this lane, and the southern edge of the Pilot Area at the termini of the Sandy Hook and Ambrose Channels. According to Captains Peterson and Deane of New Jersey Sandy Hook Pilots (personal communication, April 30, 1996) the present location and operation of the MDS does not affect ship operations.

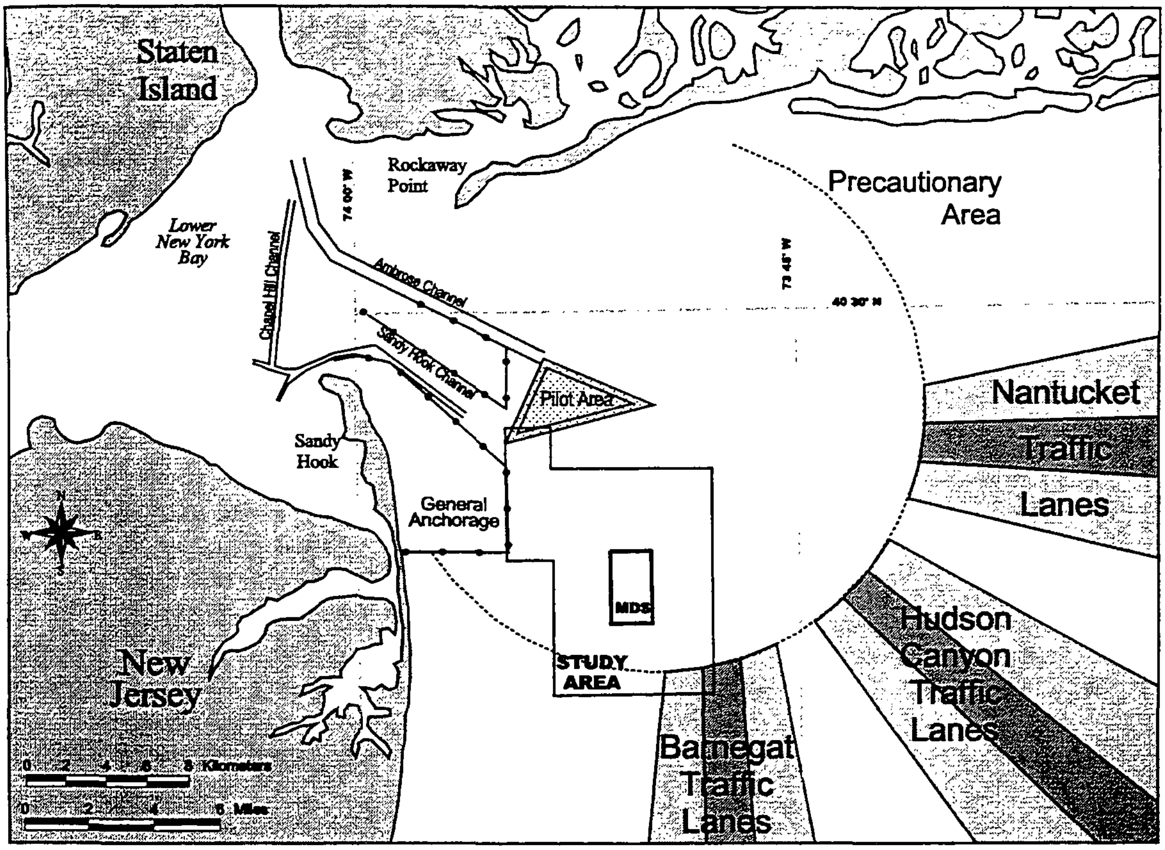


Figure 3-83. Location of the Mud Dump Site and the Study Area in relation to New York Bight Apex shipping areas.

3.5.4 Military Usage

There are no known military uses of the MDS or Study Area. However, the U.S. military can and does conduct unannounced and clandestine maneuvers and other activities in ocean waters off the U.S. With the New York-New Jersey metropolitan area's high population density and levels of commercial activity critical to the nation's economy, it is reasonable to expect that the New York Bight Apex, including waters at and around the MDS and Study Area, is an area designated by the military as important for national security. Evaluation of this importance, and present and potential conflict with military usage of the Study Area is impossible to assess without U.S. military input.

Area military installations that may operate equipment and personnel in the New York Bight Apex are listed in Table 3-37.

Table 3-37. New York-New Jersey Harbor area military installations.

Facility Name	Military Branch	Location
Earle Naval Weapons Station	Navy	Colts Neck, NJ
Fort Monmouth	Army	Eatontown, NJ
Stapleton Homeport (closed)	Navy	Staten Island, NY
Military Ocean Terminal (MOTBY)	Army, Sea Lift Command	Bayonne, NJ
Sandy Hook Station	Coast Guard	Sandy Hook, NJ
Governor's Island Station (closing)	Coast Guard	Governor's Island, NY
Rockaway Station	Coast Guard	Rockaway, NY

3.5.5 Mineral/Energy Development [40 CFR Section 228.6(a)(8)]

The only identified mineral extraction or energy development uses that have been considered for the greater Study Area region is benthic mining of sand and gravel for construction and beneficial use purposes (e.g., beach restoration).

Williams and Duane (1974) evaluated the acceptability of the sand deposits of the inner New York Bight for beneficial uses. They estimate that more than 2 billion cubic yards of clean sand located in the shallow shelf section of the inner Bight could be retrieved by dredging techniques available in 1974. Direct estimates of the volume of potentially minable material in the Study Area are not available from Williams and Duane; however, they estimate that approximately 1/4 to 1/3 billion cubic yards of sand could be recoverable from this area. The New Jersey State Geological Survey (NJGS) is presently evaluating the potential for the seaward area encompassing the seaward extension of the Shrewsbury Rocks for sand mining (J. Uptagrove, pers. comm., March 1996). Initial seismic survey information, combined with the information in Williams and Duane (1974), suggest that the sediments in the Hudson Shelf Valley (southeast corner of the Study Area) are not acceptable for sand mining due to the small gain size of the sediments and potential for historical disposal material in the area. The seaward extension of the Shrewsbury Rocks is tentatively believed to be unacceptable because of their hard sandstone makeup which is a potential obstacle to mining. The area to the north of the Shrewsbury Rocks extension is believed to be viable for sandmining. The area identified by NJGS encompasses areas of historical and current disposal and also includes the shallow basin west of the historic disposal mound. Research to confirm the viability of the sediments of the area as potential for sand mining is ongoing.

On February 12, 1996, the U.S. Minerals Management Service (MMS) issued a Request for Information (RFIN) regarding possible lease sales of sand and gravel resources in the New York Bight (MMS, 1996). Within the RFIN announcement, the Agency states that it "does not intend to issue leases in areas designated as mud dump sites nor will it permit lessees to mine deep pits for use in the disposal of any material." While MMS has indicated that future mining leases will not be granted in designated disposal site areas, the Agency did not indicate whether leases will be granted in areas of historical disposal of dredged material, sewage sludge, or other wastes within the Study Area or adjacent areas. The potential use of sand and aggregate resources located in historical (but not designated) disposal areas raises several complex issues. If these resources lie below contaminated layers of sediment, extraction may cause resuspension of the contaminants and long-term exposure to the local biota. If this is the case, a NEPA evaluation (i.e., EIS) will almost certainly be required, and other Federal and State agencies would be involved in the EIS review.

Offshore mining activities are regulated through the Outer Continental Shelf Lands Act (43 U.S.C. 1331-1356). Federal, state, and local agencies seeking to obtain access to the sand resources in the Study Area would probably develop a negotiated agreement with the U.S. Minerals Management Service (MMS) if 100% of the extracted material is used for public projects. If less than 100% of the extracted resource is for public projects, or if private companies seek mining leases, MMS is likely to use a competitive bidding process to award leases, as referenced in the February 12, 1996 RFIN (MMS, 1996).

3.5.6 Recreational Activities

Sport fishing and boating are the predominant recreational activities conducted in and near the Study Area of the Mud Dump Site. Wreck diving is a secondary recreational activity. Beach areas along the New Jersey coast, approximately 3 nmi to the west of the Study Area, are actively used for recreational activities.

As discussed in detail in Section 3.5.1.2, recreational fishing is a major socioeconomic activity throughout the New York Bight. Dredged material placement activities that change the habitat of recreationally targeted fish species could affect this activity either positively or negatively depending on placement strategies. Furthermore, the impact to sportfishing could be either actual or perceived. Examples of actual impacts include increased availability of recreational fish habitat (e.g., reef structures) or changes in the bioavailability of contaminants to the fish resources. Perceived resource impacts by fishermen are not necessarily related to actual resource impacts. For example, if anglers do not perceive an impact (e.g., fish bioaccumulation of a carcinogenic contaminant) to be a significant threat to the resources or risk to human health, the recreational activity will remain unaffected. Conversely, if fishermen perceive that an impact or risk is significant, even if it is not, the level of recreational fishing might be reduced or stopped, which in turn would negatively affect the local tourism economy. Because perceptions can effect the demand and price of fisheries products, the impact of perceptions (proven or otherwise) and actual impacts must be taken into consideration (June 16, 1995 NOAA NMFS memo to the Co-Chairs, Mud Dump Site Closure Working Group; Responses to Questions) and communicated appropriately.

Similar impacts are possible to popular recreational and sport diving. Sport diving is conducted at several locations in the Study Area by individuals and dive shops; the activities of these divers include fishing, artifact hunting (which is considered looting), and photography. If there are actual or perceived impacts to diving locations by dredged material management activities in the area, the recreational activity and associated economy could be negatively affected.

3.5.7 Natural or Cultural Features of Historical Importance [40 CFR Section 228.6 (a)(11)]

A recent review of available information (Panamerican, 1997) did not reveal any natural areas or features of potential historical significance within the Study Area. Similarly, a previous investigation (Roberts *et al.*, 1979) have found little or no evidence for sites of prehistoric occupation or utilization of offshore areas, including the Study Area, during the Holocene period.

During side scan surveys of the Study Area (SAIC, 1996a), fifteen shipwrecks were identified on the seabed of the Study Area (Figure 3-84). The cultural significance of these were unknown. To ensure compliance with Section 106 of the National Historic Preservation Act (NRHP) of 1966, as amended (16 USC 470), the National Environmental Policy Act of 1969, Executive Order 11593, and the Advisory Council Procedures for Protection of Historic and Cultural Properties (36 CFR Part 800; Abandoned Shipwreck Act of 1987); these wrecks were investigated for potential nomination to the National Register

of Historic Places. During these investigations, thirteen vessels documented as having sunk in the Study Area were also identified (Figure3-85) (Panamerican, 1997). Each of these documented vessels
was also investigated for potential cultural significance.

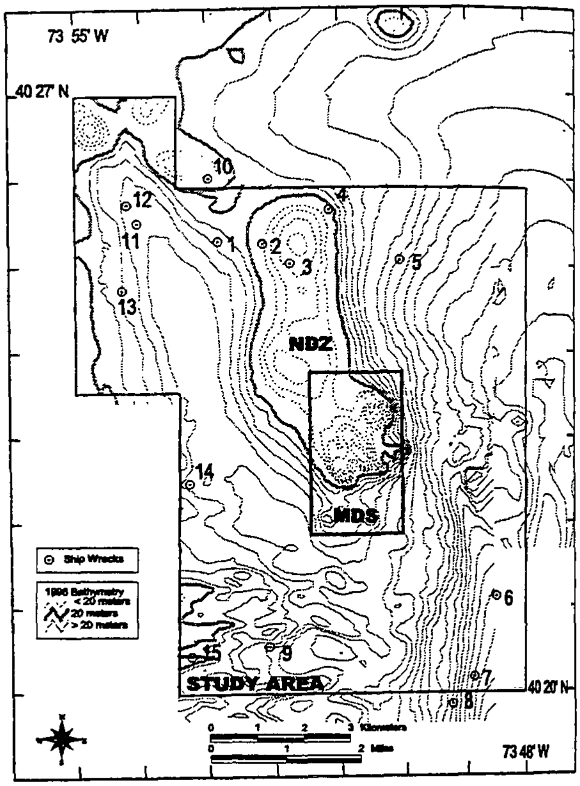


Figure 3-84. Locations of shipwrecks in the Study Area identified during side scan surveys by SAIC (1996a).

A Section 106 review must "take into account" how a Federal undertaking can affect discovered and undiscovered historical properties not listed or formally determined as eligible for listing on the National Register of Historic Places. Guidance and criteria for conducting these reviews are included in 36 CFR Part 800 and 36 CFR 60.4 of the Code of U.S. Federal Regulations and were followed in the Panamerican (1997) assessment of Study Area shipwrecks.

To establish the required NRHP information, primary and secondary archival sources or literature were contacted and researched by Panamerican. Panamerican also researched the NOAA Automated Wreck and Obstruction Information System (AWOIS, 1994) database and published shipwreck compilations from numerous sources. Additionally Panamerican conducted oral interviews with knowledgeable historians and local sources with information about shipwrecks in the Study Area. Histories of identified ship and vessel sinkings in the Study Area were compiled and this information was compared to the high resolution side-scan data and the observations reported by local divers.

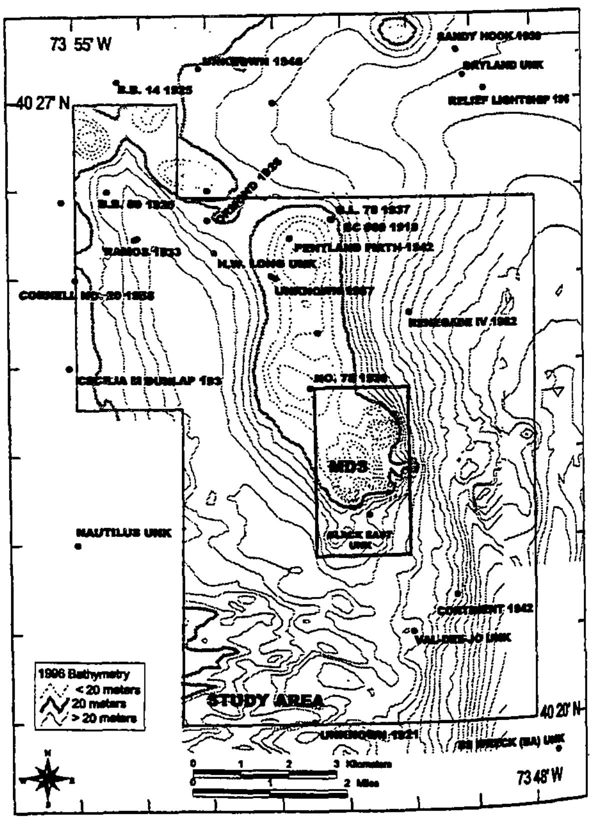


Figure 3-85. Location of vessels documented as having foundered and sunk within or near the Study Area.

Records of vessel sinking coordinates did not correlate well with most of the side-scan targets; thus, confirmation of wreck identities was problematic. Six of the targets (1, 2, 4, 6, 11, and 12 in Figure 3-84) were found to most likely represent remains of known vessels (Table 3-38). One target was tentatively identified as the remains of a known vessel. Identities of eight wrecks remain unknown.

Criteria in the *National Register Bulletin 20* "Nominating Historic Vessels and Shipwrecks to the NRHP" were used to evaluate the side-scan identified shipwrecks. The National Park Service (1985) defines shipwrecks as "a submerged or buried vessel that has floundered, stranded, or wrecked. This includes vessels that exist as intact or scattered components on or in the sea bed, lakebed, river bed, mud flats, beaches, or other shorelines, excepting hulks". A vessel's significance is "based on her representation of vessel type and her association with significant themes in American history and comparison with similar vessels". To be eligible for nomination to the NRHP, a vessel must ". . . be significant in American history, architecture, archaeology, engineering, or culture, and posses integrity of location, design, setting, materials, workmanship, feeling, and association." A vessel found eligible for nomination to the NRHP must meet one or more of four National Register criteria to be considered significant:

A. Be associated with events that have made a significant contribution to the broad patterns of our history; or

B. Be associated with the lives of persons significant in our past; or

C. Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. Have yielded, or may be likely to yield, information in prehistory or history (National Park Service, 1985).

The review by Panamerican (1997) determined that 9 of the 15 side scan targets were potentially eligible for nomination to the NRHP (Table 3-38) by meeting one or more of the above criteria. Available information on five of the remaining six targets was insufficient to make a recommendations of eligibility for nomination to the NRHP. One target, the H. *W. Long*, was identified and was found ineligible for nomination to the NRHP.

Of the nine shipwrecks found potentially eligible for nomination, four (No's. 2, 3, 4, and 10) are located on the historical dredged material disposal mound in the northern portion of the Study Area; all four of these are found in depths shallower than 20 meters. Three of these wrecks (No's. 6, 7, and 8) are located in the southeastern corner of the Study Area (Figure 3-84). None of these seven shipwrecks are located in areas found to have degraded sediments. Two of the wrecks (No's. 11 and 12) are located in the northern portion of the shallow depression west of the historic mound. Of the five shipwrecks that could not be evaluated against the NRHP criteria for lack of information, two (No's. 4 and 15) are in the southwest corner of the Study Area, two (No's. 13 and 14) are on the western boundary of the Study Area and one (No. 5) is east of the historic mound. All of these lie at depths >20m.

Of the 13 vessels known to have sunk within the Study Area, three were found ineligible for nomination to the NRHP; there was insufficient information to evaluate one of the documented sinkings. The other nine vessels were found potentially eligible for nomination to the NRHP.

Three potential actions can be undertaken regarding the shipwrecks for which eligibility of nomination to the NRHP cannot be made: 1) further study, 2) avoid the use of the area for dredged material disposal, or 3) burial. Because the eligibility is probable or unknown, avoidance during any disposal operation is considered the most acceptable action unless further investigation determines the wrecks are ineligible. The only vessel for which burial is an acceptable option is the *H. W. Long*.

Table 3-38. Documented vessel sinkings and side scan targets identified as shipwrecks in the Study Area, and their potential eligibility for listing on the National Register of Historic Places (NRHP).

Sidescan Target	Identity of Target/Vessels	Potentially Eligible for NRHP
1	most likely *H.W. Long*	Not eligible
	most likely *Ormand*	yes
3	barge	yes
4	most likely *G.L. #78*	yes
5	unknown	yes
6	most likely *Continent*	yes
7	most likely a tug boat (stripped)	yes
8	most likely a barge	yes
9	large unknown vessel	Unknown
10	possibly the *Pentland Firth*	yes
11	most likely *Ramos*	yes
12	most likely *Glen II*	yes
13	small unknown vessel	Unknown
14	unknown	Unknown
15	possibly a barge	Unknown
None	*Ramos*	yes
None	*Cecilia M. Dunlap*	yes
See above	*H.W. Long*	Not eligible
None	*G.L. #78*	yes
None	*Ormond*	yes
See above	*Glen II*	yes
See above	*HMS Pentland Firth*	yes
See above	*S.S. Continent*	yes
See above	*Sub-Chaser #60*	yes
None	*B.B. #59*	yes
None	*S/V Renegade IV*	no
None	*Val-Dee-Jo*	no
None	*Black East*	Cannot be made

3.5.8 Other Legitimate Uses of the Study Area [Section 228.6(a)(8)]

In addition to the previously described socioeconomic uses of the Mud Dump Site and the Study Area (see Sections 3.5.1 through 3.5.7 above), cable and pipeline crossings are legitimate uses of the region. During the course of this study, the presence of active cable and pipelines in the Study Area were investigated; none were found. The NOAA Chart No. 12326 "Cable Area" between Monmouth, NJ, and Rockaway Beach, NY, is inactive (Figure 3-86). Although independent confirmation was not possible, the cable area apparently once contained telegraph cables, which were operated by cable companies that either are now out of business or have been purchased by other companies. AT&T Cable Protection in Morristown, NJ, (J. Murray, AT&T, pers. comm., December 1995) reports that the only active commercial cables in the region are transatlantic cables. The nearest cable enters the ocean near Sea Girt, NJ approximately 12 nmi to the south of the Study Area and extends eastward. The nearest commercial cable exiting the New York coast is near the Mastic Beach area. The possibility that military cables are located in the area was investigated with AT&T Military Cable Protection in Greensboro, NC, (Z. Zimmerman, pers. comm., January 1996). He indicates that there are no military cables in the Study Area. However, official documentation of the absence of military cables in the Study Area could not be obtained from AT&T/Greensboro because presently there are no approved means of releasing military cable information for civilian use, such as in this SEIS. Communication with the USACE (W. Corso, pers. comm., 1996) and MCI Transmission Services Operations (J. Ross, pers. comm., 1996) supports the conclusion that there are no cable or pipeline crossings seaward of the Sandy Hook-Rockaway Beach transect. Desalinization activities do not occur in the Study Area.

3.5.9 Areas of Special Concern

There are no federal or state-designated Areas of Special Concern within the Study Area or nearby waters. The nearest Areas of Special Concern are on the New York and New Jersey coasts, and were established for the protection and enhancement of waterfowl and shore birds (Table 3-39). The largest Area of Special Concern is the 26,000-acre Gateway National Recreation Area (GNRA NPS, 1996) that encompasses most of the Jamaica Bay and Rockaway Point region of Long Island. (About 6.5 nmi to the north of the Study Area) and part of Sandy Hook, New Jersey (approximately 3.5 nmi to the north and west of the Study Area). The other areas are at least 35 nmi from the boundaries of the Study Area.

Each of the coastal waterfowl and shorebird habitat areas under protection in the New York Bight are separated from the Study Area by distance or geological features (e.g., barrier islands) or both, and are very unlikely to be affected by dredged material disposal activities at the Mud Dump Site.

Other areas/habitat that are not federally designated or protected, but provide a habitat for marine resources and warrant evaluation in this SEIS, are artificial reefs. Both New Jersey and New York have state-administered artificial reef programs that have been established or promoted the construction of artificial reefs the north, west, and south of the Study Area. (Refer to Section 3.5.2 for details.)

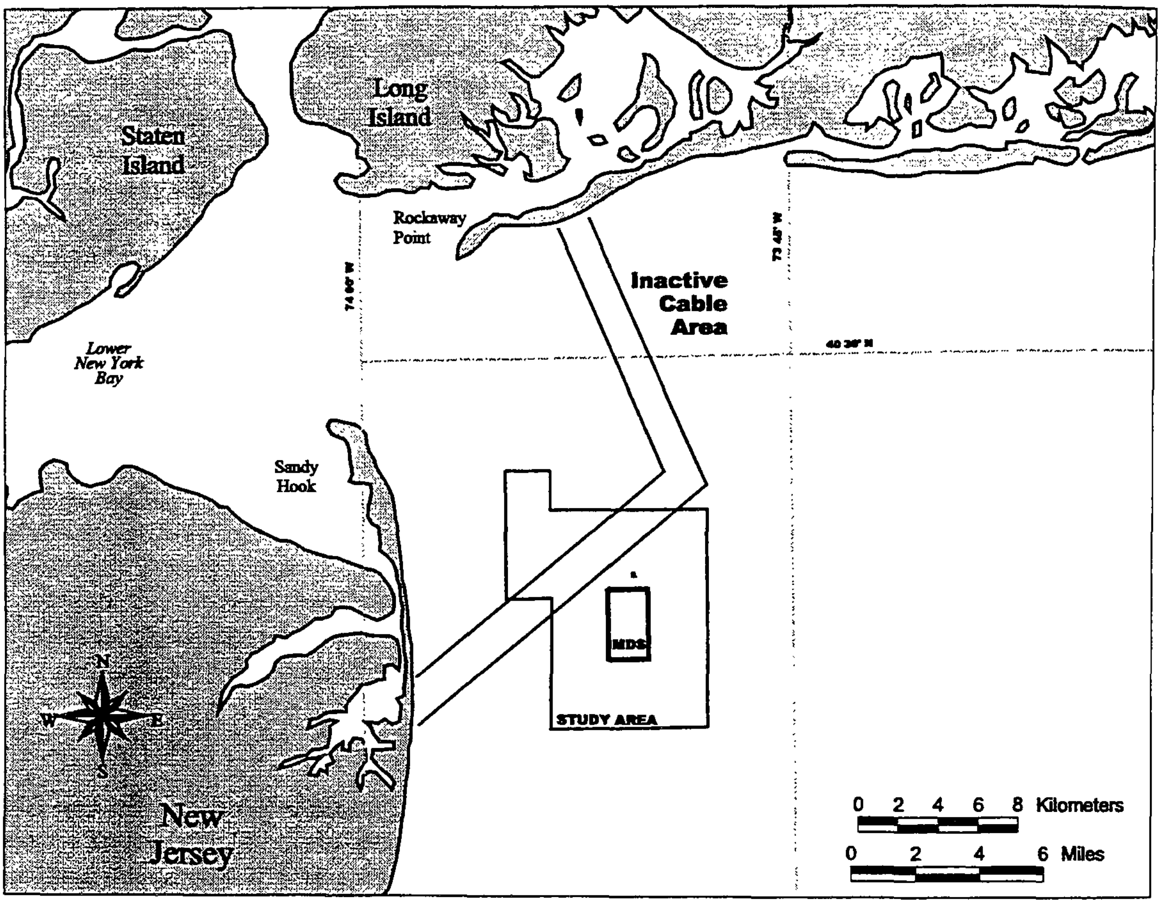


Figure 3-86. Inactive cable area crossing the Study Area.

Table 3-39. Areas of special concern, jurisdiction, and distance from the Study Area.

State	Jurisdiction	Area of Special Concern Category	Relative Location to SEIS Study Area
New York	State	Jones Beach	Southern coast of Long Island ≈ 24 nmi north of the Study Area
	State	Robert Moses Park	Western end of Fire Island ≈ 16 nmi north of the Study Area
	State	Bayswater Point Park	Jamaca Bay ≈ 6 nmi north of the Study Area
	Federal	Lido Beach National Wildlife Area	Southern coast of Long Island, ≈13 nmi north of the Study Area
	Federal	Wertheim Wildlife Refuge	Southern coast of Long Island, ≈ 24 nmi north of the Study Area\
	Federal	Sayville National Wildlife Refuge	Southern coast of Long Island, ≈37 nmi northeast of the Study Area
	Federal	Fire Island National Seashore	Southern coast of Long Island, ≈16 nmi northeast of the Study Area
	Federal	Gateway National Recreation Area (Staten Island, Jamaica Bay; Breezy Point)	Southwest coast of Long Island, ≈ 6.5 nmi northwest of the Study Area
New Jersey	State	Sedge Islands Wildlife Management Area	New Jersey shore, 34 nmi southwest of the Study Area
	State	Great Bay Boulevard Wildlife Management Area	New Jersey shore, 51 nmi southwest of the Study Area
	State	Absecon Wildlife Management Area	New Jersey shore, 57 nmi southwest of the Study Area
	State	Island Beach State Park	New Jersey shore, 30 nmi south of the Study Area
	Federal	Edwin B. Forsythe National Wildlife Refuge (Barnegat)	New Jersey shore, 37 nmi southwest of the Study Area
	Federal	Edwin B. Forsythe National Wildlife Refuge (Oceanville)	New Jersey shore, 56 nmi southwest of the Study Area
	Federal	Gateway National Recreation Area (Sandy Hook)	New Jersey shore, 3.5 nmi northwest of the Study Area

Source: GNRA NPS (1996); R. Levin, pers. comm., (1996); NJDEP pers. comm., (1996); NYSOPRHP 1996.

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4.0 ENVIRONMENTAL CONSEQUENCES

This chapter compares the physical, chemical, biological, and socioeconomic impacts of the four alternatives presented in Chapter 2 and evaluates the consequences of each. Based on the Chapter 3 characterization of historical and current conditions within the Mud Dump Site (MDS) and Study Area, the positive and negative impacts of each of the alternatives are predicted and discussed. The most recent data and information available from the MDS and Study Area are used to predict the type and degree of each impact. Where site-specific data are not available, best professional judgement is used to identify and quantify the impacts.

The MDS and Study Area information and data that have been synthesized in Chapter 3 allow a rigorous comparison of the four alternatives, in order to reach a technically-sound, regulatory-based decision for selecting the Preferred Alternative. The Preferred Alternative is defined as the alternative that provides the greatest practicable net benefit with the least environmental impacts, and is responsive to the 3-Party Letter (EPA/DOT/USACE, 1996).[1] EPA and the USACE will continue to monitor the environment of the New York Bight Apex, and will take appropriate actions through site management and monitoring plans (SMMPs), rulemakings, and permitting, as necessary, to reflect new information.

EPA's five general and eleven specific criteria for selecting ocean disposal sites [40 CFR Sections 228.5 and 228.6(a), respectively] provide the structure for organizing and evaluating the predicted impacts for the alternatives. Additionally, because three of the four alternatives include some ocean placement of sediments: no action (Alternative 1); remediation (Alternative 3); or restoration (Alternative 4); and the fact that the MDS was designated as an Impact Category I site, this chapter also considers the pertinent portions of 40 CFR Section 228.10, Evaluating disposal impact, and 40 CFR 228.11, Modification in disposal site use, of the Agency's ocean dumping regulations.

Each of the four alternatives described in Chapter 2 have both negative and positive ecological and socioeconomic impacts. Like the characterization of historical and present conditions was the focus of Chapter 3; the potential ecological impacts of the four alternatives are the focus of this chapter. Socioeconomic impacts are addressed in Chapter 4 only to the extent that these impact evaluations are relevant to the general and specific factors for selecting ocean disposal sites [40 CFR Sections 228.5 and 228.6(a)], and are typically evaluated for other NEPA evaluations of such sites (i.e., impact evaluations related to fishing areas, navigation, mineral extraction, cultural/historic features, and amenity areas).

4.1 Approach to Evaluating Consequences of the Four Alternatives

As presented in Chapter 2, four alternatives were considered under this Supplemental Environmental Impact Statement (SEIS).

Under Alternative 1, the size, location, and management of the MDS are unchanged. Only Category I dredged material will be disposed at the MDS after September 1, 1997 (since the remaining capacity for Category II dredged material will be filled before September 1, 1997).

Under Alternative 2, the MDS is closed, no Historic Area Remediation Site (HARS) will be designated, and degraded sediment areas in and around the MDS will not be remediated or restored. No remediation

[1] The July 24, 1996, 3-Party Letter states: "This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels [in accordance with 40 C.F.R. Section 228.11(c)]."

Alternative 1: **No Action**
- No change to size or management of the present Mud Dump Site (MDS)
- No remediation of areas outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas
- Disposal of Category I dredged material continues per the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/ USACE NYD, 1997a) until current remaining disposal capacity is reached
- Category II dredged material capacity will be reached by September 1, 1997

Alternative 2: **Close MDS-No HARS Designation**
- Closure of the present Mud Dump Site
- No Historic Area Remediation Site (HARS) designated
- No remediation of sediments outside of the MDS with toxicity or sediments degraded by bioaccumulative contaminants, or restoration of fine-grain sediment areas created by past dredged material disposal

Alternative 3: **HARS Remediation**
- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the Priority Remediation Area (PRA), a Buffer Zone (BZ), and No Discharge Zone (NDZ), including the MDS and sediments that have toxicity or bioaccumulative contaminants. (Refer to Appendix B for HARS latitude/longitude coordinates.)
- Remediation conducted by capping degraded sediment areas with at least 1 m of Material for Remediation. Material for remediation is defined as "...uncontaminated dredged material (i.e., dredged material that meets current Category 1 standards and will not cause significant undesirable effects including through bioaccumulation)."
- The Material for Remediation is defined as uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)
- Approximately 40.6 Myd^3 required to remediate the 9.0-nmi^2 (31-km^2) PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Remediation work prioritized by degree of sediment degradation

Alternative 4: **HARS Restoration**
- Simultaneous closure of the MDS and designation of 15.7-nmi^2 (54-km^2) HARS
- The HARS is composed of the PRA, NDZ, and BZ, including the MDS, surrounding areas that has been historically used for disposal of dredged material and other wastes (e.g., building materials, sewage sludge, industrial wastes), and sediments degraded by bioaccumulative contaminants or toxicity.
- Restoration work conducted by covering fine-grain sediment areas with at least 1 m of sandy (0-10% fines) Material for Remediation
- Approximately 46.4 Myd^3 required to restore the 10.3 nmi^2 (35.5 km^2) of fine-grained sediments in the PRA; actual placement volume may be larger to ensure at least a 1 m cap throughout the PRA
- Restoration work prioritized by degree of sediment degradation

operations will be undertaken within the 9.0-nmi^2 (31-km^2) area of the Bight Apex found to be degraded by bioaccumulative contaminants and toxicity, nor will restoration operations be conducted in the 15.7-nmi^2 (54-km^2) area of fine-grain sediments attributable to dredged material disposal.

The Alternative 3 HARS includes the MDS and surrounding areas that have been used historically for disposal of dredged material and other wastes (refer to Figure 4-1). The location of the Priority Remediation Area (PRA) in the Alternative 3 HARS was determined from analyses of chemical and toxicological samples from the SEIS Study Area (refer to Section 3.3.9.3 and Figures 3-45 to 3-48 in Chapter 3). A cap of at least 1 m of Material for Remediation will be placed throughout the PRA.

The Alternative 4 HARS has the same external border location as the Alternative 3 HARS. It includes the MDS and surrounding areas that have been used historically for disposal of dredged material and other wastes, as well as fine-grain areas attributable to dredged material disposal activities. The location of the Alternative 4 PRA (larger than the Alternative 3 PRA) was determined from analyses of sediment chemical, toxicological, and grain-size distribution samples from the SEIS Study Area.

Under both Alternatives 3 and 4, the degree of degradation determines the priority for remediation/ restoration actions (refer to Appendix C).[2]

The approach used in this chapter to compare and contrast the impacts of the alternatives [according to the criteria of Sections 228.5, 228.6(a), and 228.10] was to separate the potential impacts into two groups: "discriminating" and "nondiscriminating." The discriminating impacts, presented in Section 4.3, have substantial differences among the four alternatives. These impacts are used to rank the alternatives and select the Preferred Alternative.

The nondiscriminating impacts, which do not significantly differ among the alternatives, are presented in Section 4.2. While the evaluation of the nondiscriminating impacts is useful in assessing the acceptability of the alternatives, because they are similar across all alternatives, they do not have substantial utility for identifying the Preferred Alternative.

The environmental pros and cons of each discriminating impact are presented and discussed by the overlay method and narrative descriptions. Overlays, usually presented as figures, are used when a discriminating impact has a unique spatial element (e.g., extent of an alternative's effect on a fishing area or historical artifact area). Narrative descriptions accompany both text and tables. Table 4-1 (located at the end of Chapter 4) is a summary of all impacts, both discriminating and nondiscriminating, organized by the corresponding criteria of 40 CFR Sections 228.5, 228.6(a), and 228.10.

The evaluation of each alternative included the consideration of all possible detrimental, mitigatable, or beneficial impacts that could result from implementation of the alternatives. The evaluations were conducted with an iterative, weight-of-evidence approach, using the following four criteria (in descending order of importance):

1. Recent and verifiable numerical or otherwise quantifiable data specific to the Bight Apex or Study Area environment;

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[2] Under both Alternative 3 and 4, the PRA is divided into 1-nmi^2 areas for the purposes of prioritizing and managing the placement of dredged Material for Remediation.

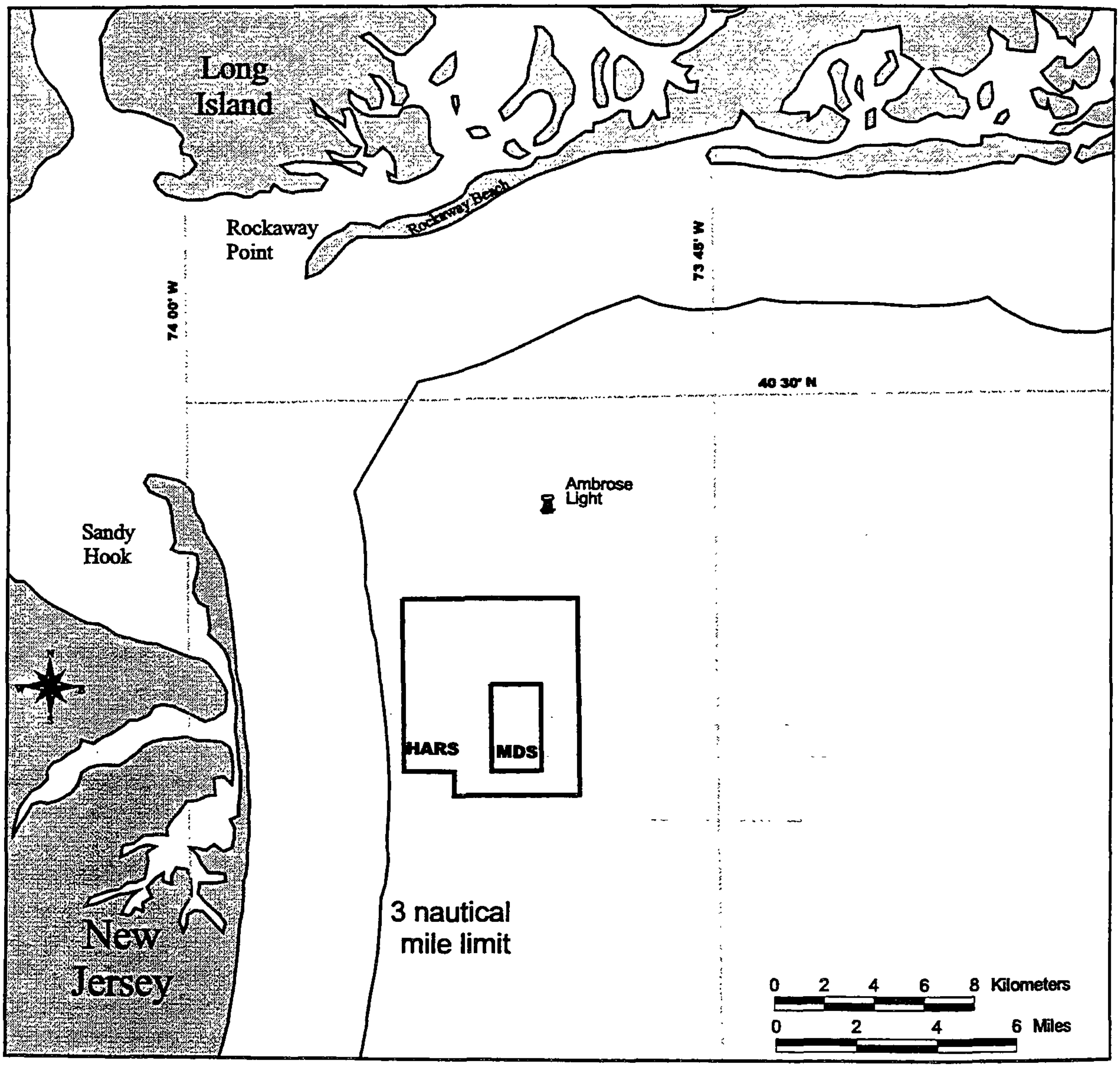

Figure 4-1. Location of Mud Dump Site (MDS) and Historic Area Remediation Site (HARS)

2. Qualitative information from verifiable sources, specific to the Bight Apex or Study Area environment;

3. Quantitative and qualitative information from verifiable sources, from other environments similar to the Bight Apex;

4. Best professional judgement of the SEIS authors and reviewers.

Impact Assessments and Use-Conflict Overlays Listed in Order of Presentation in Chapter 4

Nondiscriminating

- Marine sanctuaries, areas of special scientific importance, and other special areas of concern
- Geographically limited fisheries and shellfisheries
- Beaches, shorelines, and amenity areas
- Commercial and recreational navigation
- Mineral extraction and energy development
- Military operations
- Other legitimate uses of the ocean
- Endangered and threatened species habitat and migration
- Topography, hydrography, and hydrology

Discriminating

- Ecological impact evaluations
  - Degraded sediments
  - Benthic infauna
  - Contaminant bioaccumulation
  - Fish and shellfish resources
- Natural and cultural features of historical importance

4.2 Nondiscriminating Impacts and Use Conflicts — Common to All Alternatives

Nine categories of impacts or potential use conflicts were found to be "nondiscriminating" among the four considered alternatives. As described above, these impacts and use conflicts either do not apply to any of the alternatives, or have no substantial utility for comparing and contrasting the four alternatives so as to select a Preferred Alternative. The impacts and conflicts are discussed below in terms of their compliance with EPA's Ocean Dumping Regulations..

4.2.1 Marine Sanctuaries, Areas of Special Scientific Importance, and Other Special Areas of Concern [228.5(a), 228.6(a)(3), 228.6(a)(8), 228.10(b)(1), 228.10(c)(1)(i)]

As discussed in Section 3.5.9 of Chapter 3, there are no Federal or State-designated marine sanctuaries, areas of special scientific importance, or special areas of concern in the MDS or Study Area. Desalinization does not occur in the Study Area. The closest areas of concern are New York and New Jersey coastal reserves for waterfowl and shore bird habitat (Table 3-39). The nearest and largest area is the 26,000-acre Gateway National Recreation Area, one portion of which is on Sandy Hook, NJ, 3.5 nmi to the northwest of the Study Area (Figure 4-2). Other areas of concern are at least 35 nmi from the boundaries of the sites.

Desalinization does not occur in the Study Area.

Each of the coastal waterfowl and shorebird reserves under protection in the New York Bight are separated from the MDS and HARS by distance or geological features (e.g., barrier islands) or both, and thus would not be affected by any of the four alternatives described in Chapter 2. Birds inhabiting these protected areas are unlikely or infrequent foragers of the offshore waters of the MDS or HARS, and it is extremely remote that offshore birds will encounter and be adversely affected by any of the four alternatives.[3]

[3] Refer to Section 3.4.4 in Chapter 3 and the Endangered Species Act (ESA) Biological Assessment (EPA, 1997) for additional information on marine and coastal birds.

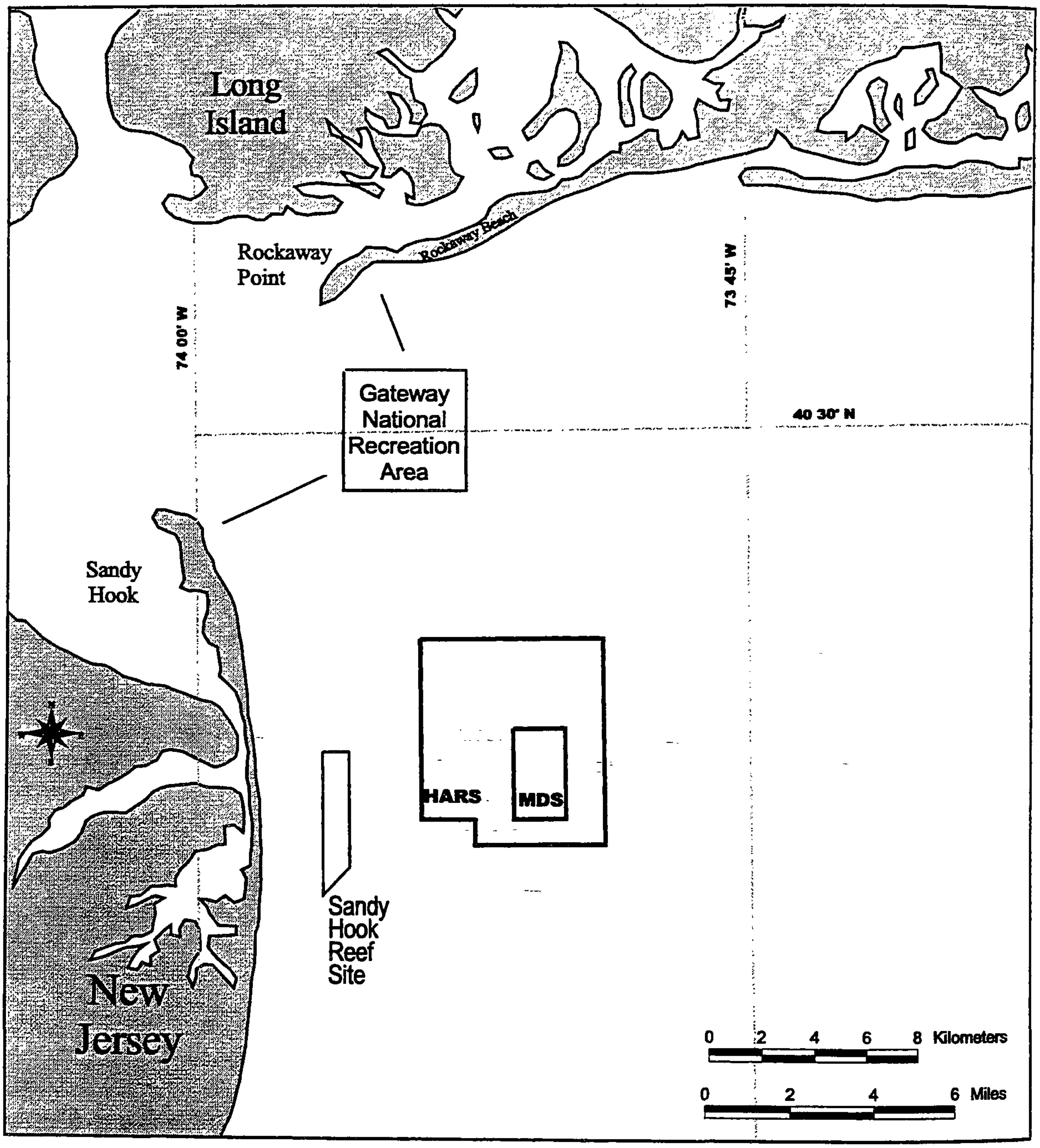

Figure 4-2. Location of Areas of Special Concern relative to the MDS and HARS.

Aquatic areas of concern are generally established for preservation or research purposes. Currently, there are no such areas within the Study Area or the New York Bight Apex. Although heterogenous and ecologically valuable, the Bight Apex has been affected and altered by numerous anthropogenic activities. As discussed in Section 3.2, since the region was settled, a large volume and variety of materials and wastes have been dumped into the New York-New Jersey Harbor and directly into the Bight Apex. Thus, it is unlikely that offshore areas of the Bight Apex would be considered by a State or Federal agency as a candidate for a special status designation.

Summary of Consequences: No marine sanctuaries, areas of special scientific importance, or other special areas of concern will be impacted by any of the four alternatives.

4.2.2 Geographically Limited Fisheries and Shellfisheries [228.5(a), 228.5(b), 228.6(a)(2), 228.6(a)(8), 228.10(c)(1)(ii)]

There are no geographically limited fisheries or shellfisheries within the MDS or HARS.[4] As discussed in Section 3.4.3 of Chapter 3, the New York Bight is a transitional region for many fish and shellfish species. Commercial catch statistics from the National Marine Fisheries Service (NMFS), NMFS trawl surveys, and surveys by the New Jersey Department of Environmental Protection (NJDEP) reveal no species that are caught exclusively in the Bight, Bight Apex, or MDS area.

More than 300 species of fish and shellfish are permanent or migratory residents in the Middle Atlantic Bight. Twenty-eight fish species (21 demersal, 4 pelagic, 3 pelagic/anadromous) and eight species of shellfish (2 squid and 6 benthic invertebrates) have been identified as commercially, recreationally, and/or ecologically important in the New York Bight. Alternative-specific impacts to fish and shellfish resources are discussed in Sections 4.3.1.4, 4.3.2.4, 4.3.3.4, and 4.3.4.4 below.

Summary of Consequences: None of the commercially, recreationally, and/or ecologically important fish and shellfish in the New York Bight have rare or limited habitats located in the MDS or the HARS. Therefore, no geographically limited fisheries or shellfisheries impacts were identified from any of the four alternatives.

4.2.3 Beaches, Shorelines, and Amenity Areas [228.5(b), 228.6(a)(3), 228.6(a)(6), 228.10(b)(1), 228.10(c)(1)(i)]

There are popular, heavily used beaches, public shorelines, and recreational facilities near the Study Area on the southern coast of Long Island, NY, and the coast of northern New Jersey. Oceanfront beaches at Highlands, NJ, will be as close as 3.5 nmi from the HARS proposed under Alternatives 3 and 4. Sediment transport to these beaches is extremely unlikely for either alternative. Resuspension and transport of MDS or HARS bottom sediments to these shorelines are equally unlikely.

Plume Development and Transport. As described in Section 3.3.6 of Chapter 3, a dredged material discharge plume follows three phases: convective descent; dynamic collapse; and passive diffusion. In the relatively shallow waters of the Study Area, dredged material hits the bottom in the dynamic collapse phase with considerable force. The collision with the bottom forces the material to spread radially from the site and forces some of the material back up into the water column. This results in additional fine-grain materials becoming temporarily suspended in the water column (plume creation) and contributing to the

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[4] Geographically limited habitats within the Study Area (e.g., shipwrecks) are evaluated in Section 4.3.

layer of flocculent sediments on the bottom (also called the epibenthic "nephloid" layer). During the passive diffusion phase, plumes can be carried from the discharge location by local oceanographic conditions (currents and turbulence).

The amount of sediment that becomes suspended in the water column following a discharge depends on the grain-size distribution of the dredged material, the cohesiveness of the material, and the water depth and oceanographic conditions at the release point. A rigorous comparison of potential plume development and transport among Alternatives 1, 3, and 4 is not possible because of the variable factors associated with different discharge sites and dredged material characteristics.[5] SAIC (1994a) examined the mass balance of several dredged-material excavation, disposal, and post-disposal fate projects, including one conducted at the MDS which determined that 3.7% of MDS discharged material is entrained into plumes that drift from the discharge point.

Related to the mass-balance projects reviewed by SAIC, EPA conducted two field-verification projects at the MDS to evaluate data generated by dilution models used to make permit decisions[6] (refer to Section 3.3.6). These studies showed that MDS dredged material plumes spread less than 500 m and that the plumes are detectable no more than 1 km from the discharge point. Total suspended solids (TSS) and contaminants in the plumes reach background concentrations within 1 hour, well within the 4-h initial mixing period.

The conclusion drawn from these studies is that plumes developed under Alternatives 1, 3, or 4 will be dispersed to background (nondetectable) levels before reaching beaches, shorelines, or amenity areas. The suspended sediment plumes meets the ocean disposal criteria and will gradually disperse and settle to the bottom, contributing to the fine-grained particle fraction in the benthic zone. Fine-grained material that settles to the bottom in shallow waters (< 20 m) in the Bight Apex will eventually be resuspended and move to deeper areas that are less affected by erosional forces (e.g., currents and storm events).

Seafloor Dispersion. Following a disposal/placement event, the fine-grained fraction of the discharged sediment spreads across the seafloor in a thin layer. Acoustic data gathered during the Port Newark/Port Elizabeth Disposal/Capping Monitoring Project[7] show that while most material disposed during this project was deposited on the bottom where expected, some fine-grained fractions spread 200-400 m beyond the flanks of the mound (SAIC, 1995a). *In situ* sediment profile imaging (camera) studies showed a 600 m maximum extension of the thin apron of dredged material from the main part of the mounds (SAIC, 1996b). The camera data also confirmed that the fine-grain material extended further in down-sloping (downhill) areas than in up-sloping (uphill) areas. This information suggests that material deposited in basin areas of the HARS will be more effectively contained and transported shorter distances relative to the main dredged material mound. Regardless of local bathymetry, camera and acoustic data

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[5] Quantifying individual discharge plumes is hampered by lack of measurement precision at the dredging site (i.e., volume of material in disposal barge), at the discharge site (i.e., amount on the bottom after discharge), and events and processes that can occur during transit to the discharge site (e.g., compaction, loss of water) (SAIC, 1994a).

[6] EPA/USACE water column tests for dredged material include determination of marine water quality criteria compliance and evaluation of potential water column toxicity. Refer to EPA/USACE (1991) and EPA Region 2/ USACE NYD (1992) for additional testing information.

[7] The Port Newark/Port Elizabeth Disposal/Capping Monitoring Project is an ongoing EPA Region 2/USACE NYD monitoring program of the integrity of the cap covering Port Newark/Port Elizabeth dredged material, which was disposed at the southern half of the MDS in 1993 (SAIC 1996a).

show that, in general, bottom dispersion of the dredged material at the MDS is limited to a relatively small area. There are no data to indicate that the situation will be different elsewhere in the HARS under Alternatives 3 and 4.

Other factors such as bedload transport can move deposited surface sediments around the seafloor. These processes, driven by tidal and storm currents, can carry fine-grain sediments in and out of the MDS or HARS (SAIC, 1996a). The movement of fine-grain sediments at the sediment-water interface is a natural phenomenon, and is sometimes discussed relative to the "nephloid layer"—the near-bottom flocculent zone, in which many small epibenthic species (e.g., mysid shrimp) live and feed.

Summary of Consequences: In summary, many factors affect the transport and fate of discharged sediment material. However, for all of the alternatives that include sediment discharge (Alternatives 1, 3, and 4), sediment transport impacts are not expected to be significant and can be monitored and managed through the site management plans, permit conditions, and surveillance operations. No material will reach beaches, shorelines, or amenity areas under any of the four alternatives.

4.2.4 Commercial and Recreational Navigation [228.5(a), 228.6(a)(8)]

As discussed in Section 3.5.3.2 of Chapter 3, the New York Bight Apex is a heavy ship traffic area (Figure 4-3). Tugs, barges, and hopper dredges traveling to and from the MDS or HARS will comprise a small fraction of the total harbor traffic, and thus the alternatives would potentially cause only a small increase or decrease in traffic congestion and accident risk. Canceled or deferred dredging projects in the Port would also present adverse impacts to large commercial vessels (e.g., tankers and container ships) that need deep water to safely transit and berth in the harbor. However, the impacts are difficult to quantify, time-dependent on other factors, or include varying amounts of uncertainty. This is particularly evident when comparing environmental and socioeconomic impacts across the four alternatives and among near-, mid-, and long-terms after alternative implementation. For example, Alternative 2 (No MDS-No HARS Designation) presents the least near-term risk of collision with a disposal/placement vessel in the Port or Apex. However, if implementation of the alternative was associated with a reduction of Port dredging, risks will increase for vessels engaged in lightering operations and deep-draft vessels forced to negotiate shallow waterways of the Port at high tide. On the other hand, the potential for environmental impacts by spills and collisions may decrease if undredged portions of the port are closed to commercial traffic due to insufficient water depth. The complexity of predicting potential navigation impacts is similar for other alternatives.

With regard to potential impacts (i.e., collisions, navigation interference) with disposal/placement vessels transiting to and from the MDS or HARS, Alternative 2, with no vessel traffic to a designated site, presents the least impact to Bight Apex navigation. The comparison of the other three alternatives, however, shows that the traffic associated with Alternatives 1, 3, and 4 is very small relative to the 11,850 commercial vessels that transit through the Apex to the Port each year (USACE Waterborne Commerce Statistics Center, 1996). With wide annual variability of MDS, commercial, and recreational traffic in the Bight Apex in recent years, all four alternatives, while potentially having different impacts, do not present significant incremental risks (either positive or negative) to Bight Apex navigation. A similar conclusion can be reached for Bight Apex and Port/Hudson River environmental impacts directly associated with navigation.

Summary of Consequences: With respect to navigation impact in the Bight Apex, disposal/placement traffic to and from the MDS or HARS under Alternatives 1, 3 and 4 are expected to have wide annual variations and are dependent on port and dredging economics. When compared to annual variability of

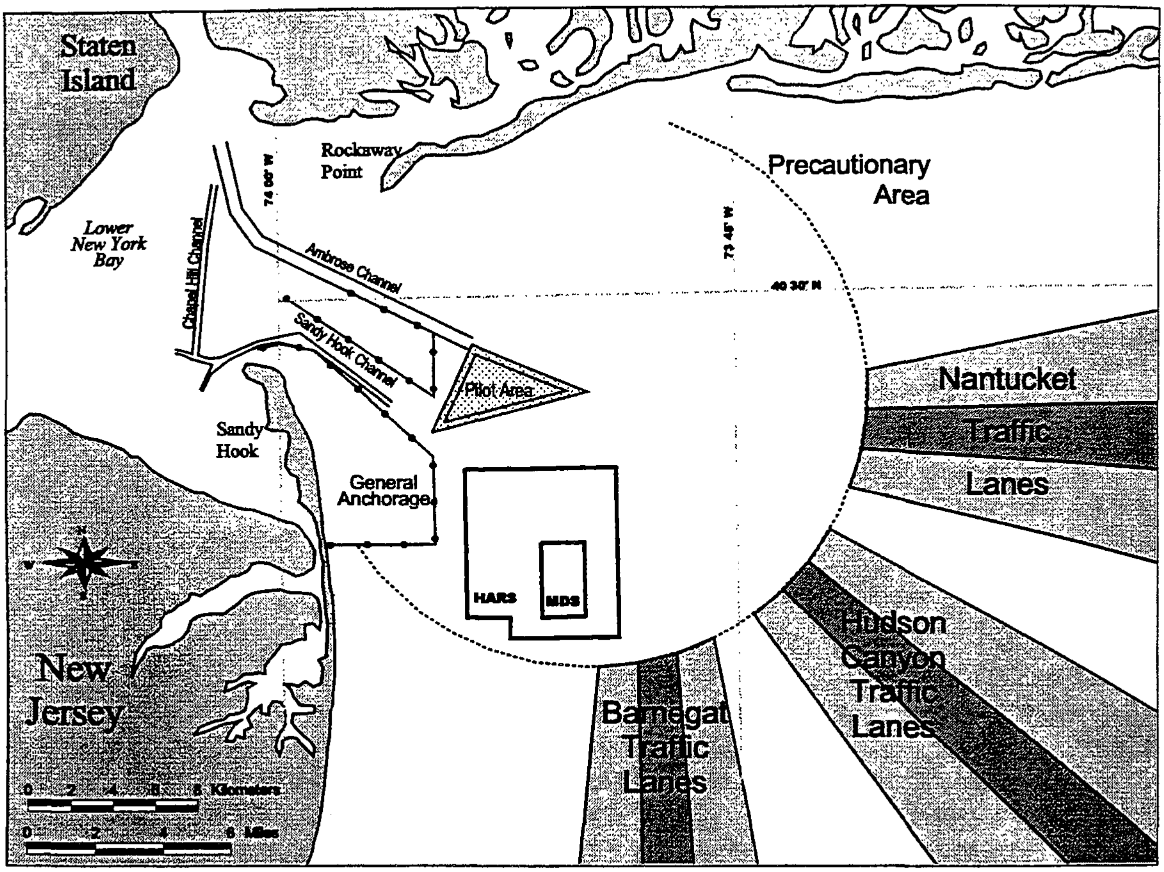

Figure 4-3. Location of the MDS and HARS in relation to shipping lanes and navigation areas of the New York Bight Apex

commercial and recreational harbor traffic, the potential consequences of Alternatives 1, 3 and 4 are roughly equivalent, and not significantly different from the impacts presented by the current operation of the MDS. Alternative 2, with no associated MDS or HARS traffic, has the least potential for navigation impact from disposal/placement operations, but the greatest near-and mid-term impacts relative to Port and Apex congestion and the hazards if lack of a designated site were associated with canceled or deferred maintenance of channels. The uncertainties associated with the navigation impacts of the four alternatives make this impact criterion of poor utility for contrasting alternatives so as to select a Preferred Alternative.

4.2.5 Mineral Extraction and Energy Development [228.6(a)(8)]

4.2.5.1 Mineral Extraction [228.6(a)(8)]

As discussed in Section 3.5.5 of Chapter 3, the only identified mineral extraction that has been considered for the Study Area around the MDS is benthic mining of sand and gravel aggregates for construction and beneficial use purposes (e.g., beach restoration, capping of degraded sediments). To date, there have been no agency or private proposals to mine aggregates within the MDS or the HARS area described under Alternatives 3 and 4. Furthermore, mining of sand and gravel resources in the New York Bight Apex has been precluded by a 1996 statement by the U.S. Minerals Management Service (MMS, 1996).

The USACE NYD and the State of New Jersey conducted a benthic coring survey in the HARS in late 1996 to locate potentially valuable aggregates. No coring data are yet available at this writing; however, it is very unlikely that deposits found under historically discharged dredged material in the HARS, or under recent dredged material in the MDS (much of which was Category II material and has been capped as a precautionary measure) can be economically extracted. Additionally, potential mining operations in the MDS or HARS would need to control the exposure of sediments that were buried by subsequent dredged material disposal operations and/or natural processes, which would result in further difficulty and expense.

4.2.5.2 Energy Development [228.6(a)(8)]

MMS has reported that there may be several basins adjacent to the Study Area with low petroleum potential. However, these areas are currently under moratorium for oil and gas exploration (EPA pers. comm. L. Bielak, MMS, 12/11/96), and thus not considered further in this evaluation.

Summary of Consequences: None of the four alternatives considered in this SEIS would impact mineral extraction or energy development.

4.2.6 Military Operations [228.6(a)(8)]

There are no known military uses of the MDS or proposed HARS. Military uses of the Bight Apex are primarily navigation related to military ships and support vessels transiting to and from the military installations listed in Table 3-37. Military navigation impacts from the four alternatives will therefore be equivalent to impacts experienced by commercial and recreational navigation traffic in the area. Expected incremental impacts of each of the four alternatives are expected to be insignificant when compared to the overall large volume of navigation traffic of the Bight Apex.

Summary of Consequences: There are no identified military operation conflicts with Bight Apex military operations.

4.2.7 Other Legitimate Uses of the Ocean [228.6(a)(8)]

In addition to the nondiscriminating legitimate uses described above in Sections 4.2.1 - 4.2.6 (i.e., marine sanctuaries, areas of scientific importance, special areas of concern; geographically limited fisheries and shellfisheries; beaches, shorelines, and amenity areas; commercial and recreational navigation; mineral extraction and energy development; and military operations) and the discriminating legitimate uses evaluated in Sections 4.3 (i.e., fish and shellfish resources, recreational and commercial fishing industries, and natural and cultural features of historical importance), the only other legitimate uses potentially found in the MDS, HARS, or surrounding areas are cable and pipeline crossings and easements.

As discussed in Section 3.5.8 of Chapter 3, the "Cable Area" on NOAA Chart No. 12326 between Monmouth, NJ, and Rockaway Beach, NY, appears to be an obsolete and inactive telegraph cable crossing. If the old telegraph cables were still in place, they are deeply buried, and further disposal/placement of sediment would not be expected to adversely effect any potential historic or cultural importance of these features (refer to 4.3.1.5, 4.3.3.5, and 4.3.4.5 for additional evaluation of historic/cultural features). No pipeline crossings or easements have been identified in the New York Bight Apex east of the Sandy Hook/Rockaway transect.

Summary of Consequences: There are no identified conflicts with legitimate uses described in Sections 4.2.1 - 4.2.6.

4.2.8 Endangered and Threatened Species Habitat and Migration [228.5(b), 228.6(a)(8)]

Endangered and threatened species potentially impacted by the four alternatives considered include marine mammals and turtles foraging or migrating through the MDS, HARS or Bight Apex.

As discussed in Section 3.4.5 of Chapter 3, the New York Bight has a relatively high diversity of marine mammals and sea turtles but a low number of resident, nonmigratory populations. Twenty-eight species of marine mammals and five species of turtles have been sighted in the New York Bight over the past several years (Sadove and Cardinale, 1993). Of species listed as endangered or threatened under the Endangered Species Act of 1973 (ESA), only the humpback whale, fin whale, loggerhead turtle, and Kemp's ridley turtle are regular visitors to coastal waters of the New York Bight, and might visit the MDS or HARS during feeding of migration.

The ESA requires consultation with Federal agencies to identify any threatened, endangered, or special-status species that may be affected by the proposed action. In accordance with the ESA, EPA initiated a threatened and endangered species consultation with the National Marine Fisheries Service (NMFS) on April 4, 1996. Based on this coordination, EPA prepared a Biological Assessment (BA; Battelle, 1997a) for the Kemp's ridley and loggerhead sea turtles, and the humpback and fin whales within the MDS and surrounding areas. NMFS concurred with this approach on May 8, 1996. The BA, sent to NMFS in May 1997, determined there is no effect to the four evaluated species.

The U.S. Fish and Wildlife Service (USFWS) expressed concerns regarding piping plover (*Charadrius melodus*)and the northeastern beach tiger beetle (*Cinindela dorsalis dorsalis*). However, further evaluation of these concerns led the Service to conclude that disposal, remediation, or restoration activities in the MDS area is unlikely to adversely affect these Federally-listed species (USFWS, 1995).

Summary of Consequences: None of the considered alternatives present new or significant impacts to endangered or threatened species or habitat.

4.2.9 Topography, Hydrography, and Hydrology [228.6(a)(1)]

Although changes in topography will occur under Alternatives 1, 3, and 4, the range of impacts to hydrography (water-column structure) and hydrology (currents) of the Bight Apex is minimal and yielded no discriminatory information that is useful for selecting the Preferred Alternative.

Under Alternative 1, the height of the dredged material mounds on the seafloor will continue to increase in all areas of the MDS that now have water depths greater than minimum management depth. Management depths (45 ft BMLW for Category I material) established in the MDS SMMP set the minimum allowable depths and expected final mound configuration (EPA Region 2/USACE NYD, 1997a). Areas within the MDS that will experience major changes in topography include the southern one-third and the northeast corner of the MDS. The major change in the present MDS mound configuration will be a southward expansion toward the southern border of the site and lengthening of the mound by approximately 1 km. This will also increase the length of the shallow basin between the New Jersey shoreline and the western border of the MDS, increasing the area sheltered from offshore storm energy. Increasing the size of the sheltered basin will likely trap additional quantities of fine-grained sediments and contaminants that enter the Bight Apex with the Hudson River Plume or are in the reservoir of surface sediments that are susceptible to bedload transport processes (including mounds of the MDS). Additional dredged material disposal/placement in the northeast corner of the MDS will broaden the present mound to the east, but will not alter general hydrographic or hydrodynamic conditions in the area.

Filling of the entire MDS to the 45-ft management depth will increase the areal extent of shallowest depths from approximately 0.29 nmi^2 (1 km^2) (approximately 15% of MDS) presently in the site to the entire disposal site. At site closure, there will be a contiguous area of approximately 7.55 km^2 (2.2 nmi^2) with a depth of about 45-ft BMLW. A relative change of this magnitude is unlikely to affect the general hydrology or hydrodynamics of the Bight Apex. Recent studies of bottom currents in the MDS between 1992 and 1994 (SAIC 1995b; McDowell *et al.*, 1994) have shown that tidally driven currents are generally oriented parallel to local topography and are weak (<10 cm/s). Further, currents were generally similar throughout the site during periods of intense storms with the majority of low-frequency fluctuation less than 20 cm/s and temporally variable. Recent storm-event studies (SAIC, 1994b; 1995b and 1995c) have shown that bottom currents in the Bight Apex Study Area are not intensified by storm waves less than 5 m. Currents at 12 m were intensified only during the major storm that passed over the area in December 1992.

Bathymetry and modeling studies conclude that surface sediments deposited between 45 and 65 ft may experience storm-induced erosion, and that the erosional forces at these depths have winnowed fine-grained sediments from the upper few centimeters of deposited dredged material mounds. This has created surface layers of coarse sediment that armors the mound from further significant erosion except during the most intense storms such as occurred in December 1992. (McDowell *et al.*, 1994; SAIC, 1995b). Each storm with greater intensity than previous storms will tend to increase the depth of armoring and grain size of the surface sediment. This armoring phenomenon is evident on portions of the disposal mound created prior to 1982 and has been observed in more recent deposits in the MDS (SAIC, 1995a). Model predictions of typical storm-induced sediment reworking and resuspension suggest minimal disturbance of sandy sediments at the 20 m depth; however, substantial resuspension of coarse sands can occur at shallow depths (< 20 m) during major storms like that of December 1992 (SAIC, 1995c; Clausner *et al.*, 1996).

Under Alternatives 3 and 4, degraded sediment areas will be capped with at least 1 m of Material for Remediation. Areas found to be degraded only exist at depths greater than 65 ft. The additional 1 m (3.3 ft) of sediment will cause topographic change that is a small fraction of the water column. Over time, a 1 m shallowing of the water column during remediation or restoration will occur. This small change in water column depth within the HARS is not expected to affect the hydrodynamics or hydrology of the Bight Apex or surrounding areas. Some small (meter)-scale topographic relief may develop depending on disposal/placement practices and long-term sediment movement in the area. These small-scale changes will gradually result in bottom roughness and grain-size characteristics similar to that observed in recent side-scan mosaics of the Apex. (Schwab, 1996; SAIC, 1996b).

Summary of Consequences: None of the four alternatives considered will substantially change or impact the hydrological characteristics of the water column or the hydrodynamic regime of the inner New York Bight. In general, topography, hydrography, and hydrology in the Bight Apex are controlled by regional winds and water currents. There may be localized hydrodynamic changes in the area of the MDS under Alternative 1, but these changes are not expected to substantially impact living resources in the area.

4.3 Discriminating Impacts and Use Conflicts — Used to Select the Preferred Alternative

This section evaluates the discriminating impacts and use conflicts of the alternatives. Five general categories of discriminating impact or use conflicts have been identified:

1. Degraded Sediments
2. Benthic Infauna
3. Contaminant Bioaccumulation
4. Fish and Shellfish Habitat and Resources
5. Natural and Cultural Features of Historical Importance

> ***Reader Note for Section 4.3***
>
> **Presentation of Impacts and Use Conflicts**
>
> Unlike in Section 4.2, where nondiscriminating impacts and use conflicts were evaluated individually and contrasted across the alternatives, discriminating impacts and use conflicts in Section 4.3 are presented and evaluated by each of the four alternatives.

4.3.1 Discriminating Impacts and Use Conflicts of Alternative 1 (No Action)

4.3.1.1 Alternative 1 (No Action) — Degraded Sediments [228.6(a)(7), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(i), 228.10(c)(1)(ii)]

As discussed in Section 3.3.9.3 of Chapter 3, about half of the surface sediments within the present MDS were identified as degraded by presence of bioaccumulative contaminants or toxicity (Figure 4-4). Ten-day acute bioassays (test organism: amphipod *Ampelisca abdita*) on sediment samples collected throughout the Study Area revealed 0 to 99% organism survival, with reference-sediment survival at 94%. Under Alternative 1, MDS stations that had less than 74% survival[8] will be remediated by the continued disposal of Category I dredged material at the site. Correspondingly, areas external to the MDS (in the Study Area) with less than 74% survival will not be remediated, and Category II- and III-type sediments presently on the bottom will remain exposed to the New York Bight ecosystem.

In general, the continued use of the MDS under Alternative 1 and the existing Site Management and Monitoring Plan (EPA Region 2/USACE NYD, 1997a) will gradually cover and cap the degraded sediments within the MDS with Category I dredged materials. Filling the MDS to its 100 Myd^3 capacity to the management depth of 45 ft BMLW will ensure that all of the degraded surface sediments in the site are permanently isolated from interaction with the biological community of the Bight Apex. When the MDS is filled, the mound will constitute a 7.55 km^2 (2.2 nmi^2) contiguous area of nondegraded, heterogenous grain-size surface sediments. Over time, the surface sediments of this shallow-water mound [above 65-ft (20 m) BMLW] will lose fine-grain sediment fractions to the winnowing processes and retain a sandy, erosion-resistant armor material. The winnowing and armoring process from the prevailing ocean currents will essentially restore the top few centimeters of sediment in the 45 to 65-ft BMLW range to sediment conditions described in Alternative 4. The flanks of the final MDS mound will grade from coarse-grain material in shallow depths to fine-grain sandy mud at the site's borders in deeper water. Overall conditions will be similar to those observed on the historic mounds north-northwest of the present site.

Outside the MDS boundaries, sediments degraded by bioaccumulative contaminants and toxicity will not receive any remediation or restoration. These areas will remain much as they are presently. Gradual

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8 Based on data from reference-sediment samples used in this study, less than 74% survival is the level at which sediment toxicity is considered to be biologically significant. Per the 1991 Green Book and the Regional Testing Manual (EPA/USACE, 1991; EPA Region 2/USACE NYD, 1992), sediment from these areas would be unacceptable for ocean dumping (i.e., Category III).

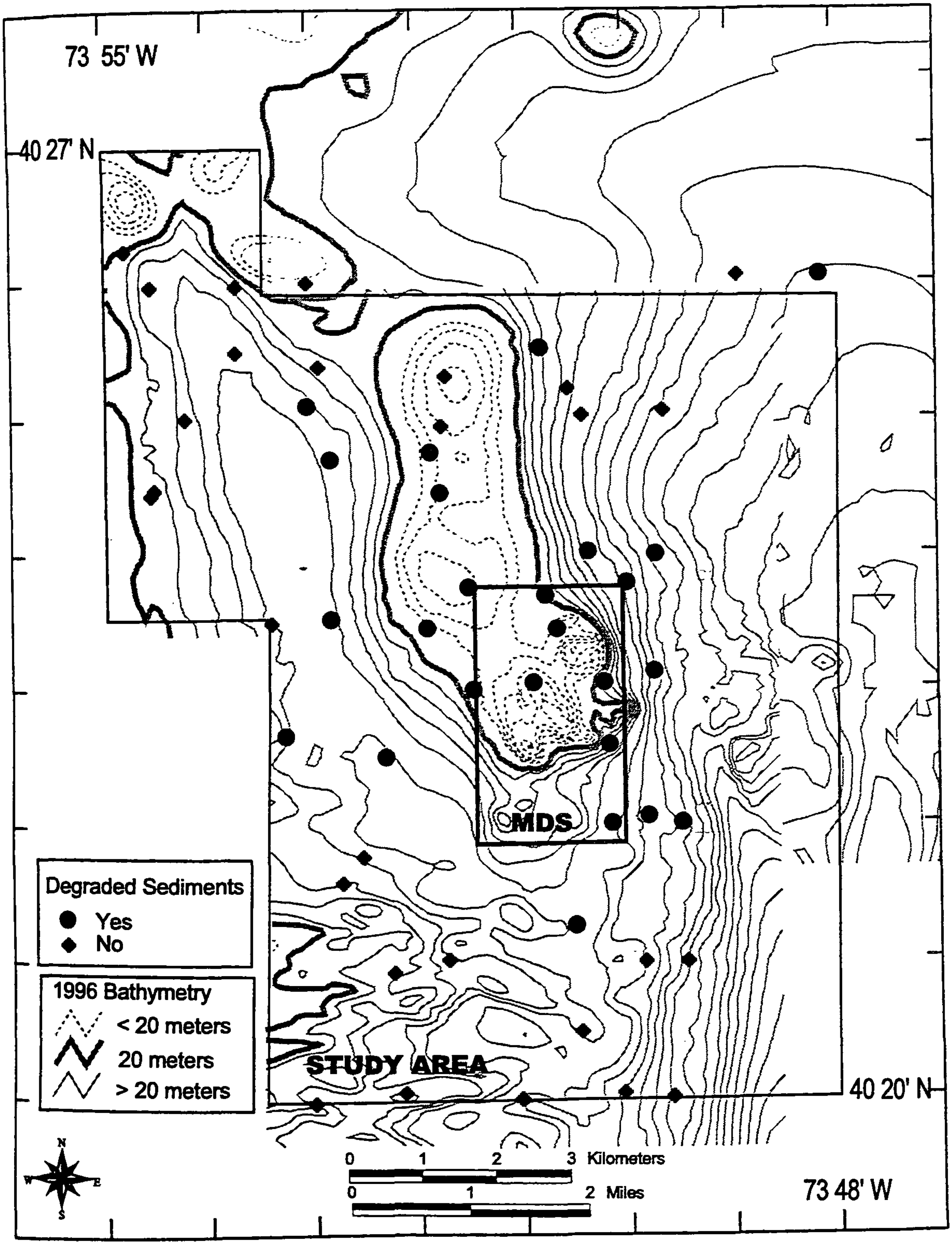


Figure 4-4. Study Area locations found to be degraded.

reduction of the degraded areas can be expected as contaminant sources to the Bight Apex are reduced and natural sediments entering the Apex become cleaner. The rate that this natural remediation occurs will depend on the success of pollution controls throughout the New York Bight watershed, and the rate of sedimentation outflows from the Hudson River and East River (including Long Island Sound). The deposition of cleaner natural sediments will eventually remediate the degraded sediments to background-level conditions. These same natural sedimentation processes will also affect the outcome of Alternatives 2-4.

4.3.1.2 Alternative 1 (No Action) — Benthic Infauna [228.10(b)(3), 228.10(b)(5), 228.10(c)(1)(ii), 228.10(c)(1)(iii)]

Two benthic infaunal communities were identified in the Study Area examined during the SEIS (see Section 3.4.2). The distribution of the two communities is reproduced in Figure 4-5. As previously described in Chapter 3, "Community Group A," referred to as the "muddy-sand community," is located in sediments with relatively high total organic carbon concentrations and at depths greater than 20 m. This community has a generally high abundance, moderate number of organisms per sediment sample, moderate species diversity and is dominated by the nut clam and polycheates. "Community Group B," referred to as the "sandy community," is found in sandy sediments that are low in organic carbon, and in water generally shallower than 20 m. This community has a generally high infaunal abundance, a moderate number of species per grab sample, and moderately low species diversity. The sandy community is dominated by *Polygordus* (a polycheate), sand dollars, and amphipods.

In 1995 and 1996, Sediment Profile Imagery (SPI) was used to evaluate infaunal communities at the MDS, calculate Organism-Sediment Indices (OSI), characterize habitat quality, and identify the deep muddy-sand community as successional Stage 1 on 3 (SAIC, 1996c; SAIC, 1995a).

The sandy sediment areas of the MDS could not be as comprehensively analyzed as muddy areas because (1) sand is more resistant to penetration by the sediment profile camera and (2) successional stage theory is limited relative to sandy sediments (SAIC, 1995a). Where sandy area measurements were obtained, data indicated a Stage 1 successional community. Highest OSI values, indicative of relatively healthy seafloor conditions, were found in the deeper (> 20 m), relatively quiescent areas on the east side of the MDS (and eastward outside the site) and along the western border of the MDS (SAIC, 1996c).

Within the MDS, the range of successional stages and OSI values are indicative of periodic habitat disruption from disposal activities and storm events (SAIC, 1995a). This is particularly evident in the monitoring results from the Port Newark/Port Elizabeth Disposal/Capping Monitoring Project (SAIC 1995a), where data show that areas that have recently received dredged material, especially the finer grained sediment areas, are recovering[9] from previous disposal activities or natural disturbances.

[9] Recovery indicated by development of Stage 3 community structure or recolonization with benthic organisms.

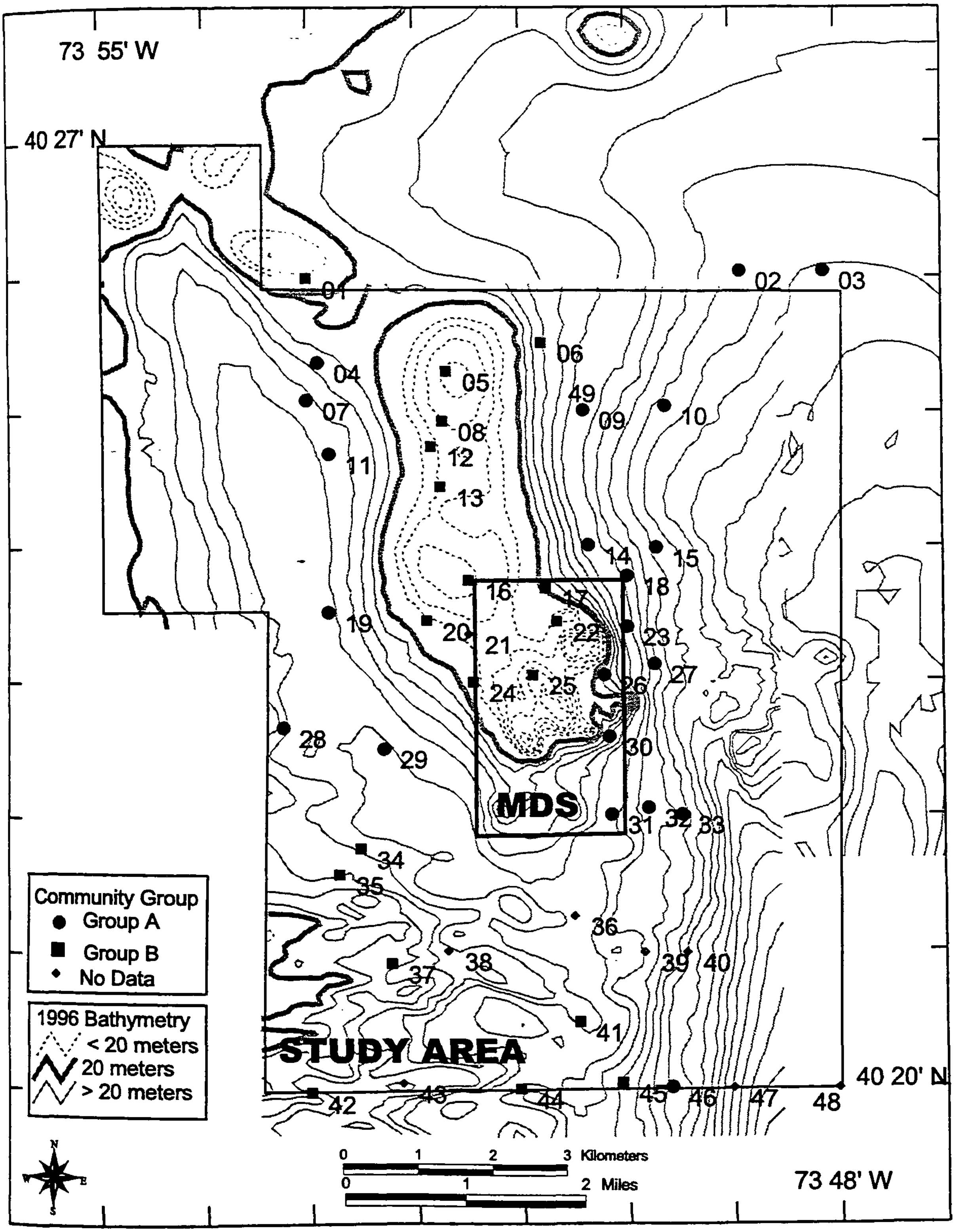
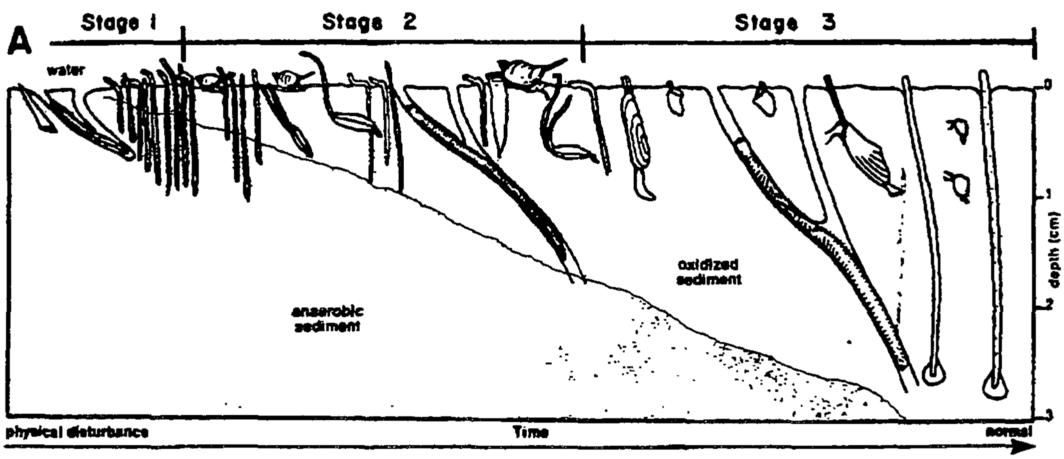


Figure 4-5. **Benthic community groups in and around the MDS.** Community Group A (circle symbols) is generally located in deep muddy areas, relative to Community Group B (square symbols) which is generally in shallower sandy areas.

Successional Stage Assessment at Dredged Material Disposal Sites

Successional stage assessment recognizes that organism-sediment interactions in low energy, fine-grained sediments follow a predictable pattern of three successional stages during recovery from a major seafloor disruption (Rhoads and Boyer, 1982; Rhoads and Germano, 1982; 1986). Disruptions can include such events as burial, seafloor erosion, changes in sediment chemistry, foraging disturbances, and bottom trawling. Pioneering or Stage 1 assemblages usually consist of small opportunistic near-surface, tube-dwelling polycheates or opportunistic bivalves. Densities are usually higher than in surrounding sediments and the organisms are associated with a shallow redox boundary and limited sediment bioturbation depths (Rhoads and Germano, 1982). Foraging fish and crustaceans are attracted to these areas because the pioneering communities represent a rich source of food and the irregular topography of disposal mounds provide refuge for organisms such as lobster (Battelle, 1990). These early successional assemblages are eventually replaced by infaunal deposit feeders; the start of this "infaunalization" process is designated arbitrarily as Stage 2. Stage 3 assemblages generally are composed of deeper living, head-down, deposit-feeding infauna. Stage 3 organisms are usually larger in size and contribute to sediment bioturbation, thus are associated with redox zones that are deeper in the sediment column.



Representation of benthic communities associated with successional stages that develop in fine-grained sediments following a disturbance.

Recolonization of Disturbed Sediments

Disposal operations in a shallow-water disposal site bury benthic infauna, which suffocate unless they can migrate vertically to the new surface. Recolonization usually starts soon after disposal concludes, and is determined by several processes, including larval recruitment, re-emergence of buried sessile organisms at the perimeter of a mound, and immigration of motile benthic, demersal, and pelagic species from adjacent areas. Generally, initial recolonization occurs by larval recruitment; however, the ability of some larger buried organisms to burrow upward through the deposited material is considerable, and recolonization through this mechanism appears to be important (Maurer *et al.*, 1981a,b; 1982). For example, the bivalve *Nucula proxima* has been shown to survive burial under 40-50 cm of sediment; other macroinfaunal organisms are able to resurface through several cm of sediment (Kranz, 1974).

Although benthic recolonization and recovery have been demonstrated within the borders of the MDS (SAIC, 1995a), the recovery period to pre-disposal conditions depends on several factors, including depth of disposed dredged material (mound thickness), frequency of disruption, sediment type and grain size, water depth and temperature, organism recruitment, and natural energy levels in the disposal area. Monitoring data from various disposal projects at the MDS suggest that Stage III assemblages on recently deposited (within 1 yr) fine-grained sediments recover quickly from disposal events (SAIC 1995a). In contrast, sandy sediments used to cap the Category II materials in the MDS tend to recover more slowly, with infaunal communities from nearby areas of similar grain size gradually becoming established and colonizing the cap material (SAIC 1995a).

Benthic infaunal communities in shallow waters (<20 m) are also affected by storm events that disrupt and delay the community recovery process. After site closure under Alternative 1, the surface sediments of the MDS are expected to experience continual stress and disruption from a variety of storm events. Thus, the benthic community that develops on the dredged material mound in the closed MDS will, over time, develop characteristics that are similar to those currently observed on the historic mounds to the north of the MDS. The flanks of the MDS mound may develop transitional communities that tend toward muddy sand communities, as currently observed in the deeper areas of the Study Area.

Considering the above information, short-term impacts to the benthic community will continue throughout the period of active disposal under Alternative 1. Impacts will generally be confined to the areas receiving dredged material. No direct impacts to communities outside of the MDS are expected, and the benthic communities in the Study Area evaluated for the SEIS are expected to remain similar to those presently observed. Recolonization of deposited material will continue in the disturbed areas of the MDS and progress toward communities similar to those currently found in the major sediment types currently in the area. Once the site is filled and closed, it is anticipated that the benthic community will be similar to that currently observed on the historic mounds north of the MDS. Thus, no long-term changes are expected other than the gradual change to a Group B infaunal community. The suitability of the resulting benthic community as a habitat and food sources for fish and shellfish resources is discussed in Section 4.3.1.4.

4.3.1.3 Alternative 1 (No Action) — Contaminant Bioaccumulation [228.10(b)(6), 228.10(c)(1)(iii)]
Inside the Mud Dump Site. Continued disposal of Category I material in the MDS and exposure of the material to the site's natural processes that winnow fine-grain materials from surface sediments, particularly above the 65-ft BMLW depth, will ultimately reduce contaminant concentrations in the surface sediments to levels similar to the older mounds of the MDS and the historical disposal mounds to the north. Once filled and closed, the relatively shallow MDS will be unlikely to accumulate new

contaminants from external sources (such as the Hudson River plume or bottom sediment transport). Storm energy will periodically resuspend and sort the post-closure natural sediments, and disperse the fine-grain, contaminant-associated particles from the area, while retaining the heavier sandy sediments on the mound surfaces [see SAIC (1996d) and Clausner *et al.* (1996)].

Because much of the present MDS is sandy in nature (some from capping projects) with relatively low concentrations of bioaccumulative contaminants, Alternative 1 will result in a small contaminant-exposure reduction to the Bight Apex. After the MDS is closed, and the sediments are recolonized, resident infauna will exhibit lower burdens of bioaccumulative contaminants in their tissues, similar to other Bight Apex areas of equivalent hydrographic and hydrologic conditions. Motile epifauna (e.g., lobster, crabs, demersal fish), however, which forage over relatively large areas of the Bight Apex, are unlikely to show any change in body burdens in response to Alternative 1 (refer to Section 4.3.1.4). Furthermore, the infauna communities that develop on the sandy closed-MDS sediments are not expected to be preferred food sources for some resource species (refer to Section 3.4.6), such as lobster,[10] which currently has elevated contaminants in the vicinity of the MDS. Motile macrofauna will accumulate lower levels of contaminants only to the extent that contaminants are reduced in all prey items, throughout their forage areas.

Outside the Mud Dump Site. In the evaluation of current conditions in the Study Area (Chapter 3), bioaccumulative contaminants were generally highest in sediments on the flanks of the historic mound and MDS. These areas are mostly outside of the MDS borders (see Figures 3-39 and 3-42). Alternative 1 will not remediate degraded sediments that lie outside of the MDS, thus will not reduce the availability of these contaminants and any resulting bioaccumulation by infauna, epifauna, and pelagic species. Reductions in contaminants external to the MDS will depend on other processes, including burial by cleaner natural sediments, and chemical and biological degradation.

Alternative 1 will not substantially change bioaccumulation and trophic transfer potentials of sediment contaminants outside the MDS.

4.3.1.4 Alternative 1 (No Action) — Fish and Shellfish Resources [228.6(a)(2), 228.6(a)(8), 228.6(a)(11), 228.10(b)(2), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(ii), 228.10(c)(1)(iii), 228.10(c)(1)(iv), 228.10(c)(1)(v)]

As discussed in Section 3.4.3 of Chapter 3, the MDS and surrounding areas provide habitat for numerous species of fish and shellfish. Twenty-eight fish and eight shellfish were identified as regionally important to the commercial and recreational fishing industry and/or the ecosystem (e.g., major prey of a fishery species). The 28 fish (listed in Table 3-14) include 21 demersal, four pelagic, and three pelagic/anadromous species. Two species of squid and six species of benthic shellfish (i.e., lobsters, crabs, clams, and scallops) were found to be commercially and/or ecologically important (Table 3-15).

Under Alternative 1, impacts to fish and shellfish resources will be generally unchanged from the present. Periodic habitat and spawning disruption within the MDS will continue to result from ongoing disposal operations. When the MDS is filled to capacity, degraded sediments within the MDS will be buried and isolated from the biotic environment, disposal-operation impacts (e.g., plumes) to demersal and pelagic fauna will stop, and the site will be gradually colonized by sandy sediment infaunal and epifaunal benthic communities. The stability of the final benthic communities, and associated fish and shellfish species, will

[10] As evidenced by the lack of worm species recovered during the October 1994 bioaccumulation study in the sandy sediments (Battelle, 1997b).

depend largely on their ability to endure erosional forces at the 45-ft BMLW level, including occasional storm events (refer to Sections 3.3.8, 3.4.2.2, and 3.4.6).

The primary concerns of Alternative 1 impacts to fish and shellfish resources are water-column impact, habitat change, contaminant trophic transfer, spawning impact, and socioeconomic issues. These five issues are discussed separately in the following paragraphs.

Water-Column Impacts. The most likely time for fish and shellfish to be exposed to water-column impacts is immediately following a discharge event. However, most fish and shellfish species of concern in the MDS are relatively motile and can flee falling material. Acute and sublethal impacts from collision with or burial by falling dredged material will be isolated and infrequent enough to be insignificant. The greater potential water-column impact to fish and shellfish is impairment of oxygen exchange from dredged material plumes.

Suspended dredged material can temporarily cause increased biological or chemical oxygen demand (BOD, COD), lacerate or disrupt the gill epithelium, physically irritate the gill, or block gas exchange by coating or clogging gill structure. Such impacts can cause mortality, but quantifying dose-response relationships is conditional on a number of factors which include life stages of the exposed organisms, duration of the impacts, and other environmental factors (e.g., temperature). The same holds for sublethal effects, such as changes in feeding behavior, choice of habitat, foraging efficiency, and spawning.

O'Connor (1991) conducted a literature review of several turbidity experiments with fish and reports a range of responses. In general, the lowest TSS concentration recorded to have any impact was about 100 mg/L, for a 10^{+}-h exposure on a sensitive life stage. Turbidity and TSS of dredged material plumes at the MDS are discussed in Sections 3.3.7 and 3.3.10 of Chapter 3. Within approximately 15 min of 4000-6000 yd^3 discharges at the site, initial dilutions range from 3,000:1 to 600,000:1. Plumes generally spread less than 500 m. The time series plots in Figure 3-52 show that TSS dilutes to about 20 mg/L within about 15 min. and to background levels (0.5-1 mg/L) well within 1 h (Dragos and Peven, 1994; Dragos and Lewis, 1993). Other EPA Region 2 and USACE NYD field studies of the MDS have shown that dredged material discharged at the site does not cause dissolved oxygen (DO) to be depressed greater than 25% in the water column after allowance for initial mixing. The current Site Management and Monitoring Plan for the MDS (EPA Region 2/USACE NYD, 1997a) specifies a 4^{+}-h period between disposal events at the site to allow for initial mixing (40 CFR Section 227.29) and compliance with the limiting permissible concentration (40 CFR Section 227.27).

The above information indicates that water-column impacts from dredged material discharges under Alternative 1 would be brief and insignificant to fish and shellfish resources. Furthermore, as the MDS fills and the water depths become shallower, particularly in the southern half of the site, the discharge plumes will be smaller and even less persistent, because less water will be entrained by the falling material.

Habitat Change. Under Alternative 1, the composition of surface sediments within the borders of the MDS will gradually change to an armored surface layer of relatively coarse material in the center of the site, grading to muddier sediments on the deeper areas on the mound flanks at the borders of the site (refer to Section 4.2.9). At site closure, the site will be a rough plateau, similar to the historic disposal mounds to the north-northwest of the site. Hard-bottom or reef structures (incl. shipwrecks) do not occur in the MDS, thus none will be covered, lost, or affected by Alternative 1.

The major consequences of Alternative 1 will be the ongoing, short-duration disruption of fish and shellfish MDS habitats as the site is filled. These habitat disruptions are expected to be partially offset by the greater topographic relief along the borders of the disposal site, particularly along the southeastern border of the site (the 17-Fathom fishing grounds). Multihabitat fish such as winter and summer flounder, silver and red hake, cod, and ocean pout, and sand-habitat species such as yellowtail flounder, scup and sea robins, should experience a net benefit from Alternative 1. Similarly, squid, sea scallop and jonah crab should benefit by creation of new habitat, after the site is closed and fine sediments are winnowed from the mid sections of the disposal area. Net habitat losers from Alternative 1 are likely to be the spotted and red hakes, as well as crabs and demersal fish that depend on muddy bottoms for prey items (refer to Sections 3.4.3.4 and 3.4.6.1 in Chapter 3).

While the burial of toxic sediments and bioaccumulative contaminants in some areas of the MDS would have some beneficial impact on fish and shellfish habitat, the improvement will not be measurable because:

- There is no evidence that current chemical conditions within the MDS are detrimental to area fish and shellfish;
- Most fish and shellfish at the MDS are temporary inhabitants, either migrating through the region or foraging over a large area of the Bight; and
- Any habitat impacts are masked by overfishing.

A potential measurable benefit from Alternative 1 is increased fish and shellfish habitat from the increased topographic relief created by filling the disposal site to capacity (see box below). The present MDS mound attracts a number of fish species, and further increases in topographic relief, particularly in the southern half of the site, will provide additional food and shelter to fish and macroinvertebrates (e.g., crabs and lobsters). The habitats outside the MDS would remain unaffected.

Fish and Shellfish Attraction to Dredged Material Disposal Mounds

There are innumerable unpublished accounts that the construction of offshore underwater mounds from dredged material creates and improves fishery habitat. Disposal site managers and field staff have long observed disproportionate fishing activity (e.g., trawlers, party boats, trap lines) at and near nondispersive dredged material disposal sites around the country. However, the beneficial effects of disposal mounds are generally understudied and undocumented, primarily because site monitoring plans are geared toward detecting negative impacts, rather than beneficial effects.

In recent years, the field of artificial reef technology has made significant advances in understanding fish attraction to and habitat creation of underwater manmade structures (e.g., Seaman and Sprague, 1991; Nakamura *et al.*, 1991). Clarke *et al.* (1988) and Clarke and Kasul (1994) describe two of the very limited number of studies that have evaluated beneficial influences on fish and shellfish by dredged material mounds and berms. In general, reef structures that occupy less than 10% of the water column tend to attract demersal species. Attractional forces include the "lee wave" phenomenon (occurs as eddies form up and downstream of an underwater structure) and the magnitude of eddy formation (function of structure height, current velocity, and side slope). Clarke and Kasul (1994) specifically evaluated a 1.5-mi long, 0.75-mi wide, 25-ft high berm of dredged material (smaller but comparable to the 2.2-nmi^2 MDS) constructed off Mobile Bay in Alabama, and attraction to the berm by spot, *Leiostomus xanthurus,* and Atlantic croaker, *Micropogonias undulatus,* as well as fish prey items that included shrimps, crabs, mysids, nekton, and polychaetes. The Clarke *et al.* (1988) paper is a more general evaluation of fish attraction to several New England dredged material disposal sites, as well as the Mobile, AL, site. The information in these two papers strongly suggest that the topography of dredged material disposal mounds benefit fishery resources in those areas.

Trophic Transfer of Contaminants. The major concerns about contaminant bioaccumulation and trophic transfer are discussed in Section 3.4.6.2. In general, the potential trophic transfer impacts that originate inside the MDS are expected to be moderately reduced from present levels by Alternative 1.

Sediments outside of the MDS, to the east and northwest of the site, that are degraded with bioaccumulative contaminants will be only passively remediated under Alternative 1 via fine sediments that drift into and settle into the area. This includes areas referred to by local fishermen as the Scotland Banks and 17-Fathom Areas. The present impacts from these degraded areas outside the MDS (a far larger area than total area of MDS) are expected to continue affecting infaunal communities (refer to Chapter 3, Section 3.4.2.3) and the fish and shellfish that feed on these communities.

On a Bight-wide basis, the benefits of isolating the degraded surface sediments in the MDS by the disposal of Category I material are not expected to be measurable. Fish and shellfish of concern (e.g., flounder and lobsters) that are subject to the degraded sediments currently in the MDS may experience an improvement in habitat. However, the relatively large foraging area of these species extends well beyond the MDS, and overall incremental improvements will be immeasurably small and probably insignificant. Similarly, habitat changes external to the MDS will be small but beneficial under Alternative 1 as disposal plumes drifting from dumping operations, and sediments winnowing from disposal mounds, settle over degraded areas. Both the Category I and II dredged material permitted for disposal at the MDS under the present SMMP are substantially less contaminated than sediments dumped before 1992 [date at which revision of the 1991 Green Book (EPA/USACE, 1991) began to be applied to MDS disposal project evaluations]. Likewise, pollution emitted from the Hudson River plume is gradually decreasing. It is logical to conclude that, over a long period of time, the deposition of new sediments in degraded areas, both inside and outside of the MDS, will improve the infauna habitat as well as the fish and shellfish that feed on these communities. These habitat improvements will probably be nondetectable among the other habitat influences (e.g., currents and storm events) and fishing pressure on the resources.

Spawning. Potential Alternative 1 impacts to fish and shellfish spawning include potential changes to spawning behavior and sites and burial of demersal eggs. As discussed relative to water-column impacts, actual disposal events will be short and infrequent, and spatially limited. Disruption of spawning activities is therefore not considered to be significant.

Any potential Alternative 1 spawning impact would occur disproportionally to demersal eggs on the seafloor, particularly to fish and shellfish whose spawning periods coincide with their peak abundance in the New York Bight and have the potential to lay a significant number of eggs within the area exposed to disposal material. The species most likely to be affected, include winter flounder, sea raven, longhorn sculpin little skate, ocean pout, rock crab, surf clam, and sea scallop (refer to Section 3.4.3.3 in Chapter 3). Potential impacts could be from contaminant toxicity to the eggs and/or suffocation from dredged material burial.[11] When the site is closed, the potential for impacts would be eliminated, and beneficial impacts to spawning and habitat could result from the enhanced topographic relief created by the filled site.

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[11] For bioaccumulative contaminants to affect biological organisms, the exposure period must be sufficiently long to allow the contaminant to be taken up and for a response to be elicited. Various experts have concluded that a practical capping thickness for biological isolation of contaminated sediments is 30-50 cm (SAIC, 1997). Pursuant to the SMMP, MDS project permits require that Category II sediment be expeditiously capped with a 1 m layer of Category I material for added protection against potential for bioaccumulation.

No lethal or sublethal effects on fish and shellfish spawning in the Study Area have been detected or attributed to degraded sediments caused by dredged material disposal. If spawning effects exist, they are beyond the ability to be measured by current methods, and are most likely being masked by natural variability of Bight-wide conditions, year-class variability of the individual species, and over fishing. These same conditions will continue with implementation of Alternatives 2 - 4.

Socioeconomic Considerations. Alternative 1 is expected to affect the socioeconomic factors of fish and shellfish resources mostly through the public perceptions of whether fish and shellfish resources are being negatively affected by the presence and management of the MDS, and whether there are health risks associated with the consumption of seafood from the New York Bight.

With regard to negative effects to fish and shellfish resources in the Study Area, EPA concurs with NOAA NMFS (1995) "...some species show evidence of contaminants in their tissues, especially those species with relatively high levels of lipids or an affinity for accumulating pollutants. The problem however, is to differentiate the source of the contaminants. Within the New York Bight itself, contaminants similar to those at the Mud Dump Site pervade the harbor estuary and flow out of the Bight with river currents. In addition, atmospheric deposition accounts for a considerable amount of Bight contamination." (NOAA NMFS, 1995). Even if physical and chemical impacts from dredged material disposal are affecting fish and shellfish at MDS, or in the larger Bight Apex, they are not detectable among the much larger and simultaneous impacts caused by recreational and commercial fishing mortality and natural mortality (NOAA NMFS, 1995). "Clearly, the recently completed fish tissue analysis undertaken by NMFS for the Environmental Protection Agency and the Corps of Engineers shows that recruited species live and thrive in the New York Bight, even near the Mud Dump Site. In addition, our studies show that Newark Bay, a source of contaminated sediments for the Mud Dump Site, apparently supports a wide variety of fish." (NOAA NMFS, 1995).

Potential dredged material disposal impacts to fish and shellfish resources in the Bight Apex are only related to the habitat loss and contaminant toxicity in the benthic areas that have significant accumulation of historically discharged dredged material. As discussed earlier, Alternative 1 is not expected to significantly impact fish habitat, and could actually be beneficial by increasing the topographic relief on the seafloor.

Contaminant levels of Study Area fish and shellfish tissue samples were compared to Food and Drug Administration (FDA) action levels. Only PCB and dioxin levels in hepatic tissue (the "tomalley") of lobster were above the action levels; no action levels were exceeded in muscle tissue of the lobster or other resource species. Exceedance of the FDA action level in the hepatic tissue of the lobster is cause for concern and may justify further study for high-risk exposure groups (e.g., pregnant women, children). Both New York and New Jersey have seafood advisories that address human-health risks associated with seafood consumption from the New York Bight.

It is reasonable to expect that under Alternative 1 public perception and responses toward dredged material disposal operations at the MDS will be relatively unchanged because the site will continue to be operated as it currently is, and potential seafood health risks will remain static or decrease as disposal of Category II material ends and Category I material is used to fill/cap the site, and contaminant source reduction in the Hudson River watershed is implemented. Correspondingly, potential health risks associated with the degraded sediment outside the MDS will also remain static in the near term under Alternative 1. In the long term, health risks from the sediment outside of the MDS can be expected to decrease as contaminants from the New York Bight watershed and airshed are gradually reduced through pollution-control programs. However, the socioeconomics of fish and shellfish resources are strongly linked to the fishing and seafood-buying public's understanding and reaction to health-risk information. Minor shifts in public perception about fish/shellfish contamination or resource impacts can significantly increase or decrease seafood consumption, fishing activity, and the associated economies of these industries (e.g., fishing gear and boat sales/rentals, shoreline restaurant business).

4.3.1.5 Alternative 1 (No Action) — Natural and Cultural Features of Historical Importance [228.6(a)(11)]

As considered in Section 3.5.7, no natural or cultural features of historic importance were located in the MDS. Although the continental shelf was once a relatively dry coastal plain suitable for prehistoric human habitation, erosion associated with sea level rise would have severely impacted site preservation. Potential prehistoric sites in the MDS have likely been deeply buried by dredged material disposal and natural sedimentation.

Side scan surveys of the MDS did not reveal any shipwrecks on the seafloor in the MDS. Two vessels were identified as having sunk within the boundaries of the MDS: one in 1938; the other was entered into the NOAA Automated Ship Wreck and Obstruction System in 1990. Neither vessel is evident in the side scan records obtained in the MDS in 1995. Either the vessels have been buried by disposal operations in the area or drifted to locations outside of the MDS boundaries prior to settling on the seafloor.

In summary, no areas of historical or cultural significance are identifiable within the MDS boundaries. Alternative 1 has no consequences under this evaluative criteria.

4.3.1.6 Pros and Cons of Alternative 1

The following is a summary of the pros and cons of implementing Alternative 1. The pros and cons of all four alternatives are compared in Section 4.4 to select the Preferred Alternative.

Alternative 1 Pros

- No impact to fish and shellfish resources, shorelines, or special areas of concern
- Limited short-term impact to benthic community within the disposal site
- Extension of the dredged material mound may provide longer berm and incrementally improve fish and shellfish habitat
- No new impacts to Bight Apex navigation
- No impact to cultural resource sites
- Provides approximately 31 Myd^3 of Category I capacity

Alternative 1 Cons

- Contaminant trophic transfer and potential human-health or ecological risks for areas outside the MDS unaffected
- Sediment areas degraded by toxic and bioaccumulative contaminants outside the MDS are not remediated or restored. This area is 6.8 nmi^2, three times bigger than the current MDS.
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)." and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

4.3.1.7 Monitoring and Surveillance for Alternative 1 [228.6(a)(5)]

The feasibility of surveillance and monitoring (physical, chemical, and biological) in the vicinity of the MDS has been demonstrated during the past 15 years (See Section 3.2.6). The location of the MDS, near the mouth of the New York-New Jersey Harbor facilitates surveillance of disposal operations as well as mobilization and operation of scientific surveys. Under Alternative 1, surveillance and monitoring of dredged material disposal operations continues as defined in the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/USACE NYD, 1997a).

4.3.2 Discriminating Impacts and Use Conflicts of the No MDS-No HARS Designation Alternative (Alternative 2)

4.3.2.1 Alternative 2 (No MDS-No HARS Designation) — Degraded Sediments [228.6(a)(7), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(i), 228.10(c)(1)(ii)]

As discussed relative to Alternative 1 and in Section 3.3.9.3 of Chapter 3, approximately half of the surface sediments within the present MDS are degraded, causing acute toxicity (a Category III characteristic) or dioxin bioaccumulation exceeding Category I levels. Throughout the Study Area, including the MDS, there are approximately 9 nmi^2 (31 km^2) of degraded sediment.

Under Alternative 2, none of the 9 nmi^2 of degraded sediment will be actively remediated or restored. Gradual reduction of the degradation areas can be expected over a long period of time as contaminant sources to the Bight Apex are reduced and natural sediments entering the Apex become cleaner. The rate that this natural remediation occurs will depend on the success of pollution controls throughout the New York Bight watershed, and the rate of sedimentation outflows from the Hudson River and East River (including Long Island Sound). The deposition of cleaner natural sediments will eventually remediate the degraded sediments to background-level conditions. Ironically, improvements in upstream soil-erosion controls, by decreasing Bight Apex sedimentation, potentially would prolong the period over which degraded areas are naturally remediated. However, because numerous factors influence natural sedimentation in the Bight Apex, the degree and rate of natural remediation of degraded sediments cannot be accurately predicted without chemical characterization data on the sediments entering the Hudson River, a forecast of future erosion in the watershed, and development of a sedimentation model that accurately predicts the fate of sediments entering the Apex.

Large storm events in the Bight Apex also have the potential to influence the degraded sediment of the Study Area, although to a lesser degree than under Alternative 1. The small areas of degraded sediments above 20 m BMLW (e.g., northeast corner of the MDS) will eventually be winnowed and sorted by winter storms, resulting in coarse, erosion-resistant surface sediments that are less degraded than present. As previously discussed, the winnowing process will move the fine-grain, contaminant-containing sediments from high-energy areas of the Bight to low-energy areas (i.e., below 20 m), resulting in sediment armoring and remediation in shallow-water areas. By the same processes, degraded sediments currently deeper than 20 m, and isolated from all but very severe storm events (100-year frequency hurricanes/noreaster), will remain degraded for longer periods than equivalent sediments in the shallow-water areas.

4.3.2.2 Alternative 2 (No MDS-No HARS Designation) — Benthic Infauna [228.10(b)(3), 228.10(b)(5), 228.10(c)(1)(ii), 228.10(c)(1)(iii)]

As discussed in Section 3.4.2 and Section 4.3.1.1, there are two distinct benthic infaunal communities in the Study Area. Neither the muddy-sand community ("Community Group A," located predominantly in sediments with relatively high total organic carbon concentrations and at depths greater than 20 m) nor the sandy community ("Community Group B," generally found on the dredged material mound surfaces less than 20 m) will be substantially changed by Alternative 2. Each community group will continue to inhabit their respective habitats and support the organisms in the corresponding next trophic levels. Infauna that bioaccumulate contaminants from the sediments, particularly the Group A infauna, will continue to do so (refer to Section 4.3.2.4).

With implementation of Alternative 2, short-term disposal-related impacts (e.g., smothering) currently affecting MDS organisms will stop. Storm-related impacts will remain unchanged until the MDS disposal mounds are eroded/winnowed to below 20 m or become armored and resistant to further erosion. Gradually, benthic community composition within the MDS will become similar to that found on the historic mounds north of the MDS. In general, however, Study Area benthic communities are not expected to substantially change following closure of the disposal site and cessation of all dredged material dumping.

4.3.2.3 Alternative 2 (No MDS-No HARS Designation) — Contaminant Bioaccumulation [228.10(b)(6), 228.10(c)(1)(iii)]

Closing the MDS, ceasing all dredged material disposal at the MDS, and not conducting any benthic remediation work will prolong the period for potential contaminant bioaccumulation. Fine-grain, degraded sediments on the flanks of the historic mound and MDS will not be remediated and will continue to be a potential source of contaminants to benthic infauna and epifauna, as well as the demersal and pelagic predators. As discussed in Sections 4.3.2.1 and 4.3.2.2, "natural remediation" of the degraded sediments and associated reductions of bioaccumulation potential will take place over a long time frame, that will depend on non-placement sedimentary processes, including natural deposition (i.e., from Hudson River plume).

In general, Alternative 2 will not substantially change current levels of contaminant bioaccumulation in the Study Area. Over the long term, deposition of cleaner natural sediments will gradually make the Study Area bioaccumulation potential approach that of the background conditions of the Bight Apex. The degree to which contaminant bioaccumulation is reduced, and the period needed to reach a steady-state condition, will depend in large part on the quality of Hudson River plume sediments and other contaminant sources (e.g., atmospheric deposition). In turn, these pollution sources to the Bight Apex are dependent on regional pollution control programs, watershed development, erosion control, and storm events.

Compared to the other three alternatives, Alternative 2 leaves the largest area (9 nmi^2) of degraded sediments exposed for the longest periods. Each of the other three alternatives include some amount of isolation of contaminated sediment within the Study Area.

4.3.2.4 Alternative 2 (No MDS-No HARS Designation) — Fish and Shellfish Resources [228.6(a)(2), 228.6(a)(8), 228.6(a)(11), 228.10(b)(2), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(ii), 228.10(c)(1)(iii), 228.10(c)(1)(iv), 228.10(c)(1)(v)]

Impacts to 28 fish and eight shellfish species (Table 3-15) that were identified as regionally important to the commercial and recreational fishing industry and/or the ecosystem will be generally unchanged from present conditions under Alternative 2. The following paragraphs summarize five areas of concern relative to Alternative 2 and fish/shellfish resources.

Water-Column Impacts. Under Alternative 2, no further dredged material will be discharged in the MDS for either disposal or remediation purposes. Consequently, there will be no water-column impacts from falling material, nor will there be impacts to feeding behavior, choice of habitat, foraging efficiency, and spawning attributable to water-column impact. Of the four alternatives, Alternative 2 has the least potential for water-column impacts to fish and shellfish resources.

Habitat Change. Under Alternative 2, composition of surface sediments above 20 m BMLW within the borders of the MDS will gradually be eroded/winnowed by storms and change to an armored surface layer of relatively coarse material in the center of the site, grading to muddier sediments on the deeper areas on the mound flanks at the borders of the site (refer to Section 4.2.9). No other habitat changes are expected. No hard-bottom or reef structures (including shipwrecks) will be covered, lost, or affected by this alternative. The potential negative consequences to fish and shellfish resources are the continued exposure of bioaccumulative contaminants and toxicity to the Bight Apex environment, and the potential bioavailability of sediment contaminants to marine organisms. There is no enhancement of fish and shellfish habitat (from increased topographic relief) under Alternative 2.

Trophic Transfer of Contaminants. Corresponding to the general lack of change regarding contaminant bioaccumulation, there will not be any significant changes in the transfer of contaminants from the sediments to Bight Apex organisms under Alternative 2. As discussed in Section 3.4.6.2 of Chapter 3, infauna that inhabit degraded sediment areas will continue to take up contaminants from the sediment.

Reductions in potential trophic transfer of contaminants under Alternative 2 will only occur through natural remediation processes. Deposition of natural sediments will gradually make the Study Area bioaccumulation potential approach that of the background conditions of the Bight Apex. The degree to which contaminant bioaccumulation is reduced, and the period needed to reach a steady-state condition, will depend on the quality of Hudson River plume sediments and other contaminant sources (e.g., atmospheric deposition). These pollution sources to the Bight Apex are dependent on regional pollution control programs, watershed development, erosion control, and storm events. In the near- and mid-term periods, sediment contaminants in the eastern and southern portions of the MDS, as well as outside areas to the east, south, and northwest of the disposal site, will continue to expose the Apex infauna to contaminants, which can potentially be transferred to higher trophic levels with detrimental effects.

Fish and macroinvertebrates (e.g., lobsters) that forage on Apex infauna in predominantly muddy areas will have the greatest exposure to contaminants and potentially experience impacts under Alternative 2. As listed in Figure 3-73 in Chapter 3, mud-dwelling fish and shellfish in the Study Area include the spiny dogfish, spotted hake, silver hake, red hake, fourspot flounder, longhorn sculpin, windowpane flounder, and horseshoe crab. On a Bight-wide basis, however, trophic-transfer impacts from sediment contaminants are not expected to be measurable, with or without the implementation of this alternative. Most of the fish and shellfish of concern that live or forage in fine-grain sediments, including the degraded sediments of the Study Area, also frequent nondegraded, less contaminated areas. These same fish and shellfish are also exposed to background contamination throughout the Bight. Furthermore, migratory species (e.g., bluefish, lobster) are exposed to contaminant sources outside the Study Area or Bight.

In summary, the trophic transfer of contaminants relative to Alternative 2 is exceedingly difficult to measure by current sampling and analytical methods. Relative to the other alternatives, however, Alternative 2 has the greatest potential for trophic transfer of contaminants because the largest area of degraded sediments will be exposed for the longest period (due to no disposal of dredged material/ placement of Remediation Material).

Spawning. Alternative 2 presents the least impact to fish and shellfish spawning in the Study Area, as no burial or other impacts will occur from dredged material dumping. The single negative impact to fish and shellfish spawning is the remote potential for lethal or sublethal effects to demersal eggs by the sediment contaminants in the degraded areas in the 9.0 nmi^2 PRA. This potential impact is strictly hypothetical. No lethal or sublethal effects on fish and shellfish spawning in the Study Area have been detected or attributed to degraded sediments caused by dredged material disposal. If spawning effects exist, they are beyond the ability to be measured by current methods, and they are most likely being masked by natural variability of Bight-wide conditions, year-class variability of the individual species, and over fishing. These same conditions apply to the other alternatives as well.

Socioeconomic Considerations. Like Alternative 1, Alternative 2 is expected to affect the socioeconomic factors of fish and shellfish resources mostly through the public's perceptions of whether fish and shellfish resources are being negatively affected by the current operation of the MDS, and potential health risks associated with the consumption of seafood from the Bight Apex after the site closes.

As discussed earlier, changes in contaminant impacts to fish and shellfish under Alternative 2, are expected to be insignificant and nondetectable by current stock assessment methods. The effects of habitat losses and eutrophication of shoreline areas, and fishing mortality nearshore and throughout the Bight Apex, overwhelm any impacts from degraded sediments occurring in the Study Area. Despite the inability to measure impacts from degraded sediments, and the degree that these impacts may continue under Alternative 2, a weight-of-evidence evaluation concludes that this alternative presents the largest potential for human health risk to area seafood consumers. This conclusion is primarily based on the fact that, under Alternative 2, the most amount of degraded sediment will be exposed to the Bight Apex ecosystem for the longest period. Unfortunately, quantifying the potential socioeconomic impacts of Alternative 2 to fish and shellfish resources is not possible for two reasons:

- Most of the fish and shellfish resources in the Apex are composed of species that forage over large areas and/or are highly migratory. Effects to these organisms by the relatively small area of degraded sediments in the Study Area are masked by other anthropogenic impacts.
- Technical data regarding impacts to fish and shellfish resources in the Study Area are subject to different interpretations. Dissemination of different interpretations can cause abrupt changes in the socioeconomics of the resources.

As with Alternative 1, relatively minor shifts in public perception about fish/shellfish contamination or resource impacts can significantly increase or decrease seafood consumption, fishing activity, and the associated economies of these industries (e.g., fishing gear and boat sales/rentals, shoreline restaurant business). Correspondingly, the socioeconomic impacts of Alternative 2 will depend in large part on whether the public believes that the implemented alternative increases or decreases health risks to seafood consumers, and whether the perceived increase or decrease in the risk is sufficiently large to result in changes in behavior (fishing practices) or purchase decisions (menu selection).

Another socioeconomic impact of Alternative 2 relates to potential impacts on the Port of New York and New Jersey. Implementation of Alternative 2 would eliminate an EPA-designated site for Category I dredged material. It would be inconsistent with the July 24, 1996, 3-Party Letter which is *inter alia* intended to help remove the immediate obstacles to dredging the Port and assure long-term use of Category I dredged material.

4.3.2.5 Alternative 2 (No MDS-No HARS Designation) — Natural and Cultural Features of Historical Importance [228.6(a)(11)]

As discussed in Section 3.5.7 of Chapter 3, a number of shipwrecks were identified within the Study Area and several of these wrecks have potential historical importance. Some could be eligible for nomination to the National Register of Historic Places following further evaluation.

Because Alternative 2 does not involve any sediment disposal/placement, no impacts to shipwrecks will occur from discharged sediment.

4.3.2.6 Pros and Cons of Alternative 2

The following is a summary of the pros and cons of implementing Alternative 2. The pros and cons of all three alternatives are compared in Section 4.4 to select the Preferred Alternative.

Alternative 2 Pros

- No impact to fish and shellfish resources, shorelines, or Special Areas of Concern
- No short-term impact to benthic community within the Study Area
- Reduced potential for impacts to Bight Apex navigation
- No impact to cultural resources

Alternative 2 Cons

- Does not address the need for benthic remediation inside or outside the MDS
- Contaminant toxicity and bioaccumulation potential from degraded sediments unchanged
- No change to potential human-health and ecological risks, including potential impacts to endangered and threatened species, from contaminant trophic transfer.
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)." and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

4.3.2.7 Monitoring and Surveillance for Alternative 2 [228.6(a)(5)]

Under Alternative 2, surveillance and monitoring of dredged material disposal operations per the MDS Site Management and Monitoring Plan (SMMP) (EPA Region 2/USACE NYD, 1997a) will stop when the disposal site is closed. However, EPA and the USACE will continue to work with applicable Federal agencies on future monitoring work.

4.3.3 Discriminating Impacts and Use Conflicts of Alternative 3 (Remediation)

4.3.3.1 Alternative 3 (Remediation) — Degraded Sediments [228.6(a)(7), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(i), 228.10(c)(1)(ii)]

As presented in Section 3.3.9.3 of Chapter 3, Study Area sediment samples were tested in 10-day acute bioassays using the amphipod *Ampelisca abdita*. Test results ranged from 0 to 99% organism survival, with reference-sediment survival at 94%. The PRA encompasses all of the HARS stations that had less than 74% survival, the level that is biologically significant and unacceptable for ocean dumping (i.e., Category III characteristics), per the 1991 Green Book and the Regional Testing Manual (EPA/USACE, 1991; EPA Region 2/USACE NYD, 1992). The PRA also covers the vast majority of the New York Bight area known to have received dredged material over the past 100 years. In general, the degraded sediments in the HARS PRA are fine-grained, below the 20 m depth contour and located east and west of the present

MDS, and in the northeast quadrant and southeastern border of the MDS itself (refer to Figure 3-48, Figure 4-4, and Figure 4-6).

Placing a 1 m cap of the Material for Remediation throughout the PRA will isolate Category II and Category III-type sediments presently on the bottom, and reduce the potential human-health and ecological impacts presented by these sediments. In the small subpart of the PRA above 20 m, sandy Material for Remediation may be required to ensure integrity of the cap during storm surges. When remediation operations are completed in the PRA, the potential for contaminant bioaccumulation will be reduced, as well as the potential for sublethal effects in benthic marine organisms and their predators (including human consumers of fish and shellfish from the area).

The long-term effectiveness of the Alternative 3 cap in the PRA will depend on two factors: (1) natural processes that act to bind and hold contaminants to the sediments (e.g., organic carbon content, storms) and (2) input, transport, and deposition of contaminants to the deeper, less energetic areas of the HARS from other sources in the area (e.g., Hudson River plume, atmospheric sources, seafloor sediment dispersion). Undiminished inputs of contaminants from nondredged material sources will likely result in gradual recontamination of some areas of remediated sediments. The degree of recontamination will be a function of the contaminant sources, level of organic carbon maintained in the sediments, and natural cycling of carbon in the coastal ocean.

Future pollution sources to both harbor sediments (future dredged material) and remediated sediments in the HARS is primarily under the control of the actions taken under the New York Harbor Comprehensive Conservation and Management Plan (CCMP). It is very probable that if pollution sources from the Hudson River plume and atmosphere continue unchecked, PRA sediments could return to an unacceptable (degraded) quality within a period of years, regardless of the quality and effectiveness of the capping operations. Additionally, the rate that the PRA is remediated with Material for Remediation will also influence the overall effectiveness of the alternative relative to current and future impacts.

4.3.3.2 Alternative 3 (Remediation) — Benthic Infauna [228.10(b)(3), 228.10(b)(5), 228.10(c)(1)(ii), 228.10(c)(1)(iii)]

As discussed in Section 3.4.2 and Section 4.3.1.1, there are two distinct benthic infaunal communities in the HARS (Figure 4-7). The sandy community ["Group B"] is found on dredged material mounds within the HARS that are less than 20 m (65 ft) BMLW (i.e., the No Discharge Zone) and will not be impacted by implementation of Alternative 3. In contrast to the Group B community, a large fraction of community Group A (located in predominantly muddy sediments) will be buried under Alternative 3. Most of the infaunal organisms in the PRA will be smothered, and a short period (e.g., an annual cycle) will lapse until the community is recolonized and reestablished from adjacent areas. At the community level, the impact will be short term, and spatially and temporarily insignificant.

About 80% of the benthic community in the PRA of the HARS will be impacted by burial during the course of Alternative 3 remediation operations. However, these impacts will be one-time events occurring at discrete subareas of the PRA. Group A communities inhabiting nearby areas will recolonize subareas of the PRA soon after the subareas are remediated. As has been documented in other dredged material sites and in the MDS specifically (SAIC, 1995a; SAIC 1997), full recovery of Group A communities is expected to occur over a period of several seasons.

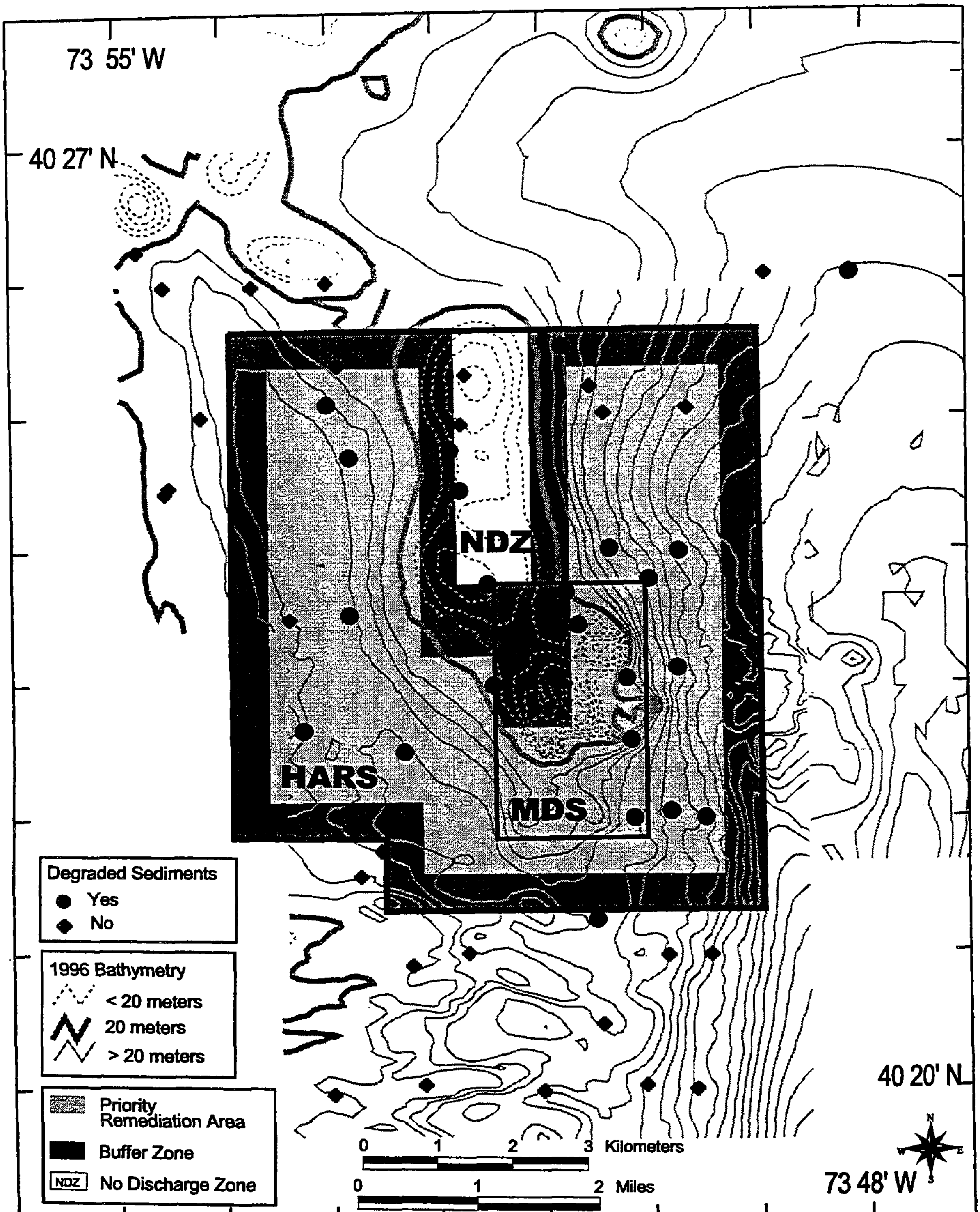

Figure 4-6. Alternative 3 Historic Area Remediation Site (HARS) and locations of degraded sediment. The Priority Remediation Area (PRA) is the U-shaped, light-shade area. The surrounding dark-shade area is the HARS Buffer Zone (BZ).

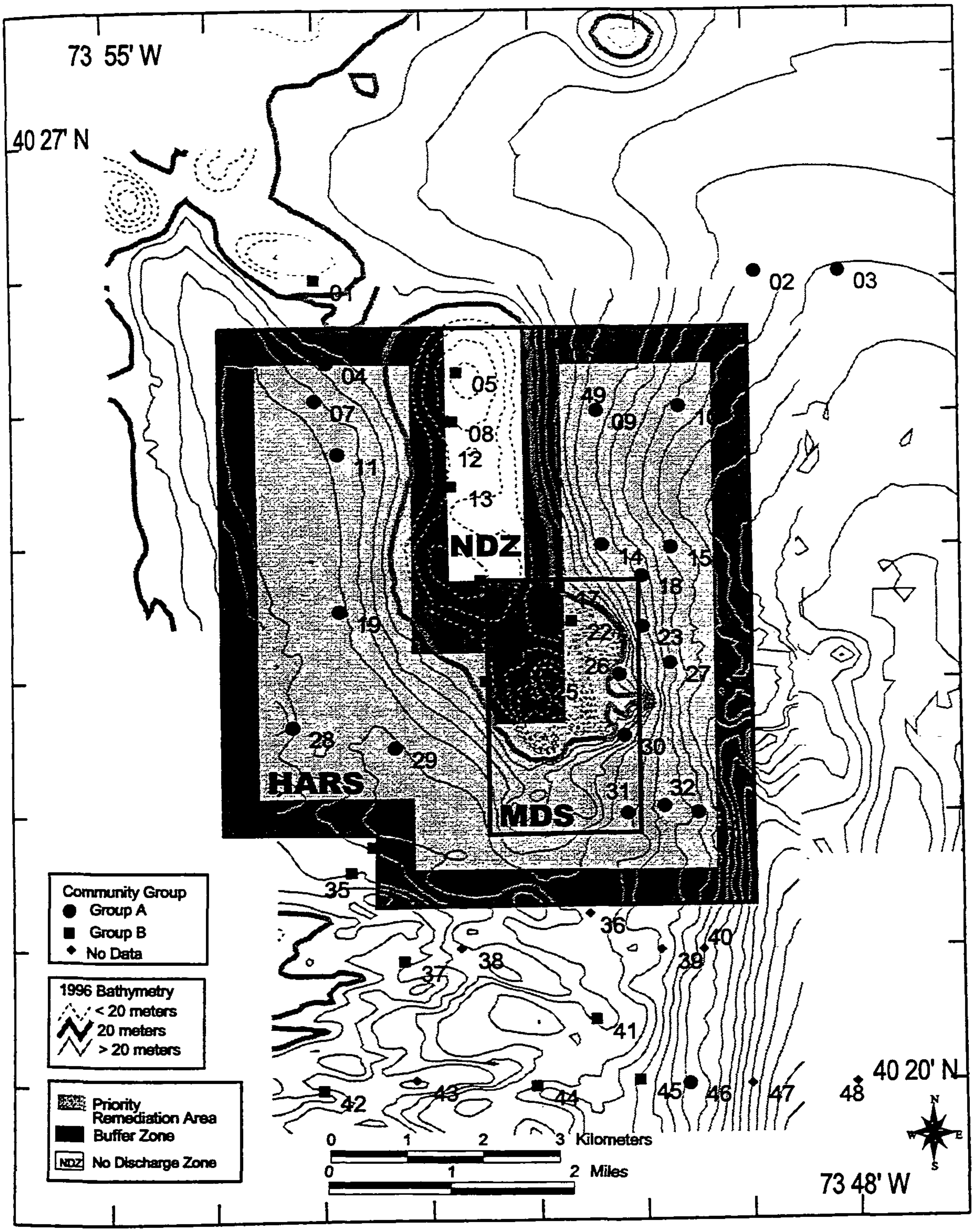

Figure 4-7. Benthic community groups in and around the HARS. Community Group A (circle symbols) is generally located in deep muddy areas, relative to Community Group B (square symbols) which is generally in shallower sandy areas.

As described under Alternative 1, deposited New York Bight Apex dredged material is recolonized by (1) benthic infauna that are able to unbury themselves (where the mound thickness is sufficiently thin), (2) adult and juvenile infauna that migrate from uncapped areas, and (3) larval infauna that settle on the new substrate (SAIC, 1997). The composition of the community that eventually colonizes the capped area will depend largely on the texture (grain size) of the surface sediments. To the maximum extent practicable, each remediation area will be remediated with Remediation Material of similar grain-size/composition as sediments located within that particular remediation area. Thus, the community in the remediated PRA is not expected to be greatly different than presently found.

Impacts to infaunal characteristics from changes in the water depth (in the range of 1 m) will be minor. Thus, Alternative 3 will not place communities that recolonize the remediation sediments in a more energetic environment such as that experienced at depths above 20 m. Alternative 3 will not increase the potential for natural events (i.e., storms) to affect these communities.

As discussed under Alternative 1, the rate that benthic communities are buried under Alternative 3 will be balanced by recolonization of the sediments. Recolonization of the remediated areas will occur within one annual cycle, and take several years to fully develop the benthic community that corresponds to the new conditions (EPA Region 2 Benthic Ecology Workshop, December 1996). The net effect of remediation will be that, at any given time, only a small portion of the PRA will receive Remediation Material. Thus, potential benthic impacts from remediation should be limited to a specific remediation area.

In summary, because the Material for Remediation placed in the PRA will be similar to existing habitat conditions, and applied to relatively small areas, Alternative 3 impacts to benthic infauna are expected to be quickly mitigated by rapid recovery of resident community organisms at the perimeters of the disposal mounds, and recolonization by organisms from nearby areas. Benefits to HARS infauna will be the removal or reduction of potentially lethal or sublethal effects caused by contaminants in the current PRA sediments.

4.3.3.3 Alternative 3 (Remediation) — Contaminant Bioaccumulation [228.10(b)(6), 228.10(c)(1)(iii)]

Alternative 3 will cap PRA areas exhibiting Category II and III characteristics with Material for Remediation. Post-remediation contaminant bioavailability to the benthic community (i.e., infauna and infauna predators, including fish) will depend on:

- Contaminant levels
- Effectiveness of the remediation operations
- Erosion, bioturbation, and other forces that homogenize bottom sediments, and
- Contaminants and organic carbon loading from other sources (e.g., Hudson River plume, atmosphere), which is expected to vary seasonally by natural processes and in the long-term by actions to control New York Bight watershed and airshed pollution.

Geochemical relationships of the New York Bight suggest that sediments with low TOC (i.e., similar to muddy sands outside the HARS) that are remediated will eventually develop contaminant concentrations that are at the lower end of concentrations presently observed in the degraded areas. By extension, benthic organisms living in these sediments will have lower contaminant burdens in their tissues. This will, in turn, make lower concentrations available to higher trophic level organisms, resulting in lower contaminant levels in higher organisms.

Based on the above scenario, it is reasonable to expect that Alternative 3 will help lower contaminant levels in higher organisms that inhabit the HARS. Organisms such as crabs, lobsters, and demersal fish that currently feed on HARS infauna with high body burdens of contaminants will receive decreasing contaminant exposure as the PRA is remediated. This exposure reduction will be a beneficial effect on Bight Apex organisms, and human beings will have less risk of adverse effects from consumption of Bight Apex seafood.

4.3.3.4 Alternative 3 (Remediation) — Fish and Shellfish Resources [228.6(a)(2), 228.6(a)(8), 228.6(a)(11), 228.10(b)(2), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(ii), 228.10(c)(1)(iii), 228.10(c)(1)(iv), 228.10(c)(1)(v)]

Relative to fish and shellfish resources, the primary effect of Alternative 3 will be a general improvement of benthic habitat in the degraded sediment areas predominantly located west and southwest of the historic disposal mounds in the center of the HARS, and along the eastern and southern borders of the present MDS.

Over the long term, Alternative 3 will improve benthic habitat by reducing contaminant exposure, and thus benefit regional fish and shellfish resources, particularly demersal species and pelagic species with demersal eggs. In the near term, while remediation operations are underway, Alternative 3 will have impacts comparable to Alternative 1. During the remediation operation period, localized and periodic habitat and spawning disruption will occur from the placement of Remediation Material. Infaunal and epifaunal communities in the degraded areas will be covered by a cap of at least 1 m of Material for Remediation, and these areas will be temporarily removed as sources of food and habitat for demersal fish and shellfish until they are recolonized. Similarly, until the site is closed, impacts to demersal eggs could potentially occur from sediment plumes from remediation operations.

After the PRA is capped with at least 1 m of Material for Remediation:

- All degraded sediments within the HARS will be buried and isolated from the biotic environment,
- Remediation operation impacts (e.g., plumes) to demersal and pelagic fauna will stop, and
- The site will begin to recolonize by infaunal and epifaunal communities specific to the final surface sediments.

The stability of the final benthic communities and associated fish and shellfish species will depend largely on (1) quality of the sediments (e.g., grain size, organic carbon content, bottom roughness), (2) susceptibility of the communities to storm events, (3) local ecosystem dynamics, and (4) commercial and recreational fishing pressure.

The primary impacts during implementation of Alternative 3 are similar to those of Alternative 1. Alternative 3 is expected to impact fish and shellfish resources through water-column impacts, benthic habitat change, contaminant trophic transfer, spawning, and socioeconomic issues related to the resources. However, these impacts will be spatially limited, temporary, and probably nondetectable by resource assessment measures (e.g., trawl surveys). In the long-term, the net result of Alternative 3 to fish and shellfish resources is expected to be beneficial. The five areas of potential impact are discussed in the following paragraphs.

Water-Column Impacts. As with Alternative 1 and 4, Alternative 3 potentially can result in impacts to fish and shellfish through collision with falling dredged material and exposure to dredged material plumes. As discussed in Section 4.3.1.4, most fish and shellfish species of concern in the Bight Apex are motile and can flee falling material, or survive burial of a few centimeters of sediment following a given disposal/placement event. Some juvenile, small-bodied, and slow-moving organisms will be buried and smothered. However, as with Alternative 1, acute and sublethal resource-level impacts would be isolated and infrequent enough to be insignificant.[12]

The greater potential for water-column impacts to fish and shellfish would be temporary impairment of oxygen exchange from plumes. As previously discussed, plume tracking studies at the MDS have demonstrated that:

- Plume behavior is variable depending upon the type of grain size (coarse to fine-grained material);
- Rapid settling of coarse material and turbulent mixing results in initial dilutions of the plume on the order of 3,000:1 to 600,000:1 within 15 min of discharge, based on measurement of total suspended solids (TSS), and dioxin and furan concentrations (Dragos and Peven, 1994);
- Plume dilutions after 2 hours range from approximately 64,000:1 to 557,000:1 (Dragos and Peven, 1994);
- TSS near the center of the plume body reach near background levels in 35-45 minutes;
- The release of dredged material into the water column results in rapid dispersal (turbulent mixing) of the plumes within the first few minutes after release;
- A small amount of fine-grained sediment (silt and clay) remained measurable in the water column for up to 3 hours (SAIC, 1994a);
- MDS plumes do not cause dissolved oxygen (DO) to be depressed greater than 25% in the water column, after allowance for initial mixing.
- Recorded TSS concentrations are below the impact levels for sensitive life stages of water-column organisms (e.g., fish larvae).

In summary, plume impacts are expected to rapidly dissipate and be insignificant to fish and shellfish resources.

Habitat Change. To the maximum extent practicable, remediation will be conducted with material similar to the sediments in that remediation area. However, because of the anticipated limited availability of sandy Material for Remediation (due in part to the competing uses for sandy material such as for beach nourishment), remediation operations under Alternative 3 will change some of the sandy surface sediments presently within the HARS to sand-mud or silt/clay-mud composition. Current sandy areas shallower than 20 m that are remediated with silt and clay materials for remediation will eventually change back to sandy sediment areas, due to benthic winnowing and armoring . The rate of change back to sand will depend on

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[12] As presented in Section 4.2.4, the estimated number of dredged material barge or hopper dredge trips to the MDS under Alternative 3 is 382 per year. Conservatively estimating 5 min per discharge event equates to approximately 32 h/yr of potential impact.

storm event occurrence and other physical oceanographic phenomena (i.e., currents). Correspondingly, sandy areas deeper than 20 m that receive fine-grain materials for remediation would remain fine grain, except to the extent that additional sandy material is used to cover such areas.

While no reef structures (including shipwrecks) will be covered, lost, or substantially affected by Alternative 3 (refer to Section 4.3.3.4), some hard and rough bottom areas will be impacted by burial — particularly east of the present MDS and in the vicinity of the former Cellar Dirt Site which overlaps the part of the eastern BZ and a small area of the PRA (refer to Figure 4-8). Additionally, Figure 4-9 shows that the PRA includes two major hook and line fishing areas to the east and west of the present MDS. These areas are dependent on hard/rough bottom features which will be altered by the placement of at least a 1 m cap of Material for Remediation. This alteration can be mitigated by placement of materials similar to the hard bottom types in these areas as it becomes available. Similarly, areas on the northern slope of the historical disposal mound, adjacent to the BZ and NDZ, support hook and line fisheries as well as trawling and lobster areas. These areas will also be potentially impacted by Alternative 3. Soft-bottom species, such as spotted hake, will be temporarily affected by loss of habitat, but are expected to recolonize the remediated areas as the infaunal and epifaunal communities become reestablished. If sandy Material for Remediation is in short supply, present sandy areas deeper than 20 m within the PRA could be transformed into silt and mud bottoms.

Loss of hard-bottom features under Alternative 3 will cause negative impacts to tautog, black sea bass, cunner, and lobster habitat. Loss of gravel and pebble substrates will negatively affect silver hake, cod, little skate, sea raven, longhorn sculpin, winter flounder, ocean pout, sea scallop, rock crab, and jonah crab. Most of these gravel and pebble species are also found in other habitats which are not expected to be permanently changed by remediation operations. Thus, gravel and pebble substrate species are expected to still reside in the HARS following remediation operations. However, hard-bottom fish, and to some degree lobster, may permanently lose habitat; the value of these resources will be proportionately impacted. No known natural processes are likely to reestablish hard-bottom features in the HARS after remediation operations are completed. However, it may be possible to mitigate for loss of hard-bottom habitat through the placement of similar material or artificial reefs within the HARS.

Under Alternative 3, habitat impacts to multi-habitat and mud-habitat fish will be temporary, and similar to Alternative 1. As placement of remediation sediment is conducted throughout the HARS, prioritized by degree of degradation, both pelagic and demersal fish and shellfish species may experience temporary habitat disruption. As previously discussed, water-column impacts will be brief and insignificant on the large scale of the affected resources. Demersal fish and shellfish that forage or shelter on mud and silt habitat will be little impacted, and the impacts will be self-mitigating as the remediation activities move to other parts of the HARS and the benthic communities are reestablished. All impacts to multi-habitat and mud-habitat fish and shellfish resources in the HARS will stop after completion of the remediation activities; no permanent negative impacts are anticipated.

Trophic Transfer of Contaminants. The trophic transfer of contaminants (discussed in Section 3.4.6.2) is another reason for establishing the HARS and conducting remediation of the degraded sediment areas. Trophic transfer is a function of bioaccumulation of contaminants from the sediment by infauna, and the efficiency of transferring the contaminants from prey to predator. Placement of at least a 1 m cap of Material for Remediation over the entire PRA will effectively and permanently isolate the contaminants in the sediments from the biotic zone of the New York Bight Apex.

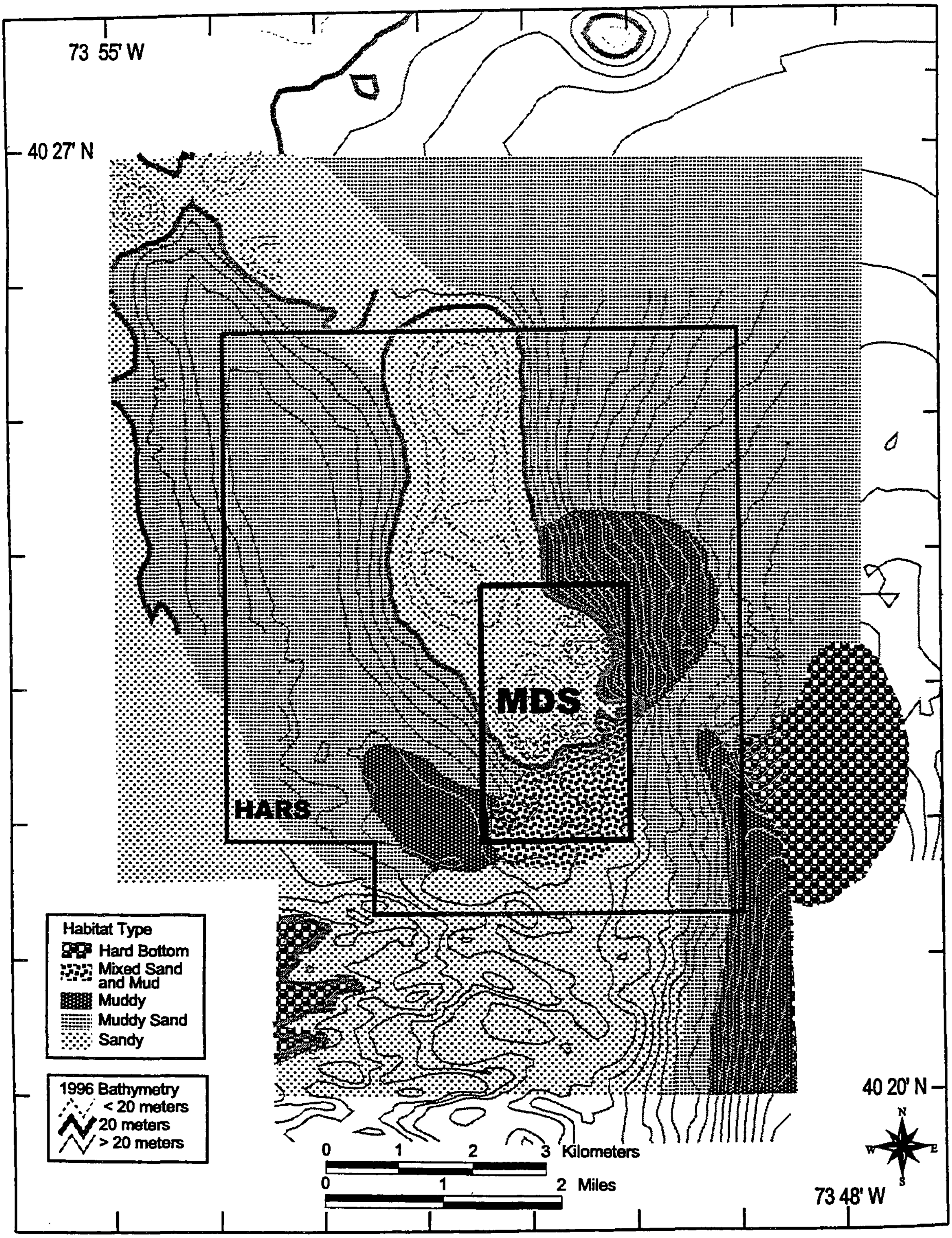

Figure 4-8. Major bottom habitat types of the MDS and HARS.

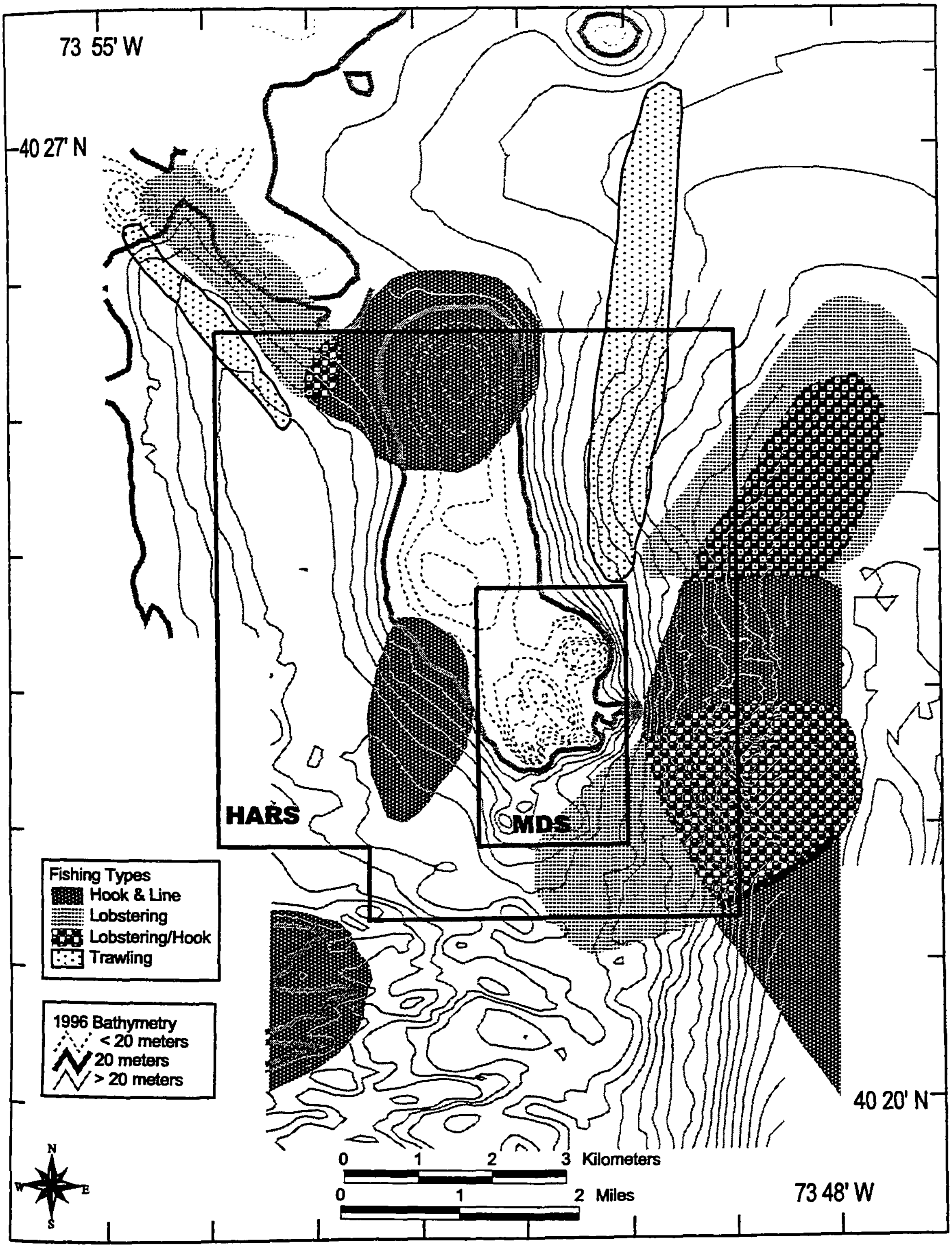

Figure 4-9. Major fishery areas of the MDS and HARS.

The rate that remediation operations are conducted will depend on availability of materials for remediation to cover the 9-nmi^2 PRA. While parts of the PRA are being remediated, other parts awaiting remediation will be exposed to fish and shellfish resources. Pollution control advances in the metropolitan region in the intervening period may alleviate part of this problem by leading to less contamination of natural sediments entering the Bight Apex, thus providing natural remediation.

On an Apex-wide basis, a general weight-of-evidence evaluation indicates that isolating degraded surface sediments in the HARS by capping them with remediation material will benefit the habitats of fish and shellfish resource species. However, the resulting habitat improvements are unlikely to be measurable by any resource stock-assessment procedure (e.g., quantitative fish trawls, bioaccumulation analyses). As discussed under Alternative 1, contaminant impacts to fish and shellfish from the presence of degraded sediments in the HARS are relatively small compared to impacts from fishing mortality, habitat losses, and eutrophication. Therefore, substantial improvements in habitat quality under Alternative 3 may not be detectable because of the ongoing magnitude of these other impacts.

Spawning. Impact to fish and shellfish spawning from Alternative 3 is generally the same as for Alternatives 1 and 4—potential interruption of spawning activities and sites, and burial of demersal eggs. As previously discussed relative to water-column impacts, placement events will be short and infrequent, and while not as spatially limited as Alternative 1, location-specific disruptions will be solitary events (as the remediation work is conducted across the PRA).

Potential spawning impacts will occur disproportionally to demersal eggs on the seafloor, particularly to fish and shellfish whose spawning periods coincide with their peak abundance in the New York Bight and who, then have the potential to lay a significant number of eggs within the PRA. The species most likely to be affected include winter flounder, sea raven, longhorn sculpin, little skate, ocean pout, and rock crab (refer to Section 3.4.3.3 in Chapter 3), through coverage of substrates (e.g., gravel and small rocks). When remediation is completed, the impacts to demersal eggs will stop. Unlike Alternative 1, but like Alternative 4, Alternative 3 would not significantly enhance topographic relief, and therefore would not result in any accompanying beneficial impacts to spawning and habitat..

As with fish and shellfish resource impacts related to habitat change and contaminant trophic transfer, total impacts to spawning from Alternative 3 will probably be masked by the natural variability of Bight-wide conditions, year-class variability of the individual species, and fishing activity.

Socioeconomic Considerations. Like Alternative 1, Alternative 3 is expected to affect the socioeconomic factors of fish and shellfish resources mostly through the public's perceptions of whether fish and shellfish resources are being affected by the operation of the HARS, and potential health risks associated with the consumption of seafood from the New York Bight.

As discussed earlier, decreases in availability of sediment contaminants to fish and shellfish under Alternative 3 are expected to be nondetectable by current stock assessment methods. Correspondingly, resource impacts, while expected to be positive (beneficial) from Alternative 3, will probably be masked by fishing mortality, habitat losses, and by contamination and eutrophication in the Bight.

With regard to potential human health risk, a weight-of-evidence evaluation indicates that isolation of contaminants in the degraded sediments from fish and shellfish resources should decrease potential for any human-health risks. However, because most of the HARS fish and shellfish resources are composed of species that forage over large areas, and some that are highly migratory, actual risk reduction may be low and probably unmeasurable. As discussed earlier under Alternative 1, public interpretation of technical data can significantly affect the socioeconomics of fish and shellfish resources under Alternative 3. If the public believes that HARS remediation under Alternative 3 decreases the risk associated with eating New York Bight seafood, commercial and recreational fishing activities may increase. With this in mind, meaningful prediction of the socioeconomic impacts on fish and shellfish resources of Alternative 3 is not possible at the present time.

Another socioeconomic impact of Alternative 3 relates to potential impacts on the Port of New York and New Jersey. Implementation of Alternative 3 would provide an EPA-designated site for Remediation Material. This would be consistent with aspects of the July 24, 1996, 3-Party Letter related to dredging of Port by helping assure long-term use of Category I dredged material.

4.3.3.5 Alternative 3 (Remediation) — Natural and Cultural Features of Historical Importance [228.6(a)(11)]

As summarized in Section 3.5.7, features of potential cultural historic importance were identified in the HARS following a cultural resources evaluation. These features included 6 shipwrecks and the old Cable Area identified on NOAA navigation charts.

While natural features within the HARS may contain artifacts of cultural significance, these features have been altered by erosion associated with sea level rise (Panamerican, 1997). Further, historic matter or artifacts contained within such natural features have likely been buried under the dredged material mound and are therefore preserved.

The former Cable Area that extends through the central and northwestern portion of the HARS (see Figure 3-86) was evaluated for potential historical significance (Panamerican, 1997). The evaluation found that while the Cable Area is potentially historically significant, available information on the Area is insufficient for a comprehensive evaluation, or determination of the exact location of any cables still buried. However, because the cables are buried, additional burial during remediation will not adversely impact these features. Should other Federal actions be proposed in the Cable Area, analysis of the cultural significance of these features should be reopened.

Side scan surveys located 6 shipwrecks on the seafloor within the HARS (Figure 4-10). Two shipwrecks (No's. 3 and 4) are located within the No Discharge Zone. One wreck (No. 2) is located in less than 20 m of water and is within the Buffer Zone of the HARS. Sediment in the vicinity of these three wrecks is sandy. The remaining three wrecks (No's. 1, 5, and 14) are located in water depths greater than 20 m and are within the PRA.

A cultural resource evaluation conducted by Panamerican (1997) evaluated whether any of these wrecks could be considered eligible for nomination to the National Register of Historic Places (NRHP). Wrecks No. 1 (*H.W. Long*), No. 2 (*Ormand*), and No. 4 (*G.L.#78*) could be assigned likely identifications. Wrecks 3, 5, and 14 could not be assigned to any identification. The *H.W. Long* was found to be not eligible for nomination to the NRHP and no recommendation for nomination has been made. The *G.L.#78* and *Ormand* were found eligible for nomination to the NRHP. Available information was insufficient to make recommendations of eligibility for the other four wrecks. Overall, the cultural resource evaluation was found consistent with Section 106 of the National Historic Preservation Act and further investigation for eligibility is not recommended for these wrecks (Panamerican, 1997). However, if other Federal actions are proposed in the vicinity of the wrecks, the analysis of the cultural significance for any wrecks potentially affected should be reopened.

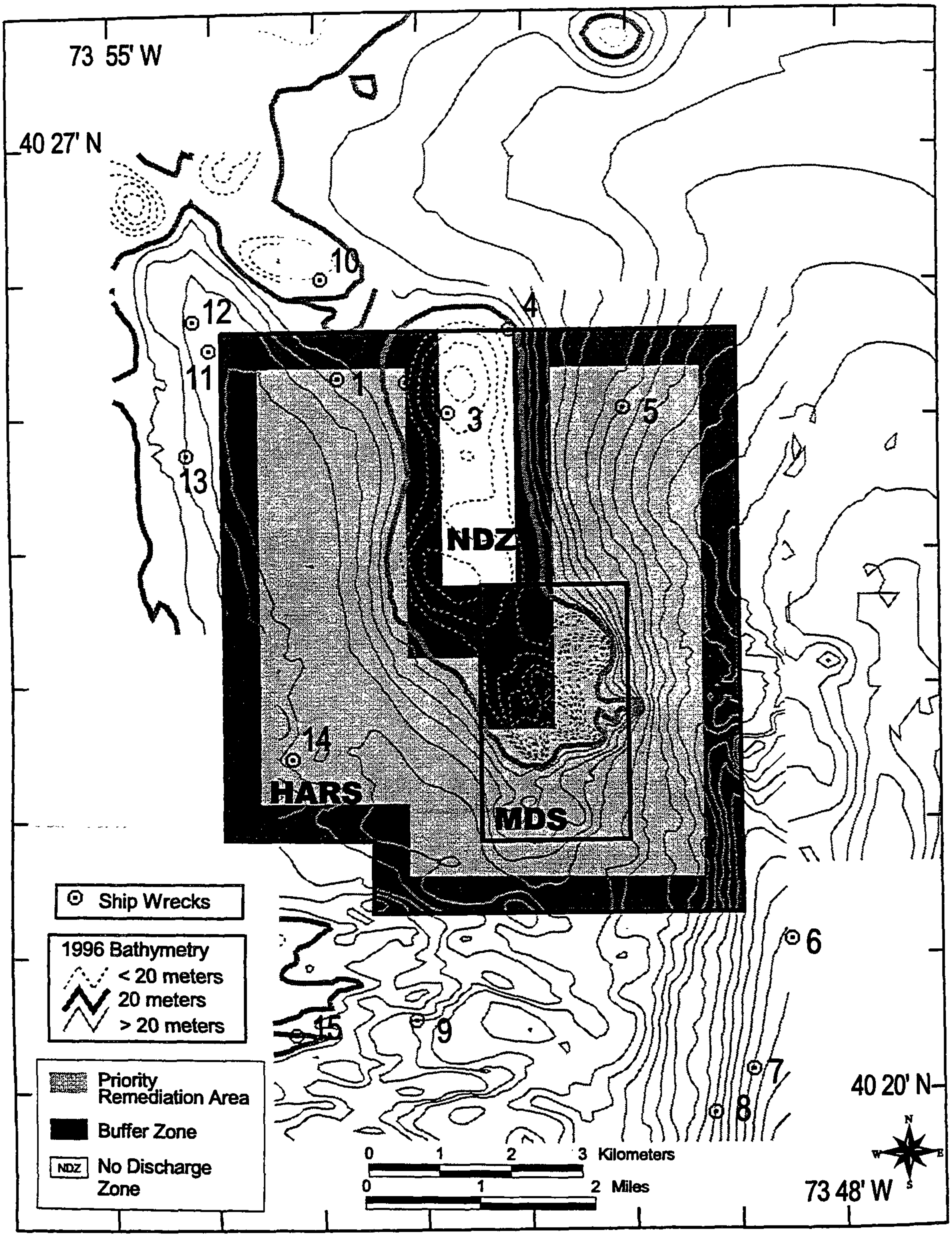

Figure 4-10. Location of side scan-identified shipwrecks on the sea floor of the HARS.

Based on these findings, avoidance or burial during placement of Remediation Material under Alternative 3 were considered as options to ensure the integrity of the wrecks. Each option has benefits and drawbacks which are considered below.

The major benefits of burial include:

- Preservation of the wreckage, and
- Isolation of the wreck from looting.

The drawbacks to burial include the necessity to excavate the wrecks should this be required in the future for those wrecks likely to be eligible for nomination to the NRHP or for which the potential for eligibility could not be determined, and the loss of fish and shellfish habitat provided by the wrecks. Also significant is the likelihood of further damage to the wrecks during burial, especially if the Remediation Material has boulders or other consolidated material that could crush exposed portions of the wreckage. If such actions were taken, any burial scenario would require that a marine archeologist define the appropriate materials and precisely control placement of material near or on the wrecks.

The benefits of avoidance include:

- Accessability for future cultural studies, and
- Availability of the wrecks as fish habitat.

The drawbacks include continued accessability of the wrecks to looting, physical, chemical and biological decay of the wreckage that is above the seafloor, and exposure of biota to contaminants in the surrounding degraded sediments. The latter factor is considered minimal given the ability of site managers to specify an avoidance distance from wreck locations. For example, if an avoidance distance of 500 m (0.27 nmi) radius from a wreck were established, approximately 0.79 Mm^3 (approximately 1 Myd^3) of Material for Remediation per wreck would be excluded. The area in the HARS that would not be remediated under this alternative is about 0.9 nmi^2 (3.2 km^2) or about 10% of the total area requiring remediation. Thus, the impact of not remediating these sediments with respect to bioaccumulation of sediments and transfer of contaminants to marine organisms is small and likely not measurable (see Section 4.3.3.3). The impact on the overall availability of contaminants relative to the Bight Apex is even less.

While eligibility for nomination to the NRHP of most shipwrecks in the HARS is unknown, it is likely that they are of some historical significance. Further, only two wrecks (No.'s 1 and 14) are located in the highest priority area for remediation. Consideration of the above factors, and the benefits and drawbacks of burial and avoidance during remediation, indicate that avoidance of the wrecks is preferable from a cultural resource perspective. This conclusion is based on the following.

- The significance of many of the wreck targets is unknown; accessability to the targets for future cultural resource evaluation is easier under the avoidance option than under the burial option.

- The relatively small areas in the vicinity of wrecks that would not be remediated will have minimal ecological impact on the overall anticipated improvements in the Bight Apex.

- The wrecks will remain fully available as fish and shellfish habitat.

- Potential damage to the wrecks from placement operations can be avoided using available technology.

Although avoiding the wrecks during remediation will not have any effect on these cultural resources, the option does not relieve any agency of the burden to pursue Section 106 of the NRHP for other Federal actions that may affect these wrecks.

4.3.3.6 Pros and Cons of Alternative 3

The following is a summary of the pros and cons of implementing Alternative 3. The pros and cons of all four alternatives are compared in Section 4.4 to justify the selection of the Preferred Alternative.

Alternative 3 Pros

- Meets the need for remediation
- Degraded sediment areas (exhibiting Category II and III type characteristics) throughout the PRA are capped with at least 1 m of Material for Remediation
- Decreased contaminant toxicity and bioavailability to fish and shellfish resources; increased habitat quality
- Reduced potential for trophic transfer of contaminants, including to human beings (seafood consumers)
- Decreased ecological and human-health risk
- The 500 m buffer zones delineated around all identified shipwrecks (1) ensure that Material for Remediation does not impact cultural or historic resources, (2) allow for further study of the sites for potential National Registry of Historic Places (NRHP) eligibility, and (3) have little impact on overall PRA remediation
- Habitat associated with the shipwrecks are maintained; no impact to reef fish and shellfish habitat
- Meets the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)" and "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

Alternative 3 Cons

- Small areas of unremediated sediment in the vicinity of HARS shipwrecks will remain exposed, and may continue to potentially impact fish and shellfish resources at these habitats
- Habitat disruption during PRA remediation operations
- Losses of some sandy and hard/rough-bottom habitat in degraded sediment areas

4.3.3.7 Monitoring and Surveillance for Alternative 3 [228.6(a)(5)]

As discussed under Section 4.3.1.8 for Alternative 1, the feasibility of surveillance and monitoring (physical, chemical, and biological factors) in the vicinity of the HARS has been demonstrated by surveillance and monitoring activities conducted at the MDS during the past 15 years. The location of the HARS near the mouth of the New York/New Jersey Harbor facilitates surveillance of placement operations as well as mobilization and operation of scientific surveys to the site. Surveillance and monitoring operations under Alternative 3 would follow activities similar to those defined in the MDS Site Monitoring and Management Plan (SMMP) (EPA Region 2/USACE NYD, 1997a).

4.3.4 Discriminating Impacts and Use Conflicts of Alternative 4 (Restoration)

4.3.4.1 Alternative 4 (Restoration) — Degraded Sediments [228.6(a)(7), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(i), 228.10(c)(1)(ii)]

Alternative 4 would use predominantly sandy material to cover and restore muddy surficial sediments that are degraded by bioaccumulative contaminants and toxicity in the PRA (refer to Figure 4-11 for Alternative 4 PRA location). The result will be that this alternative will, in the near-term following restoration operations, reduce contaminant levels in surface sediments of the PRA to levels lower than would occur under Alternative 3. Additionally, the use of sandy material for restoration will change the benthic habitat structure, particularly for infauna, epifauna, and demersal fish and shellfish that depending on mud sediments for food or spawning purposes. Over time, however, restored areas that are below 20 m will gradually accumulate new fine-grain sediment depositions from restoration operations elsewhere in the HARS and from natural sources. The "rebounding" of the fine-grain sediments in the deeper areas of the HARS will be most pronounced below 20 m — the depth below which only severe storm events (100-year frequency hurricanes/noreasters) influence sediment resuspension and transport. Contaminant concentrations in restored areas that subsequently receive new fine-grain materials from deposition of the Hudson River plume will likely change (increase) over time.[13] The limited area of degraded sediments above 20 m are predominantly sandy, and will become less contaminated and generally remain sandy following the placement of Remediation Material.

PRA areas that are deeper than 20 m will initially become less contaminated and sandier following restoration, but then will rebound back to muddy conditions due to natural sedimentation and transport processes for adjacent bottom areas. As the mud (carbon) content of these deep areas increases, contaminant concentrations will likely also rebound.

Another major factor of Alternative 4, compared to Alternative 3, is the additional time (and expense) necessary to cap the PRA with sandy Materials for Remediation. PRA restoration under Alternative 4, will be significantly longer than under Alternative 3 (possibly 3-5 times longer). The reason for this lengthy restoration period is that only sandy materials could be used, and these are relatively scarce (compared to other sediments). In addition, as discussed previously, there are competing demands for use of sand. Therefore, it would take significantly longer to get adequate volumes of sand to restore this site, and the sand that was obtained would likely be at greater expense. During this period, bioaccumulative

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[13] Ongoing natural sedimentation from the Hudson River plume and other sources will also occur under Alternatives 1, 2 and 3. However, because sandy material would not be placed in fine-grain, depositional areas under these other alternatives, there will not be an eventual "rebounding" of the bottom from sandy to fine sediments. Only in Alternative 4 will the PRA sediment grain-size, and associated biological communities, change from fine-to-coarse-to-fine conditions.

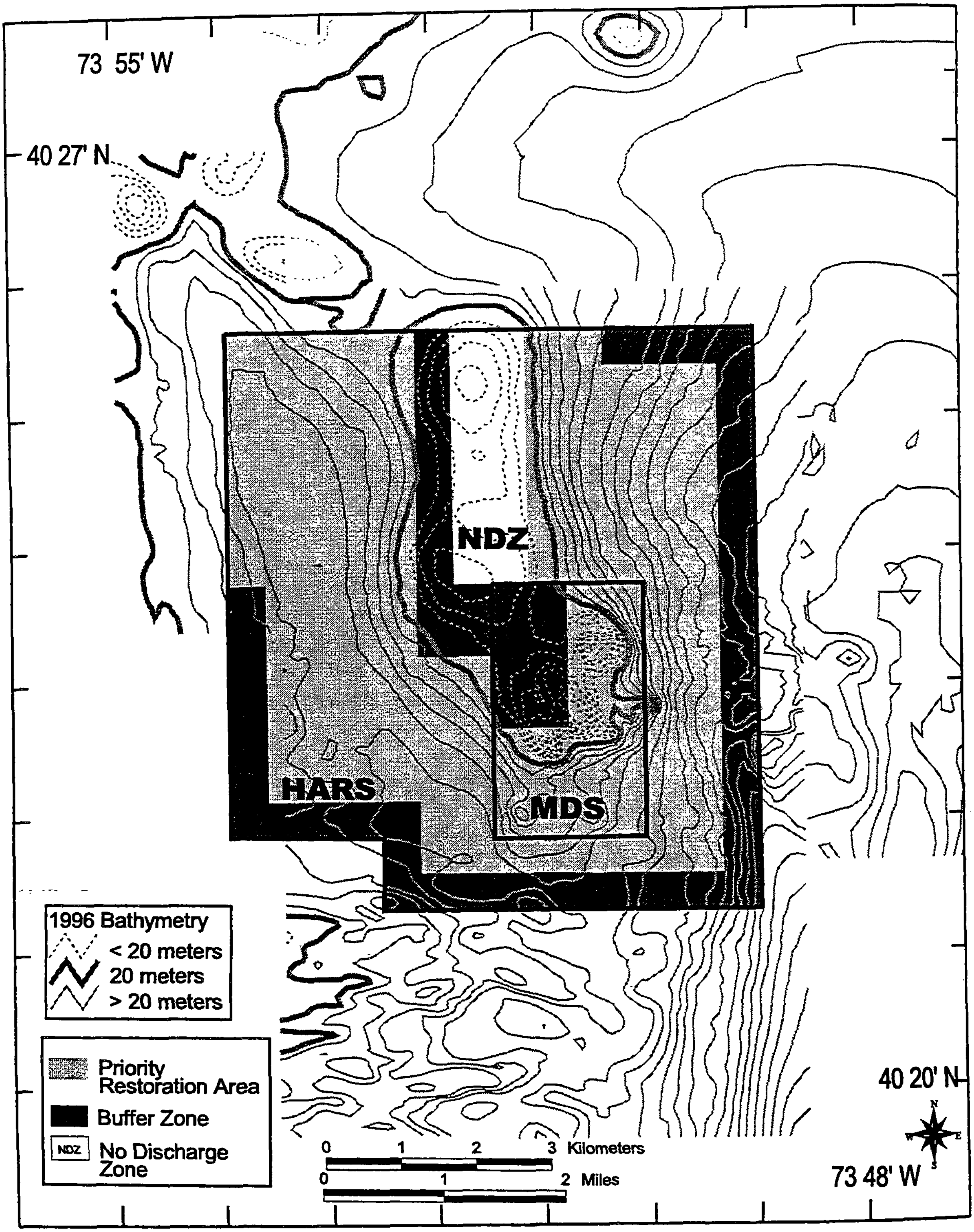

Figure 4-11. Alternative 4 Historic Area Remediation Site (HARS). The Priority Restoration Area (PRA) is the U-shaped, light-shade area. The surrounding dark-shade area is the HARS Buffer Zone (BZ). The unshaded area within the HARS is the shallow-water No Discharge Zone (NDZ), which contains no degraded sediments.

contaminants and toxicity in the surficial sediments will continue to remain exposed to the biotic zone (fish, shellfish, etc.) of the New York Bight Apex, and deep areas that are restored in the early years of the program will very likely receive new sediments and contaminants from near-bottom transport and deposition processes from adjacent areas awaiting restoration.

In summary, the positive aspects of restoring degraded sediment areas under this alternative are counterbalanced by the great period and expense to conduct the work and the potential for rebound back to muddy conditions in areas deeper than 20 m. During the restoration period, degraded sediment areas scheduled for future restoration will continue to expose their physical and chemical properties to resident organisms, as well as to adjacent areas that are nondegraded or have already been restored.

4.3.4.2 Alternative 4 (Restoration) — Benthic Infauna [228.10(b)(3), 228.10(b)(5), 228.10(c)(1)(ii), 228.10(c)(1)(iii)]

As discussed in Section 3.4.2 and Sections 4.3.1.1 and 4.3.3.1, there are two distinct benthic infaunal communities in the HARS. The sandy community (Community Group B, found on sandy sediments and at water depths less than 20 m) occupies 10-20% of the HARS and is generally not associated with sediments requiring restoration. Thus, Alternative 4 will have no impact on this community. In contrast, muddy sediment (Community Group A) organisms will be buried by restoration work. During the course of Alternative 4, approximately 60 to 70% of Community Group A in the HARS will be impacted by burial. However, these impacts will not occur simultaneously over the site, and will extend over a multi-year period. As in the case of Alternative 3, burial of benthic communities in the areas being restored will be a one-time effect. Restoration work at specific locations is not expected to be repeated unless monitoring shows that the capping operations were incomplete or ineffective.

The benthic communities that initially colonize the restored PRA are expected to be similar to the Group B communities presently found in areas shallower than 20 m. As discussed in Section 4.3.4.1, the grain size distributions of the surface sediments relative to those presently found in the degraded areas are expected to change from predominantly fines to coarse fractions under this alternative, and the benthic infaunal community will change correspondingly. Because this new Group B community will be located at more quiescent depths (i.e., less impact from storms), the likelihood of continual disturbance from natural events is low and the community will have a greater chance to become more stable.[14]

The long-term impact to benthic infauna under Alternative 4 will be influenced by several factors (i.e., the final community structure that develops, and the communities' contribution of the ecology of the Bight Apex ecosystem). Net community changes after restoration will be determined by (1) the rate that degraded sediments are restored (capped), (2) the rate that infaunal communities colonize the sandy sediments, and (3) natural factors such as transport and deposition of fine grained sediments into the restored areas that may modify habitat characteristics. These three processes will occur over relatively long time scales. While recolonization of these sediments will likely occur within an annual cycle after coverage, full infaunal recovery of the restored areas is likely to take several years (SAIC, 1997). Faster restoration rates will have greater immediate impact (faster reduction of degraded areas; faster change in the benthic community type), and provide less time for the benthic ecosystem to adjust to the changes. In contrast, slower restoration rates will enable the ecosystem to adjust more slowly which may mitigate the impact of altering the sediment texture in the degraded areas.

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[14] At the >20 m level, the shallowing of the water column by approximately 1 m by restoration operations will not expose the new Group B communities to a more energetic environment.

The most important consideration, relative to benthic infauna changes under Alternative 3, is that all sandy Material for Remediation placed in the HARS under Alternative 4 will eventually be covered by fine-grain natural sediment, which is continually deposited in the Bight Apex. Infaunal communities presently inhabiting fine-grain areas (Group A communities) of the Alternative 4 PRA will be displaced for a period of years following restoration operations. During the Group A displacement period, Group B infauna that prefer sandy environments are expected to colonize the restored areas. As the restored areas gradually revert to fine-sediment environments by natural processes, Group A communities are expected to become reestablished (and Group B habitat created by the restoration operations will be lost). A significant unknown factor is how predator communities will respond to the temporary loss of Group A infauna prey, and the temporary presence of Group B infauna. Another unknown factor is whether the natural sediment deposited over restored areas will cause toxicity or contain less bioaccumulative contaminants than presently in the PRA.

In summary, predicting the effects of Alternative 4 on benthic infauna is complicated by the transport and deposition of fine-grain sediments into the restored areas from external sources such as the Hudson River plume and bedload sediment movement. However, because most of the restored sediments will be located in relatively quiescent areas (below the depth of storm induced erosion), gradual post-restoration deposition of fine particles is expected to recreate Community Group A habitat that is capped by sandy Material for Remediation. The import of external fine sediments to the restored PRA will be the rate-limiting step for long-term response by benthic infauna.

4.3.4.3 Alternative 4 (Restoration) — Contaminant Bioaccumulation [228.10(b)(6), 228.10(c)(1)(iii)]

Relative to Alternative 3 and the discussions in the preceding two sections, capping the PRA with sandy Material for Remediation under Alternative 4 will lower bioaccumulation potential for benthic prey species, because sand has generally less contaminants than fine-grain sediments.

In Battelle (1997b), infauna from sandy stations of the Study Area had substantially less contaminant body burdens than infauna from muddy stations. Therefore, it is logical to conclude that as the PRA is restored with sandy material under Alternative 4, infauna bioaccumulation will be lower, and infauna predators' (e.g., demersal fish and lobsters) body burdens will be lower as well. On an ecosystem-wide basis, and with regard to fish and shellfish resources in the Bight Apex, the change in bioaccumulation is expected to be beneficial; however, it will also probably be nondetectable by current measurement technologies.

An unknown factor relative to Alternative 4 and its effect on contaminant bioaccumulation is how and whether predators currently feeding on Community A infauna in the PRA will respond to the restoration operations and the temporary removal of food sources. Lobster, for example, inhabit the muddy areas and consume polycheates, which are generally lower in abundance in sandy sediments. It is likely that Alternative 4 will negatively affect the lobster resource by forcing the animals either to change to a less-preferred/inferior food source or to forage outside the PRA until fine sediments are redeposited by natural processes and polychaete abundance is restored. Similar impacts may occur to winter flounder and yellowtail flounder (see Table 3-18 in Chapter 3).

4.3.4.4 Alternative 4 (Restoration) — Fish and Shellfish Resources [228.6(a)(2), 228.6(a)(8), 228.6(a)(11), 228.10(b)(2), 228.10(b)(4), 228.10(b)(6), 228.10(c)(1)(ii), 228.10(c)(1)(iii), 228.10(c)(1)(iv), 228.10(c)(1)(v)]

The primary benefit of Alternative 4 to fish and shellfish resources will be the isolation of degraded sediments and contaminants in the HARS. As discussed earlier, Figure 4-6 shows degraded areas are west and southwest of the historic disposal mounds in the center of the HARS, and along the eastern and southern borders of the present MDS. By covering degraded sediments with sandy Material for Remediation, fish and shellfish resources that feed or shelter on this type of substrate should benefit. Correspondingly, fish and shellfish that depend on mud or silt sediments or hard bottoms in the PRA will be negatively impacted. In the short term, the impacts to these species will be unmitigatable.

Like Alternatives 1 and 3, Alternative 4 will cause periodic habitat and spawning disruption. As infaunal and epifaunal communities in the degraded areas are covered with at least a 1 m cap of sandy Material for Remediation, the areas will be temporarily removed as sources of food and habitat for demersal fish and shellfish until they are recolonized. Impacts from direct burial of sediment are expected to be about the same as the other alternatives, but impacts from suspended material are expected to be substantially less.

When the HARS is fully restored, all of the degraded sediments within the PRA will be buried and isolated from the biotic environment, restoration operation impacts (e.g., plumes) to demersal and pelagic fauna will stop, and the site will eventually be colonized by infaunal and epifaunal communities that inhabit sandy sediments. As with Alternative 3, the stability of final benthic communities and associated fish and shellfish species under Alternative 4 will depend on surface sediment characteristics (grain size, organic carbon content, contamination), storm events, ecosystem dynamics, regional pollution sources, and fishing pressure.

As restoration operations are conducted in the PRA, shoreward areas of greatest degradation will be restored first. Commercially, recreationally, and/or ecologically important fish and shellfish in these areas will be impacted to varying degrees. Most of these impacts will be spatially limited, temporary, and probably nondetectable by present resource assessment measures (e.g., trawl surveys). Under Alternative 4, fish and shellfish dependent on sandy sediments should experience a net benefit and improved environment. Multihabitat, soft-bottom, and hard-bottom fish and shellfish will be impacted during and after restoration operations, but over time, their habitats will gradually recover as new fine sediments are deposited by natural processes. Mitigative measures for any loss of hard bottom communities may also be implemented if appropriate materials become available (see below).

Water-Column Impacts. Similar to the impacts described under Alternatives 1 and 3, restoration operations will potentially affect individual fish and shellfish by collision with falling dredged material and oxygen-exchange interruption by sediment plumes. Like the other alternatives, acute and sublethal impacts from falling sediment are isolated and infrequent enough to be insignificant. Furthermore, because of the use of only sandy Material for Remediation under Alternative 4, direct impact from potential impairment of oxygen exchange by plumes is expected to be less of a factor than from either Alternative 1 or 3.

As for Alternative 3, HARS restoration operations will require that the placement vessels evenly spread the sediments along the bottom relatively evenly. The resulting sediment plumes may be somewhat larger than those created following an MDS disposal event, like under Alternative 1, but the sandy Material for Remediation used in Alternative 4 will have significantly fewer fine-grain particles and corresponding lower TSS concentrations. Alternative 4 plumes are thus expected to (1) be less persistent than either the Alternative 1 or 3 plumes, (2) be well below the 100 mg/L effects threshold concentration reported by O'Connor (1991-SF Bay Rept), and (3) result in $<25\%$ DO depression after allowance for initial mixing.

Habitat Change. Under Alternative 4 the HARS will initially receive approximately 40.5 Myd^3 of sandy Remediation Material. Silt and mud surface sediments in the HARS will be changed to a large-grain sandy substrate.

No reef structures (including shipwrecks) will be covered, lost, or substantially affected by Alternative 4, but several square kilometers of hard and rough bottom areas will be impacted by burial — mostly east of the present MDS and in the vicinity of the former Cellar Dirt Site (refer to Figures 3-18 and 3-19). As with Alternative 3, several large areas of the HARS that support various commercial and recreational fishing operations will be permanently impacted (compare Figure 4-8 to Figure 4-9). Lost hard-bottom habitat includes two major hook and line fishing areas to the east and west of the present MDS. Losses will be due to placement of the 1 m cap of sandy Material for Remediation.

An additional hook and line area on the northern slope of the historical disposal mound, and several trawling and lobster areas will be lost in the later stages of the HARS restoration. Soft-bottom (mud) species, such as spotted hake, will permanently lose all habitat in the HARS. Multi-habitat species are expected to continue to be present throughout the HARS during the restoration period. The resulting densities and viability of these species will depend mostly on Bight-wide factors, including fishing pressure, pollution sources, and eutrophication.

Loss of hard-bottom features and muddy sediments under Alternative 4 will cause negative impacts to tautog, black sea bass, cunner, spotted hake, and lobster habitat. Loss of gravel and pebble substrates will negatively affect silver hake, cod, little skate, sea raven, longhorn sculpin, winter flounder, and ocean pout, sea scallop, rock crab, jonah crab. Most of these gravel and pebble species are also found in other habitats which are not expected to be permanently changed by restoration operations. Thus, gravel and pebble substrate species are expected to still reside in the HARS following site restoration. However, the hard bottom and mud-bottom fish, and to some degree lobster, will permanently lose habitat; the value of these resources will be proportionately impacted.

Construction of artificial reefs could be conducted to compensate for loss of hard-bottom features in the HARS. No known natural processes are likely to reestablish hard-bottom features in the HARS.

Habitat impacts to multi-habitat fish will be temporary, and similar to the other alternatives. Both pelagic and demersal fish and shellfish species may experience temporary habitat disruption. As previously discussed, water-column impacts will be brief and insignificant on the large scale of the affected resources. Demersal fish and shellfish that forage or shelter on sandy habitat will be little impacted, and the impacts will be self-mitigating as the restoration activities move to other parts of the HARS and the benthic communities are reestablished. All impacts to multi-habitat fish and shellfish resources in the HARS will stop shortly after completion of the restoration activities; no permanent negative impacts are anticipated.

As discussed under Alternatives 1 and 3, contaminant impacts to fish and shellfish from degraded sediments in the HARS are relatively small compared to impacts from fishing mortality, habitat losses, and eutrophication. Given the lengthy restoration period, in addition habitat improvements under Alternative 4 are unlikely to be measurable by any resource stock-assessment procedure (e.g., quantitative fish trawls). Substantial improvements in habitat quality by Alternative 4 will not be detectable because of the ongoing magnitude of these other impacts, particularly from commercial and recreational fishing mortality. The magnitude and scale of these other impacts could change dramatically during the lengthy course of the PRA restoration operations.

Trophic Transfer of Contaminants. Control of contaminant bioaccumulation and the potential for trophic transfer (discussed in Section 3.4.6.2) is a principal reason for establishing the HARS and conducting restoration of the degraded sediment areas. As with Alternative 3, the placement of at least a 1 m cap of sandy Remediation Material over the degraded sediments in the PRA will effectively and permanently isolate the contaminants in the sediments from the biotic zone of the New York Bight Apex. The small fraction of fine-grain sandy material that escapes into the water column will quickly (within 3 h) become unmeasurable and not degrade the bottom.

A main negative aspect of Alternative 4 relative to trophic transfer of contaminants is that the degraded areas in the HARS will continue to be exposed to the environment for a prolonged period. This is primarily due to the large size of the Alternative 4 PRA and the expected limited availability of sandy Materials for Remediation. The lengthy restoration period will allow degraded sediments awaiting restoration to continue to impact fish and shellfish resources. Pollution control advances in the metropolitan region in the intervening period may lessen this problem by reducing contamination of natural sediments entering the Bight. With the expected long period for PRA restoration operations, it is very likely that some degraded sediments will be partially remediated by natural sedimentation before restoration work is conducted. However, this natural remediation will be predominantly of fine-grain, muddy and silty material.

Spawning. The primary impact to fish and shellfish spawning from Alternative 4 is expected to be minor. Losses of fine-grain sediments during placement operations (i.e., plumes) will be infrequent and small. Thus, impacts from plumes to demersal eggs are expected to be insignificant. Impacts could result to fish and shellfish that spawn or attach eggs to rocks or hard substrates (e.g., ocean pout). Artificial reefs could be placed in the area to mitigate for losses in this habitat type.

When restoration is completed, the minor impacts from restoration activities to demersal eggs will stop. Like Alternative 3, there will be no beneficial impacts to spawning and habitat from enhanced topographic relief. Alternative 4 will not appreciably change large-scale topographic features in the HARS.

As with fish and shellfish resource impacts related to habitat change and contaminant trophic transfer, total impacts to spawning from Alternative 4 will most certainly be masked by the natural variability of Bight-wide conditions, year-class variability of the individual species, and fishing activity.

Socioeconomic Considerations. Like the other alternatives, Alternative 4 is expected to affect the socioeconomic factors of fish and shellfish resources through the public's perceptions of whether fish and shellfish resources are being affected by the operation of the HARS, and potential health risks associated with the consumption of seafood form the New York Bight.

As discussed earlier, decreases in contaminant impacts to fish and shellfish under Alternative 4 are expected to occur slowly and will likely be nondetectable by current stock assessment methods. Both negative and beneficial impacts to the resources caused by this alternative will be masked by fishing mortality, habitat losses, eutrophication and non-dredged material contamination in the Bight. Similarly, the increment of human-health risk reduction from isolation of bioaccumulative contaminants and toxicity in the sediments will probably be nondetectable over the course of the lengthy restoration period. During this period, public perceptions toward seafood and fishing could change many times, as could other factors that affect resource utilization (i.e., fishing) and the related socioeconomics of affected industries (e.g., gear and boat sales/rentals, shoreline business and tourism).

Another socioeconomic impact of Alternative 4 relates to potential impacts on the Ports of New York and New Jersey. Implementation of Alternative 4 would provide an EPA-designated site only for sandy Remediation Material. Alternative 4 thus is not as effective in assuring the long-term use of Category I dredged material as Alternative 3 as stated in the 3-Party Letter.

4.3.4.5 Alternative 4 (Restoration) — Natural and Cultural Features of Historical Importance [228.6(a)(11)]

There are no substantive differences between Alternatives 3 and 4 relative to the historical features of importance in the HARS. Therefore, the consequences and assessment result in a recommendation that avoidance of the wrecks in the HARS, with appropriate management and control over placement operations, has no impact to the cultural value of the wrecks located in the area to be restored.

4.3.4.6 Pros and Cons of Alternative 4

The following is a summary of the pros and cons of implementing Alternative 4. The pros and cons of all four alternatives are compared in Section 4.4 to justify the selection of the Preferred Alternative.

Alternative 4 Pros

- Meets the need for remediation
- Degraded sediment areas (exhibiting Category II and III type characteristics) throughout the PRA capped with at least 1 m of sandy (1-10%) Material for Remediation
- Decreased contaminant bioavailability and possible sublethal effects to fish and shellfish resources; increased habitat quality
- Reduced potential for trophic transfer of contaminants, including to human beings (seafood consumers)
- Decreased ecological and human-health risk
- The 500 m buffer zones delineated around all identified shipwrecks (1) ensure that material for restoration does not impact potential cultural or historic resources, (2) allow for further study of the sites for potential NRHP eligibility, and (3) have little impact on overall PRA restoration
- Habitat associated with the shipwrecks are maintained; no impact to reef fish and shellfish habitat
- Meets the intent of the July 24, 1996, 3-Party Letter regarding: "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause undesirable effects including through bioaccumulation)."

Alternative 4 Cons

- Loss of mud, muddy-sand, and rough/hard-bottom habitats; possible negative effects to living resources (e.g., lobster and winter flounder)
- Lengthy restoration period, and continued exposure of degraded sediments to the biotic zone of the New York Bight Apex
- Limited availability of Remediation Material from the Port of New York and New Jersey and surrounding areas
- Small areas of unrestored sediment in the vicinity of HARS shipwrecks will remain exposed, and may continue to potentially impact fish and shellfish resources at these habitats
- Does not meet the intent of the July 24, 1996, 3-Party Letter regarding: "The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material."

4.3.4.7 Monitoring and Surveillance for Alternative 4 [228.6(a)(5)]

Monitoring and surveillance feasibility and questions for Alternative 4 are the same as described under Alternative 3. In addition to the hypotheses tested under Alternative 3, monitoring will also test hypotheses related to habitat and predator-prey interactions resulting from covering mud and silt areas with sandy Remediation Material, and corresponding changes to recreational and commercial fish and shellfish resources.

4.4 Preferred Alternative

An iterative comparison of the physical, chemical, biological, and socioeconomic impacts of the four alternatives has led EPA to select Alternative 3 as the Agency's Preferred Alternative. Alternative 3 was found to have the most benefits and the least negative impacts for meeting the need for remediation in the Historic Area Remediation Site, and helping assure the long-term use of Category I dredged material.

Alternative 3 is the alternative that can most quickly remove from the biotic zone of the New York Bight Apex the potential risks presented by the degraded sediments of the PRA. Capping the PRA with Material for Remediation will also prevent the degraded sediment erosion and dispersion by seafloor processes and storm events, and the associated exposure of bioaccumulation contaminants and toxicity in these sediments.

The July 24, 1996, 3-Party Letter states "designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material." As Alternative 4 only allows for the use of sandy Material for Remediation, otherwise acceptable Remediation Material from the Port that is composed of silts and clays would be excluded from restoration operations, rather than being used for remediation. In addition, such materials would potentially need to be disposed in non-ocean sites (e.g., harbor pits and landfills). The placement of silt and clay material suitable for remediation in nearshore and upland locations will, in addition to being expensive, unnecessarily consume disposal capacities of non-ocean sites that can accept Category II and III material; it will also waste a resource that can expeditiously remediate the degraded sediments of the HARS. Filling of nearshore and upland disposal sites with large volumes of silt and clay material suitable for remediation is less preferable than using such sites for Category II and III disposal, where transportation and containment costs and environmental risks can be minimized.

Alternative 3 also presents the most positive and fewest negative impacts to commercial, recreational, and ecologically important fish and shellfish. Fish and shellfish inhabiting degraded areas will be only temporarily displaced by placement of at least a 1 m cap of Material for Remediation. Few fish and motile shellfish will be directly impacted by the remediation operations, but infauna and epifauna prey organisms will be buried. The associated fish and shellfish will not be able to forage at the remediated areas until the prey communities become reestablished. Recolonization of the prey communities (benthic infauna), specific to the quality of the Remediation Material, is expected to occur within about one year; full recovery may take several years. Area-specific recovery periods will depend largely on the season during which the dredged material is placed on the site, recruitment success of infaunal and epifaunal species, and storm events, if any.

Some areas of high-relief and mixed habitat (e.g., east of the Mud Dump Site) will be permanently lost under Alternative 3, but no more so than would occur under Alternative 4. Leaving these areas unremediated, as would occur under Alternatives 1 and 2, will allow continued exposure of degraded sediments in these areas. Except for the isolation of the degraded sediment by burial, and the loss of some hard-bottom habitat, the diverse habitat types that exist within the borders of the HARS will be maintained during and after the remediation operations. After all remediation work is complete at the HARS, benthic conditions within the site are expected to remain static, affected only by occasional severe storms, coastal pollution, and fishing activities.

Management of the HARS under Alternative 3 is summarized in Chapter 5. Details are provided in EPA's (1997) HARS SMMP document (see Appendix C). The division of the PRA into nine 1-nmi^2 cells facilitates comprehensive benthic characterization of the site, as well as management of the Remediation Material placement operations and post-placement monitoring. If monitoring activities show that the remediation work for a particular cell is incomplete, or otherwise not containing the underlying degraded sediments, additional remediation or other work will be conducted.

Finally, compliance with the National Historic Preservation Act (NHPA) under Alternative 3 is met by avoidance of the six shipwrecks in the HARS during remediation operations. Only four of the wrecks are located in high-priority remediation areas. The continued exposure of degraded sediments within 500 m of the wreck structures is considered by EPA to be acceptable for compliance with the NHPA, preservation of the wrecks for future cultural-resource evaluations, and use of the wrecks as reef structures for fish and shellfish species that preferentially inhabit the wreck for shelter and food sources.

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
40 CFR Sections 228.5(a-e): General Criteria for the Selection of Sites				
228.5(a): Avoid interference with other activities - areas of existing fisheries or shellfisheries - regions of heavy navigation	1. Several fish and shellfish are found in the MDS; disposal operations periodically disrupt their habitats (M) 2. Anecdotal evidence of fish attraction to disposal areas (N) 3. At site closure, sandy habitat will predominate; fish such as spotted hake and red hake will loose habitat, demersal fish and crabs will loose access to some prey species; no significant habitat change outside the site (M/N) 4. MDS is outside of the major navigation lanes but in precautionary zone (M/N) 5. No reported interferences under present disposal practices (M/N)	Not applicable	1. Several fish and shellfish areas may receive short-term impacts as habitats in the PRA are remediated (M) 2. Location of some remediation areas in major navigation areas; may cause some short-duration interference (M) 3. Experience at the MDS indicates interferences can be managed and mitigated (M)	1. Several fish and shellfish areas may receive short-term impacts as sandy habitats are restored; muddy habitat fish will have longer term impacts (M) 2. Change of muddier bottom areas to sandier sediment may alter prey habitat and community, resulting in changes to fish and shellfish resources (U) 3. Rate of restoration operations will allow the ecosystem time to respond and will likely minimize long-term impact (N) 4. Same as 2 and 3 of Alternative 3

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.5(b): Perturbations to the environment during initial mixing; reduction to ambient levels - before reaching beaches, shoreline, marine sanctuary - before reaching geographically limited fishery or shellfishery	1. Dilution is rapid; plume concentrations reach ambient levels within 1 h (M) 2. Plumes do not reach any shorelines or areas of special concern (N) 3. There are no geographically limited fisheries or shellfisheries in the area (N) 4. Management actions can be implemented to ensure transport beyond site boundaries during initial mixing are minimized (M) 5. Compliance with EPA Ocean Dumping Regulations ensure that WQC are not exceeded outside the MDS (M)	Not applicable	1. Dilution is rapid; plume concentrations reach ambient levels within 1 h (M) 2. Plumes do not reach any shorelines or areas of special concern (N) 2. There are no geographically limited fisheries or shellfisheries in the area (N) 3. Buffer Zone ensures transport beyond HARS boundaries during initial mixing are minimized (N) 4. Compliance with EPA Ocean Dumping Regulations ensure that WQC are not exceeded outside the HARS (N)	1 - 4 are the same as Alternative 3 2. Plumes do not reach any shorelines or areas of special concern (N) 5. Sandy nature of the restoration material will likely result in minimal plume development (N) 6. Compliance with EPA Ocean Dumping Regulations ensure that WQC are not exceeded outside the HARS (N)
228.5(c): Closure of interim ODMDSs	Not applicable	Not applicable	Not applicable	Not applicable

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.5(d): The size of disposal sites will be limited - for identification and control of any immediate adverse impacts - for implementation of monitoring and surveillance to prevent long-range impacts	1. No evidence of immediate adverse impacts attributable to the operation at the MDS (N) 2. Ability to conduct surveillance and to monitor for short- and long-term impacts have been demonstrated by routine monitoring programs and collection of information to support development of this SEIS and other studies (N)	Not applicable	1. HARS boundaries delineated to encompass sediment areas affected by historic dredged material disposal; PRA divided into 1 nmi^2 cells to ensure remediation is complete (N) 2. Same as #2 for Alternative 1	1. HARS boundaries delineated to encompass sediment areas degraded by dredged material disposal; PRA divided into 1 nmi^2 cells to ensure remediation is complete (N) 2. Same as #2 for Alternative 1
228.5(e): Designating historically used sites or sites beyond the continental shelf	1. Area is a designated site (N) 2.The purpose of the SEIS was to evaluate the need for remediation/restoration of historically used disposal areas in the Bight Apex; candidate disposal sites beyond the continental shelf were not evaluated (N)	Not applicable	1. HARS includes Bight Apex areas that have received dredged materials for over 100 years (N) 2. Sites beyond the continental shelf were not evaluated under this SEIS (N)	1-2. Same as Alternative 3

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
40 CFR Sections 228.6(a)(1-11): Specific Criteria for Site Selection				
228.6(a)(1): Geography, depth, topography, distance from the coast	1. Located in inner New York Bight, west of the drowned Hudson Shelf Valley (N) 2. Site 2.2 nmi^2 (7.8 km^2) located on naturally occurring sand covered with dredged material since 1978 or earlier (N) 3. Present depths range from 15.8 to 28.8 m (52 to 94 ft) (N) 4. Topographic high created by dredged material disposal dominates the northern 2/3 of site; southern 1/3 is deeper; mound flank forms eastern slope of shallow basin to the west; eastern flank grades into the Hudson Shelf Valley (N) 4. Nearest coastline is 5.3 nmi to the west (N) 5. Mound surface sediments primarily sand; greater portion of fine-grain sediments material below 20 m; variable grain size in southern 1/3 of the MDS (N)	Not applicable	1. Same as Alternative 1 2. PRA is 9.0 nmi^2 (31 km^2) located on naturally occurring sands covered with dredged material since 1978 or earlier (N) 3. Depths ranges from 14 to 42 m (46 to 138 ft) (N) 4. Apex of the historic dredged material mound extends through central portion of the HARS; shallow basin dominates western PRA; eastern third slopes from mound apex towards axis of Hudson Shelf Valley (N) 5. Nearest coast line is 3.5 nmi east of Highlands, NJ (N) 6. Sediments in deeper areas fine-grain; shallower areas sandy (N)	1. Same as Alternative 1 2. PRA is 10.3 nmi^2 (35.5 km^2) located on naturally occurring sands covered with dredged material since 1978 or earlier (N) 3-6. Same as Alternative 3.

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(2): Location relative to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile stages	1. Fish and shellfish resources throughout Bight Apex are diverse; 28 fish, 2 squid, and 6 benthic shellfish in the area are commercially, recreationally, or ecologically important (N) 2. Area is transitional habitat for most fish species; many spawn in or near Bight; most spawn planktonic eggs; demersal species spawn throughout Bight (N) 3. Many fish in area are multi-habitat species (N) 4 Pelagic fish and squid unaffected by disposal operations (N) 5. Relatively high diversity of marine mammals and sea turtles; low resident, nonmigratory population; no evidence of impact to these species (N) 6. High diversity of pelagic birds that breed outside Bight Area; some feed in waters of the Apex; no evidence of impact (N)	Not applicable	1-6. Same as Alternative 1 7. Short-term loss of some fish habitat during remediation operations with silt and clay material (M)	1-6. Same as Alternative 1 7. Short-term loss of some fish habitat during restoration operations with sandy material (M) 8. Long-term alteration of muddy habitats at >65 ft (20 m) BMLW (U in the short-term; N in the long-term)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(3): Location relative to beaches and amenities	1. Located at least 5 nmi from nearest beaches and amenity areas (N) 2. No areas of special concern in or near the site (N)	Not applicable	1. Located at least 3.5 nmi from the nearest beaches and amenity areas (N) 2. No areas of special concern in or near the HARS (N)	1-2. Same as Alternative 3
228.6(a)(4): Types and quantities of wastes and disposal methods (including packaging methods)	1. Only material in compliance with U.S. Ocean Dumping Regulations, USACE Permits, EPA Region 2/ USACE NYD Regional Testing Manual, and MDS SMMP can be disposed; most sediments are fine-grained and predominated by clays and silts (N) 2. Up to 31 Myd^{3} of Category I material (N) 3. Approximately 2.5 Myd^{3} per year are disposed (N) 4. Split-hull barges and self-contained hydraulic dredges of 4000-6000 yd^{3} capacities; dispose at predetermined areas marked by buoys and specified in disposal permits; vessels slowly moving when discharging to avoid development of steep mounds that exceed site management depth (N)	Not applicable	1. Per the July 24, 1996, 3-Party Letter, the HARS is designated to reduce impacts to acceptable levels in accordance with 40 CFR 228.11(c). (N) 2. PRA will be remediated with at least 1 m (3 ft) of Material for Remediation; remediation operations prioritized by degree of habitat degradation; cells with greatest degradation and closest to shoreline remediated first (N) 3. PRA requires over 40.6 Myd^{3} Material for Remediation (N) 4. Same as Alternative 1	1 and 4. Same as Alterative 3 except that the capping material will be sand 2. PRA will be restored with at least 1 m (3 ft) of Material for Remediation; remediation operations prioritized by degree of habitat degradation; cells with greatest degradation and closest to shoreline remediated first (N) 3. PRA requires over 46.4 Myd^{3} of sandy dredged Material for Remediation (N)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(5): Feasibility of site surveillance and monitoring	1. MDS surveillance and monitoring conducted jointly by EPA Region 2, USACE NYD, and USCG (B) 2. Bight Apex location and shallow depths facilitate monitoring and minimize monitoring costs relative to more distant or offshore locations (B) 3. Comprehensive knowledge and data of present conditions ensures unacceptable impacts are readily detected, evaluated, and managed as appropriate (B)	1. Surveillance and monitoring of dredged material disposal operations per MDS SMMP will stop when the site is closed. EPA and the USACE will continue to work with applicable Federal agencies on future monitoring work.	1-3. Same as Alternative 1	1-3. Same as Alternative 1

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(6): Site dispersion, transport, mixing characteristics, including prevailing currents direction and velocity	1. Prevailing long-term net currents are to the south (N) 2. Local currents are dominated by oscillatory tidal forces and result in no net transport of water (N) 3. Short-term dispersion in the water column is a function of tidal forces and currents at the time of discharge (M) 4. Deposited sediments are relatively stable under non-storm conditions (N) 5. Resuspension and dispersion after deposition is primarily caused by major storm activity such as 100 year frequency storms (i.e. hurricanes or noreasters); the most intense storms can resuspend and transport sandy sediments deposited in less than 20 m of water (U) 6. Deposited sediment texture and water depth control storm effects/transport (M) 7. Potential for transport of material to beaches and amenities is negligible (N)	Not applicable	1-7. Same as Alternative 1 8. Material used for remediation in the PRA would be subjected to dispersive forces only during very intense storm events (ca. 100-yrs) (U)	1-7. Same as Alternative 1 8. Sandy materials used for restoration will have greater resistance to dispersive forces than materials utilized for remediation; hurricanes and noreasters can influence resuspension and transport only during very intense storm events (ca. >100-yrs) (U)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(7): Existence and effects of current and previous discharges and dumping in the area including cumulative effects	1. Previous dredged material disposal throughout site (M) 2. Approximately 25% of the site is degraded from historical activities; continued disposal under SMMP will cover and isolate any degraded sediment materials in MDS (B) 3. Previous discharges have affected the topography and possibly enhanced fish habitat (B) 4. No verifiable evidence of direct detrimental effects from dredged material disposal (N) 5. Possible cumulative effects will be reduced by additional dredged material disposal under MDS SMMP (B)	1. No remediation of degraded sediments in MDS or surrounding areas (U)	1. Evidence of previous disposal throughout the site that has contributed to degraded sediments in the HARS (M) 2. Approximately 9.0 nmi^2 (31 km^2) of degraded sediments in HARS will be remediated with smaller grain sizes (i.e., silt and clay) (B) 3. Previous discharges have affected the topography throughout site; possibly enhancing fish habitat (B) 4. Remediation operations will cause negligible changes to habitat (N) 5. No verifiable evidence of direct detrimental effects from dredged material disposal (N) 6. Remediation will cover and isolate degraded sediments of the PRA reducing potential cumulative effects (B)	1 and 3 - 6. Same as Alternative 3 2. Approximately 10.3 nmi^2 (35.5 km^2) of fine-grain sediments in the HARS will be restored to predisposal conditions with sandy material (B)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(8): Interference with other shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of specific scientific importance and other legitimate uses	1. No known interferences with legitimate uses of the MDS or surrounding areas (N) 2. Larger mound at MDS may enhance fishery resources (B) 3. Nearest artificial reef area is 3.4 nmi (6.3 km) west of the MDS (N)	Not applicable	1. No known interferences with legitimate uses of the area (N) 2. Existing mound at the current MDS may enhance fishery resources (B) 3. Nearest artificial reef area is approximately 1.5 nmi (2.7 km) west of the HARS (N)	1-3. Same as Alternative 3

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(9): Existing water quality and ecology of site	1. Water quality in and near MDS is good; water quality can be affected by Hudson River outflow and natural seasonal cycles (N) 2. All operations comply with EPA Ocean Dumping Regulations and site management plans (N) 3. Demersal and pelagic fish are abundant in the site; active commercial and recreational fishing area (N) 4. Two benthic infaunal communities occur in the MDS (sandy and fine-grain); abundance in both is high; diversity is moderate; distribution of the two communities appears to correlate more closely with sediment grain size and organic carbon than contaminant level (N)	Not applicable	1-4. Same as Alternative 1	1-4. Same as Alternative 1

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
***Key:* N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.6(a)(10): Potential for the development or recruitment of nuisance species in the disposal site	1. No evidence for recruitment of nuisance species (N) 2. No evidence for enhancement of nuisance species blooms in inshore areas (N)	Not applicable	1-2. Same as Alternative 1	1-2. Same as Alternative 1
228.6(a)(11): Proximity to natural or cultural features of historical importance	1. No known natural or cultural features of historic importance identified in the MDS (N)	Not applicable	1. Several shipwrecks found on seafloor in HARS have potential cultural significance; cultural significance of others could not be determined (M) 2. Avoiding shipwreck targets during remediation operations (not covered; 500 m buffer zone) will ensure no impact to these features (N)	1-2. Same as Alternative 3
40 CFR Section 228.10: Evaluating Disposal Impact				
228.10(b)(1): Movement into estuaries, sanctuaries, beaches, or shorelines	1. No evidence of past or future discharged dredged material moving into estuaries, sanctuaries, beaches, or shorelines (N)	Not applicable	1. No evidence for Remediation Material moving into estuaries, sanctuaries, beaches, or shorelines expected (N)	1. No evidence for Remediation Material moving into estuaries, sanctuaries, beaches, or shorelines expected (N)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(b)(2): Movement towards productive fish or shellfish areas	1. Entire New York Bight and Bight Apex is a productive fish and shellfish area (N) 2. No evidence for significant movement of dredged material plumes or deposited material towards fishing or shellfishing areas (N) 3. Fine-grain sediments may be transported out of the MDS by storm surges (U) 4. No evidence of seafloor sediment movement adversely impacting fish or shellfish resources (N)	Not applicable	1. Same as Alternative 1 2. Remediation may cause disruption of muddy habitats (U in the short-term; N in the long-term) 3. No movement of remediation material plumes or deposited sediment towards fishing or shellfishing areas predicted (N) 4. Storm surges not likely to move sediment in sufficient amounts to adversely impact fishing areas (N)	1. Same as Alternative 1 2. Restoration may cause long-term alteration of fisheries associated with muddy habitats (U) 3. Same as Alternative 3 4. Sandy Remediation Material will reduce potential for storm-induced resuspension and transport; minimizes adverse impacts to fishing areas (B)
228.10(b)(3): Absence from the disposal site of pollution-sensitive biota characteristic of the area	1. Two infaunal community types are in the MDS - Community Group A is generally found in high TOC, muddier sediments that have higher contaminant levels - Community Group B is found in sandier sediments with lower contaminant levels (N) 2. Both community groups are diverse, healthy, and neither show evidence of pollution (contaminant) impact (N)	Not applicable	1-2. Same as Alternative 1	1-2. Same as Alternative 1

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
Key: **N = No Impact; U = Unmitigable Impact; M = Mitigable Impact; B = Beneficial Impact**

Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(b)(4): Progressive, nonseasonal changes in water quality or sediment composition, when attributable to the dumping	1. No impacts to water quality 1 h after disposal (N) 2. Sediments with elevated contaminants located within and outside the MDS boundary; dredged material disposal likely but not sole source of elevated concentrations (U)	1. No remediation of degraded sediments in MDS or surrounding areas (U)	1. No impacts to water quality 1 h after disposal (N) 2. Historical dredged material disposal likely but not sole source of elevated contaminants observed in HARS (M) 3. Capping PRA sediments will stop contaminant exposure to biotic zone (B)	1-3. Same as Alternative 3
228.10(b)(5): Progressive, nonseasonal changes in biota composition	1. No evidence of past or present progressive or adverse changes in biotic composition attributable to past disposal operations (N) 2. There are several non-disposal factors affecting progressive non-seasonal changes of fish and shellfish resources (i.e. overfishing, coastal habitat loss, and eutrophication) (M)	Not applicable	1. Evidence from MDS monitoring indicates relatively rapid (within an annual cycle) recovery of benthic communities buried by capping operations (N) 2. Non-disposal factors affecting progressive non-seasonal changes of fish and shellfish resources (i.e., overfishing coastal habitat loss, and eutrophication) will not be changed (N)	1. Same as Alternative 3 2. Progressive changes in biotic composition of restored areas may occur as muddy habitat is changed to sandy habitat; however, non-disposal factors affecting fish and shellfish resources (i.e., overfishing, coastal habitat loss, and eutrophication) will not be changed (U)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
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Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(b)(6): Accumulation of material constituents (including pathogens) in marine biota at or near the site	1. Contaminant bioaccumulation present in infauna prey species collected in infauna and near the MDS (U) 2. Dioxin and PCB levels are elevated in hepatic tissue of lobsters from New York Bight Apex and Hudson Shelf Valley (U) 3. Contaminants in recreational fish do not exceed FDA human-health action levels (N) 4. Contaminants in lobster and infauna may result from sediment disposed at the MDS or other contaminant sources (M) 5. Definitely linking contaminant levels in MDS sediments to contaminants in lobsters is not possible because of the lobsters' large foraging and seasonal migration areas (N) 6. Continued use of the MDS for Category I sediment disposal will reduce sediment contamination in <5 km^2 of the Bight Apex (N)	Not applicable	1. Current contaminant bioaccumulation present in infauna prey species collected in fine-grain sediments of the HARS (N) 2. Current contaminants in recreational fish do not exceed FDA human-health action levels (N) 3. Contaminants in lobster and prey species may be reduced resulting from remediation of HARS or other contaminant sources (B) 4. Remediation of the HARS with a least a 1 m cap of dredged material will reduce contaminant bioaccumulation in the Bight Apex (B)	1-4. Same as Alternative 3 Bight Apex (N)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
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Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(c)(1)(i): Progressive movement/ accumulation in detectable concentrations above normal ambient concentrations within 12 miles of shoreline, sanctuary or critical area	1. The MDS is within 5.3 nmi of the shoreline; sediment in portions of the site and contiguous areas contain elevated levels of some contaminants compared to the historical baseline in the area and in sediments not under the influence of past and present disposal sites in the Bight Apex. Continued use of the MDS will bury some of the contaminants, and reduce exposure to the benthic ecosystem (B)	Not applicable	1. The HARS is within 3.5 nmi of the shoreline; sediment in portions of the HARS contain elevated levels of some contaminants compared to the historical baseline in the area and in sediments not under the influence of past and present disposal sites in the New York Bight. Remediation of HARS sediments will bury these contaminants (B) 2. Accumulation of contaminants from other sources such as the Hudson River outflow or other areas of the Bight may cause a rebound in contaminant levels relative to success of CCMP (U) 3. Bedload transport and other seafloor processes are likely to spread contaminants from degraded sediment areas to newly remediated areas nearby. The degree of recontamination will depend on the rate remediation operations are conducted and interim storm events (U)	1-4. Same as Alternative 3

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Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(c)(1)(ii): Sediment, biota, or water column of the disposal site, or areas outside the disposal site where waste is detectable above normal ambient concentration, that result in statistically significant decreases in populations of valuable commercial or recreational species, or species essential to the propagation of such species	1. Contaminants in surface sediments within the MDS are also found outside the site and areas adjacent to historical disposal mounds (M) 2. Some contaminants bioaccumulate in infauna and epifauna collected in the Bight Apex (U) 3. No evidence to support hypothesis that contaminant bioaccumulation is adversely affecting propagation or populations of any species within the Bight Apex (N) 4. No human health effects identified (N) 5. Partial reduction possible of undetected effects by covering contaminated sediments in the MDS (B)	Not applicable	1. Elevated levels of contaminants are found in historically discharged sediments within the HARS (M) 2. Some contaminants bioaccumulate in infauna and epifauna collected in the HARS and Bight Apex (M) 3. No evidence to support the hypothesis that contaminant bioaccumulation is adversely affecting propagation or populations of any species within the HARS (N) 4. No human health effects identified (N) 5. Remediation of contaminated sediments will reduce potential for undetected effects (B)	1-4. Same as Alternative 3 5. Restoration of contaminated sediments will reduce potential for undetected effects (B)

Table 4-1. Comparison of MDS and HARS Alternatives and Summary of Environmental Consequences
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Ocean Dumping Regulation, Key Words and Phrases	Alternative 1: No Action	Alternative 2: No MDS/HARS	Alternative 3: Remediation	Alternative 4: Restoration
228.10(c)(1)(iii): Accumulation of wastes such that impairment of other major uses of the site or other adjacent areas occurs	1. 45-ft management depth will ensure shallow areas of MDS do not threaten commercial or military navigation (N) 2. Potential socioeconomic impact regarding public confidence in seafood safety (M) 3. No impact to cultural features or fishing uses (N)	Not applicable	1. Depth of sediments to be remediated are below 65 ft (20 m); capping with approximately 1 m of Material for Remediation will not threaten commercial or military navigation (N) 2. Potential socioeconomic impact—public confidence in seafood safety will be improved (B) 3. Impact to cultural features or fishing can be avoided by not burying shipwrecks (N)	1-3. Same as Alternative 3
228.10(c)(1)(iv): Adverse affects on the taste and odor of commercial or recreational species	1. No impacts identified (N)	Not applicable	1. Same as Alternative 1	1. Same as Alternative 1
228.10(c)(1)(v): Toxic levels *(in water column)* consistently identified outside ODMDS above ambient levels outside the site more than 4 hours after a disposal event	1. No WQC exceedances outside the site, or inside the site 1 h after disposal events (N)	Not applicable	1. Same as Alternative 1	1. Same as Alternative 1

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5.0 FEASIBILITY OF SURVEILLANCE AND MONITORING [40 CFR SECTIONS 228.5(d) AND 228.6(a)(5)]

5.1 HARS Site Management and Monitoring

Section 506 of the Water Resources and Development Act (WRDA) of 1992, which amended the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), requires the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (USACE) to prepare a Site Management and Monitoring Plan (SMMP) for the proposed HARS. WRDA provides that after January 1, 1995, no site shall receive a final designation unless an SMMP has been developed. The draft document (contained in Appendix C) constitutes the EPA Region 2 and USACE New York District (NYD) required WRDA SMMP, and identifies a number of actions, provisions, and practices to (1) manage operational aspects of dredging and HARS remediation activities and (2) perform HARS monitoring tasks (including surveillance and monitoring activities). EPA has determined that portions of the HARS are Impact Category I [40 CFR 228.11(c)], and the HARS SMMP has been developed to provide that the site be managed to reduce impacts to acceptable levels, in accordance with 40 CFR 228.11(c).

The Draft HARS SMMP, is being released and distributed with this SEIS for public comment. Comments on the SMMP should be directed to:

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The objectives of the HARS SMMP are as follows:

A. Provide for the remediation of required areas within the HARS by placing a one-meter cap (minimum required cap thickness) of the Material for Remediation on sediments within the PRA (inside the HARS). Sediments within the PRA have been found to exhibit Category II and Category III dredged material characteristics and will be remediated.

B. Provide that no significant adverse environmental impacts occur from the placement of the Material for Remediation at the HARS. The phrase "significant adverse environmental impacts" is inclusive of all significant or potentially substantial negative impacts on resources within the HARS and vicinity. Factors to be evaluated include:

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

   2. Movement of materials toward productive fishery or shell fishery areas;

   3. Absence from the HARS of pollution-sensitive biota characteristic of the general area;

   4. Progressive, non-seasonal, changes in water quality or sediment composition at the HARS, when these changes are attributable to the Material for Remediation placed at the HARS;

5. Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the HARS, when these changes can be attributed to the effects of the Material for Remediation placed at the HARS;

6. Accumulation of material constituents in marine biota near the HARS.

C. Recognize and correct any potential unacceptable conditions before they cause any significant adverse impacts to the marine environment or present a navigational hazard to commercial and recreational water-borne vessel traffic. The term "potential unacceptable conditions" is inclusive of the range of negative situations that could arise as a result of the Material for Remediation placement at the HARS such that its occurrence could have an undesirable affect. Examples could include things such as: Remediation Material placement mounds exceeding the required management depth or Remediation Material placement barges releasing materials in the wrong locations.

D. Determine/enforce compliance with MPRSA Permit conditions.

E. Provide a baseline assessment of conditions at the HARS.

F. Provide a program for monitoring the HARS.

G. Describe special management conditions/practices to be implemented at the HARS.

H. Specify the quantity of Remediation Material to be placed at the HARS, and the presence, nature, and bioavailability of the contaminants in the Material for Remediation.

I. Specify the anticipated use of the HARS, including the closure date (the date upon which EPA Region 2/USACE NYD determines that all areas within the PRA of the HARS has been remediated by placement of at least 1 m of Remediation Material).

J. Provide a schedule for review and revision of the HARS SMMP.

6.0 COORDINATION

This chapter contains information on public involvement and interagency activities related to the *Supplement to the Environmental Impact Statement on the New York Dredged Material Disposal Site Designation for the Designation of the Historic Area Remediation Site (HARS) in the New York Bight Apex* (Section 6.1 and 6.2); evidence of endangered and threatened species consultation (Section 6.3); and public distribution of the SEIS (Section 6.4).

6.1 Public Announcement

On February 3, 1995, EPA issued a Public Announcement (PA) stating that the Agency would commence a study of a 23-nmi^2 area surrounding the existing Mud Dump Site (MDS). The product of the study was to be a Supplemental Environmental impact Statement (SEIS) that would evaluate the potential expansion of the MDS for the disposal of Category I and II material (Exhibit 1). Subsequent to the February 3, 1995 PA, EPA added an additional 7- nmi^2 to the SEIS study area to encompass all benthic areas that showed evidence of previous dredged material disposal activities in the New York Bight Apex. During the course of its environmental investigations, EPA determined that some parts of the study area could be classified as Category III. This factor, coupled with issues raised by the concerned public, led regulators to question the appropriateness of continued use or expansion of the MDS for the disposal of dredged material from the New York Bight, and to identify the need to remediate the MDS and surrounding areas. The development of the SEIS for the expansion of the MDS was terminated in light of a July 24, 1996 3-Party Letter (Exhibit 2) signed by the agency heads of the EPA, the U.S. Army, and the U.S. Department of Transportation, calling for closure of the MDS and simultaneous designation of the HARS.

In light of the July 24, 1996, 3-Party Letter, EPA issued a second PA on September 11, 1996, stating that the Agency would prepare an SEIS for the closure/de-designation of the MDS and simultaneous designation of the HARS (Exhibit 3). This action is consistent with EPA's procedures for voluntary preparation of environmental impact statements for significant regulatory actions (39 FR 37119). As such, a formal public scoping meeting is not required. However, alternative mechanisms have enabled EPA to receive information from other regulatory agencies and members of the public to develop this SEIS. These activities are identified below.

6.2 Coordination Activities Conducted during the Preparation of the SEIS

During the development of the SEIS, a number of public and technical meetings were held to solicit a broad input on the proposed SEIS.

The Dredged Material Management Forum (Forum) was convened in June 1993 by the EPA, the USACE, the New York State Department of Environmental Conservation, and the New Jersey Department of Environmental Protection to facilitate discussions among governmental, environmental, commercial, and public interest groups on a variety of issues associated with the dredging and disposal of sediments from the Port of New York and New Jersey and surrounding areas. The Forum has met six times since its inception. In light of the many policy issues associated with the management of dredged material, a number of workgroups were established by the Forum: Dredging, Transport and Disposal; Containment; Criteria; Decontamination Technologies/Siting; and the MDS/HARS workgroup. The MDS/HARS workgroup has been charged with the responsibility of assisting EPA to develop this SEIS. Toward this end, the workgroup has met regularly to discuss key issues that would be included in the SEIS, and has reviewed preliminary drafts of the SEIS chapters. A list of workgroup members is provided in Exhibit 4.

Pursuant to 40 CFR Section 228.6 (a)(8), EPA evaluated the proposed project's potential impacts to fishing. Toward this end, EPA held two public meetings in Freeport, New York (April 25, 1996), and Monmouth Beach, New Jersey (May 6, 1996). EPA's intention at both sessions was to share with the fishing community the results of scientific surveys that have been conducted in the SEIS Study Area that would be used in guiding policy decisions concerning the placement of Remediation Material and to discuss these findings. Approximately one dozen people participated in the meeting at Freeport, New York; about 300 people participated in the meeting held in Monmouth Beach, New Jersey. The information obtained at these meetings from members of commercial and recreational fishing organizations, divers, environmental organizations, and private citizens, has been factored into the development of the SEIS for the designation of the HARS.

Also, as part of the coordination activities, EPA invited recognized experts in the field of benthic community ecology and oceanography to provide technical input in a Benthic Ecology Workshop on December 17, 1996. The workshop evaluated the benthic community structure data (collected from the various surveys in support of the SEIS and any available historical data) along with sediment chemistry, toxicity, and worm body-burden level data. The workshop participants were asked to provide scientific recommendations and evaluations from the perspective of the "value" of the benthic community currently existing in the SEIS Study Area and the need for remediation or restoration. The workshop members also discussed various approaches to conducting remediation and restoration operations. A list of the workshop invitees and participants is provided in Exhibit 5.

6.3 Threatened and Endangered Species Consultation

The Federal Endangered Species Act (ESA) requires consultation with Federal agencies to identify any threatened, endangered, or special-status species that may be affected by the proposed action. EPA initiated its consultation process with the U.S. Fish and Wildlife Service (USFWS) on April 6, 1995. The consultation process was concluded with USFWS on July 28, 1995, with USFWS's concurrence that EPA's action was not likely to adversely affect Federally listed species under USFWS's jurisdiction (Exhibits 6-9).

In accordance with the ESA, EPA also initiated a threatened and endangered species consultation with the National Marine Fisheries Service (NMFS) on April 4, 1996. Based on this coordination, EPA concluded that the preparation of a Biological Assessment was warranted for the Kemp's ridley and loggerhead sea turtles, and the humpback and fin whales within the MDS and surrounding areas; NMFS concurred with this approach on May 8, 1996 (Exhibits 10-11). The Biological Assessment was sent to NMFS in May 1997.

6.4 Public Distribution of the SEIS and Proposed Rule for the Designation of the Historic Area Remediation Site

The aforementioned September 11, 1996 PA for the preparation of the SEIS was sent to approximately 800 parties—Federal and State agencies, environmental, commercial, and public interest groups that constitute the Dredged Material Management Forum's mailing list. These same parties, together with the appropriate congressional offices and local municipalities within the geographic scope of the proposed action, were provided with the subject SEIS. Additional copies of the SEIS may be requested by contacting Joseph Bergstein, EPA Region II, at (212) 637-3890, or e-mail bergstein.joseph@epamail.epa.gov.

EPA issued the Notice of Availability and the Proposed Rule for the designation of the HARS in May 1997. Approximately one month after the publication of the Notice of Availability of the SEIS in the Federal Register, EPA will commence public hearings on the Proposed Rule to designate the HARS.

The following tentative dates and locations have been established for the public hearings.

June 16, 1997: 7 p.m., Monmouth Beach Municipal Hall Auditorium, Monmouth Beach, NJ
June 17, 1997: 7 p.m., Social Services Building Auditorium, Mineola, Long Island, NY
June 18, 1997: 2 p.m., Port Authority of New York & New Jersey, New York City, NY

The comment period for the SEIS and the Proposed Rule is anticipated to close on June 30, 1997. Comments received at the public hearings and on the SEIS and Proposed Rule will be considered in the development of the Final Rule, which EPA intends to issue in order to meet the September 1, 1997 date specified in the July 24, 1996, 3-Party Letter for simultaneous designation of the HARS and de-designation of the Mud Dump Site.

EXHIBIT 1

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, NEW YORK 10278-0012

FEB 3 1995

To All Interested Government Agencies, Public Groups and Citizens:

In 1984, the Environmental Protection Agency (EPA) designated the New York Bight Dredged Material Disposal Site (Mud Dump Site [MDS]) to receive up to 100 million cubic yards of dredged materials generated in the Port of New York and New Jersey and nearby harbors. Approximately 67 million cubic yards of dredged material has been disposed of at the MDS since its designation; the remaining capacity of the MDS for Category II sediments (see Endnote) has been reduced due to a variety of factors, including disposal strategies and mound height restrictions for different categories of dredged material.

In consideration of the limited remaining capacity of the MDS, there is a need to develop a dredged material management plan to establish immediate, short-, mid-, and long-term dredged material disposal alternatives. Towards this end, the Dredged Material Management Forum was convened in June 1993 by the EPA, the Army Corps of Engineers, the New York State Department of Environmental Conservation, and the New Jersey Department of Environmental Protection to facilitate discussions among governmental, environmental, commercial, and public interest groups on a variety of issues associated with the dredging and disposal of sediments from the Harbor. As part of this effort, and in response to input from the Forum principals and participants, EPA has decided to consider expansion of the MDS.

Accordingly, pursuant to EPA's procedures for voluntary preparation of environmental impact statements (EIS) for significant regulatory actions (39 FR 37119), EPA is announcing its decision to prepare a supplement to the 1984 EIS on the designation of the MDS to address the impacts associated with its expansion. The geographical scope of the study will be an area of approximately 23 square nautical miles surrounding the MDS (see Enclosure 1). The supplemental EIS will address the five general and 11 specific criteria for designating ocean disposal sites presented in 40 CFR Parts 228.5 and .6, respectively (see Enclosure 2). Additionally, because the subject action involves the possible expansion of an existing ocean disposal site, the evaluation will also consider the impacts of past disposal at the MDS pursuant to 40 CFR Part 228.10 (see Enclosure 3). At a minimum, the supplemental EIS will evaluate the following alternatives:

- no-action (i.e., no expansion of the MDS);
- expansion of the MDS for Category I material; and
- expansion of the MDS for Category I and Category II material.

In evaluating the action alternatives, the supplemental EIS will identify the locations within the study area that are best suited to receive the two categories of dredged material. Additionally, if the MDS is expanded for the disposal of Category II material, the use of the site will only be permitted if there are no environmentally preferred, practicable, non-ocean disposal alternatives. Moreover, the supplemental EIS will evaluate the potential remediation and, insofar as possible, restoration of the MDS, adjacent impacted areas, and historical disposal areas.

Concurrently, EPA is terminating the preparation of the EIS for the designation of an Alternate Mud Dump Site (AMDS) for the disposal of dredged material unacceptable for disposal at the present MDS. This action is in response to Section 412 of the 1990 Water Resources Development Act which removes the statutory requirement to designate an offshore AMDS.

If you have any questions concerning this announcement, need additional information regarding the preparation of the supplemental EIS, or would like to be included in the mailing list for the project, please contact Robert Hargrove, Chief, Environmental Impacts Branch, at (212) 264-1892.

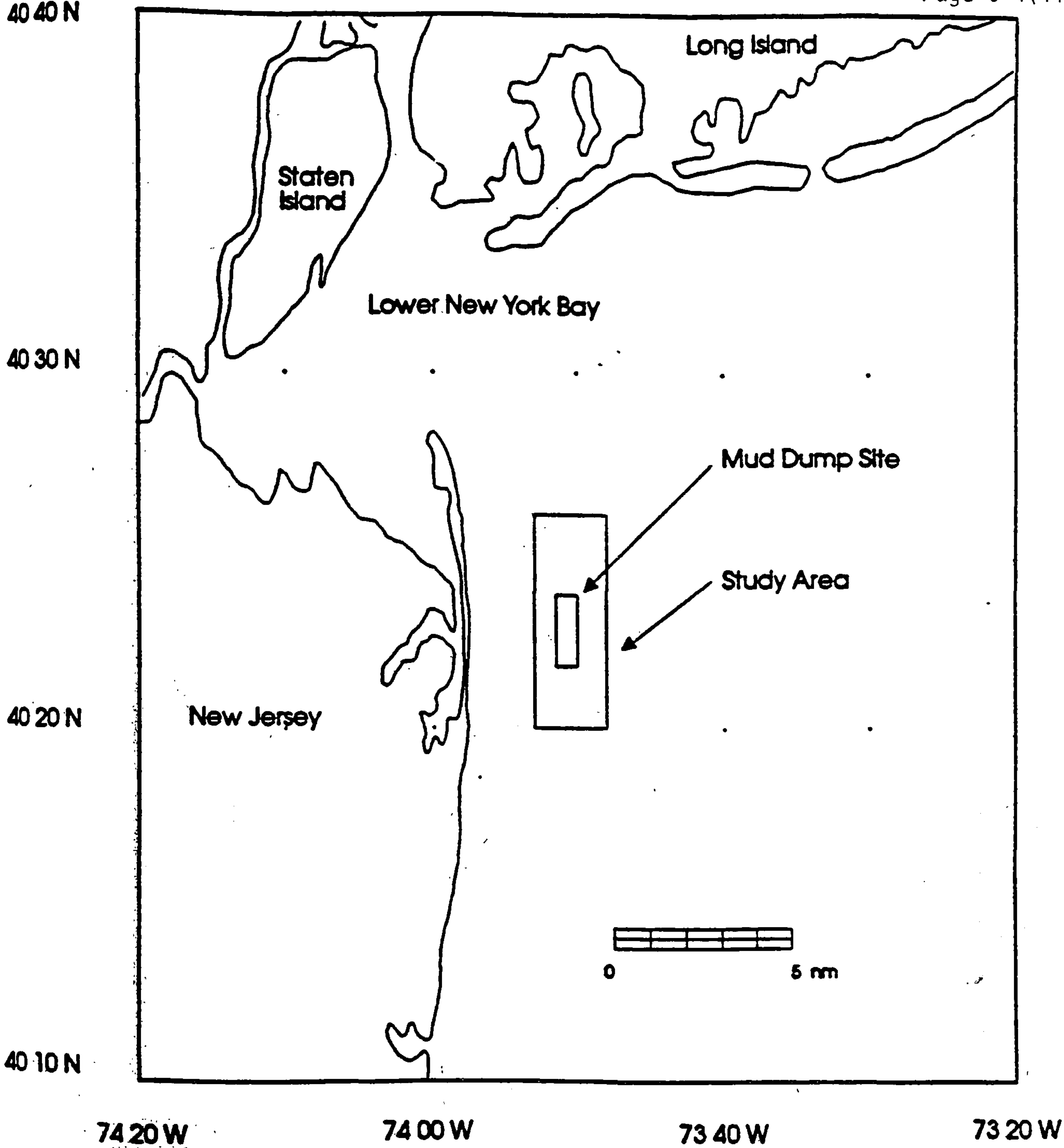
Sincerely,

William J. Muszynski

Jeanne M. Fox
Regional Administrator

Enclosures

Note: Dredged material from New York Harbor and its environs is separated into three (3) categories: Category I material is acceptable for unrestricted ocean disposal; Category II material is acceptable for ocean disposal with appropriate management practices (e.g., capping); and Category III material is unacceptable for ocean disposal.



Location of the Mud Dump Site and the Expanded Mud Dump Site Study Area

40 CFR Part 228.5 General Criteria for the selection of sites

(a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(c) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Parts 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

40 CFR Part 228.6 Specific criteria for site selection

(a) In the selection of disposal sites, in addition to other necessary or appropriate factors determined by the Administrator, the following factors will be considered:

(1) Geographical position, depth of water, bottom topography and distance from coast;

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches and other amenity areas;

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any;

(5) Feasibility of surveillance and monitoring;

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site;

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

(b) The results of a disposal site evaluation and/or designation study based on the criteria stated in paragraphs (b)(1) through (11) of this section will be presented in support of the site designation promulgation as an environmental assessment of the impact of the use of the site for disposal, and will be used in the preparation of an environment impact statement, for each site where such a statement is required by EPA policy. By publication of a notice in accordance with this part 228, an environmental impact statement, in draft form, will be made available for public comment not later than the time of publication of the site designation as proposed rulemaking, and a final EIS will be made available at the time of final rulemaking.

Enclosure 3

228.10 Evaluating disposal impact.

(a) Impact of the disposal at each site designated under section 102 of the Act will be evaluated periodically and a report will be submitted as appropriate as part of the Annual Report of Congress. Such reports will be prepared by or under the direction of the EPA management authority for a specific site and will be based on an evaluation of all data available from baseline and trend assessment surveys, monitoring surveys, and other data pertinent to conditions at and near a site.

(b) The following types of effects, in addition to other necessary or appropriate considerations, will be considered in determining to what extent the marine environment has been impacted by materials disposed of at an ocean disposal site:

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

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

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

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

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

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

(c) The determination of the overall severity of disposal at the site on the marine environment, including without limitation, the disposal site and adjacent areas, will be based on the evaluation of the entire body of pertinent data using appropriate methods of data analysis for the quantity and type of data available. Impacts will be categorized according to the overall condition of the environment of the disposal site and adjacent areas based on the determination by the EPA management authority assessing the nature and extent of the effects identified in paragraph (b) of this section in addition to other necessary or appropriate considerations. The following categories shall be used:

(1) Impact Category I: The effects of activities at the disposal site shall be categorized in Impact Category I when one or more of the following conditions is present and can reasonably be attributed to ocean dumping activities;

(i) There is identifiable progressive movement or accumulation, in detectable concentrations above normal ambient values, of any waste or waste constituent from the disposal site within 12 nautical miles of any shoreline, marine sanctuary designated under title III of the Act, or critical area designated under section 102(c) of the Act; or

(ii) The biota, sediments, or water column of the disposal site, or of any area outside the disposal site where any waste or waste constituent from the disposal site is present in detectable concentrations above normal ambient values, are adversely affected by the toxicity of such waste or waste constituent to the extent that there are statistically significant decreases in the populations of valuable commercial or recreational species, or of specific species of biota essential to the propagation of such species, within the disposal site and such other area as compared to populations of the same organisms in comparable locations outside such site and area; or

(iii) Solid waste material disposed of at the site has accumulated at the site or in areas adjacent to it, to such an extent that major uses of the site or of adjacent areas are significantly impaired and the Federal or State agency responsible for regulating such uses certifies that such significant impairment has occurred and states in its certificate the basis for its determination of such impairment; or

(iv) There are adverse effects on the taste or odor of valuable commercial or recreational species as a result of disposal activities; or

(v) When any toxic waste, toxic waste constituent, or toxic byproduct of waste interaction, is consistently identified in toxic concentrations above normal ambient values outside the disposal site more than 4 hours after disposal.

(2) Impact Category II: The effects of activities at the disposal site which are not categorized in Impact Category I shall be categorized in Impact Category II.

EXHIBIT 2

ENCLOSURE

July 24, 1996

The Honorable Frank Pallone
United States House of Representatives
Washington, D.C. 20510

Dear Congressman Pallone:

Your leadership and support have been essential in advancing our shared goals of protecting the ocean environment, while ensuring the competitiveness of the Port of New York and New Jersey and the economic health of the region. We are writing to announce our commitment to several substantial new steps to provide additional Administration support for those goals. We believe the three-point plan outlined below demonstrates this Administration's commitment to the continued growth and vitality of the port, to protective regulation of ocean disposal, and to a stronger partnership with the states in protecting regional commerce and the marine environment.

1. We will close the Mud Dump Site by September 1, 1997

After years of contention, this Administration is prepared to help resolve the controversy over disposal at the Mud Dump Site (MDS) off the New Jersey coast.

Environmental, tourism, fishing, and other community groups have long contended that the MDS should be closed immediately. These views reflect the important environmental values that New Jersey's communities identify with their coastal environment. Community concerns have been heightened by the unhappy history of other environmental threats that these communities have had to endure -- ranging from oil spills to the littering of shorelines with medical waste. This history warrants sensitivity to concerns about the MDS, including concerns about continued use of the site for so-called "category 2" material. When these concerns are coupled with the limited category 2 disposal capacity we expect the site to provide, we must conclude that long-term use of this site for disposal activity is not realistic.

Accordingly, the Environmental Protection Agency (EPA) will immediately begin the administrative process for closure of the MDS by September 1, 1997. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with the management standards in 40 C.F.R. Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 C.F.R. Section 228 as the Historic Area Remediation Site. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228.11(c)). The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation). Our ongoing environmental assessment activities at the site will be modified to reflect these new commitments. We also will seek to reinforce this approach in appropriate legislation.

Although we recognize that eventual closure of the MDS, followed by remediation, is appropriate, immediate closure could jeopardize the Port, which may need short-term use of the site to dispose of category 2 material. To strike the appropriate balance, use of the site for category 2 material will have to be supported with certifications by the permit applicant, and a finding by the Corps of Engineers that: 1) the affected states or ports were asked to provide alternative sites for disposal of the material identified by the permit, and that the states or ports failed to provide a reasonable alternative site; and 2) the disposal of category 2 material at the MDS will not increase the elevation at the MDS higher than 65 feet below the surface. Any elevation limits will be designed to contain material within the current lateral limits of the MDS, and will be set based on scientific evidence.

2. We will help remove the immediate obstacles to dredging the Port

The Port Authority of New York and New Jersey, terminal operators, shipping lines, and labor groups have identified numerous ways in which we can help expedite dredging in the Port. We have heard, and are responding to, their concerns.

Making the MDS available for category 2 material for the next 12 months, and allowing the elevation at the site for category 2 material to increase, would remove the most immediate and major federal obstacles to dredging. The designation of the Historic Area Remediation Site will assure long-term use of category 1 dredge material.

Our outreach to the companies, longshoremen, harbor pilots, and others whose livelihood depends on the Port, has identified many additional steps our agencies can take to further facilitate adequate dredging in the Port. A major source of concern and potential cost for permit applicants has been uncertainty surrounding the testing that must support permit applications. Accordingly, by the end of August, EPA will finalize its proposal that tests of only two species, not three, will be required of permit applicants. EPA then will invest at least nine months in a process for all affected groups -- industry, labor, and environmental groups -- to help the Agency review the ocean disposal testing requirements and ensure that any further revision reflects both sound policy and sound science.

The Corps of Engineers will expedite the processing of dredging permit applications and completion of its own dredging projects. The Corps will issue public notices for dredging permits within 15 days after a completed application is submitted, or will have requested any additional information necessary to make the application complete. Within 90 days, the Corps will either issue the permit, deny the permit, or commit in writing to a deadline for the permit decision. The Corps responsibility for the federal channels will also be met: with cooperation from the states and the funding requested by the President, the Corp. will ensure maintenance dredging for 10 high-priority federal channel projects before the end of 1997.

The Honorable Frank Pallone
Page 3

In addition, the Corps and EPA will accelerate their work with the affected state and local governments on a sound dredge material management plan, and complete the interim plan by August 30, 1996. This interim plan will identify any steps that are necessary to sustain dredging through 1997. The final plan will be completed by September, 1998.

Most importantly, we expect that our commitments concerning the MDS will diminish or eliminate the possibility of litigation challenging permits and the EPA rule change during the period prior to September 1, 1997. This proposal is predicated on that result.

3. We will help ensure the health of the Port and the environment for the 21st Century

The short-term efforts identified here cannot truly help the Port without effective long-term strategies to ensure that dredge material is managed properly. We recognize the significant efforts and commitments that New York and New Jersey have made with us to put those strategies in place. We will reinforce those efforts, so that long-term growth of the Port is sustained and sustainable.

Recognizing that a vital Port should be able to accommodate the full range of world-class ships, the Corps will soon begin an expedited feasibility study of alternatives for a 50 foot deep Port, including recent legislative proposals on this issue. The Corps will seek Congressional authorization and take steps to reprogram funds to allow the study to begin in 1996, and the study will be designed for completion in 1999. Recognizing that dredging is not the only issue affecting the future of this and other Ports, the Department of Transportation is committed to a six-month study of the causes of cargo diversion from our East Coast ports. This study, which will be developed in consultation with other affected agencies, will recommend any additional measures that are needed to enhance the international competitiveness of our East Coast ports.

Continued growth of the Port must be coupled with aggressive development of disposal alternatives and expanded efforts to reduce toxic pollution in the harbor. The Administration will continue to support legislation and appropriations to support cost-sharing of upland disposal alternatives. The Administration will also seek support for the range of continuing efforts to develop acceptable alternatives. For example, EPA is today announcing $1.2 million in contract awards to support development of decontamination technologies for dredge material. In addition, the Corps will immediately seek necessary authorization and funding to begin the technical design and feasibility studies needed for environmentally sound confined containment facilities, in anticipation that such facilities may be part of the final dredge material management plan. We also will pursue additional steps to reduce and address toxic pollution in the estuary. We will seek to minimize polluted runoff by funding and supporting local and region-wide watershed planning and implementation activities. By September 1996, EPA will invest $100,000 to facilitate pollution reduction in the Arthur Kill. All of these efforts will be coordinated with the Harbor-Estuary Comprehensive Conservation and Management Plan, which is the blueprint for working cooperatively with

The Honorable Frank Pallone
Page 4

state and local governments, businesses, and citizens to reduce toxic pollution in the watershed.

We will be calling upon every member of the New Jersey and New York delegations, as well as the affected state and local governments, to continue our constructive and cooperative efforts to sustain port growth and environmental protection. We will also be submitting periodic reports to the President on our success in implementing this plan and on any continuing obstacles to harbor dredging.

We appreciate your continuing leadership and advice as we work together to ensure a healthy economy and a healthy environment for the region.

Sincerely,

Carol M. Browner
Administrator
United States Environmental Protection Agency

Federico F. Pena
Secretary
United States Department of Transportation

Togo D. West, Jr.
Secretary
United States Department of the Army

EXHIBIT 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

SEP 11 1996

To Interested Government Agencies, Public Groups, and Citizens:

In accordance with the Clinton Administration's July 24, 1996 plan for the Port of New York and New Jersey, the Environmental Protection Agency (EPA) is modifying the scope of the supplemental environmental impact statement (SEIS) on the expansion of the Mud Dump Site (MDS) to evaluate only the designation of the Historic Area Remediation Site (HARS). Concurrently, EPA is beginning the official administrative process for closure of the MDS.

On February 3, 1995, in response to recommendations contained within the proposed Comprehensive Conservation and Management Plan (CCMP) for the New York-New Jersey Harbor Estuary Program, as well as input received from the Dredged Material Management Forum, EPA announced plans to prepare a SEIS on the possible expansion of the MDS. The SEIS was to evaluate the following specific alternatives within a 23 square nautical mile area surrounding the MDS: no action (i.e., no expansion of the MDS); expansion for the disposal of Category 1 material; and expansion for the disposal of Category 1 and 2 material. In accordance with the CCMP, the SEIS was also to include an evaluation of the potential remediation and, insofar as possible, restoration of the MDS, adjacent areas, and historical disposal areas.

Subsequent to the February 1995 announcement, a number of scientific surveys were conducted, which indicate that impacts of historical disposal exist outside the aforementioned study area. Accordingly, the study area was enlarged to approximately 30 square nautical miles to include those portions of the New York Bight Apex in the vicinity of the MDS that are indicative of historical disposal (see enclosure). While the study area has been enlarged, it was never EPA's intention to designate the entire study area as the Expanded MDS. Moreover, enlargement of the study area does not mean that it has surface contamination throughout. In fact, the studies indicate that much of the study area is not contaminated.

On July 24, 1996, Vice President Gore announced the Clinton Administration's plan to help protect and preserve the environment and promote economic growth in the Port of New York and New Jersey. This announcement begins the official administrative process for closure of the MDS by September 1, 1997 outlined in the Clinton Administration's plan. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with the management standards in 40 CFR Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be redesignated under 40 CFR Section 228 as the HARS. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 CFR Section 228.11[c]). The HARS will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category 1 standards and will not cause significant undesirable effects including bioaccumulation).

Accordingly, EPA is hereby revising the scope of the SEIS to evaluate only the designation of the HARS for the purposes of remediation. Towards this end, the SEIS will identify those portions of the study area to be included in the HARS, the type of uncontaminated dredged material (sand, silt, or clay) to be used, and the priority for remediation in each portion of the HARS. EPA expects to issue the SEIS on the designation of the HARS and the proposed rule on the closure of the MDS and designation of the HARS in January 1997. The final rule for the closure of the MDS and designation of the HARS will be issued before September 1, 1997.

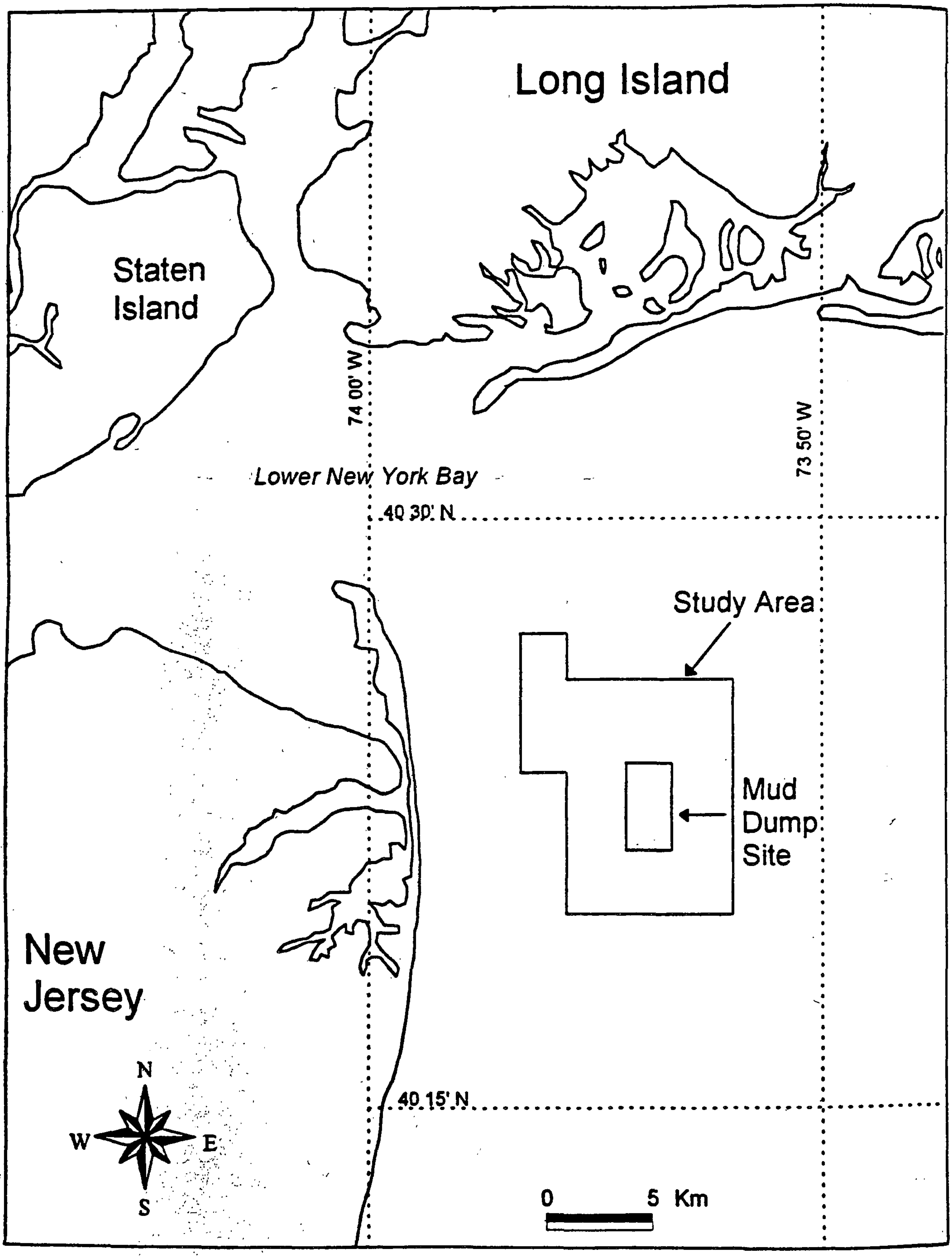
If you have any questions concerning this announcement, need additional information regarding the preparation of the SEIS, or would like to be included in the mailing list for the project, please contact Robert Hargrove, Chief, Strategic Planning and Multi-Media Programs Branch, at (212) 637-3495.

Sincerely,

Jeanne M. Fox

Jeanne M. Fox
Regional Administrator

Enclosure



Location of mud dump site and study area.

EXHIBIT 4

MUD DUMP SITE WORKGROUP as of June 28, 1995

Chairpersons:

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3. **Larry Schmidt**
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   Office of Program Coordination
   401 East State Street, CN402
   Trenton, NJ 08625
   Phone: 609-292-2662
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4. **Thomas Fote**
   Atlantic State Marine Fisheries Comm.
   22 Cruiser Court
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   Fax: 908-506-6409

5. **Bill Greaux**
   38 Hutchinson Drive
   Port Monmouth, NJ 07758
   Phone: 908-787-7716
   Fax: 908-308-0847
   (Mon - Thurs)

6. **David Buerle, PhD.**
   NYSDOS
   Division of Coastal Resources
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7. **Shirley Delnero**
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8. **Jack Lipton**
   Hudson River Fishermans Assoc.
   520 Marion Lane
   Paramus, NJ 07652
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9. **Ralph Pastore** — Phone: 718-317-1582 / Fax: 718-967-6304
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    New York, NY 10004

15. **Cindy Zipf** — Phone: 908-872-0111 / Fax: 908-872-8041
    Clean Ocean Action
    P.O. Box 505
    Sandy Hook, NJ 07732

16. **Peter L. Sattler** — Phone: 212-582-0380 / Fax: 212-581-5719
    Interstate Sanitation Comm.
    311 W. 43rd Street
    New York, NY 10036

17. **Mr. Kevin Tyne** — Phone: 202-225-3371 / Fax: 202-226- 1272
    Conresswoman Molinari's Office
    2435 Rayburn HOB
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18. **Rav Freidel** — Phone: 516-668-9483 / Fax: Same No.
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    Montauk, NY 11954

19. **Georgina Morgenstern** — Phone: 718-595-5969 / Fax: 718-595-5037
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35. **Greg Storey** Phone: 212-323-6616
New York Shipping Association, Inc. Fax: 212-524-9304
2 World Trade Center, 20th Floor
New York, NY 10048-0075

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New York Aquarium FAX: 718-265-3420
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NYZS The Wildlife Conservation Society
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40. **Bernard J. Blum** Phone: 718-474-4193
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43. **Jennifer Dilorenzo** **Phone: 908-229-6070**
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44. **Andrew Voros, Executive Director** Phone: 908-932-6555x503
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EXHIBIT 5

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Michael Murray	IT Corp.	908-469-5599 x317	908-469-7275
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Bob Reid	NMFS	908-872-3020	908-872-3088
Fred Grassle	Rutgers	908-932-6555 x540	908-932-8578
Frank Steimle	NMFS	908-872-3000	908-872-3088
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Jack Word	Battelle	617-934-0571	617-934-2124
Roy Kropp	Battelle	617-934-0571	617-934-2124
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Judy Wilson	MMS	703-787-1075	703-787-1115

Benthic Ecology Workshop Members

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Bill Corso	COE - NYD	212-264-1275	212-264-5472
Howard Ruben	COE - NYD	212-264-1275	212-264-5472
John Tiedemann	Clean Ocean Action	908-872-0111	908-872-8041
Bob Reid	NMFS	908-872-3020	908-872-3088
Bob Will	COE	212-264-1275	212-264-5472
Bob Cerrato	MSRC, SUNY	516-632-8666	516-632-8820
Mark Burlars	COE	212-264-4663	212-204-6454
Joel O'Connor	EPA Region 2	212-637-2795	212-637-3889
Larry Swanson	MSRC, SUNY	516-632-8704	516-632-8064
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Scott McDowell	SAIC Newport	401-847-4210	401-849-1585
Jack Word	Battelle, MBL	360-681-3668	360-681-3681
Roy Kropp	Battelle, Duxbury, MA	617-934-0571	617-934-6199
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Judy Pederson	MIT Sea Grant	617-252-1741	617-258-1615
Eric Adams	MIT Sea Grant	617-253-6595	617-258-8854
Tom Fredette	COE	617-647-8291	617-647-8303
Joe Bergstein	EPA	212-637-3890	212-637-3771

EXHIBIT 6

APR 0 6 1995

Mr. Clifford Day
Field Supervisor
U.S. Fish and Wildlife Service
927 N Main Street, Building D
Pleasantville, New Jersey 08232

Dear Mr. Day:

I am writing to request the U.S. Fish and Wildlife Service's (FWS) input to determine whether there are any federal endangered/threatened species under FWS jurisdiction present in the vicinity of the Mud Dump Site (MDS) and its environs. I have enclosed, for your review, the Environmental Protection Agency's (EPA) public announcement initiating the preparation of a supplemental environmental impact statement for the expansion of the MDS. The enclosure includes a map identifying both the existing MDS and the area being evaluated for possible site expansion.

In compliance with the mandate of Section 7 of the Endangered Species Act of 1973, as amended, the EPA is requesting a written statement from you indicating whether any endangered or threatened species under FWS jurisdiction may be present in the project area. Please advise us concerning the range of territory covered by any federal endangered/threatened species that may be found in the area, and whether activities at the site may result in impacts to these species. Please note that EPA is also initiating Section 7 consultation with the National Marine Fisheries Service to assess any potential endangered/threatened species issues under its jurisdiction.

We appreciate your assistance in this matter. If you have any questions or require additional information, please contact Joseph Bergstein of my staff at (212) 264-6677.

Sincerely yours,

Robert W. Hargrove, Chief
Environmental Impacts Branch

Enclosure

cc: D. Beach, NMFS
S. Morgan, USFWS-Cortland
N. Schlotter, USFWS-Long Island

2PM-EI:JBERGSTEIN:X6677/4/5/95 LAN: CORD&ATN.FWS

EXHIBIT 7

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232

IN REPLY REFER TO:

ES-95/65

Tel: 609-646-9310
FAX: 609-646-0352

May 3, 1995

Mr. Robert W. Hargrove, Chief
Environmental Impacts Branch
U.S. Environmental Protection Agency, Region II
290 Broadway
New York, New York 10007-1866

Dear Mr. Hargrove:

This responds to your April 6, 1995 request to the U.S. Fish and Wildlife Service (Service) for information on the presence of endangered and threatened species within the vicinity of the study area for the proposed expansion of the Mud Dump Site, an area designated in 1984 by the U.S. Environmental Protection Agency (EPA) for the disposal of dredged materials generated in the Ports of New York and New Jersey and nearby harbors. The EPA is preparing an Environmental Impact Statement (EIS) to address impacts associated with the proposed expansion of the Mud Dump Site. The study area includes the Mud Dump Site and a 23-square-nautical-mile area surrounding the site.

Authority

This response is provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate review and comments by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*), if any permits are required from the U.S. Army Corps of Engineers pursuant to the Clean Water Act of 1977 (33 U.S.C. 1344 *et seq.*), nor do they preclude comments on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Federally-listed Species

Enclosed are current summaries of the federally-listed and candidate species in New Jersey for your information. Although not within the 23-square-nautical-mile study area surrounding the Mud Dump Site, two federally-listed threatened species, the piping plover (*Charadrius melodus*) and northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), have been documented to occur along the Atlantic coastline within three nautical miles of the study site.

The piping plover is a small, territorial shorebird that nests on sand beaches or within dunes, sometimes on sandy gravel or dredge spoil. Piping plover nests consist of only a shallow scrape in the sand, frequently lined with shell fragments. Nests are often found near small clumps of vegetation. Piping plovers feed primarily on marine macroinvertebrates in the intertidal zone of ocean beaches and in mud flats on bayside beaches. The piping plover is susceptible to a variety of impacts including beach stabilization and renourishment projects, and disturbance from humans.

The northeastern beach tiger beetle was historically found along New Jersey's undeveloped Atlantic coastal beaches from Sandy Hook to Holgate. The Service has recently initiated recovery activities to restore this diurnal, predatory insect to portions of its former range. In October 1994, a reintroduction of the northeastern beach tiger beetle was undertaken by the Service at the Gateway National Recreation Area, Sandy Hook Unit along two sections of Atlantic coastal beach.

Northeastern beach tiger beetle larvae occur over a relatively narrow band of the upper intertidal to high drift zone, thus many larvae are regularly covered during high tide. Tiger beetle larvae are "sit-and-wait predators," which dig vertical burrows in the sand and wait at the burrow mouth, rapidly extending from their burrows to seize small prey passing nearby. Primary prey items are small amphipods, flies, and other beach arthropods. Additionally, adult northeastern beach tiger beetles have been observed scavenging on dead amphipods, crabs, and fish. Northeastern beach tiger beetle larvae pass through three developmental stages or instars during a full two-year life cycle, over-wintering twice as larvae, pupating at the bottom of their burrows, and emerging as winged adults during their third summer. The northeastern beach tiger beetle is threatened by destruction and disturbance of its natural beach habitat from shoreline development and beach stabilization projects, high recreational use, offshore spills of oil or other contaminants, pesticide spraying for mosquito control, and natural phenomenon such as winter beach erosion, flood tides, and hurricanes.

Except for the aforementioned species and an occasional transient bald eagle (*Haliaeetus leucocephalus*) or peregrine falcon (*Falco peregrinus*), no other federally-listed or proposed threatened or endangered flora or fauna under Service jurisdiction are known to occur within the vicinity of the project site.

The Service recommends that potential impacts to the piping plover and northeastern beach tiger beetle from movement of materials disposed of at the proposed expansion of the Mud Dump Site onto oceanfront beaches, shorelines, or intertidal areas be addressed through preparation of a Biological Assessment. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act to prepare a Biological Assessment if the proposal is a major construction project that requires an EIS. The assessment should contain information concerning listed species or species proposed for listing that may be present in the action area and an analysis of any potential effect of the proposed action on such species. The following may be considered for inclusion in a Biological Assessment of the proposed project, although actual contents are at the discretion of the federal authorizing agency:

(1) results of field surveys to determine if listed species are present or occur seasonally;

(2) views of recognized experts on the species;

(3) literature review;

(4) analysis of direct, indirect, and cumulative effects of the action on the species; and,

(5) analysis of alternative actions.

Biological Assessments may be consolidated with interagency cooperation procedures required by other statutes such as the Fish and Wildlife Coordination Act or the National Environmental Policy Act. The satisfaction of the requirements of these other statutes, however, does not in itself relieve a federal agency of its obligation to comply with the Biological Assessment procedures of the Endangered Species Act. The results of a Biological Assessment may be incorporated into the EIS. If the Biological Assessment indicates that no listed or proposed species are present or will be affected, and the Service concurs, in writing, with the assessment, then no formal consultation pursuant to Section 7 will be required.

Candidate Species

Candidate species are species under consideration by the Service for possible inclusion on the List of Endangered and Threatened Wildlife and Plants. Although candidate species receive no substantive or procedural protection under the Endangered Species Act, the Service encourages federal agencies and other planners to consider candidate species in project planning. The Northern diamondback terrapin (*Malaclemys terrapin terrapin*) has been documented to occur along the Atlantic coastline within three nautical miles of the study site.

The New Jersey Natural Heritage Program (NHP) provides the most up-to-date information on candidate species in New Jersey, as well as maintaining information on State-listed species. The NHP may be contacted at the following address:

Mr. Thomas Breden
Natural Heritage Program
Division of Parks and Forestry
CN 404
Trenton, New Jersey 08625
(609/984-0097)

All candidate species identified within the study area as a result of the NHP data search and any project-related adverse impacts to these species should be addressed in the EIS.

Further information on New Jersey's State-listed wildlife species may be obtained from the following office:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609/292-9400)

Information contained in this letter and additional information obtained from the aforementioned sources represents the public interest for fish and wildlife resources and should warrant full consideration in the project planning process. The Service requests that no part of this letter be taken out of context and if reproduced, the letter should appear in its entirety.

Please contact Annette Scherer of my staff if you have any questions or require further assistance regarding threatened or endangered species.

Sincerely,

Robert Frakes

for Clifford G. Day
Supervisor

Enclosures

EXHIBIT 8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - REGION II
290 BROADWAY
NEW YORK. NEW YORK 10007-1866

JUN 30 1995

Clifford G. Day, Supervisor
Pleasantville Field Office
U.S. Fish and Wildlife Service
927 N Main Street, Building D
Pleasantville, New Jersey 08232

Dear Mr. Day:

This is in response to your May 3, 1995 letter regarding the presence of endangered/threatened species within the vicinity of the study area for the proposed expansion of the Mud Dump Site (MDS). Your letter states that two federally-listed threatened species, the piping plover (Charadrius melodus) and the northeastern beach tiger beetle (Cicindela dorsalis dorsalis), have been documented to occur along the Atlantic coastline within three nautical miles of the study area. Accordingly, you recommended that the Environmental Protection Agency (EPA) prepare a Biological Assessment (BA) of the impacts of expanding the MDS on these two terrestrial species.

Following receipt of your letter, Joseph Bergstein and Annette Scherer, of our respective staffs, discussed your concerns in greater detail. Ms. Scherer indicated that the Fish and Wildlife Service (FWS) routinely recommends the preparation of BAs whenever federally-listed species may be found in the vicinity of a study area for an environmental impact statement. Further, she clarified that, in this case, the FWS recommendation reflects a concern about the possible movement of materials disposed of at the expanded MDS onto oceanfront beaches, shorelines, or into intertidal areas.

Over the last several years, the EPA has conducted numerous hydrodynamic surveys in the New York Bight. These surveys indicate that dredge plumes dissipate rapidly (i.e., within two hours). Moreover, the surveys demonstrate that the mean current flows in the New York Bight Apex are away from oceanfront beaches, shorelines, and intertidal areas. (Copies of the reports are enclosed for your information and review.) Based on the aforementioned hydrodynamic surveys, it is clear that material disposed of at the MDS and environs is not transported to shoreline or intertidal habitats that support the piping plover and the beach tiger beetle. Accordingly, EPA does not believe that the proposed expansion of the MDS will adversely affect these species. With this in mind, we request your written concurrence with this conclusion, pursuant to 50 CFR Part 402.13, within 30 days of your receipt of this letter.

If you have any questions or require additional information, please contact me at (212) 637-3495, or have your staff contact Joseph Bergstein at (212) 637-3521.

Sincerely yours,

Robert W. Hargrove, Chief
Environmental Impacts Branch

Enclosures

cc: D. Beach, NMFS
N. Schlotter, USFWS-Long Island
S. Morgan, USFWS-Cortland

EXHIBIT 9

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232
Tel: 609-646-9310
FAX: 609-646-0352

IREPLY REFER TO:
ES-95/111

July 28, 1995

Mr. Robert W. Hargrove, Chief
Environmental Impacts Branch
U.S. Environmental Protection Agency, Region II
290 Broadway
New York, New York 10007-1866

Dear Mr. Hargrove:

This letter responds to your June 30, 1995, request to the U.S. Fish and Wildlife Service (Service) for concurrence with your determination that the proposed expansion of the Mud Dump site, an area designated in 1984 by the U.S. Environmental Protection Agency (EPA) for the disposal of dredged materials generated in the Ports of New York and New Jersey and nearby harbors, is not likely to adversely affect federally-listed species.

This response is provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate review and comments by the Service as afforded by the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*), if any permits are required from the U.S. Army Corps of Engineers pursuant to the Clean Water Act of 1977 (33 U.S.C. 1344 *et seq.*), nor do they preclude comments on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

The Service's previous correspondence on this project, dated May 3, 1995, recommended that an assessment be conducted of potential impacts to two federally-listed threatened species, the piping plover (*Charadrius melodus*) and northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*), from materials disposed of at the proposed expansion of the Mud Dump site. The Service's recommendation reflected a concern regarding potential movement of disposal materials onto oceanfront beaches, shorelines, or intertidal areas. In response to the Service's recommendation, the following documents detailing the results of hydrodynamic studies conducted at the Mud Dump site were provided for the Service's review:

- *Analyses of Moored Current and Wave Measurements from the New York Mud Dump Site: November 1992 to March 1993, Draft Report*, Report No. 11 of Dioxin Capping Monitoring Program, Science Applications International Corporation Report No. 302, Newport, Rhode Island, November 1993;

- *Analyses of Moored Current and Wave Measurements from the New York Mud Dump Site: June through September 1993, Draft Report*, Report No. 12 of Dioxin Capping Monitoring Program, Science Applications International Corporation Report No. 303, Newport, Rhode Island, December 1993;

- *Draft Final Report for Plume Tracking of Dredged Material Containing Dioxin*, Battelle Ocean Sciences, Duxbury, Massachusetts, February 1994; and

- *Analyses of Moored Current and Wave Measurements from the New York Mud Dump Site: The Year 1 Program, March 1992 to March 1993*, Report No. 15 of Dioxin Capping Monitoring Program, Science Applications International Corporation Report No. 336, Newport, Rhode Island, January 1995.

Hydrodynamic studies indicate that fines (silt and clay) from dredged material plumes remain in the water column in measurable amounts for up to two and one-half hours after release (Dragos and Peven, 1994) and have been documented to move outside of the Mud Dump site (Dragos and Peven, 1994; Science Applications International Corporation, 1993). However, the mean speeds of currents transporting water parcels and suspended particulate matter out of the Mud Dump site are weak, ranging up to 12 centimeters per second (0.8 kilometers in two hours) (Science Applications International Corporation, 1993). Based upon a review of the hydrodynamic information provided and the distance of the Mud Dump expansion study area from areas supporting the piping plover and northeastern beach tiger beetle (three nautical miles), the Service concurs with the EPA's determination that the proposed expansion of the Mud Dump Site is not likely to adversely affect federally-listed species. If additional information on listed or proposed species or contradictory hydrodynamic information becomes available, this determination may be reconsidered.

Please contact Annette Scherer of my staff if you have any questions or require further assistance regarding threatened or endangered species.

Sincerely,

Robert Fraker

for Clifford G. Day
Supervisor

References

Dragos, P. and C. Peven. 1994. Draft final report for plume tracking of dredged material containing dioxin. Battelle Ocean Sciences, Duxbury, Massachusetts. 49 pp. + appendices.

Science Applications International Corporation. 1993. Analyses of moored current and wave measurements from the New York Mud Dump site: November 1992 to March 1993. Draft Report, Report No. 11 of Dioxin Capping Monitoring Program, Science Applications International Corporation Report No. 302. Science Applications International Corporation, Newport, Rhode Island. 59 pp.

EXHIBIT 10

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY - REGION II
290 BROADWAY
NEW YORK, NEW YORK 10007-1866

APR 0 4 1996

Mr. Christopher Mantzaris, Chief
Habitat & Protected Resources
National Marine Fisheries Service
1 Blackburn Drive
Gloucester, Massachusetts 01930

Dear Mr. Mantzaris:

The Environmental Protection Agency (EPA) is preparing a supplemental environmental impact statement (SEIS) on the possible expansion of the Mud Dump Site (MDS). The SEIS will clearly identify the habitat within the study area, and include an estimate of the potential capacity for disposal of dredged material. Further, the SEIS will provide a thorough explanation of the type of material to be disposed of, assessments of potential cumulative impacts of dredged material disposal, and measures to minimize potential impacts.

Additionally, the SEIS will fully evaluate the effects of expansion of the MDS on federally listed endangered and threatened species. Towards this end, this letter initiates informal consultation, pursuant to Section 7 of the Endangered Species Act (ESA), on this action's potential impacts to any endangered or threatened species under the jurisdiction of the National Marine Fisheries Service (NMFS).

Six listed species under the NMFS's jurisdiction have been identified in the vicinity of the MDS: the right whale (Eubalaena glacialis), fin whale (Balaenoptera physalus), humpback whale (Megaptera novaeangliae), Kemp's ridley sea turtle (Lepidochelys kempii), leatherback sea turtle (Dermochelys coriacea), and green sea turtle (Chelonia mydas). Additionally, the threatened loggerhead sea turtle (Caretta caretta) has been identified within the MDS. Further, we understand that the harbor porpoise (Phocoena phocoena), which has been proposed for listing as a threatened species, has also been sighted in the vicinity of the MDS.

In preliminary discussions between our staffs, a number of references were identified that indicate that disposal of dredged material at an Expanded MDS will not affect several of the aforementioned species. These documents, which were provided to your office, contain information indicating that dredged material disperses within three hours; therefore, it would be biologically unavailable to plankton, or to cetaceans and sea turtles that feed on plankton/planktivorous fish. Furthermore, the documentation illustrates that preferred food sources of several of the endangered species are not found within the MDS or the expanded study area. Based on this information, EPA believes that dredged material disposal at the MDS and environs will not affect the green sea turtle, the leatherback turtle, the right whale, and the harbor porpoise, for the following reasons:

- The green sea turtle feeds on food sources that are located in the Long Island Sound such as seagrass, Fucus, Codium, Ulva and Enteromorpha; these plants are not located in the Expanded MDS study area. Given this food preference, this species is generally not located in waters of the MDS or its environs.

- The leatherback sea turtle demonstrates a feeding preference for jellyfish. The insignificant lipid fractions in jellyfish, as well as their short life expectancy reduces the likelihood of significant accumulation of pollutants such as PCB or dioxin that would, in turn, pose potential adverse impacts to this pelagic feeder. Moreover, juvenile leatherback turtles forage in waters less than 40 feet deep; we expect to restrict dredged material disposal at the Expanded MDS to waters deeper than 50 feet.

- Regarding right whales, there are no known records of right whales feeding in the New York Bight Apex. Rather, high use areas include coastal Florida and Georgia as calving areas, and the Great South Channel east of Cape Cod, Massachusetts, the Bay of Fundy, the Browns and Baccaro Banks off Nova Scotia for feeding.

- With respect to the harbor porpoise, the information we have reviewed indicates that this species is not known to interact with dredge and disposal operations. Rather, the major impact on harbor porpoise populations is gillnet fishing.

With the above in mind, we are not planning to prepare Biological Assessments (BAs) for these species.

The Marine Protection, Research, and Sanctuaries Act precludes the dumping of materials in the ocean that would cause adverse environmental effects, ensuring that federally-listed endangered and threatened species will be protected. Moreover, the provision of NMFS-trained observers aboard ships involved in dredged material disposal operations provides additional protection for endangered and threatened species.

In any event, Ms. Laurie Silva of your staff, has provided information to us regarding the foraging behavior of the Kemp's ridley and loggerhead sea turtles, and the distribution of juvenile humpback and fin whales within the MDS and environs that indicates that these species may be affected by disposal operations. Accordingly, based on a review of this information, EPA has decided to prepare BAs pursuant to 50 CFR 402.12, for the four species.

In preparing the BAs, we will utilize the information that has been provided by NMFS, in conjunction with a variety of EPA reports, and other reference material. The BAs will also consider surveys and studies of the New York Bight Apex and Expanded MDS study area conducted over the past two years by EPA and the Army Corps of Engineers. Furthermore, these BAs will gauge the likelihood of increased vessel traffic at the MDS as a result of its expansion, weigh the potential impact to the species, and identify appropriate mitigation measures.

I would appreciate your written concurrence with this approach within 30 days of your receipt of this letter. If you have any questions or require additional information, please contact me at (212) 637-3495.

Sincerely yours,

Robert W. Hargrove, Chief
Environmental Impacts Branch

cc: S. Gorski, NMFS Sandy Hook
M. Ludwig, NMFS Milford
M. Greges, USACE

EXHIBIT 11

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administrati
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930

MAY 8 1996

Robert W. Hargrove, Chief
Environmental Impacts Branch
U.S. Environmental Protection Agency
290 Broadway
New York, NY 10007-1866

Dear Mr. Hargrove:

This is in response to your letter concerning the ongoing consultation for the Mud Dump Site (MDS). We concur with your determination that dredged material disposal at the mud dump site is not likely to adversely affect green sea turtles, leatherback turtles, the right whale or harbor porpoise that may occasionally transit the MDS area. We also concur that these activities do have the potential to impact loggerhead and Kemp's ridley sea turtles and humpback and fin whales and that a biological assessment should be prepared to assess this potential. However, we also support your conclusion that properly screened clean material is not expected to have water quality impacts on these species and that implementation of observer coverage for disposal operations will help reduce the potential for impacts on these species.

The primary concerns relative to these disposal operations and impacts on these species are vessel collisions, water quality, and degradation of foraging habitat. Our understanding from previous phone calls and correspondence is that this consultation should cover the use of the mud dump site in general, not just the expansion. Consequently, estimates of annual volume and vessel traffic should be on overall use of the MDS including the expansion. A consultation was previously conducted on use of the MDS specifically for the Port Newark/Port Elizabeth Project, but this does not constitute a consultation on the potential impacts of the site for all the other projects using this as a disposal area. However, much of the material compiled for that project is applicable to this consultation and should be incorporated. The benefits of a consultation on the use of the site is that the cumulative impacts can be adequately addressed and disposal of material from future projects that meet the requirements set forth in the project scope will not require individual consultations. This will insure that appropriate protection is afforded to protected species, and reduce the workload associated with individual project review.

If you have any further questions regarding this information , please contact Laurie Silva of my staff at (508) 281-9291.

Sincerely,

Dr. Andrew A. Rosenberg
Regional Director

7.0 LIST OF PREPARERS

This Supplemental Environmental Impact Statement (SEIS) was prepared by Battelle and it subcontractors under EPA Contract Nos. 68-C2-0134 and 68-C7-0004, with technical direction and guidance from U.S. Environmental Protection Agency (EPA) staff.

The following EPA staff participated in the preparation of the SEIS:

EPA Staff	Title	Location
George Pavlou	Deputy Director, Division of Environmental Planning and Protection	EPA Region 2, New York City, NY
Robert W. Hargrove	Chief, Strategic Planning and Multi-Media Programs Branch	EPA Region 2, New York City, NY
Mario Del Vicario	Chief, Placed-Based Protection Branch	EPA Region 2, New York City, NY
Joseph Bergstein	Environmental Scientist, Project Manager	EPA Region 2, New York City, NY
Douglas Pabst	Oceanographer, Chief Scientist for MDS/HARS Ocean Surveys	EPA Region 2, New York City, NY
Suzanne Schwartz	Acting Director, Ocean and Coastal Protection Branch (OCPD)	EPA Headquarters, Washington, DC
John Lishman	Chief, Marine Pollution Control Branch, OCPD	EPA Headquarters, Washington, DC
David Redford	Team Leader, Ocean Dumping Implementation Team, OCPD	EPA Headquarters, Washington, DC

Battelle staff members and Battelle subcontractors who prepared this document, with their titles and primary areas of responsibility, are as follows:

Battelle Staff	Title	Primary Area of Responsibility
Kurt Buchholz	Principal Research Scientist	Work Assignment Leader; Lead author: Chapters 1, 2, 4
Carlton Hunt	Senior Research Scientist	Lead author: Chapter 3; senior reviewer
Karen Foster	Principal Research Scientist	Fish and shellfish data evaluation and synthesis; Section 7 Endangered Species Act evaluation; senior reviewer
Jerry Neff	Senior Research Leader	Section 7 Endangered Species Act evaluation; senior reviewer

Battelle Staff	Title	Primary Area of Responsibility
Roy Kropp	Principal Research Scientist	Benthic ecology data evaluation and synthesis; senior reviewer
Heather Trulli	Research Scientist	Technical writing and bibliography maintenance
Rosanna Buhl	Program/Work Assignment Quality Assurance (QA) Officer	QA review
Mark Kirk	Senior Data Analyst	Mapping and graphics development
John Hennessy	Senior Research Scientist	Mapping and graphics development
Charles (Ned) Morse	Research Scientist	Mapping and graphics development
Debbie Tanis	Research Scientist	Technical writing
Amanda Orrick	Researcher	Technical writing and editing
Lynn McLeod	Researcher	Technical writing
Joanne Lahey	Research Technician	Bibliography maintenance
Heather Amoling	Desktop Publishing Specialist	Word processing and layout
Barbara Greene	Senior Word processing Operator	Word processing
Laura Emilson	Administrative Coordinator	Word processing
Ellen Rosen	Library Clerk	Literature searches
Offshore & Coastal Technologies		
Paul Dragos	Oceanographer	Physical environment data evaluation and synthesis
Panamerican Maritime, L.L.C.		
Stephen R. James	Marine Archeologist	Cultural resources assessment
Michael C. Krivor	Marine Archeologist	Cultural resources assessment
Norine Carroll	Marine Historian	Cultural resources assessment

In addition, draft chapters of the SEIS were reviewed and commented on by the MDS/HARS Workgroup of the Dredged Material Management Forum. Members of the Workgroup are listed in Exhibit 4 of Chapter 6.

APPENDIX A

Fisheries Data from NMFS Northeast Fisheries Science Center Resource Surveys and New Jersey DEP Trawl Surveys

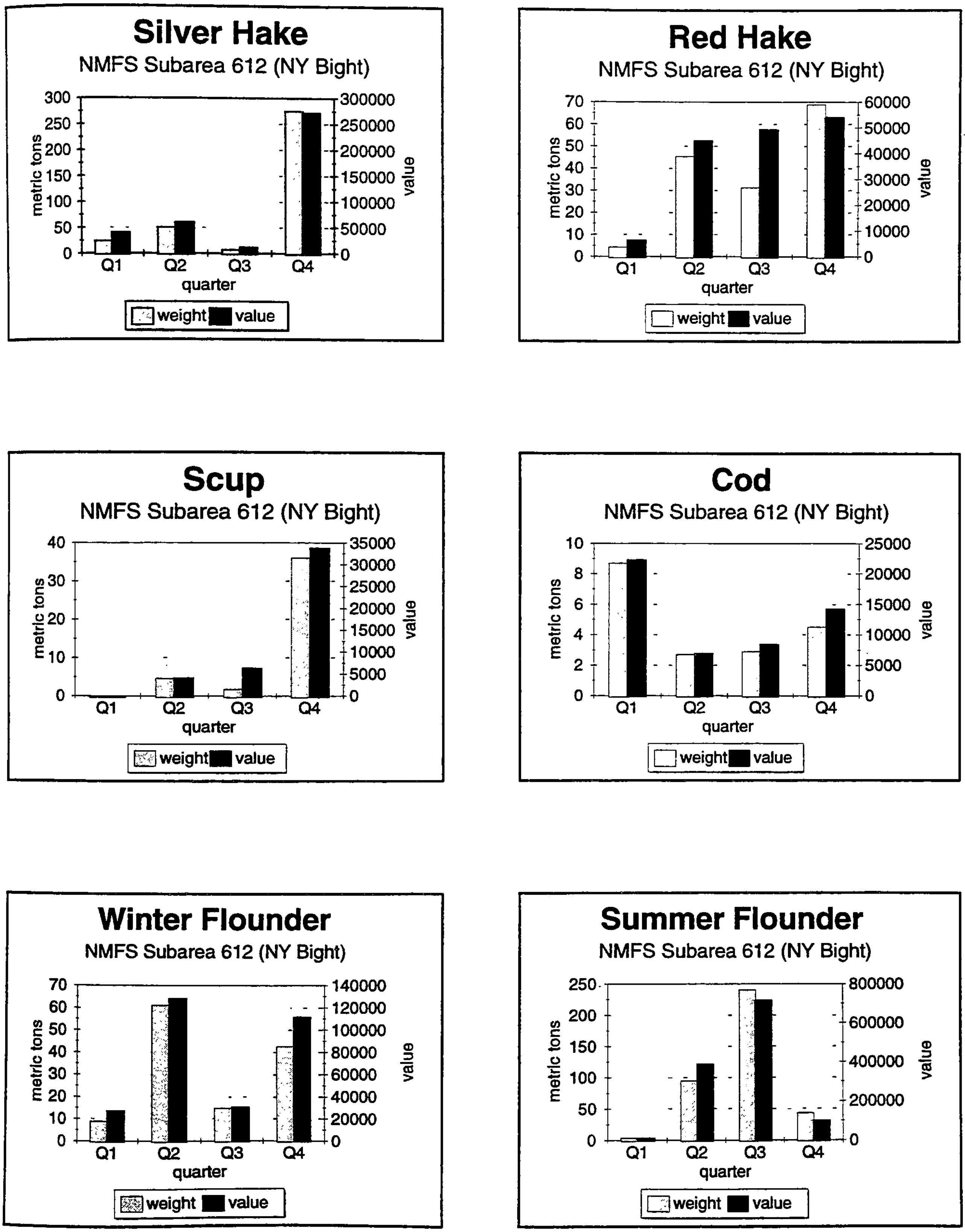
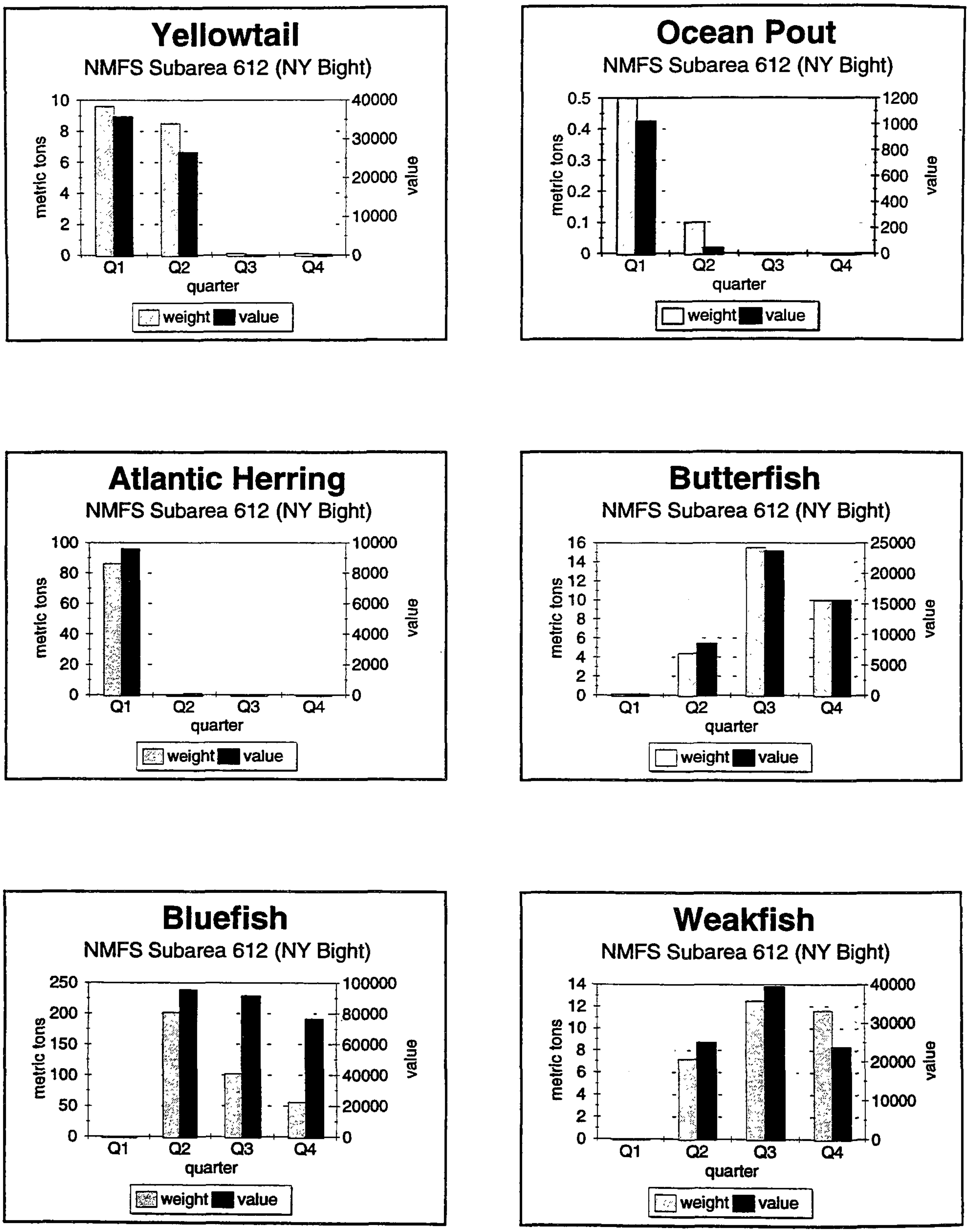


Figure A-1. 1993 Commercial Catch Data, Reported by NOAA National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA.



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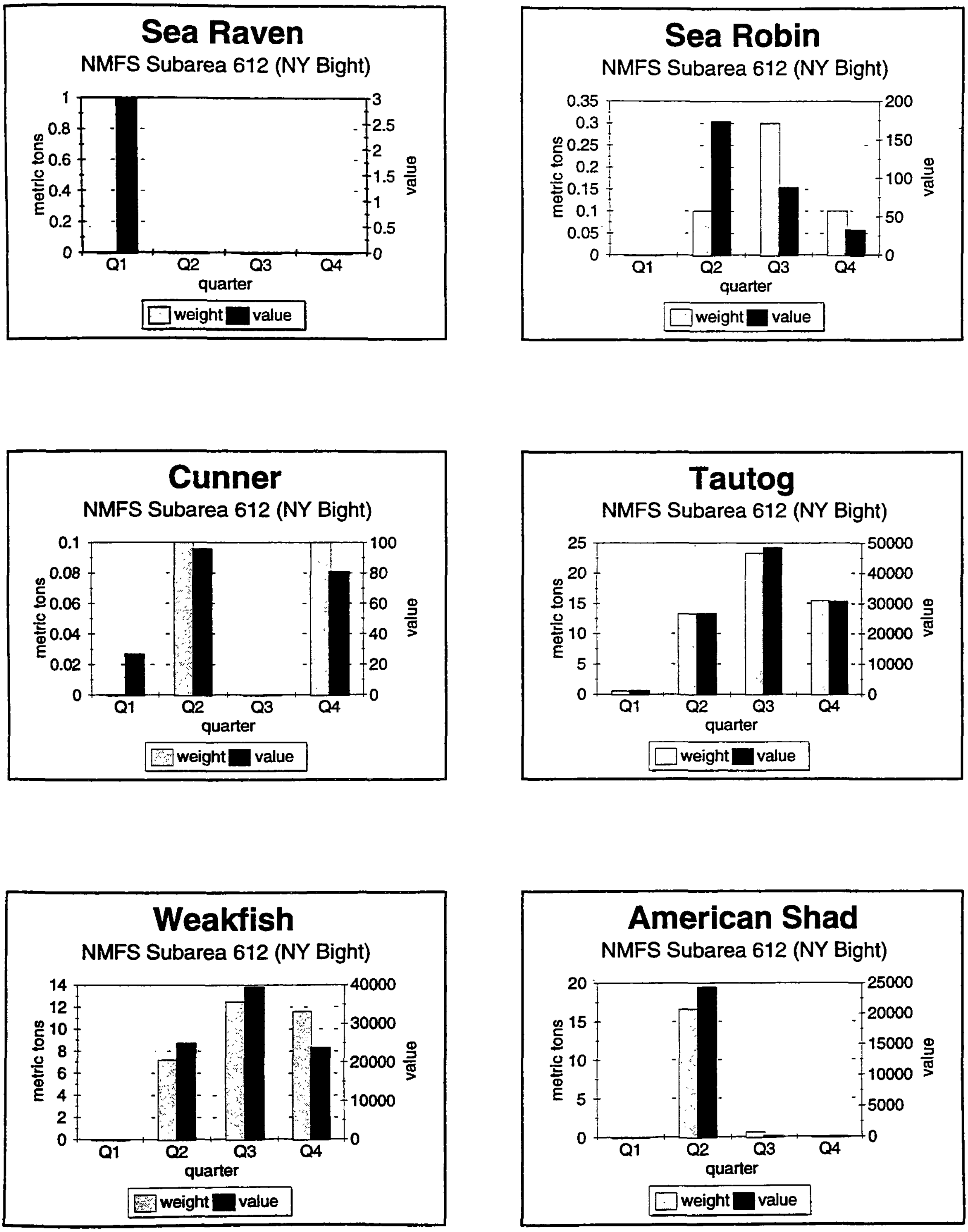

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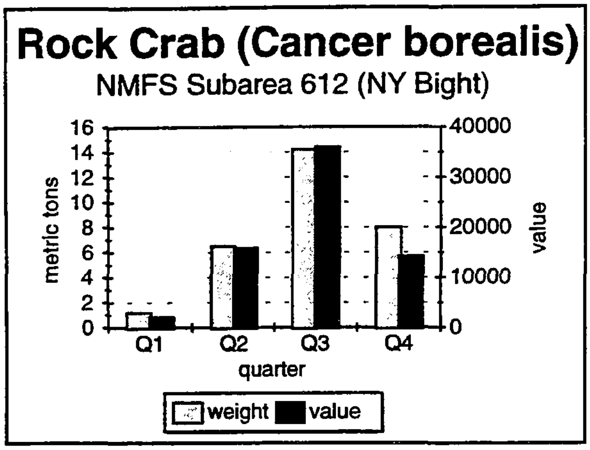

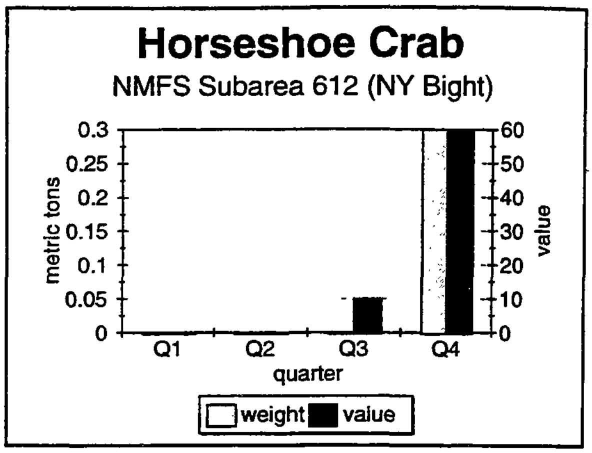

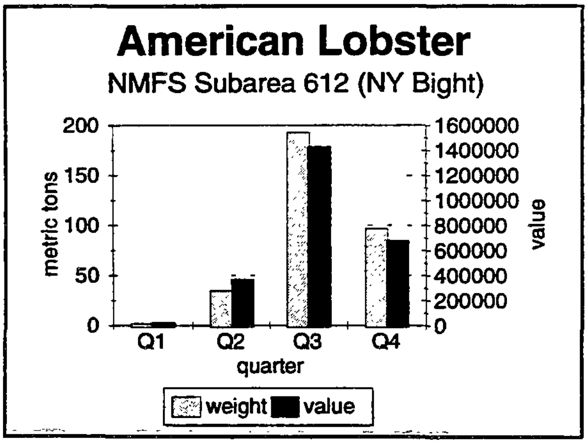

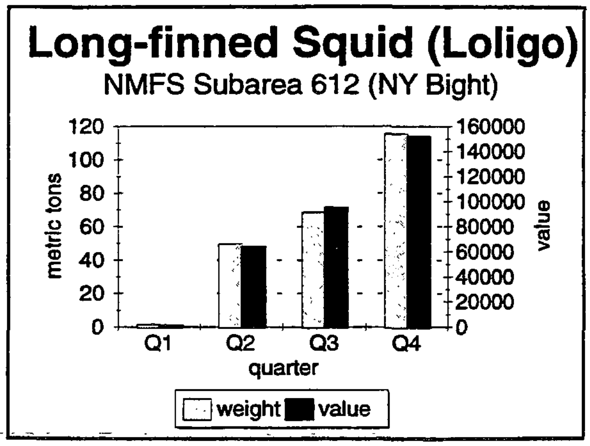

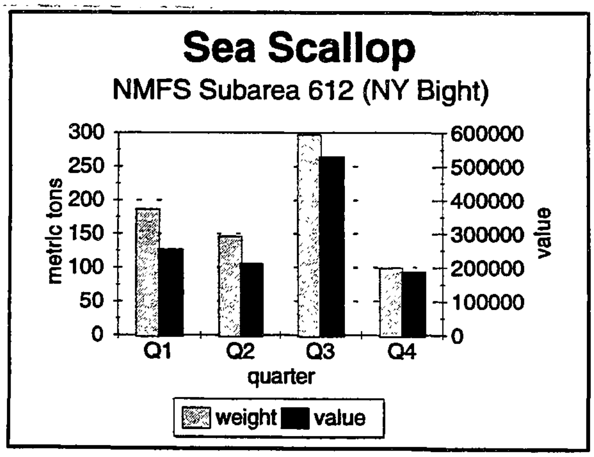

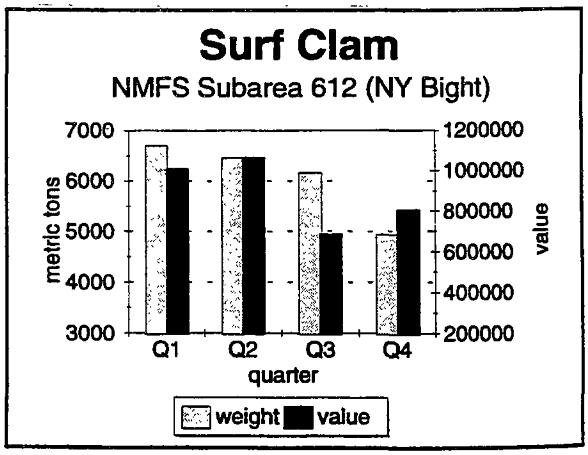

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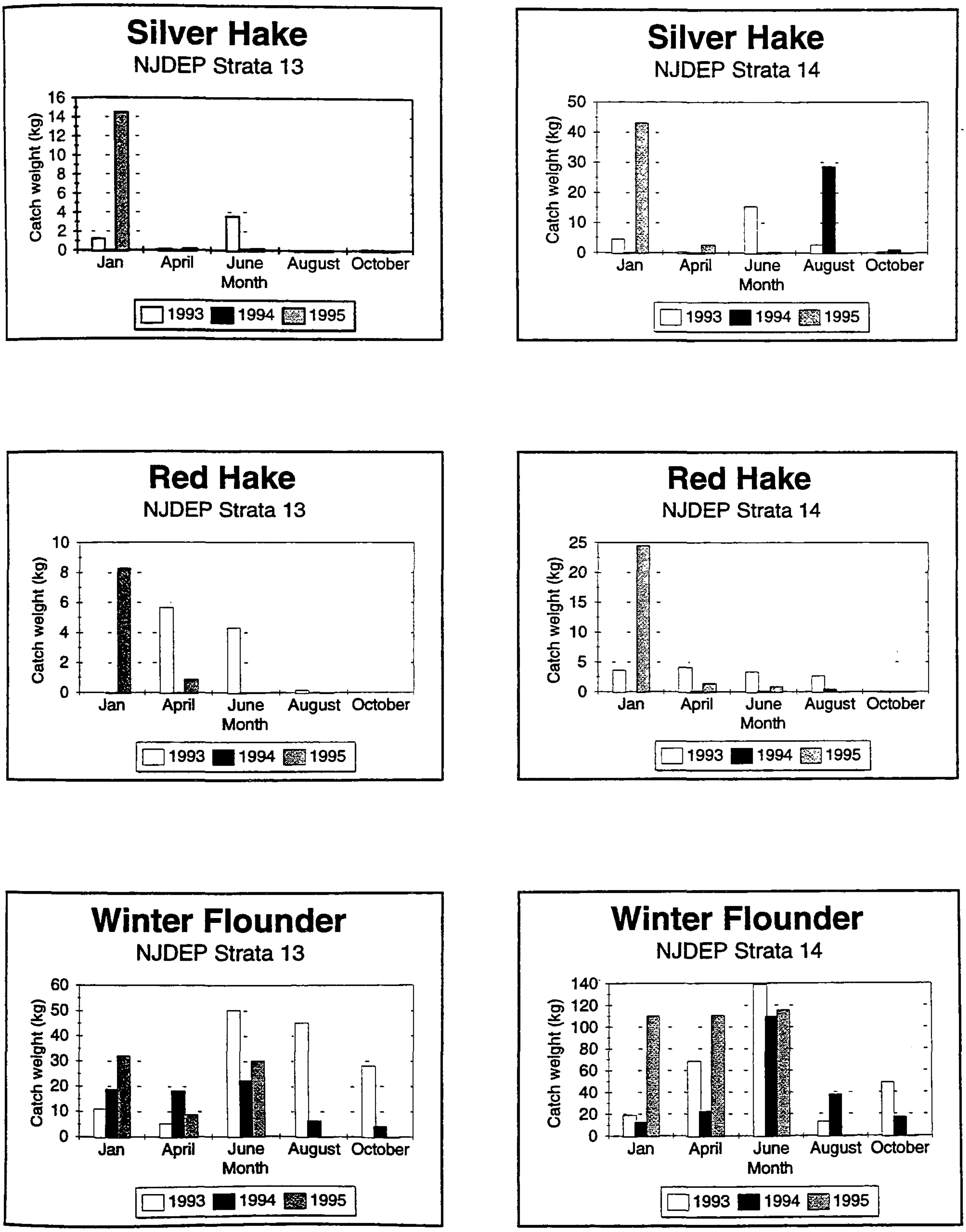
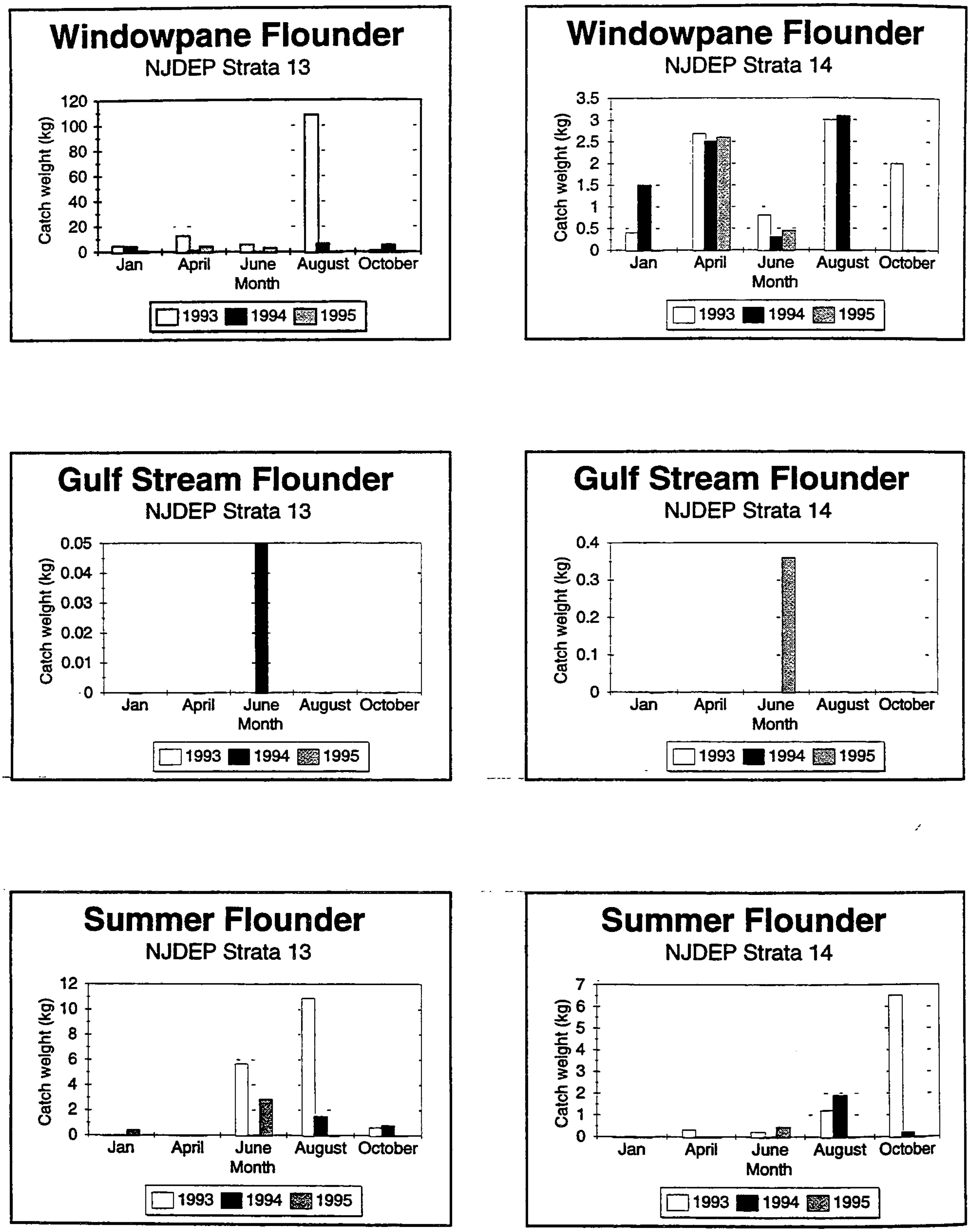


Figure A-2. **1993 - 1995 Strata 13 and 14 Research Trawl Data, Reported by New Jersey Department of Environmental Protection, Fish and Wildlife Division, Port Republic, NJ.**



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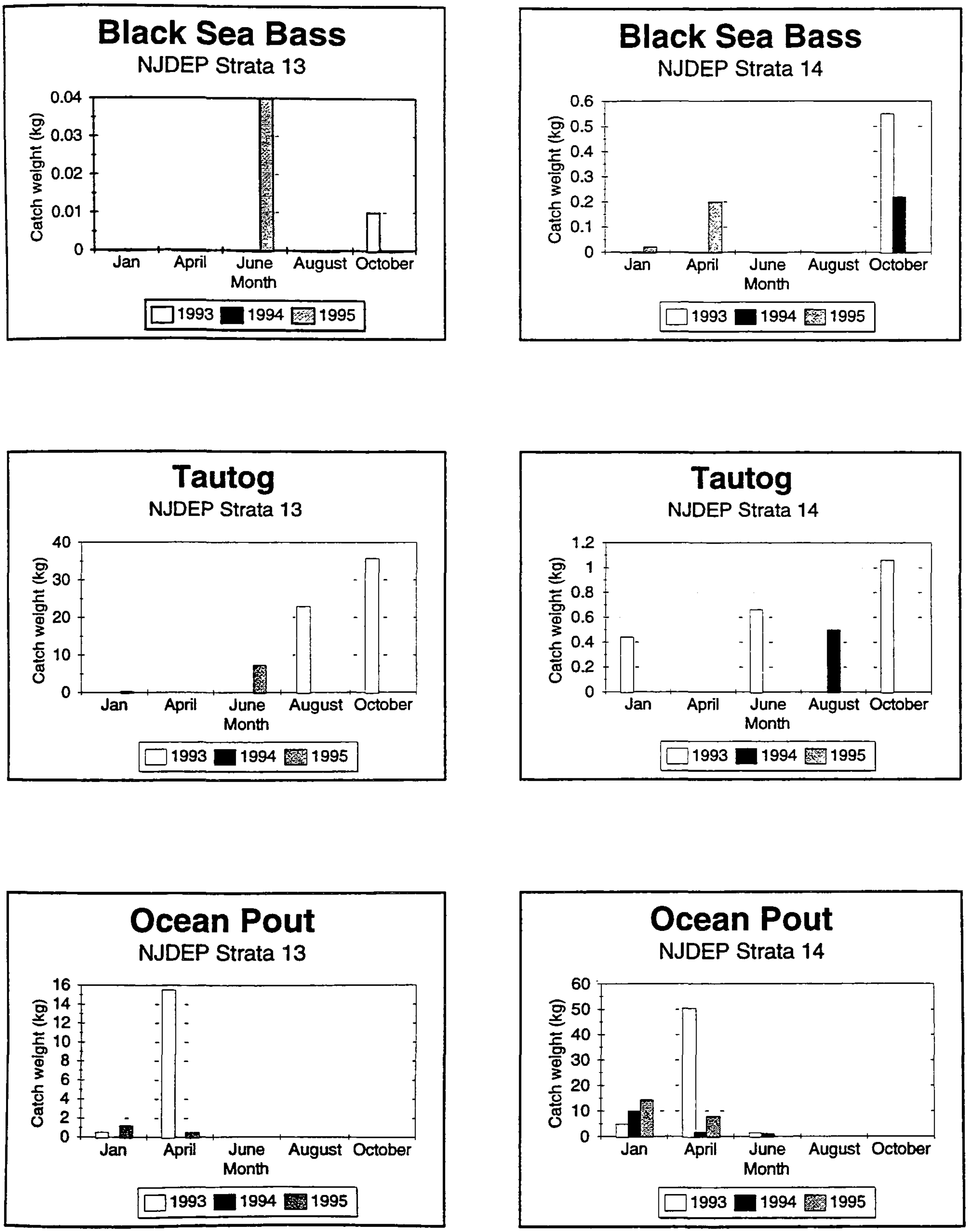

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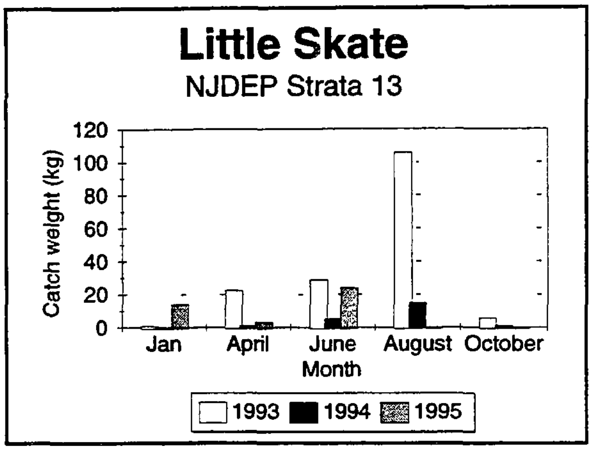

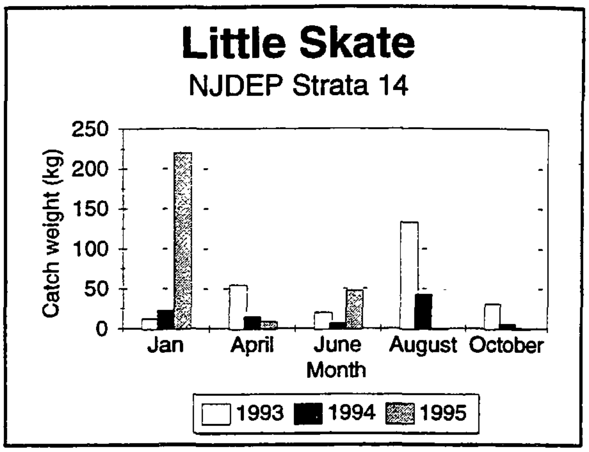

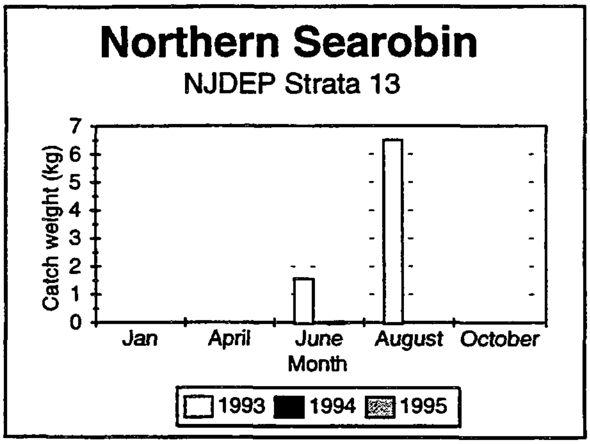

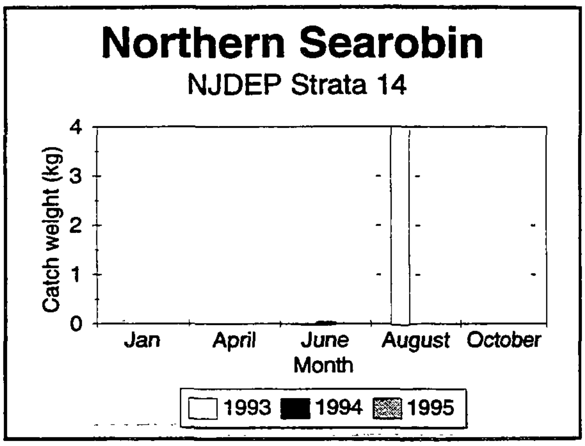

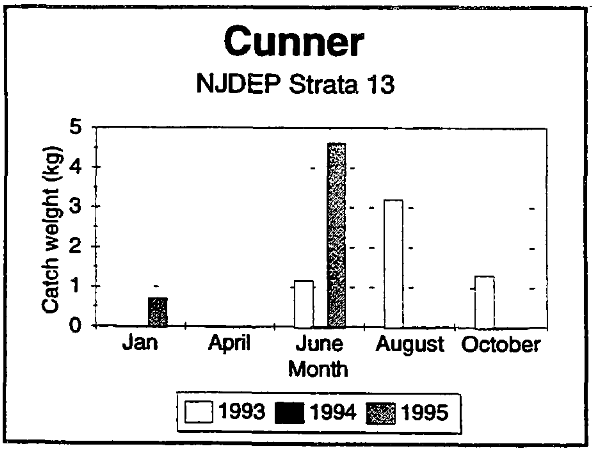

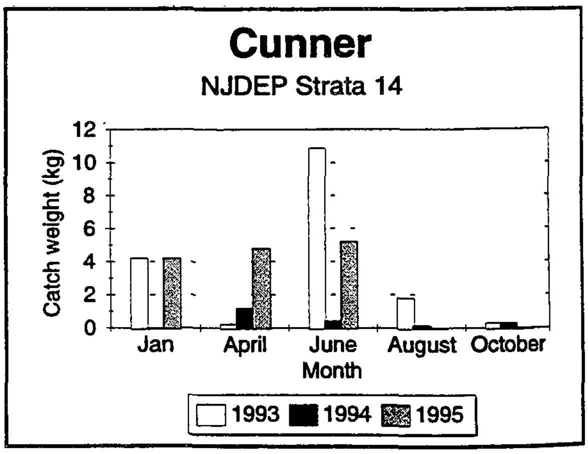

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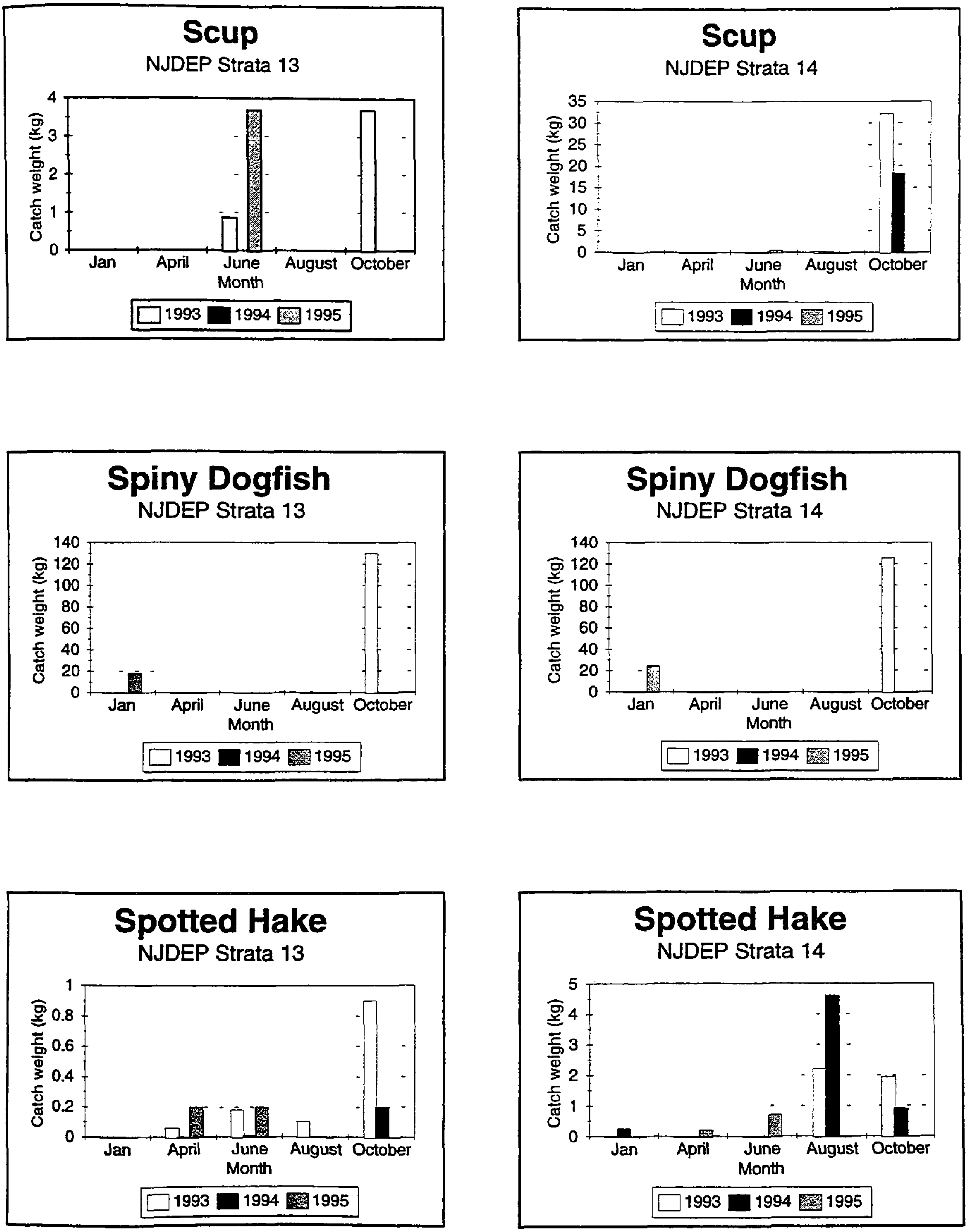

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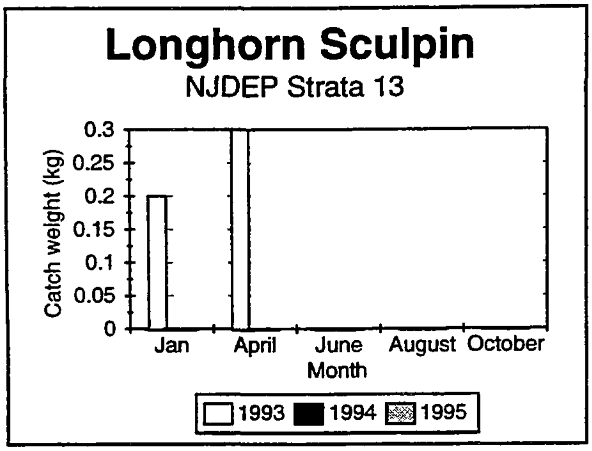

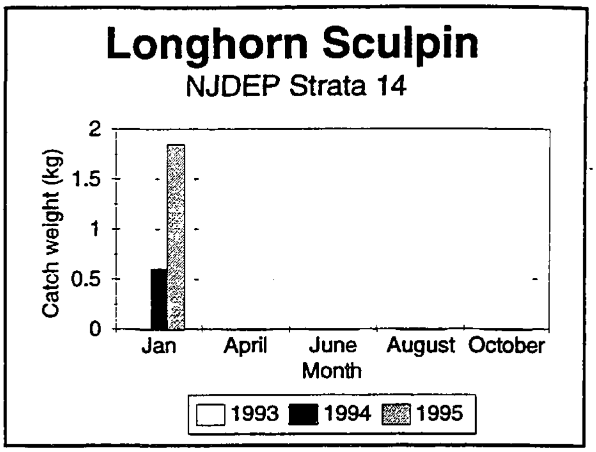

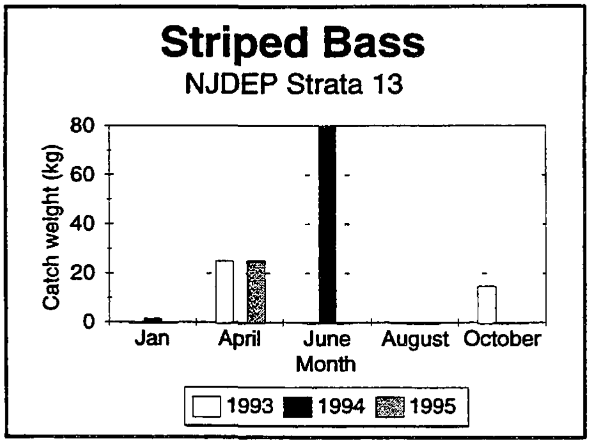

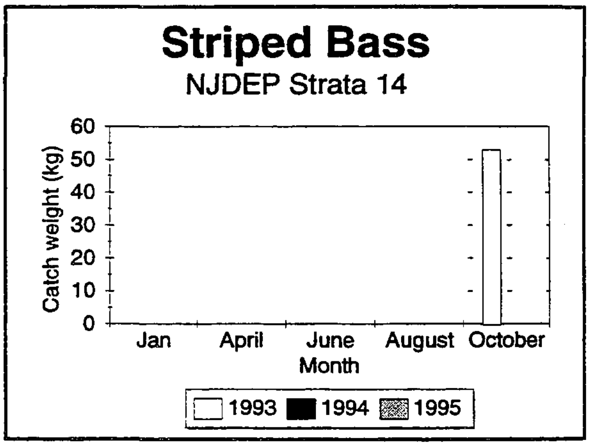

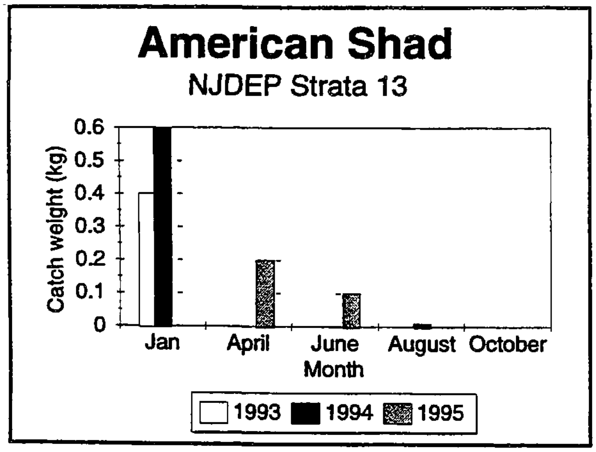

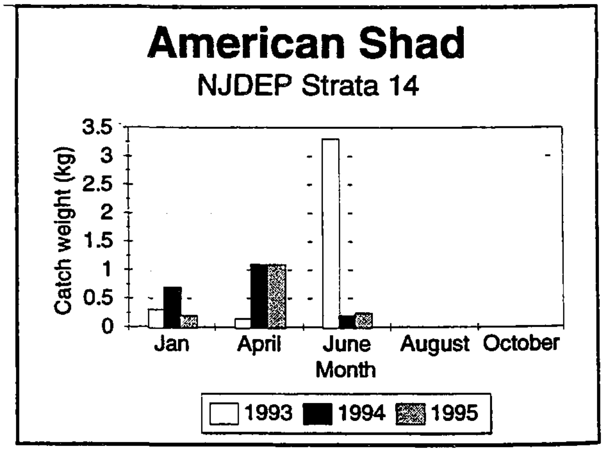

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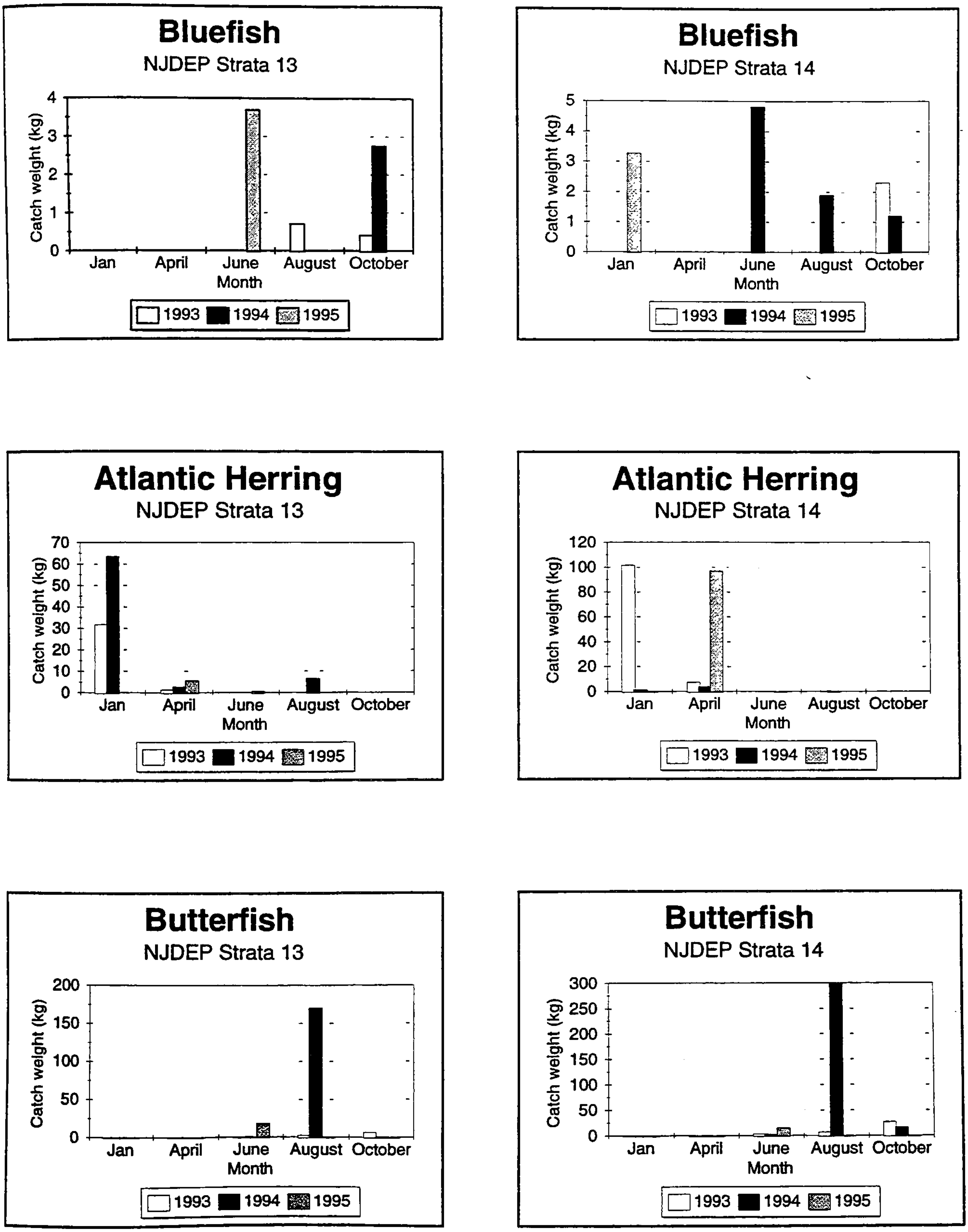

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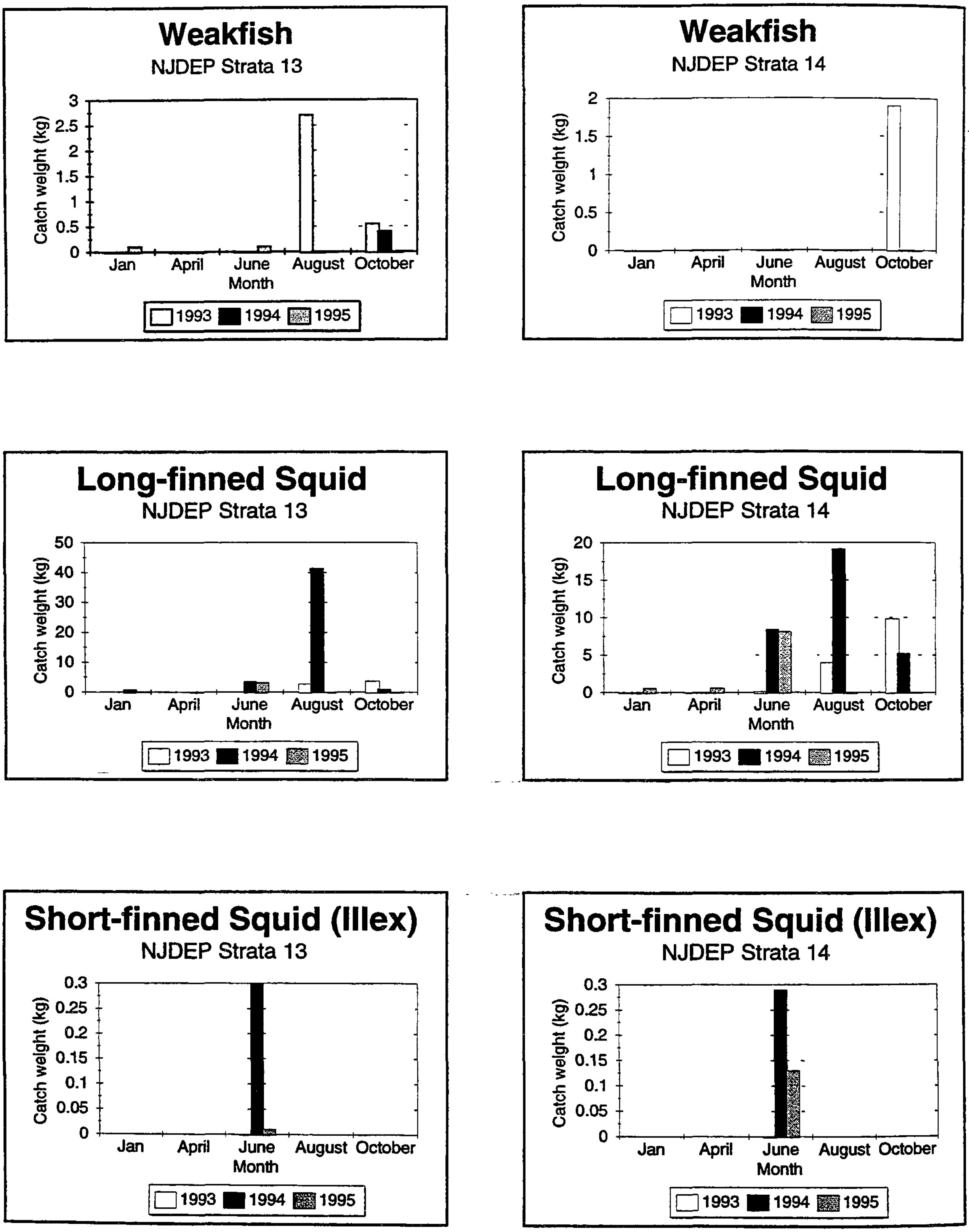

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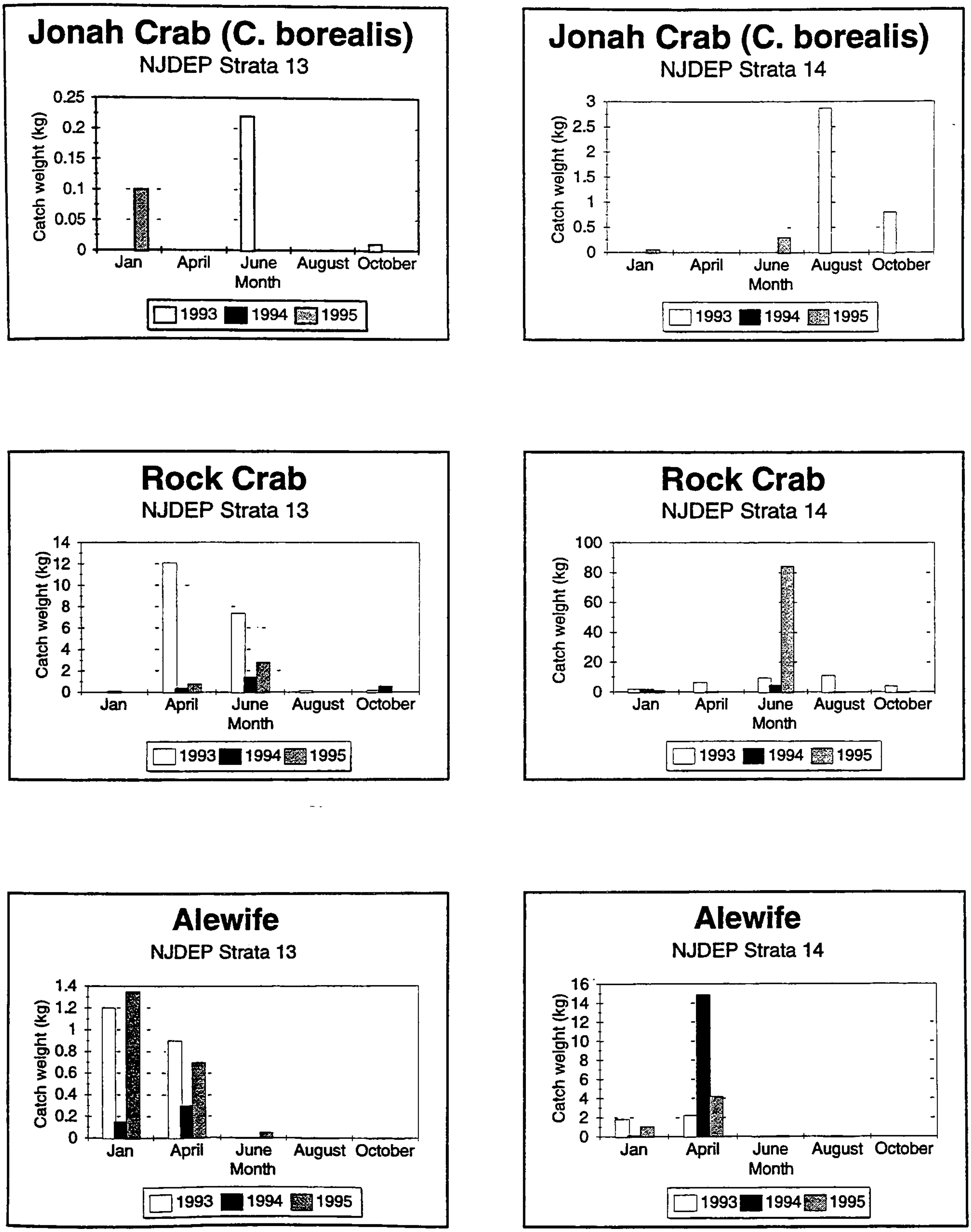

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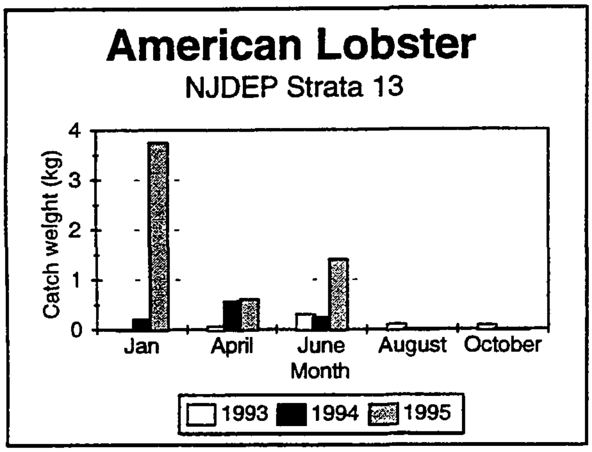

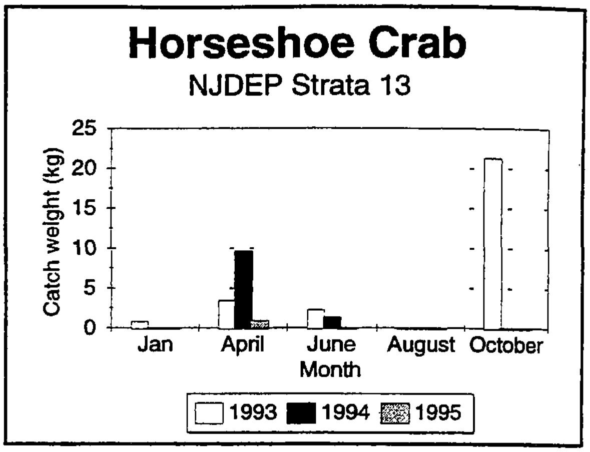

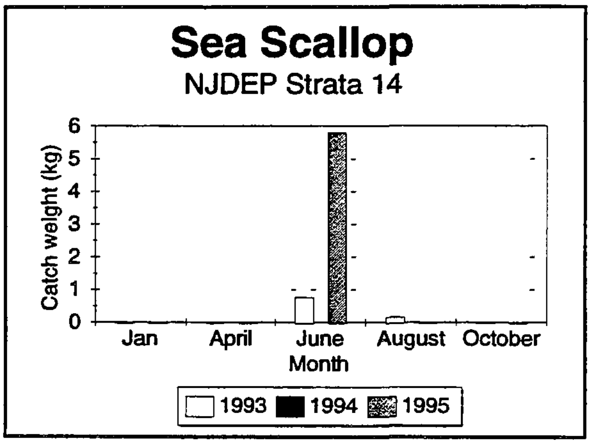

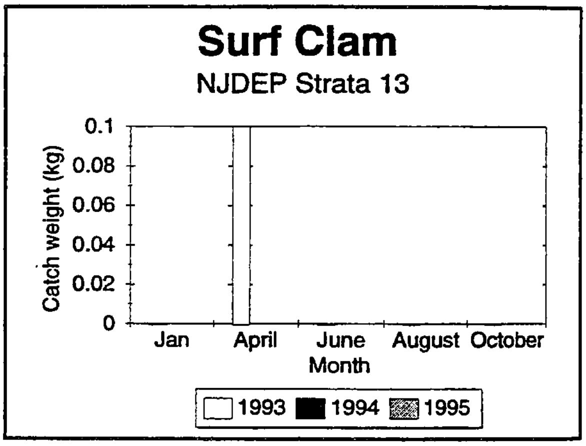

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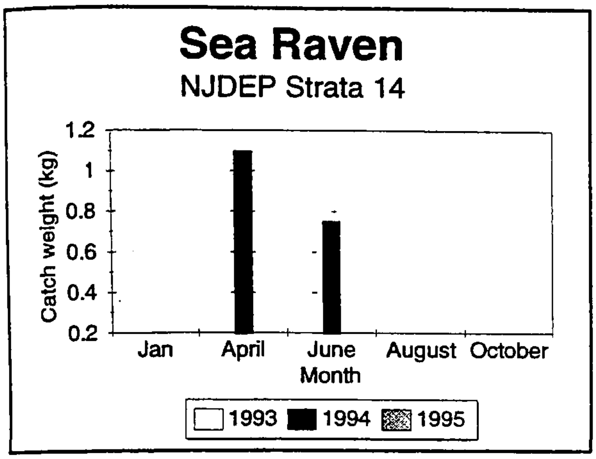

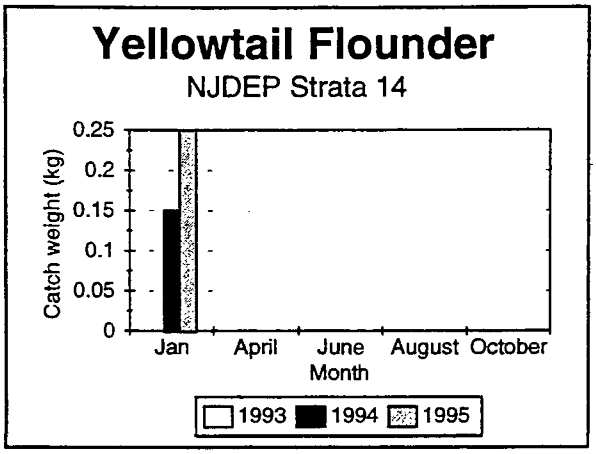

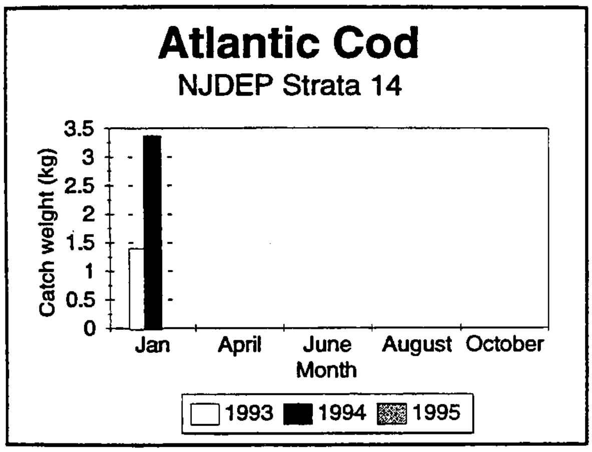

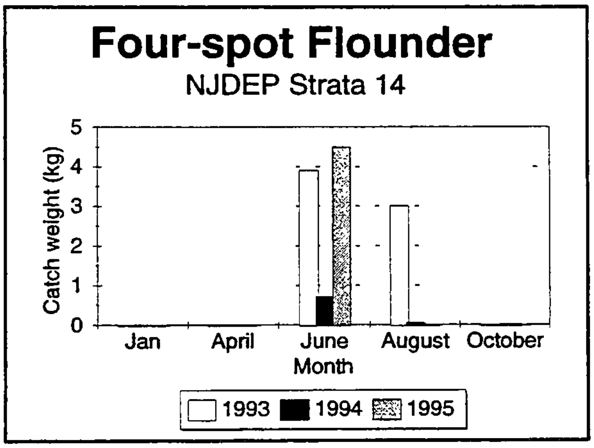

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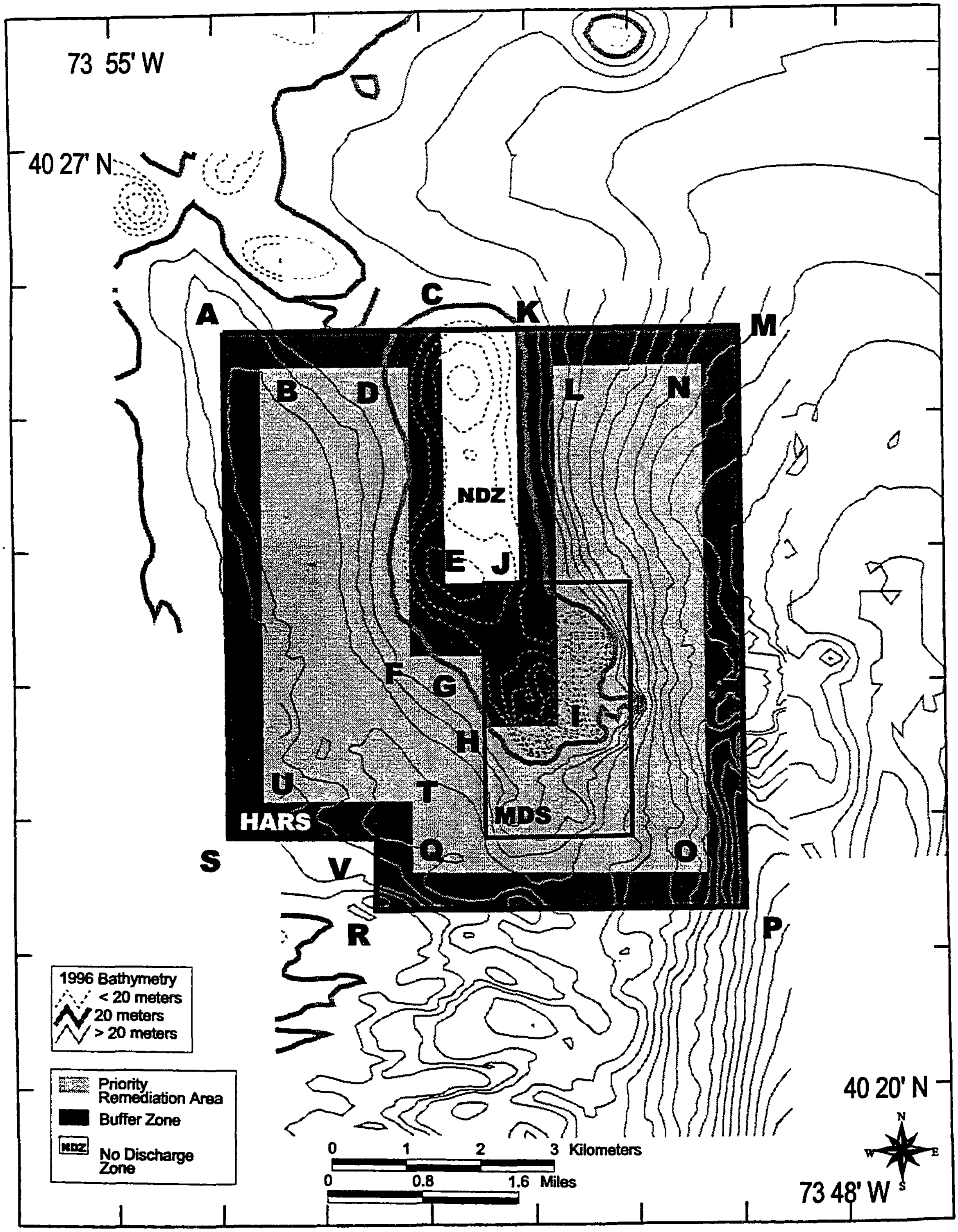
APPENDIX B

Latitude and Longitude Coordinates of HARS Borders, including Priority Remediation Area (PRA), No Discharge Zone (NDZ), and Buffer Zone (BZ)

Cross Reference to Positions in Appendix B Figure

Point	Decimal Lat	DMS Lat	Decimal Long	DMS Long
A	-73.8986	-73 53' 55"	40.4275	40 25' 39"
B	-73.8928	-73 53' 34"	40.4230	40 25' 23"
C	-73.8634	-73 51' 48"	40.4275	40 25' 39"
D	-73.8689	-73 52' 8"	40.4229	40 25' 22"
E	-73.8634	-73 51' 48"	40.3962	40 23' 46"
F	-73.8691	-73 52' 9"	40.3869	40 23' 13"
G	-73.8577	-73 51' 28"	40.3869	40 23' 13"
H	-73.8577	-73 51' 28"	40.3780	40 22' 41"
I	-73.8454	-73 50' 43"	40.3780	40 22' 41"
J	-73.8516	-73 51' 6"	40.3962	40 23' 46"
K	-73.8516	-73 51' 6"	40.4275	40 25' 39"
L	-73.8456	-73 50' 44"	40.4229	40 25' 22"
M	-73.8160	-73 48' 58"	40.4275	40 25' 39"
N	-73.8219	-73 49' 19"	40.4229	40 25' 22"
O	-73.8219	-73 49' 19"	40.3598	40 21' 35"
P	-73.8158	-73 48' 57"	40.3554	40 21' 19"
Q	-73.8689	-73 52' 8"	40.3600	40 21' 36"
R	-73.8749	-73 52' 30"	40.3554	40 21' 19"
S	-73.8986	-73 53' 55"	40.3645	40 21' 52"
T	-73.8689	-73 52' 8"	40.3689	40 22' 8"
U	-73.8929	-73 53' 34"	40.3689	40 22' 8"


73 55' W
40 27' N
A
C
K
M
B
D
L
N
NDZ
E
J
F
G
I
H
U
T
MDS
HARS
S
V
Q
O
R
P
1996 Bathymetry
< 20 meters
20 meters
> 20 meters
Priority Remediation Area
Buffer Zone
NDZ
No Discharge Zone
0
1
2
3
Kilometers
0
0.8
1.6
Miles
40 20' N
73 48' W
N
W
E
S

APPENDIX C

HARS Site Management and Monitoring Plan

US ARMY CORPS
OF ENGINEERS
NEW YORK DISTRICT

DRAFT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2

Site Management and Monitoring Plan for the Historic Area Remediation Site

U.S. Army Corps of Engineers
New York District
26 Federal Plaza
New York, New York 10278-0090

U.S. Environmental Protection Agency
Region 2
290 Broadway
New York, New York 10007-1866

Table of Contents

1. Background

As stated in a July 24, 1996 letter to several New Jersey Congressmen, signed by U.S. Environmental Protection Agency Administrator Carol Browner, Secretary of Transportation Federico F. Peña, and Secretary of the Army Togo D. West, Jr. (3-Party Letter):

> "Environmental, tourism, fishing, and other community groups have long contended that the MDS should be closed immediately. These views reflect the important environmental values that New Jersey's communities identify with their coastal environment. Community concerns have been heightened by the unhappy history of other environmental threats that these communities have had to endure -- ranging from oil spills to the littering of shorelines with medical waste. This history warrants sensitivity to concerns about the MDS, including concerns about continued use of the site for so-called "category 2" material. When these concerns are coupled with the limited category 2 disposal capacity we expect the site to provide, we must conclude that long-term use of this site for disposal activity is not realistic.
>
> Accordingly, the Environmental Protection Agency will immediately begin the administrative process for closure of the MDS by September 1, 1997. The proposed closure shall be finalized no later than that date. Post-closure use of the site would be limited, consistent with the management standards in 40 C.F.R. Section 228.11(c). Simultaneous with closure of the MDS, the site and surrounding areas that have been used historically as disposal sites for contaminated material will be re-designated under 40 C.F.R. Section 228 as the Historic Area Remediation Site. This designation will include a proposal that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228.11(c)). The Historical Area Remediation Site will be remediated with uncontaminated dredged material (i.e. dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation)."

Consistent with the above provision of the July 24, 1996, 3-Party Letter, on September 11, 1996, EPA announced the following actions: (1) modification of the scope of the existing Supplemental Environmental Impact Statement (SEIS) by eliminating the proposal to expand the Mud Dump Site (MDS) for Category II dredged material disposal and (2) implementation of the July 24, 1996, 3-Party Letter by closing the MDS by September 1, 1997 and simultaneously designating the HARS for the purpose of remediation.

EPA has prepared and issued for public comment a Supplemental Environmental Impact Statement (SEIS) and Proposed Rule to implement the 3-Party Letter. Closure/de-designation of the MDS and designation of the HARS will require the preparation of a final HARS SMMP and Final Rule.

Section 506 of the Water Resources and Development Act (WRDA) of 1992, which amended the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA), requires the EPA and the U.S. Army Corps of Engineers (COE) to prepare a Site Management and Monitoring Plan (SMMP) for the HARS. WRDA provides that after January 1, 1995, no site shall receive a final designation unless an SMMP has been developed. This document constitutes the joint EPA Region 2 and COE New York District (NYD) required WRDA SMMP and identifies a number of actions, provisions, and practices to manage the operational aspects of dredging, HARS remediation activities, and HARS monitoring tasks. The HARS SMMP was written to address the SMMP elements specified in WRDA 1992 and is consistent with the joint EPA and COE National Guidance Document entitled, "Guidance Document for Development of Site Management and Monitoring Plans for Ocean Dredged Material Disposal Sites" **(EPA/COE, 1996)**. EPA has determined that portions of the HARS are Impact Category I [40 CFR 228.11(c)], and the HARS SMMP has been developed to provide that the site be managed to reduce impacts to acceptable levels, in accordance with 40 CFR 228.11(c).

2. HARS Remediation:

The HARS designation provides that the site be managed to reduce impacts at the site to acceptable levels (in accordance with 40 C.F.R. Section 228. 11(c)). The goal is that, consistent with the 3-Party Letter, "The Historic Area Remediation Site will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause significant undesirable effects, including through bioaccumulation)." **(hereinafter referred to as "the Material for Remediation" or "Remediation Material")**.

3. HARS Description (See Section 8)

The HARS (which includes the 2.2 square nautical mile MDS) is approximately 15.7 square nautical miles in size and includes the following 3 areas:

Priority Remediation Area (PRA): 9.0 square nautical mile area to be remediated with at least one meter of the Remediation Material.

Buffer Zone: an approximately 5.7 square nautical mile area (0.27 nautical mile wide band around the PRA) in which no placement of Remediation Material will be allowed, but may receive Remediation Material that incidentally spreads out of the PRA.

No Discharge Zone: an approximately 1.0 square nautical mile area in which no placement or incidental spread of the Material for Remediation is allowed.

4. Objectives

The objectives of the SMMP are as follows:

A. Provide for the remediation of required areas within the HARS by placing a one-meter cap (minimum required cap thickness) of the Material for Remediation on sediments within the PRA (inside the HARS). Sediments within the PRA have been found to exhibit Category II and Category III dredged material characteristics and will be remediated.

B. Provide that no significant adverse environmental impacts occur from the placement of the Material for Remediation at the HARS. The phrase "significant adverse environmental impacts" is inclusive of all significant or potentially substantial negative impacts on resources within the HARS and vicinity. Factors to be evaluated include:

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

2. Movement of materials toward productive fishery or shell fishery areas;

3. Absence from the HARS of pollution-sensitive biota characteristic of the general area;

4. Progressive, non-seasonal, changes in water quality or sediment composition at the HARS, when these changes are attributable to the Material for Remediation placed at the HARS;

5. Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the HARS, when these changes can be attributed to the effects of the Material for Remediation placed at the HARS;

6. Accumulation of material constituents in marine biota near the HARS.

C. Recognize and correct any potential unacceptable conditions before they cause any significant adverse impacts to the marine environment or present a navigational hazard to commercial and recreational water-borne vessel traffic. The term "potential unacceptable conditions" is inclusive of the range of negative situations that could arise as a result of the Material for Remediation placement at the HARS such that its occurrence could have an undesirable affect. Examples could include things such as: Remediation Material placement mounds exceeding the required management depth or the Remediation Material barges releasing materials in the wrong locations.

D. Determine/enforce compliance with MPRSA Permit conditions.

E. Provide a baseline assessment of conditions at the HARS.

F. Provide a program for monitoring the HARS.

G. Describe special management conditions/practices to be implemented at the HARS.

H. Specify the quantity of Remediation Material to be placed at the HARS, and the presence, nature, and bioavailability of the contaminants in the Material for Remediation.

I. Specify the anticipated use of the HARS, including the closure date.

J. Provide a schedule for review and revision of the HARS SMMP.

5. HARS Management Roles and Responsibilities

5.1. Regulatory/Statutory Responsibilities

Under MPRSA, the COE and the EPA have been assigned various duties pertaining to HARS management. EPA and COE share responsibility for MPRSA permitting and HARS designation and management, as briefly summarized below.

5.1.1. Section 102 of the MPRSA

EPA is assigned permitting authority for non-dredged material. EPA also designates recommended times and sites for ocean disposal (for both non-dredged and dredged material), and develops the environmental criteria used in reviewing permit applications. NYD determinations to issue MPRSA permits are subject to EPA review and concurrence.

5.1.2. Section 103 of the MPRSA

COE is assigned permitting responsibility for dredged material, subject to EPA review and concurrence that the material meets applicable ocean disposal criteria. The COE is required to use EPA-designated ocean disposal sites to the maximum extent feasible.

6. Coordination

EPA Region 2 and the NYD jointly manage the New York/New Jersey Harbor Dredged Material Disposal Program and the HARS. EPA Region 2 and the NYD will continue to coordinate the exchange of information, HARS management and monitoring resources, and documentation of site management decisions. NYD and EPA Region 2 will continue to provide each other with all pertinent data and information as it becomes available. Specifically, upon discovery/notification, any information concerning disposal/dredging violations will be shared between EPA Region 2 and the NYD.

A regional Memorandum of Understanding (MOU) was prepared for disposal activities at the MDS. Adjustments are being made to the MOU to reflect remediation activities to be conducted at the HARS.

7. Funding

The costs involved in site management and monitoring will be shared between EPA and the NYD to the extent allowed by funding levels in any given Fiscal Year (subject to appropriations). EPA Region 2 and the NYD have historically budgeted approximately one million dollars for MDS SMMP activities and anticipate the same funding level through FY 1998. Sufficient funds will be available to implement HARS SMMP activities. This SMMP will be in place until modified and/or the remediation of the HARS is completed and the HARS is closed.

8. BASELINE ASSESSMENT

MPRSA 102 (c)(3)(A) requires that the SMMP include a baseline assessment of conditions at the site.

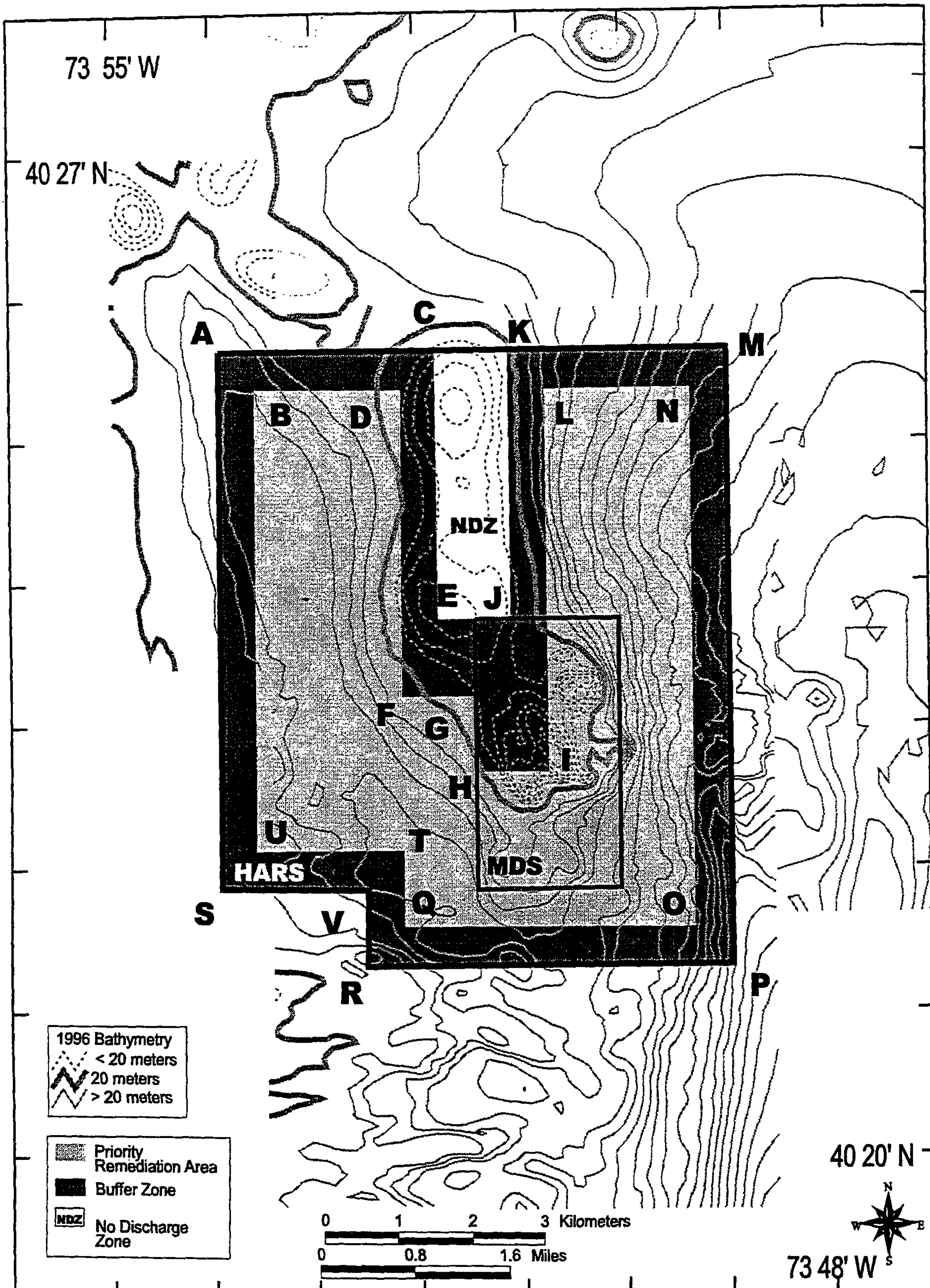
8.1. HARS Characterization:

The HARS (which includes the 2.2 square nautical mile MDS) is a 15.7 square nautical mile area located approximately 3.5 nautical miles east of Highlands, New Jersey and 7.7 nautical miles south of Rockaway, Long Island, bounded by the following coordinates (**Figure 1**):

Point	Latitude DMS	Longitude DMS	Latitude DDM	Longitude DDM
A	40° 25' 39" N	73° 53' 55" W	40° 25.65' N	73° 53.92' W
M	40° 25' 39" N	73° 48' 58" W	40° 25.65' N	73° 48.97' W
P	40° 21' 19" N	73° 48' 57" W	40° 21.32' N	73° 48.95' W
R	40° 21' 19" N	73° 52' 30" W	40° 21.32' N	73° 52.50' W
S	40° 21' 52" N	73° 53' 55" W	40° 21.87' N	73° 53.92' W
V	40° 21' 52" N	73° 52' 30" W	40° 21.87' N	73° 52.50' W

DMS = Degrees, Minutes, Seconds
DDM = Degrees, Decimal Minutes

Figure 1: HARS



The proposed HARS includes the following 3 areas:

Priority Remediation Area (PRA): 9.0 square nautical mile area to be remediated with at least one meter of Remediation Material, bounded by the following coordinates:

Point	Latitude DMS	Longitude DMS	Latitude DDM	Longitude DDM
B	40° 25' 23" N	73° 53' 34" W	40° 25.38' N	73° 53.57' W
D	40° 25' 22" N	73° 52' 08" W	40° 25.37' N	73° 52.13' W
F	40° 23' 13" N	73° 52' 09" W	40° 23.22' N	73° 52.15' W
G	40° 23' 13" N	73° 51' 28" W	40° 23.22' N	73° 51.47' W
H	40° 22' 41" N	73° 51' 28" W	40° 22.68' N	73° 51.47' W
I	40° 22' 41" N	73° 50' 43" W	40° 22.68' N	73° 50.72' W
L	40° 25' 22" N	73° 50' 44" W	40° 25.37' N	73° 50.73' W
N	40° 25' 22" N	73° 49' 19" W	40° 25.37' N	73° 49.32' W
O	40° 21' 35" N	73° 49' 19" W	40° 21.58' N	73° 49.32' W
Q	40° 21' 36" N	73° 52' 08" W	40° 21.60' N	73° 52.13' W
T	40° 22' 08" N	73° 52' 08" W	40° 22.13' N	73° 52.13' W
U	40° 22' 08" N	73° 53' 34" W	40° 22.13' N	73° 53.57' W

DMS = Degrees, Minutes, Seconds
DDM = Degrees, Decimal Minutes

Buffer Zone: an approximately 5.7 square nautical mile area (0.27 nautical mile wide band around the PRA) in which no placement of Remediation Material will be allowed, but may receive Remediation Material that incidentally spreads out of the PRA, bounded by the following coordinates:

Point	Latitude DMS	Longitude DMS	Latitude DDM	Longitude DDM
A	40° 25' 39" N	73° 53' 55" W	40° 25.65' N	73° 53.92' W
B	40° 25' 23" N	73° 53' 34" W	40° 25.38' N	73° 53.57' W
C	40° 25' 39" N	73° 51' 48" W	40° 25.65' N	73° 51.80' W
D	40° 25' 22" N	73° 52' 08" W	40° 25.37' N	73° 52.13' W
E	40° 23' 48" N	73° 51' 48" W	40° 23.80' N	73° 51.80' W

F	40° 23' 13" N	73° 52' 09" W	40° 23.22' N	73° 52.15' W
G	40° 23' 13" N	73° 51' 28" W	40° 23.22' N	73° 51.47' W
H	40° 22' 41" N	73° 51' 28" W	40° 22.68' N	73° 51.47' W
I	40° 22' 41" N	73° 50' 43" W	40° 22.68' N	73° 50.72' W
J	40° 23' 48" N	73° 51' 06" W	40° 23.80' N	73° 51.10' W
K	40° 25' 39" N	73° 51' 06" W	40° 25.65' N	73° 51.10' W
L	40° 25' 22" N	73° 50' 44" W	40° 25.37' N	73° 50.73' W
M	40° 25' 39" N	73° 48' 58" W	40° 25.65' N	73° 48.97' W
N	40° 25' 22" N	73° 49' 19" W	40° 25.37' N	73° 49.32' W
O	40° 21' 35" N	73° 49' 19" W	40° 21.58' N	73° 49.32' W
P	40° 21' 19" N	73° 48' 57" W	40° 21.32' N	73° 48.95' W
Q	40° 21' 36" N	73° 52' 08" W	40° 21.60' N	73° 52.13' W
R	40° 21' 19" N	73° 52' 30" W	40° 21.32' N	73° 52.50' W
S	40° 21' 52" N	73° 53' 55" W	40° 21.87' N	73° 53.92' W
T	40° 22' 08" N	73° 52' 08" W	40° 22.13' N	73° 52.13' W
U	40° 22' 08" N	73° 53' 34" W	40° 22.13' N	73° 53.57' W
V	40° 21' 52" N	73° 52' 30" W	40° 21.87' N	73° 52.50' W

DMS = Degrees, Minutes, Seconds
DDM = Degrees, Decimal Minutes

No Discharge Zone: an approximately 1.0 square nautical mile area in which no placement or incidental spread of the Material for Remediation is allowed, bounded by the following coordinates:

Point	Latitude DMS	Longitude DMS	Latitude DDM	Longitude DDM
C	40° 25' 39" N	73° 51' 48" W	40° 25.65' N	73° 51.80' W
E	40° 23' 48" N	73° 51' 48" W	40° 23.80' N	73° 51.80' W
J	40° 23' 48" N	73° 51' 06" W	40° 23.80' N	73° 51.10' W
K	40° 25' 39" N	73° 51' 06" W	40° 25.65' N	73° 51.10' W

DMS = Degrees, Minutes, Seconds
DDM = Degrees, Decimal Minutes

From 1994 to 1996, EPA Region 2 and the NYD conducted a variety of oceanographic surveys with their respective contractors Battelle and SAIC within an approximately 30 square nautical mile study area (including the 15.7 square nautical mile HARS). In 1994, sediment samples were collected from within the MDS and the HARS and analyzed for toxicity, sediment chemistry, benthic community structure, and worm tissue analyses **(Battelle, 1996 and 1997)**. In 1995, sidescan sonar, REMOTS®, seafloor photography, and precision bathymetry were conducted within the HARS **(SAIC 1995a, b, and c)**. **Together the data from these surveys represent the baseline conditions against which all future monitoring data will be compared (Baseline Data).** These surveys serve as the HARS Baseline Assessment because they are the most comprehensive surveys conducted to date, utilizing state-of-the-art sampling and analytical techniques/procedures. In addition, these surveys represent the most recent conditions and assessments of the HARS to which any later data can be compared.

These Baseline studies conducted revealed levels of toxicity within the MDS and surrounding area that would fail ocean disposal criteria and qualify as Category III dredged material (**See Table 1**). Analyses conducted on all worm tissue collected from the HARS revealed levels of dioxin in excess of 1 pptr but less than 10 pptr, indicative of Category II dredged material **(See Table 3)**.

Bathymetry **(Figure 1)** collected in September 1995 **(SAIC, 1995a)** and side scan sonar data collected in March 1995 **(SAIC, 1995b)** are included in the baseline data set. As of September 1995 and May 1996, water depths in the HARS range from 40 feet (12 meters) to 138 feet (42 meters) BMLW.

8.2 Monitoring Findings

8.2.1 Physical Characteristics

The physical characteristics affecting the placement of Material for Remediation in the HARS, as determined from moored measurements of waves and near-bottom currents, and measurements of suspended solids concentration within plumes of dredged material disposed of at the MDS, can be summarized as follows:

1. Near-bottom, oscillatory tidal currents at the MDS and HARS are relatively weak with maximum speeds on the order of 10 cm/s (0.2 knot; **SAIC 1994a**). Mean currents are also weak (less than 0.2 knot) with directions that are dependent upon location, water depth, and bottom topography **(SAIC 1994b)**.

2. Surface waves are generally less than 2 m in height except during major storms, which occur most frequently in the fall and winter seasons (**SAIC 1995c**). Wave-induced near-bottom currents are greater than 20 cm/s (0.4 knot) only when surface wave heights exceed 3 m, wave periods are in excess of 10 sec, and storm centers are to the east or southeast (this analysis included the significant December 11, 1992 Northeaster). These wave conditions are

encountered less than 3% of the time in the fall and winter, and less than 1% of the time in the spring and summer (**SAIC 1994a**).

3. Plume tracking studies of dredged material disposed of at the MDS have demonstrated:

-plume behavior is variable depending upon the type of grain size (coarse to fine-grained material).
-rapid settling of material and turbulent mixing that result in initial dilutions of the plume on the order of 3,000:1 to 600,000:1 within 15 minutes of placement based on total suspended solids (TSS) and dioxin/furans **(Battelle, 1994)**.
-plume dilution after 2 hours ranged from approximately 64,000:1 to 557,000:1 **(Battelle,1994)**.
-total suspended solids (TSS) near the center of the dredged material placement plume body reach near background levels in 35 to 45 minutes **(Battelle, 1994)**.
-the release of dredged material into the water column resulted in rapid dispersal (turbulent mixing) of the plumes within the first few minutes after release; and (2) plume dilution after two hours, based on total suspended solids, ranged from approximately 64,000:1 to 557,000:1 **(Battelle, 1994)**.
-a small amount of fine-grained sediment (silt and clay) remained measurable in the water column for up to 3 hours. A review of dredged material placement and the mass balance questions can be found in **SAIC (1994)**.

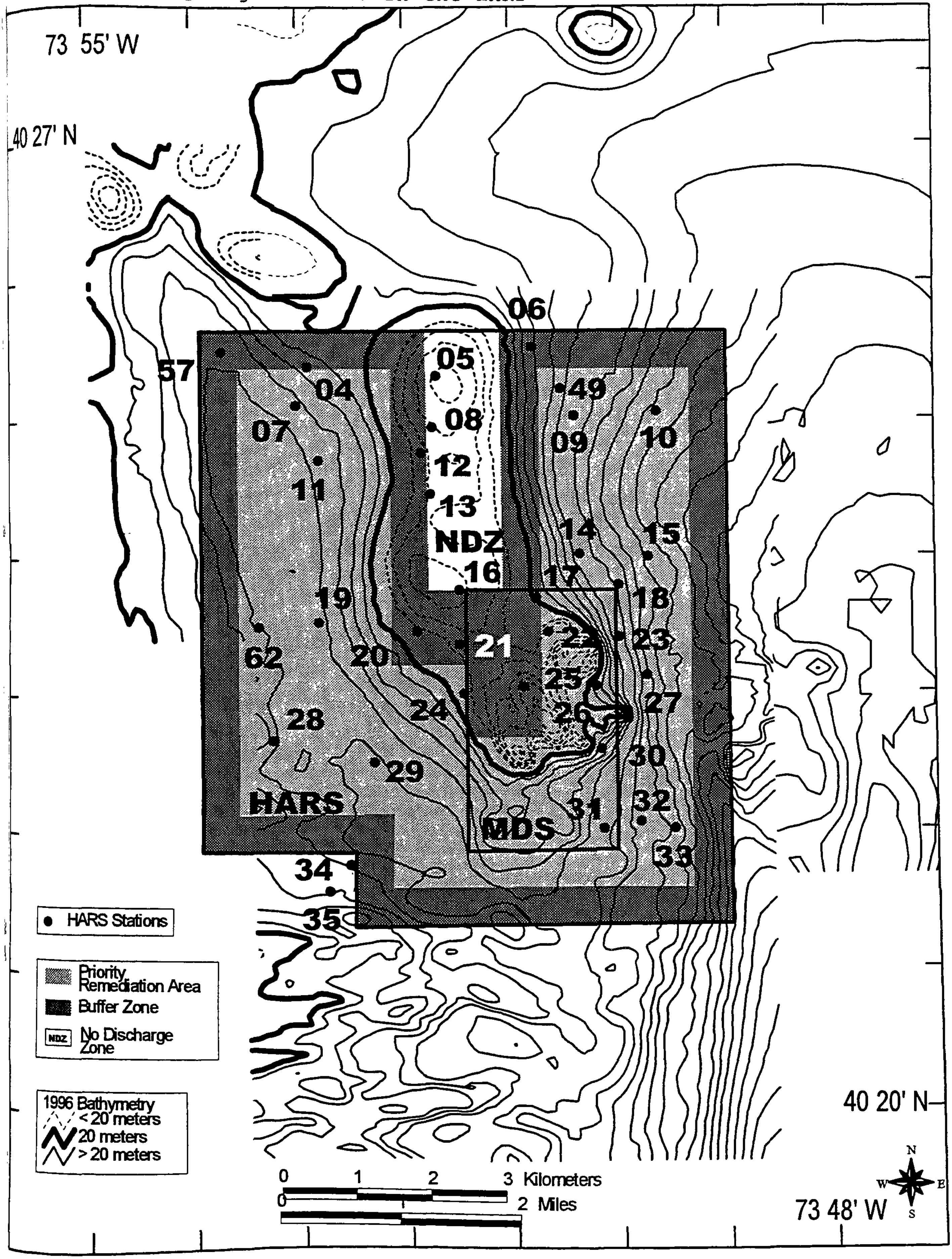
8.2.2 Sediment Contaminant Concentrations/Toxicity Test Results:

The spatial pattern of the sediment grain-size distribution from the HARS was complex and included areas dominated by muddy (fine-grained) sediments and others dominated by coarse sediments (primarily sand). Total organic carbon (TOC) ranged from less than 0.005% to 3.56% **(Battelle, 1996)**. The ranges of organic and trace metal contaminant concentrations varied widely within the HARS and are listed in **Table 1**.

Sediments from the HARS were used in 10-day benthic acute toxicity tests using *Ampelisca abdita*. Test results indicate that sediments in the HARS exhibit between 0% and 99% amphipod survival in these laboratory tests (reference sediments exhibited 94% amphipod survival) **(Table 1)**. Test results less than 74% (20% less than reference site and statistically significant) would be considered biologically significant to *Ampelisca abdita* and unacceptable for ocean disposal (category III) **(EPA/COE, 1991)**, **(EPA Region 2/NYD, 1992)**. The PRA within the HARS was delineated for remediation purposes based principally upon the *Ampelisca abdita* toxicity test results.

Specific sampling locations for each station are shown in **Figure 2** and **Table 2** (for further information see **Battelle, 1996**)

Figure 2: Sampling Stations in the HARS



8.2.3 Water Column Characteristics/Circulation:

1. The HARS is located on the shallow continental shelf within the New York Bight. The mean flow of water column, based on long-term current meter moorings on the Atlantic Shelf, is towards the southwest, along depth contours through the New York Bight **(EPA, 1997)**.

2. Physical characteristics of the aquatic systems in the New York Bight are complex. Circulation in the Bight is dominated by a relatively slow flow to the southwest (3.7 cm/sec), occasionally with a clockwise eddy in the New York Bight Apex (**EPA, 1982**).

3. Nearshore surface currents are strongly influenced by winds and surface runoff. Average surface currents inshore of the 100-meter isobath (which includes the entire Apex) flow southward from Cape Cod to Cape Hatteras, at mean speeds of approximately 3.7 cm/sec. The southerly flow of the Hudson River plume along the New Jersey coast forces an opposing northward flow of more saline waters to the east (**EPA, 1982**).

4. Average shoreward bottom current speeds of 5 cm/sec (0.1 knot) have been reported in the Hudson Shelf Valley (**EPA, 1982**). The axis of the Hudson Shelf Valley separates two general bottom current directions. East of the valley, flow is generally in a northwest-northeast direction, towards Long Island; while west of the axis, the flow is generally in a southwest-northwest direction, towards New Jersey **(EPA, 1982)**.

5. Maximum salinities (33 to 34 ppt) occur inshore during the winter (February and March) when sub-freezing conditions reduce river runoff. The spring thaw reduces the surface salinity, particularly nearshore, and strong vertical and horizontal gradients may develop. In summer surface salinities are at the annual minimum (27 to 31 ppt) and bottom salinities are (27 to 29 ppt) **(EPA, 1982)**.

Table 1. Concentration Ranges of Sediment Contaminants in the HARS (Battelle, 1996)[1]

Parameter	Concentration
	(% *Ampelisca* Survival)
Toxicity	0 to 99
	(ng/g dry weight or ppb)
Total PAH	10.7 to 33,067
Total PCB[2]	0.73 to 678.4
Total DDT	<0.07 to 151
	(ng/Kg dry weight or pptr)
2,3,7,8-TCDD	<0.2 to 41.7
	(μg/g dry weight or ppm)
Silver	<0.04 to 7.33
Arsenic	2.3 to 29.7
Cadmium	<0.03 to 3.22
Chromium	15.4 to 187.2
Copper	4.8 to 178.2
Mercury	<0.03 to 2.47
Nickel	<3 to 99.4
Lead	10.2 to 402.0
Zinc	20.5 to 329.0

1 = Values reported for chemicals listed in the Regional Testing Manual **(EPA Region 2/NYD, 1992)**. For additional information see **Battelle, 1996 and EPA, 1997**.
2 = PCB values should be multiplied by 2 in order to compare approximately with values from Regional Testing Manual **(EPA Region 2/NYD, 1992)**.

Table 2. Sampling Stations in the HARS.

Sta.	Station Description[a] Latitude (°N)	Longitude (°W)	Depth (ft)	Comments
4	40°25.39′	73°52.91′	73	Fine brown sand.
5	40°25.32′	73°51.70′	50	Medium brown sand; shell hash, crabs.
6	40°25.53′	73°50.79′	75	Medium brown sand.
7	40°25.11′	73°53.02′	80	Fine to medium muddy sand, shell hash.
8	40°24.95′	73°51.74′	56	Fine dark material.
9	40°25.03′	73°50.40′	85	Brown sand and shell hash to sandy brown mud.
10	40°25.06′	73°49.62′	98	Soft brown mud.
11	40°24.71′	73°52.81′	80	Dark brown, muddy, clay-like material.
12	40°24.76′	73°51.85′	58	Fine to medium brown sand.
13	40°24.46′	73°51.76′	59	Fine to medium light brown sand.
14	40°24.02′	73°50.36′	88	Brown/black mud.
15	40°24.00′	73°49.71′	100	Light grey mud with underlying black layer.
16	40°23.76′	73°51.50′	56	Fine brown sand to brown sand over black mud and clay.
17	40°23.70′	73°50.77′	65	Black mud over sand.
18	40°23.79′	73°49.99′	88	Fine mud, dark grey over dark black layer.
19	40°23.53′	73°52.82′	86	Brown sand over mud to black sandy mud.
20	40°23.46′	73°51.90′	66	Fine brown sand.
21	40°23.36′	73°51.50′	62	Light sand.
22	40°23.45′	73°50.66′	66	Fine brown sand over mud.
23	40°23.41′	73°49.99′	86	Black mud with petroleum smell.
24	40°23.00′	73°51.46′	68	Coarse brown sand and black mud to fine brown sand.
25	40°23.05′	73°50.89′	50	Fine to medium to coarse brown sand.
26	40°23.05′	73°50.21′	66	Thick black mud, silty on top.
27	40°23.13′	73°49.73′	99	Brown muddy clay.
28	40°22.67′	73°53.26′	83	Firm brown mud.
29	40°22.51′	73°52.31′	83	Firm, brown mud with sand.
30	40°22.59′	73°50.17′	84	Medium to fine brown sand with some mud; many tubes.
31	40°22.01′	73°50.15′	92	Dark brown sandy mud to medium dark, hard-packed sand. Some coarse sand.
32	40°22.06′	73°49.80′	94	Sandy brown to black mud, large *Nereis*. Rocky.
33	40°22.01′	73°49.48′	100	Brown mud-gravel-sand mix, to coarse brown sand..
34	40°21.77′	73°52.53′	78	Light brown sand.
35	40°21.58′	73°52.73′	72	Light brown sand.
49	40°25.23′	73°50.53′	80	Fine grain, worm tubes.
57	40°25.50′	73°53.71′	76	Surficial sediments fine silt/sand; dark underlying sediments
62	40°23.50′	73°53.38′	78	Coarse sand mixed with fines.

For data from specific stations see Battelle, 1996.

6. A summary of wave climate data in the area of the HARS (National Weather Service offshore meteorological platform at Ambrose Light, 40.5°N/73.8°W) for the period November 1984 through December 1993 shows that the highest waves were recorded in the winter months and in the early spring, with waves exceeding 2 meters about 4% of the time and exceeding 3 meters about 1% of the time **(EPA, 1997)**.

8.2.4 Biological Characteristics (**Battelle, 1996**)

A. Benthic Community

1. Mean total benthic infaunal abundance within the HARS was 26,482 (+/- 28,555) individuals/m^2.

2. The average total number of species per benthic sample within the HARS was 23.9 (+/- 6.5). The proportion of species was: annelids 61%, crustaceans 17%, and molluscs 11%.

3. Benthic species diversity (H') within the HARS was 2.3 (+/-0.8).

4. Benthic distribution of organisms:

a. Annelida: annelids accounted for about 68% of the infaunal abundance in the HARS. The spinoid worm *Prionospio steenstrupi* (a surface deposit feeder) was found in densities of 3,432 (+/-5,314) individuals/m^2. *Polygordius* (an archiannelidan worm) was found in densities of 7,734 (+/-26,091) individuals/m^2. *Pherusa* (a surface deposit feeder) was found in densities of 784 (+/-1,628) individuals/m^2.

b. Crustacea: crustaceans abundance in the HARS averaged 1,000 (+/-2,335) individuals/m^2 and accounted for about 4% of the total infaunal abundance in the HARS. Amphipods were present at densities of 799 (+/-2,173) individuals/m^2.

c. Mollusca: molluscs accounted for about 21% of the total infaunal abundance in the HARS. The nut clam (*Nucula proxima*), a selective deposit feeder, was found in densities of 5,269 (+/-8,844) individuals/m^2.

d. Miscellaneous Phlya: The sand dollar *Echinarachnius parma* (Echinodermata)was found at densities of 867 (+/-1,958) individuals/m^2 in the HARS. Various species of sea anemones (Anthozoa) were found within the HARS at densities of 377 (+/-417) individuals/m^2. *Phoronis*, a tube dwelling suspension feeder, was also found within the HARS at densities of 507 (+/-906) individuals/m^2.

B. Commercial/Recreational Fish Resources:

1. Finfish: The New York Bight Apex is a transitional region for many species of fish and

shellfish. The area is occupied by many fish species. The following species of finfish are known to inhabit the New York Bight Apex:

a. Demersal Species: Silver Hake, Red Hake, Yellowtail Flounder, Scup, Summer Flounder, Winter Flounder, Tautog (Blackfish), Cod, Black Sea Bass, Little Skate, Windowpane Flounder, Fourspot Flounder, Ocean Pout, Cunner, Spiny Dogfish, Spotted Hake, Northern Searobin, Striped Searobin, Gulf Stream Flounder, Sea Raven, Longhorn Sculpin

b. Pelagic Species: Butterfish, Atlantic Herring, Bluefish, Weakfish

c. Pelagic/ Anadromous: American Shad, Alewife, Striped Bass

2. Shellfish: Surf Clam, Sea Scallop, American Lobster, Long-finned Squid, Rock Crab, Horseshoe Crab, Short-finned Squid, Jonah Crab

C. Endangered/Threatened Species:

The Material for Remediation placement in the HARS is not likely to affect Endangered/Threatened Species **(Battelle, 1997a)**. Disposal Inspectors (with marine mammal/sea turtle observation certification) are required to accompany each placement trip to the HARS. One of the Disposal Inspectors' duties is to observe the presence of Endangered/Threatened Species. Placement of the Material for Remediation is prohibited at the HARS if Endangered/Threatened Species are observed. EPA Region 2 has prepared a Biological Assessment (BA) **(Battelle, 1997a)** as part of the HARS SEIS Process for Finback Whale, Humpback Whale, Kemps Ridley Sea Turtle, and the Loggerhead Sea Turtle. The BA, which concludes that the designation of the HARS is not likely to affect the Finback Whale, Humpback Whale, Kemps Ridley Sea Turtle, and the Loggerhead Sea Turtle is available upon request.

8.2.5 Worm Body Burden Concentrations

Metals levels in worm **(Polychaetes)** tissue from the study area were similar to those in samples collected from outside the HARS Study Area (30 square nautical miles) but still within the Bight Apex **(EPA, 1997 and Battelle, 1997)**. Worm tissue concentrations of metals were relatively consistent across the HARS **(Table 3)**. Thus, metals levels in the worm tissue can be considered to be relatively invariant over broad regions of the inner Bight.

Organic compounds in worm tissue throughout the HARS were more variable than the metals **(Table 3)**. Generally, total PAH concentrations in the Study Area were significantly higher than those from the Apex **(Battelle, 1997)**. PCB levels in worm tissue from the Study Area were higher relative to outside Apex areas to the east and south **(Battelle, 1997)**. Pesticide levels in worms from the study area were generally low **(Table 3)**; total DDT concentrations in worm tissue from areas to the east and southeast of the HARS Study Area were consistently lower than measured in samples from the HARS Study Area. Dioxin and furan levels in worm tissue were relatively similar within and outside the HARS Study Area (Battelle, 1997).

Table 3. Worm (Polychaetes) Tissue Concentrations in the HARS (Battelle, 1997)[1]

Parameter	Concentration
	(ug/kg wet weight or ppb)
Total PAH	244.28 to 928.18
Total PCB[2]	54.61 to 225.43
Total DDT	13.32 to 44.78
	(ng/Kg wet weight or pptr)
2,3,7,8-TCDD	2.96 to 5.84
	(μg/g wet weight or ppm)
Silver	<0.05 to 0.15
Arsenic	1.85 to 5.53
Cadmium	<0.04 to 0.12
Chromium	0.73 to 3.44
Copper	1.21 to 4.84
Mercury	<0.02 to 0.06
Nickel	0.57 to 1.84
Lead	1.37 to 6.22
Zinc	15.60 to 30.40

1 = Values reported for chemicals listed in the Regional Testing Manual (EPA Region 2/NYD, 1992). For additional information see Battelle, 1997 and EPA, 1997.
2 = PCB values should be multiplied by 2 in order to compare approximately with values from Regional Testing Manual (EPA Region 2/NYD, 1992).

8.3 HARS History

The NY Bight Apex which includes the HARS and surrounding area has been historically utilized for ocean disposal of dredged material and a variety of waste products (building materials, sewage sludge, industrial waste, garbage, mud, steam ashes, one man stone, derrick stone, and street sweeping) since the 1800s. The New York Bight Apex is defined as the area of approximately 2,000 km^2 extending along the New Jersey coastline from Sandy Hook south to 40^0 10' latitude and east along the Long Island coastline from Rockaway Point to 73^0 30' longitude. Ocean disposal of garbage was eliminated in 1934, and other waste product disposal practices ended as a result of the passage of the Ocean Dumping Ban Act (sewage sludge disposal ended in 1992)(**Figure** 3 depicts former EPA designated Ocean Disposal Sites in the New York Bight Apex). Dredged material placement in the New York Bight Apex began "officially" in 1888 at a point 2.5 miles south of Coney Island. At that time, the New York Harbor U.S. Congressional Act of 1888, established that the Supervisor of New York Harbor had the authority to grant permits for ocean disposal **(Williams, 1979)**. In 1900 the location was moved to a point one-half mile south and eastward of Sandy Hook Lightship, due to shoaling. In 1903 it was moved 1.5 miles east of Scotland Lightship **(Figure 4)**.

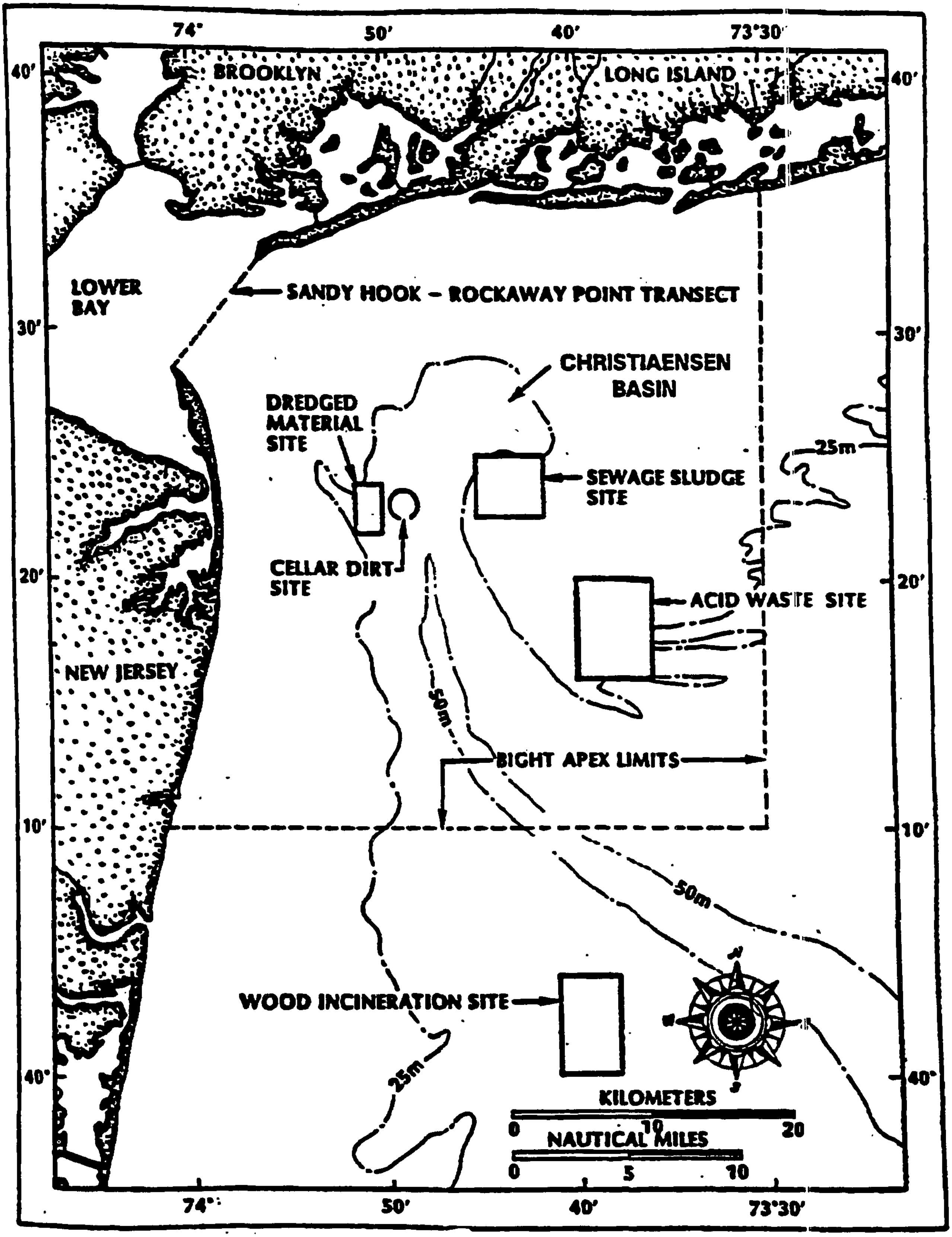
In 1972, the MPRSA was enacted, providing EPA with the authority to designate Ocean Disposal Sites. The MDS was designated as an Interim Ocean Dredged Material Disposal Site in 1973 and incorporated by regulation in 1977. In 1984 the MDS was designated as a "final" Ocean Dredged Material Disposal Site, with a maximum capacity of 100 million cubic yards of dredged material. Since 1984, approximately 68 million cubic yards of dredged material have been disposed of at the MDS. Although available documentation of disposal volumes prior to 1976 is sparse, between 1976 and 1983 approximately 47 million cubic yards of dredged material was disposed within the MDS. Very little information is available on the quantity of material historically disposed in the HARS. However, a description of the types of materials and historical disposal locations in the HARS is provided in **Williams, 1979**.

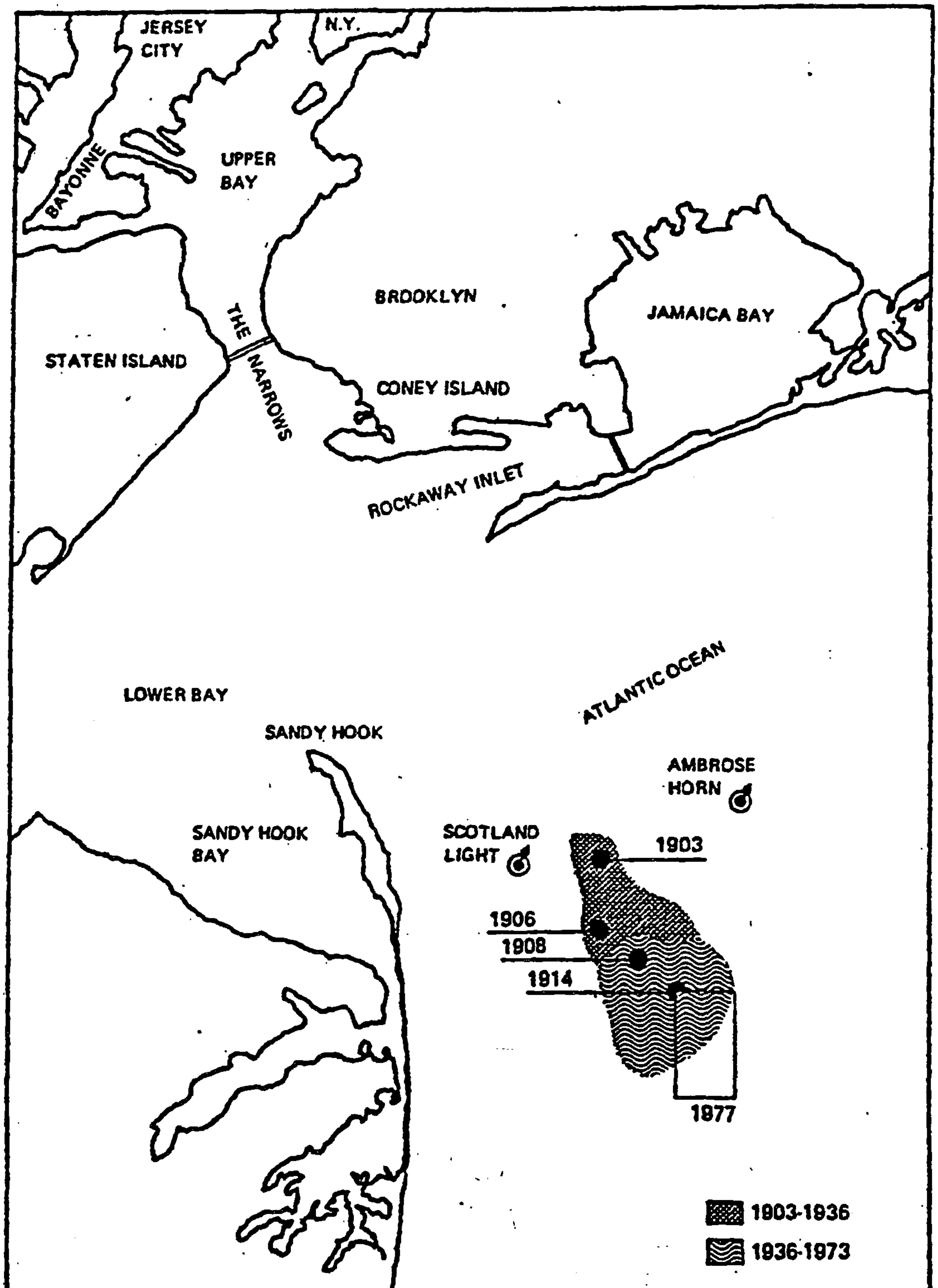
8.4 Transportation and Placement Methods Utilized at the HARS

The Material for Remediation will be placed at the HARS utilizing split-hull barges. Self-contained COE hydraulic dredges, will be utilized for placement of the Material for Remediation for approximately 30 to 60 days per year. Permits issued will require (by contract specification and/or work order for Federal Navigation Projects) placement at a pre-determined location within the HARS. The placement location will be marked either by a single taut-moored buoy, with a specified placement radius, or a series of buoys designating the placement area boundaries. Buoys will be placed and maintained by the NYD and/or their representative. Specific instructions/requirements will be contained in the Department of the Army (DA) Permits issued by the NYD.

The PRA within the HARS is comprised of 9 areas; each area is approximately 1 square nautical mile in size. Placement of Remediation Material will be managed in priority order, beginning with Area 1 (highest priority for remediation) and ending with Area 9 (lowest priority for remediation) **(Figure 5)**. Each area's use will be discontinued upon completion of remedial activities and demonstration through bathymetry that at least a 1 meter cap (minimum required cap thickness) of the Material for Remediation has been placed over the entire area.

Figure 3: Former EPA Designated Ocean Disposal Sites



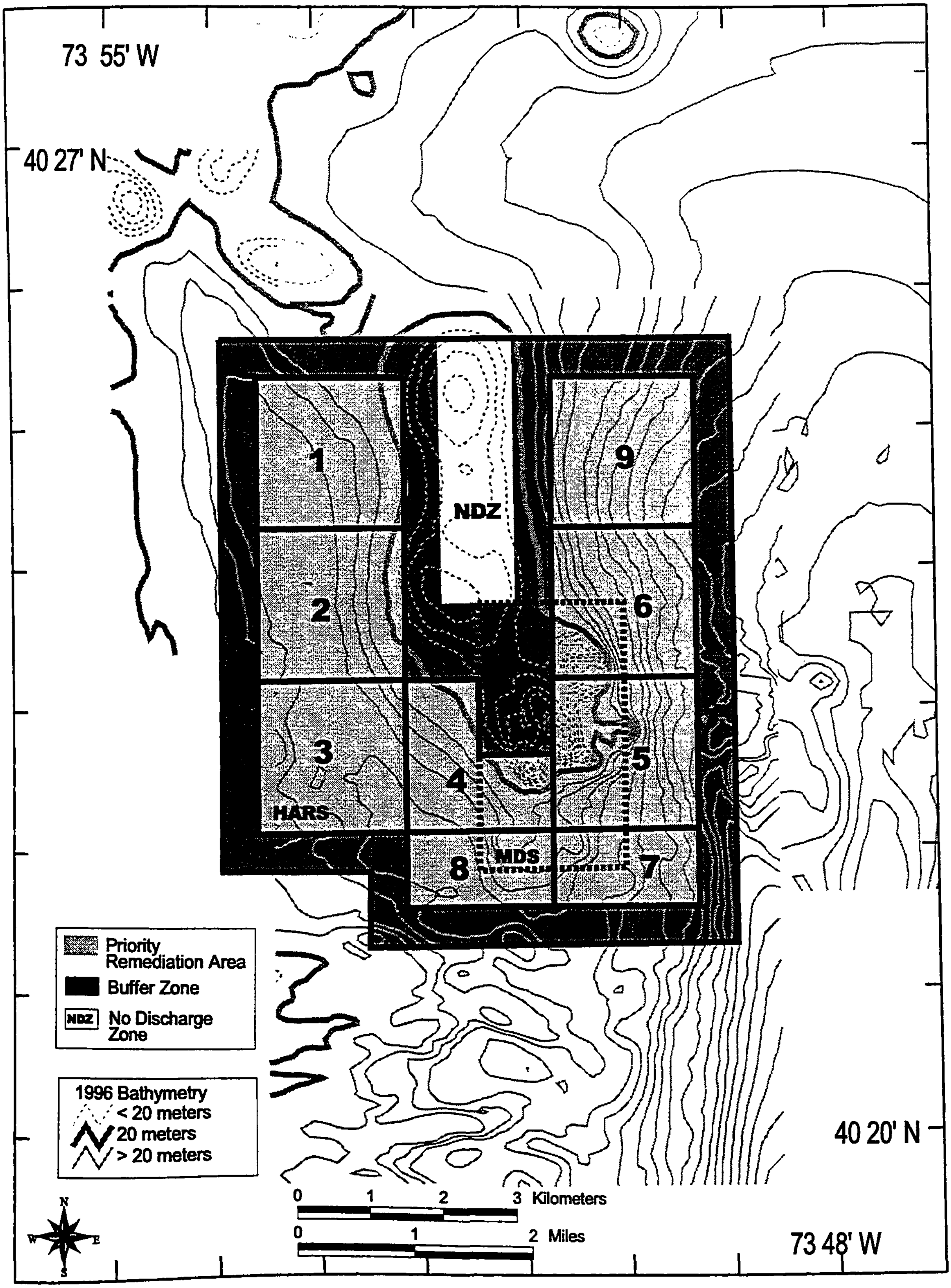


SOURCE: U.S. Army Corps of Engineers, 1977. Unpublished material.

Figure 4

HISTORICAL DREDGING DISPOSAL SITES

Figure 5: Remediation Areas 1-9



8.5 Enforcement Activities

EPA and the NYD have used past enforcement experiences to modify the guidelines for the ocean placement of the Material for Remediation at the HARS, in order to ensure that the placement of Material for Remediation in the HARS takes place in accordance/compliance with applicable permit conditions **(EPA Region 2/NYD, 1997)**.

9. Monitoring Program

MPRSA 102 (c)(3)(B) requires that the SMMP include a program for monitoring the site.

EPA Region 2 and the NYD have developed a tiered monitoring approach, similar in breadth and scope to the New England Division's Disposal Area Monitoring System (DAMOS). DAMOS is a regional program initiated by the New England Division of the COE to investigate the physical, biological, and chemical impacts of ocean placement of dredged material at sites in the northeast **(Germano, 1993 and SAIC, 1993)**. Incorporating many of the guidelines, principles, and methods first instituted under DAMOS, the EPA Region 2/NYD's HARS Monitoring Program (HARSMP) will serve to address both the regulatory and technical issues associated with the open-water (i.e., ocean) placement of the Material for Remediation, and the HARS in general. Two different monitoring approaches and levels of intensity will be utilized: (1) for the entire HARS, and (2) for the specific remediation areas (1-9), within the PRA. The tiered approach is comprised of levels of increasing investigative intensity, and is an environmentally sound and cost-effective method for generating the technical information necessary to properly manage the HARS/PRA.

9.1 HARS Monitoring Program (HARSMP)

The HARSMP will focus on the overall impacts of the placement of the Material for Remediation on the entire HARS and each of the 9 individual remediation areas in the PRA. In addition to addressing the Null Hypotheses (H_o) (see Section 9.2) overall goals of the HARSMP are as follows:

A. The HARS will be remediated with uncontaminated dredged material (i.e., dredged material that meets current Category I standards and will not cause significant undesirable effects including through bioaccumulation).

B. To continue to verify that the Material for Remediation placed at the HARS for the purpose of remediation does not cause any significant adverse environmental impacts, and does cause desirable impacts, such as non-toxicity to amphipods. The phrase "significant adverse environmental impacts" is inclusive of all significant or potentially substantial negative impacts on resources within the HARS and vicinity. Factors to be evaluated include:

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

2. Movement of materials toward productive fishery or shell fishery areas;

3. Absence from the HARS of pollution-sensitive biota characteristic of the general area;

4. Progressive, non-seasonal, changes in water quality or sediment composition at the HARS, when these changes are attributable to the Material for Remediation placed at the HARS;

5. Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the HARS, when these changes can be attributed to the effects of the Material for Remediation placed at the HARS;

6. Accumulation of the Material for Remediation constituents in marine biota near the HARS.

C. To continue to assess and monitor sediment quality improvement as a result of remediation activities at the HARS as compared to the HARS Baseline Data (40 CFR Section 228.9 and Section 228.10) and the Impact Category I conditions in the PRA within the HARS (40 CFR Section 228.11).

9.2 Questions/Hypotheses (H_o) to be addressed by Monitoring/Surveillance Activities in the HARSMP:

The most frequent application of statistics in research is to test a scientific hypothesis **(Sokal and Rohlf, 1981)**. The hypothesis being tested is called the null hypothesis (H_o). EPA recommends use of null hypotheses in developing monitoring programs **(EPA, 1991 and EPA/COE, 1996)**. Acceptance or rejection of the null hypothesis is typically based upon statistical tests (e.g., Analysis of Variance, T-tests, Regressions, Averages, Medians, Standard Deviations) at various standard significance levels. If we reject the null hypothesis, then we are accepting the alternative hypothesis, which is typically stated as the converse of the null hypothesis.

The types of data and frequency of data collection that are necessary to test each hypothesis are described in Section 9 of the HARS SMMP, specifically in **Table 4**. The data collected during each tier will be utilized to accept or reject the specific null hypothesis being tested/evaluated using standard statistical tests for significance.

Null Hypotheses (H_0):

Monitoring information will be utilized to test the following null hypotheses:

$H_0$1: Placement of the Material for Remediation has modified the sediment characteristics such that all areas in the PRA within the HARS have been remediated.

Actions:
-Conduct Tier 1 Bathymetry
-Conduct Tier 2 Sediment Toxicity Tests annually in the specific area(s) (1 through 9 depending upon placement schedule) where the Material for Remediation has been placed.
-Upon satisfaction that at least one meter of the Material for Remediation has been placed in any given remediation area (through use of precision bathymetry), Tier 1 and 2 post-remediation monitoring activities will be required.

$H_0$2: The PRA has been capped with at least 1 meter of the Remediation Material.

Actions:
-Conduct Tier 1 bathymetry quarterly in the specific remediation area(s) (1 through 9 depending upon disposal schedule) where the Material for Remediation has been placed and annually for the entire HARS.
-Continue remediating with Remediation Material until precision bathymetry indicates each of the PRA areas (1 through 9) has been remediated with at least 1 meter of Remediation Material.

$H_0$3: Remediation Material placement operations are consistent with the requirements of the issued permits.

Actions:

-Utilize the COE Certified Disposal Inspector Reports and information submitted by permittees to determine compliance.
-Conduct independent surveillance of remediation operations
-See Section 10 for corrective actions/enforcement

$H_0$4: Major storms (hurricanes, northeasters, etc.) are not causing erosion/loss of cap material such that less than 60 cm (24 in) of cap material exists over the remediated areas within the HARS (including capped mounds inside the boundaries of the former MDS).

Actions:

-Conduct Tier 1 post-storm bathymetry surveys
-Implement contingency capping with Material for Remediation, as necessary to 1 meter.

$H_0$5: Remediation Material placement operations are not causing significant unacceptable impacts (physical, chemical, biological) at the HARS and surrounding area.

Actions:

-Conduct Tier 1 bathymetry to detect any loss of Remediation Material and pre-HARS dredged material from the HARS.
-Conduct Tier 2 sediment chemistry biennially on the entire HARS or sooner for a specific PRA area (1 through 9) upon determination of successful remediation (Post-remediation monitoring).
-Conduct Tier 3 benthic community structure analyses biennially within the HARS and surrounding area (sooner if Tier 1 and 2 results trigger additional monitoring).

$H_0$6: Remediation Material placement at the HARS has no significant direct impact on endangered/threatened species.

Actions:

-Review Certified Disposal Inspector Reports to ensure that the Material for Remediation is not being placed in the HARS in the presence of any marine mammals/endangered turtles.
- Monitor marine mammals/sea turtle landings/strandings.

$H_0$7: Remediation Material placement does not significantly (see definition of significant adverse impact) alter the benthic community structure of the HARS or surrounding area in the long-term (i.e., allowing sufficient time for re-colonization by the same or similar organisms).

Actions:

- Utilize annual Tier I REMOTS®/SPI (See Section 9.8 for description of technology) to assess sediments distribution and other sediment properties/characterization.
-Conduct Tier 3 Benthic Community Structure Monitoring biennially or sooner if Tier 1 and Tier 2 results trigger additional monitoring.

9.3 The HARSMP

The tiered HARSMP consists of the following three tiers:

The tiers are structured based upon the type of monitoring (physical, chemical, biological) required and do not need to be conducted sequentially. However, the results of the lower tiers will be evaluated and utilized where applicable to initiate higher tiered monitoring **(Table 4)**.

Tier 1: Physical Monitoring

Determine the physical distribution of the Material for Remediation after its placement at the HARS (i.e., assess whether material conformed to the placement design). Types of measurements will include: plume tracking, bathymetry, sidescan sonar, sub-bottom profiling, REMOTS®/SPI, sediment coring, and wave/current measurements.

Tier 2: Chemical Monitoring

Determine the chemical distribution of contaminants of concern on sediment quality and evaluate bioaccumulation of contaminants of concern in benthic organisms (body burden levels). Types of measurements will include sediment toxicity, sediment chemistry, and analysis of the body burden levels of contaminants within target marine species and/or determination of other sub-acute community effects (i.e., have levels of contaminants in indigenous marine species significantly changed in comparison to those in the surrounding environment?) This tier will be further subdivided so that sediment chemistry will be the trigger to proceed to the next step within the tier. Analytical methods, detection limits, and quality assurance information is contained in the EPA Region 2/NYD Regional Testing Manual **(EPA Region 2/NYD, 1992)**. Analyses are typically conducted by EPA Region 2, NYD, and/or contract laboratories.

Worm tissue (body burden levels) will be collected and archived synoptically with Tier 2 Surficial Sediment Chemistry collections. Worm tissue may be analyzed based upon Tier 2 Surficial Sediment Chemistry results. If EPA Region 2 and the NYD are unable to collect sufficient worm biomass from the remediation area/capped mound due to insufficient time being allowed for re-colonization, an additional sampling effort will be conducted at a later date (seasonally dependent) to collect the necessary worm tissue samples.

The main sampler utilized for collecting Tier 2 Surficial (up to 20 cm) sediments within the HARS is a Young-Modified Van Veen Grab Sampler. Various coring devices are utilized for collecting sediment cores. A vibro-core is typically utilized for collecting sediment at depths and for Tier 2 coring **(Table 4)**.

Tier 3: Biological Monitoring

Determine the long-term changes, if any, that would occur to benthic marine resources in and around the HARS (i.e., have physical or other effects resulted in potentially adverse impacts on the surrounding marine resources?). Types of measurements will include benthic community structure (utilizing accepted REMOTS®/SPI technology and standard benthic community structure measurements of species diversity, abundance, biomass) and fish/shellfish distribution surveys. The benthic community will be considered to be significantly altered if there is a statistically significant change from the baseline data (Baseline Data) based on the above measurements.

9.5 Frequency of Monitoring: **(Table 4)**

Implementation of HARSMP activities will take place at a required frequency and as necessary depending upon tiered monitoring results **(Table 4)**. If results indicate exceedances of trigger level(s) then decisions will be made as to whether field surveys, additional investigations, or management actions are necessary (Trigger Section 9.6).

EPA Region 2 and the NYD will convene a Scientific Review Panel (SRP), consisting predominantly of professionals from the fields of engineering, oceanography, and representatives of governmental resource agencies, to review the HARS SMMP and relevant monitoring data. Membership will include representatives from academia, federal agencies, state agencies, public interest groups, and consultants. Attendance at meetings will be by invitation only. All data reports and meeting minutes will be distributed to any interested person/party upon request. SRP meetings will be scheduled annually.

Table 4. HARSMP Types and Required Frequency of Monitoring

Type of Monitoring	General/Full HARSMP Monitoring	Remediation Area (1-9) Monitoring	Notes/Misc.
Bathymetry Tier I	Annually Post-Storm-as needed[1]	Quarterly per remediation area[2]	[1]Depends on Intensity of Storm [2] Depends on remediation activity
REMOTS®/SPI Tier I	Annually Post-Storm-as needed[1]	Quarterly per remediation area[2]	
Sidescan Sonar + Sub Bottom Tier I	Annual	Not Required[3]	[3]Not required unless data indicate need for further Tier I, II and/or III work
Coring/Surficial Physical Analyses Tier I	As needed[4]	As needed[4]	[4]Will be decided on a case by case basis
Plume Tracking Tier I	Not Required[3]	As needed[4]	
Surficial Sediment Chemistry Tier 2	biennially or sooner if needed[5] All required chemicals	Not Required[3]	[5]Sooner if Tier I results trigger Tier II investigations or if specific remediation area is sufficiently capped/remediated.

Surficial Sediment Toxicity Tier 2	biennially or sooner if needed[5]	Annually per remediation area or sooner of needed[2]	[6]Sooner if Tier I results trigger Tier II investigations or if specific remediation area is sufficiently remediated.
Body Burden Levels Tier 2	Collect with sediment and archive. Analyze as needed[6]	Not Required[3]	[6]As needed if results from Tier 1 and Tier 2 trigger additional Tier 2 work
Type of Monitoring	General/Full HARS Monitoring	Remediation Area Monitoring (1-9)	Notes/Misc.
Coring Chemical Analyses Tier 2	Collect as described under coring (Tier 1) above and archive. Analyze as needed[6,7]	Not Required[3]	[7]Toxicity/chemistry may be required in order to differentiate between the Material for Remediation and ambient PRA sediments.
Benthic Community Structure Tier 3	Biennial or sooner if needed[8]	As needed[4]	[8]If Tier II results trigger Tier III investigations
Fish/Shellfish Surveys in Bight/Apex[10] Tier 3	As needed[9]	Not Applicable	[9]Work with NOAA and States on improving/increasing Bight/Apex Monitoring

Additional Information on Notes:

Note#1: Post-storm monitoring is based upon reaching the storm intensity threshold defined in trigger #2.
Note #2: If there is no remediation activity in a given remediation area, then there will be no bathymetry or surficial sediment toxicity conducted.
Note #6: Post-remediation monitoring will be required upon satisfaction that at least one meter of the Material for Remediation has been placed in any given area (through use of precision bathymetry), Tier 1 and 2 monitoring activities will be required.
Note #4: Benthic Community Structure can be affected by grain size, and as such, Tier 3 work could be initiated based on tier results.
Notes #7, #8: Additional sampling will be based upon results from Tier 1 (physical) monitoring.

9.6 Trigger Levels:

The trigger levels are levels that will initiate making decisions as to whether field surveys, additional investigations, or management actions are necessary. Specific trigger levels/actions will be decided between EPA Region 2 and the NYD on a case-by-case basis. Based on the type of event/action that has occurred, EPA Region 2 and the NYD will work to implement the appropriate tiered action (or subset of actions) within the tiered HARSMP. Further, appropriate actions will be taken to mitigate the problem or other unacceptable situation. The following general trigger levels will apply:

1. Loss of Remediation Material, such that less than 60 cm (24 in) of remediation/cap material exists over the remediated areas within the HARS (including capped mounds inside the boundaries of the former MDS) will result in appropriate action, which may include the implementation of some type of contingency capping operations and/or trigger Tier 2 investigations in the appropriate location(s) (sediment chemistry, toxicity).

Trigger No. 1 and $H_0 2$ are designed to ensure that there is never less than 60 cm (24 in) of Material for Remediation at any time on the remediated areas within the HARS (including capped mounds inside the boundaries of the former MDS). EPA Region 2 and the NYD will not average values around the existing caps in the MDS and the Material for Remediation to be placed in the PRA to achieve an average Remediation Material thickness. Instead, all areas of the HARS will be evaluated individually to determine absolute Material for Remediation thickness.

Precision bathymetry (Tier 1) is the most accurate method for determining cap thickness across the entire capped mound/remediation area. Precision bathymetry has an approximate error/sensitivity range of +/- 1 foot (30 cm). Thus, in order to say with statistical confidence that the Tier 1 precision bathymetry is showing a "loss" of the Remediation Material, we need to experience at least a 30 cm loss of cap/Remediation Material.

EPA Region 2 and the NYD are allowing a 40 cm loss prior to initiating any contingency capping operations and/or additional monitoring. Various experts have concluded that a practical capping thickness for biological isolation/remediation ranges between 30 and 50 cm **(SAIC, 1997)**. EPA Region 2 and the NYD believe that a 60 cm cap should sufficiently protect against bioturbation; thus, at least a 1 meter cap (minimum required cap thickness) is utilized to be conservative and provide for an extra degree of protection for the Material for Remediation against storm-induced erosion. EPA Region 2 and the NYD will evaluate the precision bathymetry results on a case-by-case basis (and area-by-area) to decide if any contingency placement and/or additional monitoring is necessary.

2. Sustained storms (hurricane, northeaster, etc...) generating wave heights in excess of 4 meters and/or wave periods of 10 seconds or greater (at the HARS) will "trigger" timely and appropriate post-storm investigations, as to whether field surveys are warranted (See Baseline Section for discussion/analysis of wave patterns).

3. Statistically significant increase in sediment/tissue chemical concentrations above baseline (See Section 6) will trigger timely investigations as to whether Tier 3 biological investigations are warranted. Upon identification of statistically significant sediment concentration increases, EPA Region 2 and the NYD will examine monitoring data to determine the cause, if possible,

and decide upon corrective management actions (additional remediation, move remediation location, etc...).

4. Tier 2 surficial sediment toxicity tests indicating biologically significant amphipod toxicity in areas determined to have been remediated will trigger timely investigation as to whether additional Tier 2 analyses are required and if additional placement of the Remediation Material is needed.

9.7 Quality Assurance:

Monitoring activities will be accomplished through a combination of EPA Region 2 and NYD resources (employees, vessels, laboratories) and contractors. Documentation of QA/QC is required by both agencies for all monitoring activities (i.e., physical, chemical, and biological sampling and testing). QA/QC is documented in the form of Quality Assurance Project Plans (QAPP) and/or Monitoring Work Plan. QAPPs are required for all EPA Region 2 and NYD monitoring activities. Analytical methods, detection limits, and QA procedures are contained in the EPA Region 2 and NYD Regional Testing Manual **(EPA Region 2/NYD, 1992)**.

9.8 Description of Monitoring Technologies and Techniques:

The following is a description of the various types of monitoring activities/procedures discussed above.

A. Physical Monitoring (Long-term/Short-term)

1. REMOTS® or Sediment Profiling Imagery (SPI)

REMOTS®(Remote Ecological Monitoring of the Seafloor) technology would be implemented at each historic and on-going remediation area to map the distribution and condition of the placed Material for Remediation. The REMOTS® sediment profile imaging camera can rapidly collect and process information on sea floor conditions while documenting organism-sediment relationships. By utilizing a grid sampling strategy at the HARS based on a previous REMOTS® baseline survey in 1995 (**SAIC 1995a+b**), REMOTS® will determine grain size, evaluate benthic habitat conditions, document the process of recolonization in the remediation areas, map out areas of erosion and deposition, determine the redox potential discontinuity depth for degree of bioturbation and recolonization, and determine extreme levels of organic loading by analyzing for sedimentary methane. REMOTS® imagery will be able to derive physical dynamics at the site from the sedimentary structures observed. Automatic disk storage of all parameters measured allows data to be compiled, sorted, statistically compared, and graphically displayed.

EPA Region 2 and the NYD routinely utilize the patented capability of SAIC REMOTS® and SeaFloor Photography technology to photographically record benthic community structure.

Good examples of these technologies can be found in **SAIC (1996 a + b)**. REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis **(Rhoads and Germano, 1982)**. REMOTS ®can be utilized to rapidly and inexpensively measure mud clasts, measurement of the Material for Remediation and cap layers, apparent Redox Potential Discontinuity (RPD) Depth, sedimentary methane, infaunal successional stages, and the Organism-Sediment Index (OSI). Seafloor photography supplements the REMOTS® to provide planform images indicating sediment types, bedforms, and kinetic energy/sediment dynamics.

2. Precision Bathymetry

This type of survey is usually scheduled based on the volume of the Material for Remediation placed, and future Material for Remediation projects. Bathymetric survey lane spacing and the extent of areal coverage will be emphasized in remediation areas such as the historic disposal mounds and all on-going remediation areas. Two and 3-D Topographic Maps and sediment accumulation difference maps will be generated for each survey and compared with the previous surveys to determine remediation cap thickness.

a. The NYD will schedule hydrographic field surveys of specific areas within the HARS **(See Table 4)**. These bathymetric surveys will encompass: a) the active remediation locations within the confines of the HARS and will be performed by the NYD, b) surveys of the PRA and HARS will be conducted primarily by firms under contract to the NYD, c) regions of the site where the placement of the Material for Remediation is proposed (prior to the relocation of placement buoys), and d) additional areas of interest which may be added on an "as needed" basis.

b. Copies of all HARS data and survey results are transmitted to the EPA Region 2.

3. Sidescan Sonar/Sub-bottom Profiling Imagery

Sidescan sonar surveys have been a very effective tool for mapping the configuration and sediment surface features of the seabed within the HARS. Use of this technique permits complete coverage of broadscale surface areas of the HARS and the environs directly adjacent to the HARS. Information pertaining to topographic seafloor morphology is also obtained.

Sub-bottom profiling is valuable in determining the maximum depth of burial of various sediment type interfaces (as in a remediation capping operation) where two or more distinctly different layers of material would be encountered. In conjunction with other types of analyses, sub-bottom profiling is useful in determining discrete thicknesses of a cap.

Sidescan sonar and sub bottom profiling provide useful information in determining sediment characteristics, sediment dynamics, remediation cap integrity and thickness. However, this data does not stand alone and is combined with other Tier 1 monitoring tools (bathymetry, coring) to determine remediation cap thickness and integrity. Sidescan sonar is particularly useful in conducting a large-scale sediment quality (fine grained vs. coarse) "snapshot" of the HARS. If a severe storm impacts the HARS causing erosion and transport of in-place material, EPA Region 2 and the NYD could conduct a sidescan sonar survey to compare with previous annual sidescan sonar survey to determine any change to HARS sediment features. This in turn can be utilized to determine the need for and the location of sediment chemistry samples.

4. Sediment Coring

Gravity and vibro-core surveys of distinct areas within the HARS have been accomplished on an infrequent basis since November 1991. Core heights have ranged between 4-8 ft. penetrating several heterogeneous sediment horizons of the Material for Remediation through to the bed or basement material. In the past, subsamples from discrete core depths from specific sample sites have been taken for chemical analyses to determine the effectiveness of cap thicknesses in isolating contaminants.

5. Wave/Current Measurements

Placement of bottom-mounted, in-situ wave/current meters have been used to measure the wave and current regimes, to determine bottom stress at the HARS. Attached to the meters are underwater cameras to record sediment resuspension, and transmissometers to measure the frequency and duration of the resuspension events.

B. Chemical Monitoring (Long-term/Short-term)

Sediment chemistry of field-collected samples utilizing two techniques (i.e., coring and surficial grabs) are analyzed for numerous contaminants that may be derived from the Material for Remediation placement.

C. Biological Monitoring (Long-term/Short-term)

Recently conducted studies have included: bluefish, blackfish, fluke, sea bass, and lobster **(NOAA, 1995, NOAA, 1996, and NOAA 1996a)**. Target species will be collected utilizing a variety of sampling gear, including but not limited to trawl nets, traps, and hook and line. Targeted contaminants to be analyzed, analytical methods, and detection limits will be the same as in previous studies **(NOAA, 1995, NOAA, 1996, and NOAA 1996a)**.

1. Biological monitoring of resident and migratory fishery resources to determine contaminant effects from pre-HARS dredged material disposal has been performed at locations in and around the HARS.

2. Chemical analyses of tissue collected from invertebrates (polychaete worms), shellfish (crabs and lobsters) and vertebrates (recreational fish) have also been accomplished.

10. HARS Remediation Permit Conditions and Management Practices

MPRSA 102 (c)(3)(C) requires that the SMMP include special management conditions or practices to be implemented at the site that are necessary for the protection of the environment.

10.1. Regulatory Framework

Department of the Army (DA) permits will be issued for HARS remediation activities, and typically are valid for a period of three years. Copies of the issued permits or the letters modifying these permits can be obtained from the NYD, which issues the documents. Placement of the Material for Remediation cannot occur at the HARS without a permit (or MPRSA Section 103 (e) equivalent, e.g. Federal projects authorized by Congress).

10.1.1. Pre-Dredging Coordination

a) Response Letter

Fourteen (14) days prior to the commencement of dredging operations, the permittee and/or the dredging contractor will be required, as per special condition of the DA permit issued by the NYD (Contract Specification and/or Work Order for Federal Projects), to send a **Response Letter (Attachment No. 1)** by certified mail. The primary purposes of the Response Letter are to:

i. allow the NYD to verify before the dredging activity is undertaken that certain conditions and/or requirements listed in the DA permit are being complied with, and

ii. provide the NYD ample time to respond to the permittee/contractor notification with the exact location where placement of the proposed Material for Remediation will take place.

An appropriate location for remediation is determined through consideration of the best management practices (examples include required volume of the Material for Remediation , proximity to site boundaries, weather conditions, in-situ current and tidal regimes, consideration of water depth criteria, seafloor topography, and remediation priority). The final selection is jointly decided upon by EPA Region 2 and NYD. Pertinent sections of the Response Letter are to be completed by the permittee; the remaining sections pertaining to the location of placement buoys will be completed by the NYD before being forwarded to the permittee/dredging contractor.

A management depth will be applied to each project placed at the HARS. The "management depth" will be included as a Permit Condition (Contract Specification and/or Work Orders for Federal Projects) for that particular project. The management depth for dredged material placed at the MDS was 45 feet BMLW. This depth was established in order to address shipping and navigation concerns. This same depth will be established for the HARS in order to address shipping and navigation concerns. However, since most of the areas in the PRA are below 65 feet BMLW, and coverage with at least 1 meter of the Material for Remediation is required, the remediated areas should remain well below 45 feet BMLW. Further, placement buoys will be moved when remediation has been successfully completed around a given placement buoy, thus providing for efficient placement of the Material for Remediation by preventing significant mounding, thereby allowing for faster remediation of the HARS. The placement locations will be chosen to provide for the placement of at least 1 meter of Remediation Material over the PRA. Remediation will begin in Area 1 of the PRA until at least a 1 meter cap (minimum required cap thickness) has been placed over all of Area 1. Area 2 will be next, etc...

10.1.2. Permit Conditions

a) General -- Consist generally of standard maritime industry and U.S. Coast Guard regulation requirements.

These are standard conditions set forth so that a waterborne/sea-going activity can be carried out within the minimum or basic guidelines set, primarily for safety reasons, by the regulating authority. In most if not all cases the U.S. Coast Guard is that authority.

b) Special/Specific -- Are listed in the text of the Permit and will include:

1) Remediation area (1 through 9).

2) Seasonal restrictions or limitations regarding dredging or special conditions with respect to placement of the Remediation Material.

3) Requirements for the submission of monthly transportation and Remediation Material placement logs and volume summary sheets.

4) Reporting requirements for missing, sinking, and/or off-station placement buoys, etc.

5) Guidance pertaining to aspects of the remediation activity; including placement buoy coordinates, release/discharge procedures, and requirements to discharge at specified buoy location. Further, if upon arrival at the HARS, the placement buoy(s) are not visible and/or missing, remediation shall occur within the area specified by buoy coordinates. In order to ensure such action, the use of recommended navigational aids must be documented. The disposal inspector is required to record this on the **Transportation and Remediation Placement Log (Attachment No. 2)** and notify the NYD.

6) Records of Project Area history of each Material for Remediation dredging project

7) Timing and location of ocean placement events (single and/or multiple) shall be conducted in order to comply with the required Limiting Permissible Concentration (40 CFR Section 227.27) at any and all locations in and outside the HARS (after allowance for initial mixing (40 CFR Section 227.29)).

8) Remediation instructions: **(See Section 10.2.2).**

9) Prohibition on remediation in 4 locations that contain ship wrecks **(See Section 10.2.2).**

10.1.3. Federal Authorization

In cases where permits are not issued, as is the case with Federal Navigation Projects, the above permit conditions will be incorporated into the Material for Remediation dredging contract specifications (see MPRSA Section 103 (e)). When COE vessels conduct the dredging, "permit"-like instructions are contained within the Contract Specifications and/or Work Orders for the project. These conditions are equivalent to permit conditions and will be enforceable under applicable law.

10.1.4. Violation/Enforcement Cases and Corrective Actions

1. If any action takes place which does not conform to authorized activities described in any permit (Contract Specification and/or Work Order for Federal Projects), reauthorization, response letter, remediation requirements, seasonal restriction, and/or remediation operation, the NYD should be notified immediately by the COE Certified Disposal Inspector. In cases where activities beyond the scope of those authorized occur, appropriate action will be determined by consultation between EPA Region 2 and the NYD.

2. Dredging or remediation activity occurs only with prior NYD and EPA Region 2 approval. Those projects not in compliance with regulatory requirements will be subject to enforcement action.

3. A COE Certified Disposal Inspector must accompany all trips for placement of Remediation Material at the HARS and be present during all Remediation Material placement events in order to certify compliance with the NYD permit conditions. The Certified Disposal Inspector is required to complete, sign, and submit a **Transportation and Remediation Placement Log (Attachment No. 2)** for each event.

a. The New England Division (NED) of COE periodically conducts certification courses, open to all persons interested in becoming a COE Certified Disposal Inspector. A list of all COE Certified Disposal Inspectors endorsed by both NED and the NYD is available from either Corps installation/office. A copy of the list of Corps inspectors who are presently serving on HARS remediation events can be obtained from the NYD.

These individuals are also qualified to serve as Marine Mammal and/or Sea Turtle observers.

b. The NYD has adopted all aspects and principles of the NED inspector program and has incorporated them into the remediation management practices at the HARS. A copy of the NED guidance manual, entitled: *Guidance for Inspectors on Open Water Disposal of Dredged Material,* can be obtained from the NYD.

4. NYD and EPA Region 2 (and/or their designated representatives), reserve all rights under applicable law to free and unlimited access to and/or inspection of (through permit conditions):

I. the Remediation Material dredging project site including the dredge plant, the towing vessel and scow at any time during the course of the project.

ii. any and all records, including logs, reports, memoranda, notes, etc., pertaining to a specific dredging and Remediation Material placement project (Federal or non-Federal).

iii. towing, survey monitoring and navigation equipment.

5. Navigation logs will be maintained for each vessel (tugboat/barge) utilized for remediation activities. These logs should include the method of positioning (RADAR, LORAN-C, GPS, D-GPS, Dead Reckoning, or other), accuracy, calibration methods, any problems and actions taken. EPA Region 2 and the NYD recommend that each tugboat/barge utilized for the placement of Remediation Material at the HARS utilize D-GPS for navigation purposes.

6. If the Material for Remediation regulated by a specific DA permit issued by the NYD or Federal authorization is released, due to an emergency situation to safeguard life or property at sea in locations or in a manner not in accordance with the terms or conditions of the permit or authorization, the master/operator of the towing vessel and/or the COE Disposal Inspector shall immediately notify, by marine VHF or cellular telephone, the NYD of the incident, as required by permit. The NYD shall copy EPA Region 2 on such notification the next business day. In addition, both the towing contractor and the COE-certified disposal inspector shall make a full report of the incident to the NYD and EPA Region 2 within ten (10) days. The report should contain factual statements detailing the events of the emergency and an explanation of the actions that were ultimately taken.

7. Results from HARSMP (Section 9) will be continuously reviewed with respect to HARS remediation management practices and permit conditions to determine if any corrective actions or modifications are required.

10.1.5. Inter-Agency Cooperation

If any of the placement buoys are missing, off-station, sinking, or damaged in any way, the NYD will immediately contact the United States Coast Guard (USCG), First District Offices, Operations Division, Aids to Navigation Section, Boston, Massachusetts (Telephone Number is 617-223-8338), so that a Notice-to-Mariners broadcast and announcement can be issued. The assistance of the USCG in informing vessel traffic of errant placement buoys is accomplished under general inter-agency cooperation. The NYD is presently responsible for maintenance, repair and/or replacement of all surface markers and placement buoys placed at the HARS.

10.1.6. Data Management: Processing, Evaluation and Interpretation

A. Data collected from HARS surveys are processed and analyzed by the NYD, EPA Region 2 and/or their respective contractors. These data are used to make management decisions regarding the Material for Remediation placement operations and permit decisions. In addition, the NYD, WES, and their contractor Science Applications International Corporation (SAIC), have developed a desktop personal computer-driven Geographical Information System (GIS) to better manage the placement of the Material for Remediation at the HARS. The Disposal Analysis Network for New York (DAN-NY) System will allow the NYD and EPA Region 2 to utilize existing and future field data (bathymetry, sidescan sonar, chemistry, biology, etc...) from the HARS to calculate the Remediation Material needs at the HARS and better manage the remediation of the HARS, and monitor the HARS. NYD, WES, and EPA Region 2 will both have PC workstations capable of running the DAN-NY System.

The system was designed as a data base for most of the information the NYD is required to collect and is not limited to survey data.

B. A spreadsheet file containing contractor-reported scow volume information is maintained by the NYD. All remediation records and submitted monthly Remediation Material placement volumes for each project are proofread, verified and any discrepancies are corrected. The data file contains the following information:

1. Permit/Federal Project number
2. Permittee or Federal Project name
3. Waterway
4. Reach/Channel
5. Was the Remediation Material dredging project maintenance, widening or deepening?
6. Remediation area/buoy at which the Material for Remediation was placed
7. Remediation activity commencement date
8. Remediation activity completion date
9. Volume of Material for Remediation placed at the HARS.

10. Volume of Material for Remediation placed year-to-date at the HARS
11. The break-down of volumes generated by private (non-federal) and federal navigation projects noted separately
12. The year-to-date volumes of private (non-federal) and federal navigation projects noted separately
13. The year-to-date volume of private (non-federal) and federal navigation projects noted collectively (i.e., total volume for the year)

C. An annual HARS Material for Remediation volume summary sheet is compiled and provides information similar to the above but on a yearly basis. This summary also determines the percentage of private (non-Federal) and Federal Material for Remediation volumes placed at the HARS and the percent remediation needs remaining at the HARS.

D. The information is provided to EPA Region 2 during the first quarter of each calendar year and/or upon request. Furthermore, on a yearly basis, all Material for Remediation data will be compiled, analyzed and evaluated in a final end-of-the-year report that will be submitted to EPA Region 2.

E. On a yearly basis, all dredging, HARS remediation and testing data are compiled and submitted to COE Headquarters (HQUSACE).

10.2 HARS Remediation Management Practices

10.2.1. Reporting Requirements

A. Telephone Record

I) A record of each voyage involving an actual remediation event at the HARS is received from dredging/towing contractors on a daily basis. Utilizing a telephone answering machine (212-264-0165), a phone-in-placement notification system has been instituted and is implemented on a 24-hour, 7-day-a-week basis. All vessels transporting the Material for Remediation for the purpose of placement at the HARS must telephone the NYD no less than 2 hours prior to departure from the Port. Contractor representatives will furnish information which will include, but not be limited to, estimated transit times and scow volume as required in their DA permit/authorizations. Prompt notification will allow NYD personnel to review and confirm the permit conditions and status in a reasonable time frame. Upon the vessel's return to the Port, the dredging/towing contractors will also telephone the NYD to provide the exact information pertaining to the remediation activity which took place. This type of notification system ensures that the NYD is completely informed of daily dredging and remediation activities undertaken within the Port of New York/New Jersey. The following information is reported for each remediation event which may occur several times during the day, on the telephone answering machine:

1. Permittee's name, if applicable
2. Permit/contract number
3. Estimated scow volume
4. General description of the Remediation Material placed
5. Name and Owner of towing vessel and scow
6. The place of departure/waterway
7. The name of the HARS Remediation Area
8. Name of remediation area placement/buoy where placement will occur
9. The estimated time of arrival at the HARS Remediation Area.
10. The estimated time of return to port
11. The name of the COE certified ocean Disposal Inspector
12. Observations and general description of placement buoys including determining whether or not they may be off station, missing or sinking

NOTE: All projects, both Federal and non-federal and including those utilizing COE dredges, are required to follow this condition. In the case of Federal dredges, a standard form containing the required information is kept on file at the NYD.

ii) The dredging/towing contractor also notifies the Captain of the Port (COTP) of New York/USCG for a reference number before each vessel departs the dredging site en route to the HARS. Every trip made under the permit authorization is required to be recorded and endorsed by the master of the tow or the person acting in such a capacity.

B. Record Keeping/Documentation

In addition to taped records which provide a verbal record of the remediation activity, daily/weekly/monthly status reports are also required. If the information is incomplete or missing, immediate confirmation of the errors or discrepancies is made with the dredging/towing contractor.

I. The dredging/towing contractors are required to complete and submit a **Monthly Transportation and Remediation Placement Log (Attachment No. 3) and a Monthly Summary Sheet (Attachment No. 4)** of all dredging and remediation activities occurring under a specific permit/authorization. The summary sheet includes monthly and cumulative volumes for each dredging activity. It is required that every trip/voyage to the HARS be endorsed by the master of the tow, or the person acting in such capacity. This information must be submitted to the NYD no later than the eighth day of the month following the dredging/remediation activity. Periodically, dredging/remediation activity information acquired during the previous month in the form of telephone logs, monthly transportation and remediation placement logs, and monthly activity summaries are checked against each other to ensure accuracy of the reported information. Any inconsistencies are brought to the attention of the permittee or dredging/towing contractors for clarification.

ii. If upon arrival at the HARS placement buoy(s), the tugboat/barge navigation equipment indicates a position outside the HARS, the Certified Disposal Inspector/Shiprider must report this to the tugboat Captain/Master of the vessel and immediately notify the NYD. Placement of the Material for Remediation is not permitted outside the boundaries of the PRA within the HARS.

C. Site Inspection/Surveillance

Site Inspection

a) HARS

During periods of active remediation, every two weeks a NYD survey vessel will inspect and assess the condition and location of all moored placement buoys within the HARS. This information is recorded on the **HARS Placement Buoy Surveillance Form (Attachment No. 5).** Copies are kept on file in the NYD and forwarded to EPA Region 2. The items investigated consist of latitude, longitude, and LORAN C coordinates, as determined by GPS/DGPS, observed water depth, wind direction and speed, and sea state. Photographs of the placement buoys will be taken periodically on field inspections in order to document buoy's elevation above the surface, and any damage that it may have sustained during remediation operations. This will insure that buoys have not shifted a considerable distance from the original deployment position and that they are visible to the towing vessel and operators/Certified Disposal Inspectors during the disposal event. The relative accuracy of the navigation equipment responsible for positioning, watch circles, wind and sea conditions at the time of deployment are also taken into consideration. When it has been determined that at least one meter of Remediation Material has been placed in the location of the placement buoy and remediation activities at the placement buoy have been successfully completed, EPA Region 2 and the NYD will then coordinate a new Remediation Material placement buoy location. Initiating new placement buoy locations when remediation has been successfully completed around a given placement buoy provides for efficient placement of the Material for Remediation by preventing mounding, thereby allowing for faster remediation of the HARS.

1) Surveillance and monitoring of conditions at the HARS are also performed by USCG (ships and helicopter), NYD Vessels, and EPA Region 2 vessels and helicopter. This information is evaluated and acted upon accordingly (i.e., enforcement, re-position buoys, performance of a supplementary hydrographic survey, additional surface marker/placement buoys being placed at the site, and/or remedial action to counteract any violation which may occur).

2) Placement buoys are relocated and/or re-positioned at other locations within the site based upon appropriate mound height and water depth considerations. EPA Region 2 and the NYD both concur on the placement buoy location for each project in the **Response Letter (Attachment No. 1).**

b) Dredging Site

To ensure compliance with NYD permit conditions and Federal authorization, routine observations of dredging activities are performed by the NYD.

D. Placement Buoy Maintenance

1. Presently only one permanently moored USCG regulation buoy is located at the HARS. Designated as the "NY", its position is clearly marked and it appears on NOAA navigation charts of the New York Bight as the center of the former MDS. The "NY" buoy location is monitored at the same frequency as the placement buoys.

2. The NYD is currently responsible for the placement, recovery, maintenance and damage repair of all other placement buoys located at the site. Utilizing taut-moored buoy systems has given much greater effectiveness as a location marker for accurate placement of the Material for Remediation. This has been demonstrated by the presence of discrete pre-HARS dredged material disposal mounds evident in bathymetric surveys of the site.

3. If a buoy is reported damaged, off station, drifting, or lost, the NYD will immediately inform (by telephone, and/or FAX) the dredging/towing contractors who are actively engaged in remediation operations at the HARS. The USCG is also informed so that either a Notice-to-Mariners (NTM) emergency broadcast or local NTM report can be issued.

10.2.2 Remediation Instructions

Specific instructions/requirements for the placement of Material for Remediation are contained in the Department of the Army (DA) Permit issued by the NYD. The PRA within the HARS is comprised of 9 areas; each area is 1 square nautical mile in size. Placement will be managed so as to remediate in order of remediation priority, beginning with Area 1 (highest priority for remediation) and ending with Area 9 (lowest priority for remediation) **(Figure 4)**. Each remediation area will be closed to further placement of Remediation Material (unless additional material is required (See Trigger Levels in Section 9.6) upon completion of remedial activities and demonstration through bathymetry that a 1-meter cap (minimum required cap thickness) of the Remediation Material has been placed over the entire area). The Remediation Material placement buoy locations will be moved as necessary, to evenly spread the Remediation Material throughout each remediation area to minimize mounding.

To the maximum extent practicable, each remediation area will be remediated with Remediation Material of similar grain size/composition as sediments located within that particular remediation area. In the event that the Material for Remediation is a different grain size/composition (e.g., clay instead of silt) than the grain size/composition of the sediments located in the remediation area, after placement operations with the dissimilar Material for Remediation is completed, a final layer of Remediation Material with the same/similar grain size/composition as the original sediment found in the remediation area will be placed on top. The combined layers will total at least one meter of Remediation Material. This ensures that the biological communities will be able to re-colonize on the same or similar type sediments that existed prior to the remediation activity.

Placement of the Material for Remediation in the No Discharge Zone and/or in a 0.27 nautical mile radius around the following coordinates due to the presence of ship wrecks is prohibited:

1. 40° 25.30' W 73° 52.80' N
2. 40° 25.27' W 73° 52.13' N
3. 40° 25.07' W 73° 50.05' N
4. 40° 22.46' W 73° 53.27' N

Remediation Area No. 8 (located in the SW quadrant of the MDS) contains an area that was capped with one meter of sand in 1994 as part of a category II disposal and capping project. Monitoring results to date indicate that this area remains sufficiently capped. While this area does not require remediation, the surrounding area requires remediation and will be remediated with at least one meter of Remediation Material. During the remediation process some of the Material for Remediation may incidentally spread into this area and may even be placed on the edges of the capped category II mound. As such, remediation area No. 8 may need to be remediated with at least one meter of Remediation Material, potentially including portions of the capped category II mound.

11. Material for Remediation Testing Requirements

MPRSA 102 (c)(3)(D) requires that the SMMP include consideration of the quantity of material to be placed at the site, and also consider the presence, nature, and bioavailability of the contaminants in the material to be placed of at the HARS.

As part of the permitting process, applicants are required to test/characterize the material to be dredged in order to determine that it is suitable for use as Remediation Material in the HARS. Dredged material testing procedures/requirements (including quality assurance requirements) are contained in the following documents:

i. EPA's Ocean Dumping Regulations 40 CFR Part 227, "Criteria for the Evaluation of Permit Applications for Ocean Dumping of Materials"

ii. EPA/COE 1991, "Evaluation of Dredged Material Proposed for Ocean Disposal, Testing Manual" as amended (otherwise known as the Green Book) **(EPA/COE, 1991).**

iii. EPA/NYD1992, "Guidance for Performing Tests on Dredged Material proposed for Ocean Disposal" (otherwise known as the Regional Testing Manual) **(EPA Region 2/NYD, 1992).**

12. Anticipated HARS Use and Quantity of the Material for Remediation to be Placed at the HARS

MPRSA 102 (c)(3)(D) and (E) requires that the SMMP include consideration of the quantity of material to be placed at the HARS, and the presence, nature, and bioavailability of the contaminants in the material, as well as the anticipated use of the site over the long-term.

12.1 Anticipated HARS Use

The PRA within the HARS will be remediated by the placement of at least 1 meter of Remediation Material over all areas within the PRA.

12.2 Estimated Quantity of Material Required to Remediate (1 meter cap [minimum required cap thickness]) the PRA within the HARS:

Estimated Total to Remediate the PRA: **40,548,000 yards**

The above estimate is based upon the placement of a 1-meter cap (minimum required cap thickness) of Remediation Material on sediments within the PRA inside the HARS where sediments exhibit Category III and Category II dredged material characteristics. The total volume to remediate the PRA is an estimate. Based upon past capping experience we expect that the actual remediation volume will be higher.

13. HARS SMMP Review and Revision

MPRSA 102 (c)(3)(F) requires that the SMMP include a schedule for review and revision of the SMMP which shall not be reviewed and revised less frequently than 10 years after adoption of the plan, and every 10 years thereafter.

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APPENDIX D

Memo from C. Mantzaris, NOAA National Marine Fisheries Service to Co-chairs, Mud Dump Site Closure Working Group, June 16, 1995

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930

June 16, 1995

MEMORANDUM FOR: Co-chairs, Mud Dump Site Closure Working Group

FROM: Chris Mantzaris

SUBJECT: Responses to Questions

At the March 15 meeting of the Mud Dump Site Closure Group, Co-Chairman James Tripp asked the National Marine Fisheries Service to respond to the following questions before the next meeting.

1 - What effect does disposal of category 2 material at the Mud Dump Site and at the expanded Mud Dump Site have on fisheries?

2 - What effect do existing conditions at the Mud Dump Site and at the expanded Mud Dump Site have on fisheries?

3 - Does a noted decline in fisheries relate to activities at the Mud Dump Site?

4 - What does continued dumping at the Mud Dump Site mean to fisheries?

The Co-chairs also asked the National Marine Fisheries Service to offer recommendations to rephrase these questions. Our responses follow.

Answer to question 1 - The existing Mud Dump Site covers a two-square mile area, and the proposed expanded Mud Dump Site will cover approximately 20 additional square miles. Together, they represent a very small portion of the aquatic habitat within the New York Bight. Assuming that fish are randomly distributed throughout the Bight, a full answer to this question would require an incredibly intense and long-term investigation because the other causes of biomass mortality, such as natural environmental causes and stock exploitation, mask any effect caused by contaminants at the Mud Dump Site.

However, this question can be addressed in two ways: First, does the disposal directly kill fish and invertebrates? Clearly, the recently completed fish tissue analysis undertaken by NMFS for the Environmental Protection Agency and the Corps of Engineers shows that recruited species live and thrive in the New York Bight, even near the Mud Dump Site. In addition, our studies show that Newark Bay, a source of contaminated sediments for the Mud Dump Site, apparently supports a wide variety of fish.

Evidence linking contaminants with fish mortality in the New York Bight is insufficient. This leaves mortality induced by the physical act of dumping dredged material, which are dependent on the species' ability to flee from an impact area. Obviously, some organisms will not be successful.

Second, does disposal at sea induce chronic effects to fisheries? This question is unquestionably more difficult to answer, but clearly some species show evidence of contaminants in their tissues, especially those species with relatively high levels of lipids or an affinity for accumulating pollutants. The problem, however, is to differentiate the source of the contaminants. Within the New York Bight itself, contaminants similar to those at the Mud Dump Site pervade the harbor estuary and flow out to the Bight with river currents. In addition, atmospheric deposition accounts for a considerable amount of Bight contamination.

Species of fish that inhabit the Bight exhibit varying degrees of motility. Some, like the bluefish, are highly migratory and can pick up contaminants throughout the entire coast. Others, like the tautog, migrate little. In between are species like the winter flounder that exhibit a medium degree of motility, living at various times in the harbor and offshore. To date and in general, the highly migratory species exhibit the highest levels of tissue contamination. The reason for the higher levels of contamination is that these fish require muscle tissue capable of sudden bursts of speed as well as endurance for long trips. Such tissue, generally known as "red muscle," contain significantly higher levels of fat (lipid) than "white muscle" and have a greater affinity for organic molecules, including contaminants. Unfortunately, little conclusion about the impact of the Mud Dump Site can be drawn from any contaminants present in highly migratory fish. However, our finfish study of selected species in the Bight revealed no identifiable health threat.

A helpful tool would be a specific chemical marker found nowhere else in the Bight that exhibits similar characteristics as some of the contaminants, such as being lipophilic, which could be placed in the Mud Dump Site. After a given period of time, fish and invertebrate tissues could be examined for presence of the chemical marker.

Unfortunately, although the Corps of Engineers has investigated the concept of a marker, they have never found one. Even in the unlikely event that a marker could be found or designed, the proposed experiment would present a legal and regulatory quandary, and the expense of the experiment would likely be exorbitant. By definition, a marker would have to be a bioaccumulative substance, the overboard disposal of which would probably be in violation of federal regulations and, possibly, the criteria established by the London Dumping Convention. The expense of the experiment would probably rise significantly because the marker would have to be homogenized with a barge load of dredged material, and this process has never been fully investigated.

Answer to question 2 - This answer would be best arrived at through a survey of fishing vessels, both commercial and recreational, that fish the Bight. In other words, are there more or less fish in specific areas, including areas impacted by dredged material disposal? This might be identified by charting where vessels go: more boats in the vicinity of the Mud Dump Site than would be expected through random placement might indicate resource concentrations. Conversely, fewer vessels might indicate resource depressions.

Also, the issue of public perception must be taken into consideration. The fish-eating public may presume that New York Bight fish are not fit to eat because of dumping. The resistance to buying fish or seafood dinners affects the market side of the industry, which can trickle down as a decrease in demand and price for the product landed by the remaining fisheries.

Answer to question 3 - We have detected no unique declines in the fishery resources of the Bight that can be directly attributed to dredged material handling. Most texts and papers dealing with fisheries management assign natural mortality and excessive stock exploitation as, by far, the major sources of biomass depletion in the ocean. Such conclusions are arrived at through years of monitoring and statistical models. Should the Mud Dump Site be responsible for some mortality, it would be difficult if not impossible to detect because of the amount of biomass loss through these other avenues.

Answer to question 4 - An answer to this question depends on the answer to question 1. However, in light of the effectiveness of the Clean Water Act, it would be safe to say that continued dumping would have no greater effect than previous dumping, and as noted above, NMFS has not identified any specific Bight-wide impacts from dredged material disposal. The required testing of sediments for ocean disposal is now more demanding and rigorously evaluated by government agencies than it has been throughout history. Sediments that were routinely disposed of in the ocean as little as ten years ago would not likely be disposable today. Conceivably, such rigorous testing of sediments could change through legislative mandates. Under these circumstances, contaminated materials not acceptable for ocean disposal today, could be acceptable tomorrow.

Rephrased Questions

1 - As mentioned previously, and in spite of the obvious problems, can a chemical marker be developed that can be placed in the Mud Dump Site that would indicate uptake of contaminants from that specific area?

2 - Are fish that pass through or near the Mud Dump Site safe to eat? This would require a study similar to the New York Bight fish tissue study, but would sample fish before they arrived at the Bight Apex and after they lived in the area for a time long enough to acquire contaminants. Their tissues could be compared for signs of uptake. Control samples would have to be found away from the influence of the "shadow" of the Mud Dump Site.