United States
Environmental Protection
Agency

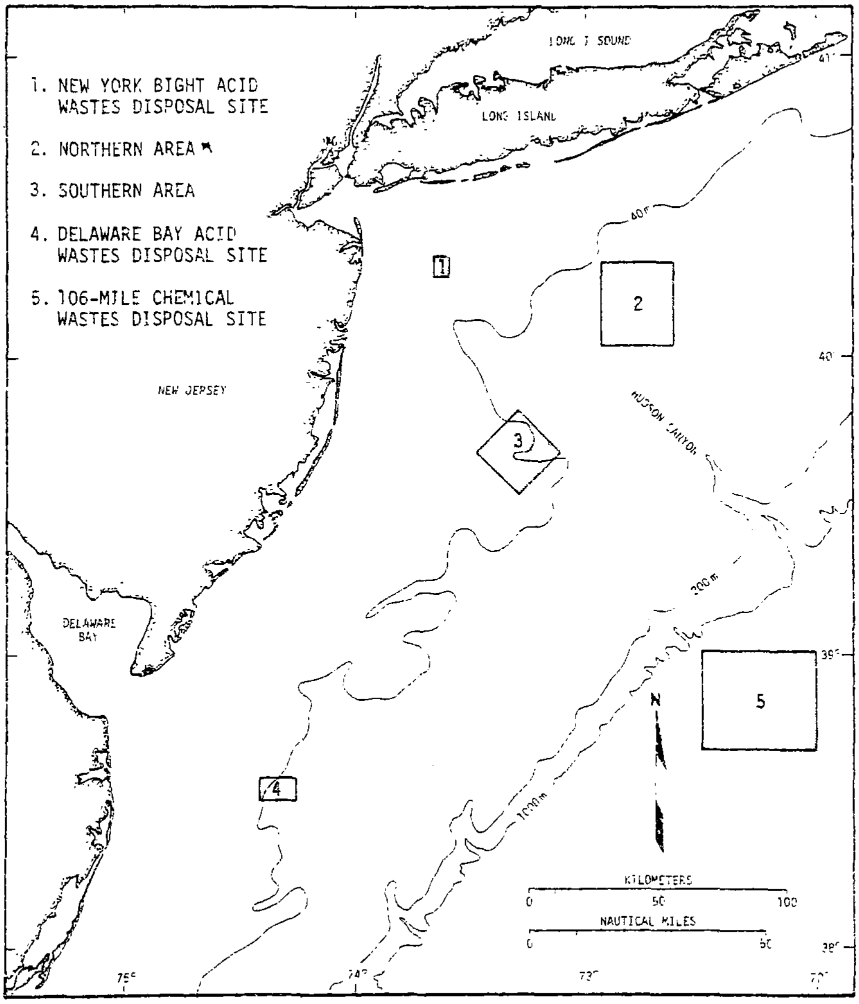
Oil and Special Materials
Control Division
Marine Protection Branch
Washington DC 20460

November 1979

Water

EPA

Draft Environmental Impact Statement (EIS) for New York Bight Acid Waste Disposal Site Designation



DRAFT

ENVIRONMENTAL IMPACT STATEMENT (EIS)
for
NEW YORK BIGHT ACID WASTE DISPOSAL SITE DESIGNATION

November 1979

EPA

Prepared Under Contract 68-01-4610
T. A. Wastler, Project Officer
for
U.S. ENVIRONMENTAL PROTECTION AGENCY
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

ENVIRONMENTAL PROTECTION AGENCY

DRAFT
ENVIRONMENTAL IMPACT STATEMENT ON THE NEW YORK BIGHT ACID WASTE DISPOSAL SITE DESIGNATION

Prepared by: U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

Approved by: T. A. Wastler (signature) — 11/27/79

T. A. Wastler
Project Officer

Date

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT
FOR
NEW YORK BIGHT ACID WASTE DISPOSAL SITE DESIGNATION

(X) Draft
( ) Final
( ) Supplement to Draft

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAM OPERATIONS
MARINE PROTECTION BRANCH

1. Type of Action

   (X) Administrative/Regulatory action
   ( ) Legislative action

2. Brief background description of action and purpose.

   The proposed action is the designation of the New York Bight Acid Waste Disposal Site for continuing use. The site is approximately 15 nautical miles east of Long Branch, New Jersey and south of Long Beach, Long Island, New York. The site is used by two industries in the New Jersey area. The purpose of the action is to provide an environmentally acceptable area for the disposal of wastes that will comply with EPA's rigid marine environmental impact criteria.

3. Summary of major beneficial and adverse environmental and other impacts.

   The major benefit of the proposed action is to provide an environmentally acceptable location for the disposal of acid wastes for which land-based treatment methods are not yet satisfactory.

Wastes have been disposed at the Acid Site since 1948 and long-term adverse effects caused by the various wastes have not been demonstrated. There are short-term adverse effects, especially upon plankton, but the ecosystem rapidly recovers. EPA's permit program mitigates such adverse effects where possible. No environmental effects caused by waste disposal at the Acid Site are irreversible or irretrievable.

4. Major alternatives considered.

The alternatives considered in this EIS are:

(1) No Action - The site would continue with an interim designation. This is not a viable alternative since the EPA is required to decide the fate of this site; i.e., final designation or end of dumping at the site.

(2) Proposed action - Use the existing Acid Site for the continued disposal of these wastes.

(3) Alternative sites - Use another ocean site for these wastes: the 106-Mile Chemical Waste Disposal Site and the Northern and Southern areas near the Hudson Canyon.

5. Comments have been requested from the following:

<u>Federal Agencies and Offices</u>

Council on Environmental Quality
Department of Commerce
    Maritime Administration
    National Oceanic and Atmospheric Administration (NOAA)
Department of Defense
    Army Corps of Engineers (CE)
    Department of the Air Force
    Department of the Navy

Department of Health, Education, and Welfare

Department of the Interior

Bureau of Land Management

Bureau of Outdoor Recreation

Fish and Wildlife Service

Geological Survey

Department of Transportation

Coast Guard

National Aeronautics and Space Administration (NASA)

National Science Foundation

Water Resources Council

States and Municipalities

Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Virginia

Private Organizations

American Chemical Society

American Eagle Foundation

American Littoral Society

Audubon Society

Center for Law and Social Policy

Environmental Defense Fund, Inc.

Freeport (LI) Boatmen's Association

Manufacturing Chemists' Association

National Academy of Sciences

National Wildlife Federation

Resources for the Future

Sierra Club

United Boatmen of New Jersey

Water Pollution Control Federation

Academic/Research Institutions

Lamont-Doherty Geological Observatory
New York State University
Rutgers University
University of Delaware
University of Rhode Island
Woods Hole Oceanographic Institution

Permittees

Allied Chemical Corp.
NL Industries, Inc.

6. The draft statement was officially filed with the Director, Office of Environmental Review, EPA, on December 6, 1979.

7. The 60-day review period for comments on the Draft EIS will end on February 12, 1979.

Comments should be addressed to:

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

Copies of the Draft EIS may be obtained from:

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

Environmental Protection Agency
Region II
Marine & Wetland Protection Branch
26 Federal Plaza
New York, NY 10007

The draft statement may be reviewed at the following locations:

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

Environmental Protection Agency
Region II
Library, Room 1002
26 Federal Plaza
New York, N.Y.

Environmental Protection Agency
Region II
Woodbridge Ave.
GSA Raritan Depot
Edison, N.J.

NOAA/MESA New York Bight Project
Old Biology Bldg.
State University of New York
Stony Brook, N.Y.

SUMMARY

This Environmental Impact Statement (EIS) provides the public information required for the decision-making process about formal designation of the New York Bight Acid Waste Disposal Site for continued use as an ocean disposal site. It recommends the types of wastes that could be released at the site, summarizes the history of waste disposal at the site, and provides guidance for the U.S. Environmental Protection Agency (EPA) to manage the site under the ocean dumping permit program.

ORGANIZATION OF THE ENVIRONMENTAL IMPACT STATEMENT

The EIS has three levels of detail: This summary highlights significant points of the chapters, permitting readers to understand major points without reading the entire text. The main text contains additional technical information, with full discussions of the options and decisions. The appendixes contain supplemental technical data and information which amplify and support the decisions. It is not necessary to read the appendixes to understand the rest of the document.

Four chapters comprise the main body of the EIS:

- Chapter 1 specifies the purpose and necessity of the proposed action and presents background relevant to ocean waste disposal. The legal framework EPA uses to select, designate, and manage ocean waste disposal sites is described.

- Chapter 2 presents alternatives to designating the Acid Site, describes the procedures by which alternatives were chosen and evaluated, and summarizes the relevant comparisons of all alternatives.

- Chapter 3 describes the environmental features of the Acid Site and the alternatives. The history of waste disposal and other activities in the site vicinities is fully described.

- Chapter 4 discusses the environmental consequences of waste disposal at the alternative sites and at the proposed location.

Five appendixes are included to support the text:

- Appendix A specifies the environmental characteristics of the New York Bight and describes the oceanographic processes occurring at the Acid Site.

- Appendix B discusses the Acid Site in detail, specific studies that have been performed at the site, and unique features.

- Appendix C describes the waste inputs to the New York Bight from all contaminant sources.

- Appendix D discusses the previous waste disposal at the Acid Site and compares these inputs to the total waste loading.

- Appendix E summarizes the existing monitoring plan at the site and defines general criteria for future site monitoring.

BACKGROUND

The Council on Environmental Quality (CEQ) identified ocean waste disposal as a potentially serious environmental problem (CEQ, 1970). As a result of CEQ's report and increasing public awareness of the dangers of unregulated waste disposal in the oceans, Congress passed the Marine Protection, Research and Sanctuaries Act (MPRSA) in 1972. This law placed the ocean disposal of barged wastes under the authority of EPA, which published the Final Ocean Dumping Regulations and Criteria in 1977 (which superseded regulations published in 1973). This was designed to regulate waste disposal, evaluate environmental effects of various waste types, and designate and manage all ocean disposal sites for continued use. These regulations identified 13 interim municipal and industrial waste disposal sites for use until waste disposal operations were terminated, or until sites were designated for use, in accordance with all regulations. The subject of this EIS is the designation of the New York Bight Acid Waste Site for continued use.

PROPOSED ACTION

EPA proposes to designate the New York Bight Acid Waste Disposal Site (Acid Site) for continued use for liquid acid waste disposal. This action will fulfill the need for a suitable location in the New York-New Jersey offshore area for disposal of certain wastes which comply with the criteria for ocean disposal, under EPA's ocean dumping permit program.

The Acid Site was first used in 1948. Only two industrial waste generators, NL Industries, Inc., and Allied Chemical Corp., are presently (1979) using the site for disposal of highly acidic waste. Acids in the waste are rapidly neutralized by seawater. Other waste constituents, present in minute quantities, have no apparent impact on the marine environment. NL Industries and Allied Chemical have each submitted reports to EPA, which demonstrate that their respective wastes comply with the environmental impact criteria of the Ocean Dumping Regulations. Land-based alternative disposal methods are currently less environmentally acceptable and more costly than ocean disposal; therefore ocean disposal of such wastes is environmentally preferred until suitable alternatives can be implemented.

Continued use of the existing interim site in the Apex of the New York Bight is the preferred alternative for several reasons. More than 30 years of studies have not documented any long-term adverse effects from acid waste disposal at this site. The amount of pollution introduced by acid waste is slight when compared with other sources, thus the transference of waste disposal activities to a more distant site would not environmentally counterbalance increased economic costs (to the waste generators and the Federal Government) and logistic difficulties of using a new site.

MAJOR ALTERNATIVES

The major alternatives to designation of the Acid Site are:

(1) No action - The site would continue with an interim designation. This is not a viable alternative since the EPA is required to decide the fate of this site; i.e., final designation or end of dumping at the site.

(2) Use of alternative ocean disposal sites.

Three other locations, the Northern and Southern Areas in the New York Bight, and the 106-Mile Chemical Waste Disposal Site located off the Continental Shelf, were considered as possible alternatives to the existing site. The following listing shows the category of each alternative site.

Site	Category
New York Bight Acid Waste Disposal Site	Existing site located on the Continental Shelf
106-Mile Chemical Waste Disposal Site	Existing site located off the Continental Shelf
Northern Area	New site located on the Continental Shelf offshore Long Island
Southern Area	New site located on the Continental Shelf offshore New Jersey

Nine municipal and industrial waste disposal sites (excluding dredged material disposal sites) exist in the mid-Atlantic region. (See Figure 2-2, Chapter 2). Sites used for other types of wastes (cellar dirt, wood incineration, wrecks, and sewage sludge) were not considered as candidates for acid waste disposal. Combinations of different waste types at a single site is generally undesirable because synergistic interactions may occur between the wastes. The Delaware Bay Acid Waste Site was not considered because of its inactive status and distance from New York Harbor.

The 106-Mile Site was considered as a viable alternative since it is presently used for disposal of aqueous industrial wastes, (including acids) and is located beyond the Continental Shelf. The Northern and Southern Areas were considered as alternative sewage sludge disposal sites, and site-specific information is available for both areas. The Alternate Sewage Sludge Site, (Figure 2-2 in Chapter 2) has been designated in the northeast corner of the Northern Area. These areas are representative of the mid-shelf region offshore New Jersey and Long Island. If another specific location were selected, the same reasoning would apply. Table S-1 summarizes the favorable and unfavorable features of each alternative considered in this EIS.

AFFECTED ENVIRONMENT

The Acid Site is located in the New York Bight Apex. The Apex is adjacent to one of the most industrialized and populated regions of the country, and receives wastes from more than 20 million people. Large quantities of acid wastes are released annually at the site, but adverse effects last only a few minutes following disposal. When compared with waste inputs from all sources, the contaminants in acid wastes are insignificant. The existing site is 15 nmi from shore, abuts the Hudson Submarine Canyon, has a sandy bottom, and is in 26 m of water.

The Northern and Southern Areas are further offshore (30 nmi), with sandy bottoms in deeper water (31 to 53 m). The Hudson Canyon, an important geological feature, and a migration route for some animals, lies between the

TABLE S-1
SUMMARY EVALUATION OF PROPOSED ACTION AND ALTERNATIVES

Alternative	Favorable Factors	Unfavorable Factors
No Action		
Continue interim site designation	None	Interim designation expires January 1980
Proposed Action		
Designate existing site	(i) Commercial resources (lobster, whiting, bluefish) not harmed by waste disposal. (ii) Site has been used over 30 years without apparent environmental damage. (iii) Nearshore location simplifies monitoring effects of disposal and surveillance of disposal operations; cost of these programs is low. (iv) Documented loss of biotic or mineral resources have not occurred due to acid waste disposal. (v) Hauling costs are low for all permittees.	(i) Although a small amount (1%) of the total input, acid wastes are additional sources of contaminants to the Apex, a highly stressed area. (ii) Acid-iron wastes form a visible plume of ferric hydroxide (rust) which is persistent (48 hours), aesthetically displeasing and may interfere with some pelagic sport fisheries.
Alternative Sites		
Off-the-Continental Shelf 106-Mile Site	(i) No adverse effects on fisheries aesthetics, or benthos due to distance from shore and depth. (ii) Short-term adverse effects on the water same as at existing site. (iii) Site has been used for 14 years for aqueous industrial wastes without apparent environmental damage.	(i) Detecting adverse changes difficult due to environmental complexity. (ii) Distance from shore increases hauling costs 5-8 times. Primary waste generator probably could not use site and could shut down plant. (iii) Surveillance and monitoring costs increased. (iv) Increased navigational hazard and risk.
On-the-Continental Shelf		
(1) Northern Area	(i) Area does not have large numbers of commercially exploitable species. (ii) Water movement carries contaminants off-Shelf and away from shore. (iii) Short-term adverse effects on the water same as at existing site.	(i) Distance from shore increases hauling costs 3-4 times. Primary waste generator probably could not use site and may shut down plant. (ii) Surveillance and monitoring costs increased. (iii) Would contaminate an area where wastes have never been dumped. Possible accumulations in the sediments.
(2) Southern Area	(i) Short-term adverse effects on the water same as at existing site.	(i) Area has potentially exploitable biotic and mineral resources. (ii) Would contaminate an area where wastes have never been dumped. Possible accumulations in the sediments. (iii) Economically, same adverse effects as in Northern Area.

two named areas. Potentially exploitable shellfish resources and mineral resources exist near the Southern Area. The Northern Area is neither unique nor especially productive.

The 106-Mile Site is located just beyond the edge of the Continental Shelf, 90 nmi from shore, in over 1,500 m of water. The site is oceanic with the water characteristics and biological features resembling more the open ocean to the east than coastal areas to the west. Chemical wastes were released there, beginning in 1961; munitions and low-level radioactive wastes have also been dumped in this area. Long-term adverse effects caused by such wastes have not been demonstrated. There are no known exploitable mineral or biological resources in the area.

ENVIRONMENTAL CONSEQUENCES

Since acid-waste liquids do not have an appreciable solid phase, the short-term effects after release will be similar at all alternative sites. Three characteristics of these liquid acid wastes are important in considering possible effects at the alternative sites:

(1) Aqueous wastes will not measurably affect benthos at deep sites, but some waste constituents may accumulate in sediment at shallow sites.

(2) Aqueous wastes have short-term (minutes to hours) effects on the water when released at rates that allow adequate dispersion, thus preventing accumulation of waste constituents in the water mass.

(3) Bioaccumulation of waste constituents in organisms that inhabit the water column (plankton or fish) is unlikely.

Acid waste disposal has had minimal adverse impacts on the environment of the Acid Site in New York Bight. Assessments of over 30 years of documentation from investigations by Federal, university, and private groups, show that there are no long-term adverse effects from the wastes. Accumulations of waste constituents in sediments are possible, but acid wastes represent less than 1% of total contaminant inputs to the Bight. Consequently, transferring waste disposals to other locations probably would not measurably improve either bottom water quality or ecosystem health in the Bight.

The effects of acid waste disposal in the Southern Area could be more severe than at the existing site. Since wastes have never been released in the area, detectable accumulations may occur and adversely affect the ecosystem. It should be noted that potentially exploitable biological (shellfish) and mineral (oil and gas) resources exist in the area, and waste disposal operations could interfere with such profitable ocean usage.

If wastes were released in the Northern Area, effects on the ecosystem would parallel those in the Southern Area. Such effects are potentially more severe than those resulting from continued use of the existing site. The adverse effects on public health and water quality would be negligible since exploitable resources are not found near the site.

If the 106-Mile Site were designated for the disposal of acid wastes, the effects would be similar to those at the existing nearshore site. Should adverse environmental effects occur, however, they would be more difficult to detect because of the inherent complex oceanographic characteristics at the site. The risk of emergency (short) dumping is further increased because of the much longer transit time to the site from New York Harbor.

CONCLUSIONS

After carefully evaluating all reasonable alternatives, EPA proposes the New York Bight Acid Waste Disposal Site for final designation for continued industrial waste disposal in compliance with the EPA Ocean Dumping Regulations and Criteria. However, under the Marine Protection, Research, and Sanctuaries Act of 1972, exploration for alternative ocean disposal areas should continue. Relevant research and development will be a condition imposed by EPA on waste generators seeking ocean disposal permits.

Wastes permitted for disposal at the site should have the following characteristics:

- Aqueous acidic wastes with low concentrations of solids

- Neutrally to negatively buoyant in seawater
- Contain no materials prohibited by the MPRSA

- Demonstrate low toxicity of neutralized wastes to representative planktonic and nektonic marine organisms

- Contain no constituents in concentrations detectable outside the site or above-normal ambient levels more than 4 hours after discharge.

The disposal operations should have the following characteristics:

- Wastes should be discharged from a vessel underway to facilitate rapid and immediate dilution.

- Each barge load should be sufficiently small to permit adequate dispersal of the waste constituents before disposal of the next load so that accumulation of waste materials does not occur due to successive dumps.

- Except in emergency situations, only one barge should be permitted within the site for disposal operations within the 4-hour period for initial mixing.

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Chapter 1

PURPOSE OF AND NEED FOR ACTION

An ocean disposal site is needed since land-based disposal methods for some acid wastes cannot be implemented using existing technology. To fulfill this need, EPA proposes to designate the New York Bight Acid Waste Disposal Site in accordance with the January 11, 1977 EPA Ocean Dumping Regulations and Criteria. This chapter defines the action to be taken, discusses the history of the regulation of ocean disposal, and summarizes the legal regime for identifying and establishing viable options.

Ocean disposal of waste materials has been practiced for generations on an international scale. In the early 1970's, U.S. legislation and international agreements were enacted to control the disposal of waste in the marine environments. This legislation greatly decreased the number of industries and municipalities using ocean waste disposal and forced the development of land-based alternatives. However, some industries and municipal waste treatment facilities produce wastes which cannot (using present-day technology) be treated or dispersed safely or economically on land, but can be ocean-dumped without seriously degrading the marine environment. Most of this waste-generating activity is centered around the heavily populated and industrialized East Coast. To safely meet the needs of ocean waste disposal, the U.S. Environmental Protection Agency (EPA) proposes to designate the New York Bight Acid Waste Disposal Site (hereafter referred to as Acid Site) for continued use.

The Acid Site has been used for waste disposal since 1948. In 1973 EPA designated this site for use on an interim basis, for disposal of acid wastes. Only three companies have used the site for waste disposal: (1) NL Industries Inc., Sayreville, New Jersey; (2) Allied Chemical Corporation Elizabeth, New Jersey; and (3) the E.I. du Pont de Nemours and Company, Grasselli Plant, Linden, New Jersey. Since December 1975, only NL Industries and Allied Chemical have used the site. The projected use of the site (1.4 million tonnes* annually until April 1981) is well below the long-term average

(2.3 million tonnes annually from 1958 to 1978). Almost all of the wastes released at the site have been highly acidic (pH below 1.0); some caustic wastes (pH about 13) were released by Du Pont-Grasselli before 1976, when their waste disposal operations were moved by EPA to the 106-Mile Chemical Waste Site.

Studies of the effects of waste disposal at the Acid Site have been conducted since 1948. Until 1972 most of the work was conducted by university scientists and sponsored by NL Industries, Inc., the main user of the site. In 1973, the NOAA-MESA New York Bight Project assessed the environmental health of the New York Bight and man's influence on the area. This work, and all other work performed at the site or in the general area, has not uncovered significant adverse effects caused by acid waste disposal.

By January 1, 1982 ocean disposal of industrial wastes will be permitted only for wastes which comply with EPA's environmental impact criteria and cannot be treated on land for environmental or economic reasons. NL Industries and Allied Chemical have demonstrated that their wastes comply with EPA's environmental impact criteria and that technically feasible alternative disposal methods are environmentally less preferable than continued use of the site; therefore, a present and future need exists for the continued use of this site. The reason for this continuing need is threefold: (1) NL Industries and Allied Chemical each produce wastes that cannot be disposed of using land-based methods, but can be released safely at the Acid Site without unreasonable degradation of the marine environment, (2) ocean waste disposal may be required for other wastes that do not comply with environmental regulations for land disposal but can be released into the marine environment without causing irreversible adverse effects, and (3) a site of known environmental characteristics is required for disposal of some wastes under emergency conditions.

*** One metric ton equals 2,205 lb. Throughout this EIS, the word tonne will be used to designate a metric ton and to distinguish it from an English ton.**

As part of the decisionmaking process in designating the Acid Site for continued use, EPA has investigated all reasonable alternatives. Two broad categories of alternatives exist: (1) take no action, which would leave the existing site with an interim designation, or (2) designate another ocean location for waste disposal.

After a careful review of the alternatives, EPA has determined that designation of the New York Bight Acid Waste Site for continued use is the most favorable course of action. Continued use of the site will permit approved dumping of the wastes at the site under current ocean dumping permits, and will provide for the disposal of new wastes which the EPA deems acceptable for ocean disposal. EPA Region II will manage the site, regulate times, rates, methods of disposal, and quantities and types of materials disposed, develop and maintain effective monitoring programs for the site, conduct disposal site evaluation studies, and recommend modifications in site use or further designation as necessary.

FEDERAL LEGISLATION AND CONTROL PROGRAMS

Until the early 1970's, there was little regulation of ocean waste disposal. Limited regulation was primarily derived from the New York Harbor Act of 1888, which empowered the Secretary of the Army to prohibit disposal of wastes, except those flowing from streets and sewers, into harbors at New York, Hampton Roads, and Baltimore. Additionally, the Refuse Act of 1899 prohibited the disposing of materials into navigable waters when disposal impeded safe navigation. Under these acts, selection of disposal locations by the U.S. Army Corps of Engineers (CE) and the issuance of permits for ocean disposal were based primarily upon transportation and navigation factors rather than environmental concerns.

Public interest in adverse effects of ocean disposal was aroused in 1969 and 1970 by incidents resulting from disposal of warfare agents in the ocean. Simultaneous studies by the National Oceanic and Atmospheric Administration (NOAA) and several universities identified potential adverse effects of sewage sludge and industrial waste disposal in the New York Bight (e.g., Buelow et al., 1968; Gross, 1970; Pearce, 1972). In 1970, the Council on Environmental Quality (CEQ), identified poorly regulated ocean waste disposal as a potential environmental danger in its Report to the President.

The CEQ's report, and the increasing public awareness of potentially undesirable effects of poorly regulated ocean waste disposal, were mainly responsible for the enactment of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, the primary U.S. legislation now regulating barged ocean waste disposal. In late 1972, when it became apparent that Congress would promulgate an Act to regulate ocean disposal, EPA began to develop criteria to provide an effective technical basis for the regulatory program. During the development of the technical criteria, EPA sought advice and counsel from its own scientists, marine specialists in universities, industries, environmental groups, and other Federal and State agencies. The criteria, first published in May 1973, completed in October 1973, and revised in January 1977, are used to evaluate needs for ocean waste disposal and potential impacts upon marine environment.

While legislation began almost 100 years ago to control waste disposal in rivers, harbors, and coastal waters, barged ocean waste disposal was not specifically regulated in the United States until the October 1972 passage of the Marine Protection, Research, and Sanctuaries Act (MPRSA, PL 92-532). This important legislation is discussed here along with relevant Federal legislation, Federal control programs initiated under MPRSA, and EPA programs for ocean disposal site designation and issuance of ocean disposal permits.

The Clean Water Act (CWA) of 1977 (PL 95-217) supplanted and superseded earlier legislation and established a comprehensive regulatory program for controlling discharge of pollutants from outfalls into navigable waters of the United States, including ocean waters. The primary objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The CWA provides for EPA to promulgate criteria to prevent degradation of the marine environment (Section 403), and to apply such criteria in the issuance of permits (Section 402). The CWA and MPRSA are the primary Federal legislative means for control of ocean waste disposal, either through use of ocean outfalls or offshore disposal sites.

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT (MPRSA)

The MPRSA regulates the transport and release of waste materials in ocean waters. The act is divided into three parts: (1) Title I, Ocean Dumping, (2) Title II, Comprehensive Research on Ocean Dumping, and (3) Title III, Marine Sanctuaries. This EIS responds specifically to Title I, Section 102(c), which charges EPA with the responsibility for designating sites and times for waste disposal.

Title I, the primary regulatory vehicle of the act, establishes the permit program for disposal of dredged and nondredged materials, mandates determination of impacts, and provides for enforcement of permit conditions. Title I of the act defines methods for regulating ocean disposal of waste originating from any country into ocean waters under the jurisdiction or control of the United States. A permit is required for the following reasons and may be obtained by any person of any nationality: (1) Any transport of wastes for ocean disposal in U.S. waters, (2) for transporting waste material away from any U.S. port, (3) or in a vessel under the U.S. flag for disposal anywhere in the world's oceans.

Title I prohibits ocean dumping of certain wastes, among them biological, radiological, and chemical warfare agents, and all high-level radioactive wastes. Title I was amended in November 1977 (PL 95-153) to prohibit barge disposal of harmful sewage sludge* after December 31, 1981. The provisions of Title I include a maximum criminal fine of $50,000, a jail sentence of up to 1 year for every unauthorized dump or violation of permit requirement, and a maximum civil fine of $50,000. Furthermore, any individual may seek an injunction against an unauthorized dumper with possible recovery of all costs of litigation.

*** Harmful sewage sludge is defined by PL 95-153 as sewage sludge that "may significantly degrade or endanger human health, welfare and amenities, the marine environment and ecological systems, or economic potential."**

Title II of MPRSA provides for comprehensive research and monitoring of ocean dumping effects on the marine environment. Under Title II, the NOAA-MESA New York Bight Project and Ocean Dumping Program have conducted extensive survey and laboratory investigations over the past several years at ocean waste disposal sites in the North Atlantic Ocean. This work aids EPA in its management of sites by providing data for site-use decisions.

Several Federal agencies share responsibilities under MPRSA (Table 1-1). The major responsibility is mandated to EPA to review, grant, and enforce dumping permits for all wastes except dredged materials, and to designate and manage all disposal sites. In January 1977, EPA issued Final Revised Ocean Dumping Regulations and Criteria (hereafter the "Ocean Dumping Regulations", 40 CFR, Parts 220 to 229). These regulations established procedures and criteria for designating and managing ocean disposal sites (Part 228), reviewing ocean disposal permit applications (Part 222), assessing impacts of ocean disposal and alternative disposal methods (Part 227), and enforcing permits (Part 226). Interim disposal sites were authorized pending final designation for continuation or termination of use. The Acid Site was one of 13 municipal and industrial sites approved for interim use.

The Corps of Engineers (CE) issues permits for disposal of dredged material after determining compliance of the material with EPA's environmental impact criteria (40 CFR 227) and is subject to EPA's concurrence. The CE is responsible for evaluating disposal applications, recommending disposal sites, and granting dredge material permits; nevertheless, dredged material disposal sites are designated and managed by EPA.

Under MPRSA, the Secretary of Transportation has assigned responsibility to the U.S. Coast Guard (USCG) for surveillance of disposal operations to ensure compliance with the permit conditions and to discourage unauthorized disposal. Violations are referred to EPA for enforcement. Surveillance includes spot checks of disposal vessels for valid permits, interception or escorting of vessels carrying waste, use of shipriders during disposal operations, aircraft overflights during waste release, and random inspections of land facilities.

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

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

All of these methods are used for surveillance at the Acid Site, and interception and escort by USCG vessels or aircraft are the most common methods. In addition, the USCG is testing the feasibility and accuracy of an automatic Ocean Dumping Surveillance System (ODSS), which is based on electronic navigation. This system has been field-tested and evaluated by the USCG for future use in routine surveillance.

Title II of MPRSA charges NOAA to conduct comprehensive monitoring and research programs on the effects of ocean dumping on the marine environment, including potential long-term effects of pollution, over-fishing, and man-induced changes in oceanic ecosystems. Responsibility for field investigations of ocean disposal effects is shared with EPA. Title III of MPRSA authorizes NOAA to designate coastal marine sanctuaries, after consultation with other affected Federal agencies, and to regulate all activities within these sanctuaries.

The Department of Justice initiates relief actions in court, upon EPA's referral, in response to violations of the terms of MPRSA. When necessary, injunctions to cease ocean dumping are sought. Civil and criminal fines and jail sentences may be levied, based on the magnitude of the violation. The Department of State seeks effective international action and cooperation in protecting the marine environment by negotiating international agreements furthering the goals of MPRSA.*

The MPRSA has been amended several times since 1972. Most of the amendments concern annual appropriations for administration of MPRSA; however, two amendments are noteworthy. One amendment in March 1974 (PL 93-254) brought the Act into full compliance with the Convention. Another amendment (PL 95-153) passed in November 1977, prohibits disposal of harmful sewage sludge in ocean waters after December 31, 1981.

OCEAN DISPOSAL SITE DESIGNATION

Under Section 102(c) of the MPRSA, the EPA Administrator is authorized to designate sites and times for ocean disposal, provided that the waste contains no prohibited materials and will not unreasonably degrade or endanger human health, welfare, amenities, marine environment, ecological systems, or economic potential. EPA, therefore, established criteria for designating sites in Part 228 of the Ocean Dumping Regulations.

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* The most significant international negotiation with respect to ocean waste disposal is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (hereinafter referred to as "the Convention" or "the Ocean Dumping Convention").

General site-selection criteria are listed in Section 228.5:

(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 do not meet the criteria for site selection set forth in [Section] 228.5 to 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-term 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.

Factors considered under the specific criteria for site selection treat the general criteria in additional detail. If a proposed site satisfies the specific criteria for site selection, it meets the broader, general criteria. Eleven factors are considered in Section 228.6:

- Geographical position, depth of water, bottom topography and distance from coast.
- Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases.
- Location in relation to beaches and other amenity areas.

- Types and quantities of wastes proposed to be disposed of and proposed methods of release, including methods of packing the waste, if any.

- Feasibility of surveillance and monitoring.

- Dispersal, horizontal transport, and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.

- Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).

- Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance, and other legitimate uses of the ocean.

- The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.

- Potentiality for the development or recruitment of nuisance species in the disposal site.

- Existence at, or in close proximity to the site of any significant natural or cultural features of historical importance.

These factors are applied to the Acid Site in Chapter 2.

Once designated, the site must be monitored for adverse impacts of waste disposal. EPA monitors the following effects (listed in Section 228.10b) to determine the extent to which the marine environment has been affected by material released at the site:

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

- Movement of materials toward productive fishery or shellfishery areas.

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

- Progressive nonseasonal changes in water quality or sediment composition at the disposal site when these changes are attributable to materials disposed of at the site.

- Progressive nonseasonal 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.

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

EPA has established impact categories (Section 228.10c) in its Ocean Dumping Regulations which specify impacts detected by site monitoring which dictates modifications in use of the disposal site:

> (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 the normal ambient values) of any waste or waste constituent from the disposal site within 12 nmi of any shoreline, marine sanctuary designated under Title III of the Act, or critical area designated under Section 102 (c) of the Act. (ii) The biota, sediments, or water column of the disposal site, or any area outside the disposal site where any waste or waste constituent from the disposal site is present in detectable concentrations above the 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. (iii) Solid waste materials disposed of at the site have accumulated there, or in areas adjacent to the site to such an extent that major uses of the site or of the adjacent areas are significantly impaired. 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. (iv) There are adverse effects on the taste or odor of valuable commercial or recreational species as a result of disposal activities. (v) When any toxic waste, toxic waste constituent, or toxic byproduct of waste interaction, is consistently identified in toxic concentrations above the normal ambient values outside the disposal site more than four 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.

OCEAN DUMPING PERMIT PROGRAM

EPA's Ocean Dumping Regulations establish a program for the application, evaluation, and issuance of ocean dumping permits. Once a site is designated for use, permits for disposal at the site can be issued by the EPA or CE authority having jurisdiction over the site. The Ocean Dumping Regulations are specific about the procedures used to evaluate permit applications, and the granting or denying of such applications. EPA and the CE evaluate permit applications primarily to determine whether there is: (1) a demonstrated need for ocean disposal, and that no other reasonable alternatives exist (40 CFR 227 Subpart C), and (2) compliance with the environmental impact criteria (40 CFR 227 Subpart B, D, and E).

Compliance with EPA's environmental impact criteria ensures that the proposed waste disposal will not "unduly degrade or endanger the marine environment" and that this disposal will not cause unacceptable adverse effects on human health, the marine ecosystem, or other uses of the ocean. The criteria are too lengthy to include here; however, the relevant points are briefly summarized below:

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

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

- **Trace contaminants** in the liquid fraction must neither exceed the marine water quality criteria (EPA, 1976) nor exist in toxic and bioaccumulative forms.

- **Trace contaminants** must neither render edible marine organisms unpalatable nor endanger health of humans, domestic animals, shellfish, and wildlife.

- **Bioassays** on the suspended particulates or solid fractions must not indicate occurrence of significant mortality or significant adverse sublethal effects, including bioaccumulation due to waste dumping.

- **When bioassay methods are unavailable:** Maximum concentrations of mercury and cadmium apply; organohalogen concentrations must be less than is known to be toxic to organisms; oils in the waste must not produce a visible sheen on the water.

Six types of ocean dumping permits may be issued: (1) Interim, (2) Special, (3) General, (4) Emergency, (5) Research, and (6) Incineration-at-Sea. In the past, EPA has usually issued Interim Permits. These permits are valid for 1 year, maximum. They are issued when the permittee has not demonstrated compliance of the waste with the environmental impact criteria, but can demonstrate that the need for ocean disposal is of greater significance to the public interest than the possible adverse environmental impacts. Moreover, Interim Permits cannot be issued to applicants who were not issued permits before April 23, 1978. Holders of Interim Permits must have a compliance schedule which will demonstrate either complete phaseout of ocean dumping or compliance with the environmental impact criteria by December 31, 1981. After that date, EPA will not issue Interim Permits and ocean disposal of harmful wastes will cease. No present permittees at the Acid Site hold Interim Permits.

Special Permits (issued when the applicant demonstrates a need for ocean disposal and when wastes comply with the environmental impact criteria) may be issued for a maximum of 3 years. Holders of Special Permits are not subject to the 1981 deadline for cessation of the ocean disposal of harmful wastes, as long as the criteria governing such permits continue to be met. Some industrial permittees and all CE permittees have been granted Special Permits. NL Industries and Allied Chemical each hold Special Permits for use of the Acid Site.

General Permits are issued for ocean disposal of materials which will have minimal adverse effects on the environment. Examples of materials covered by currently effective General Permits are human remains or ashes for burial at sea, target vessels for ordnance testing, and derelict vessels transported for scuttling.

Emergency Permits may be issued for ocean disposal of materials which are unacceptably risky to human health and for which there are no other reasonable disposal techniques. Emergency Permit requests are considered individually by EPA Headquarters on the bases of the waste's characteristics and the safest means for its disposal.

Research Permits may be issued for releasing material into the ocean as part of a research project, when the scientific merit of the project outweighs any potential adverse effects. EPA designates the disposal site(s) to be used by Research Permit holders on the basis of the nature of the study project.

Incineration-at-Sea Permits are either Research, Interim, or Special permits. Currently effective Incineration-at-Sea permits are Special Permits, issued for disposal of materials at the New York Bight Wood Incineration Site. As Special Permits, they are issued for a maximum period of 3 years. Burning at the Wood Site is conducted under specified weather conditions and the ash is transported back to shore and used as landfill.

INTERNATIONAL CONSIDERATIONS

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

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

> The proposed action is to designate the New York Bight Acid Waste Disposal Site for continued use. Thirty years of studies on the effects of acid wastes disposed at the site have not produced evidence of any adverse, long-term effects on the site environment. Alternative sites (Figure 2-1) were considered but rejected because there would be no environmental benefits and barging costs to the waste generators and monitoring costs to the Federal Government would increase. The quality of the marine environment in the Bight Apex would not improve if the ocean disposal of acid wastes were moved to another site. The No-Action alternative was rejected because there is a current need for disposal of these wastes.

After reviewing the alternatives, EPA proposes that the interim New York Bight Acid Waste Disposal Site be designated for continued use. The alternatives considered were:

- No Action Alternative: The existing Acid Site Would retain its interim designation.
- Proposed Action: Designate the existing Acid Site.
- Use of Other Sites: Designate another, existing or new, disposal site.

The environmental consequences of each alternative, and the economic burdens, implications and effects of each alternative have been predicted from analyses of available data and are discussed below. Evaluations and comparisons of the alternatives are based upon three major considerations:

- Public Health and Safety
- Ecosystem Effects
- Economic Costs

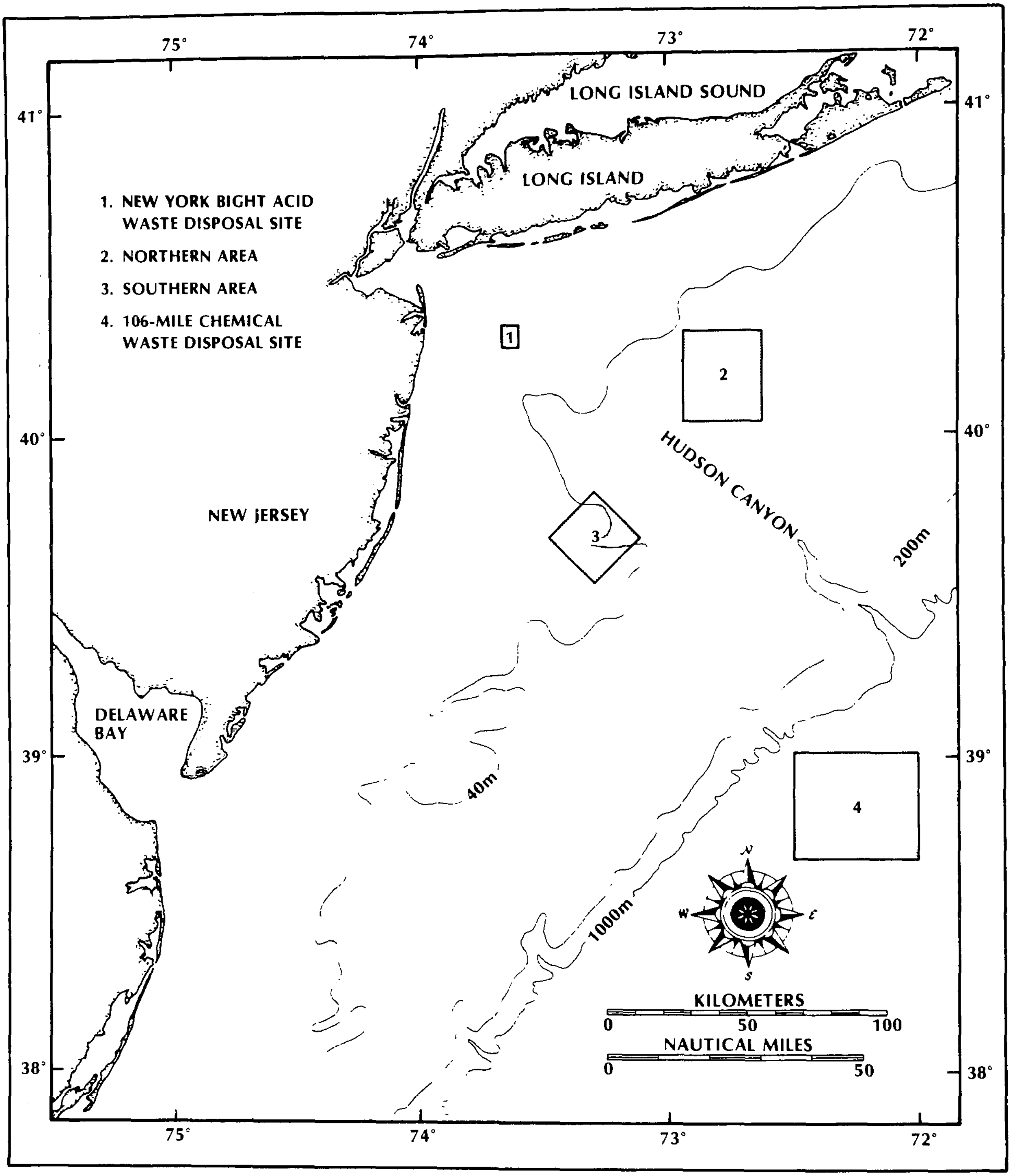

Figure 2-1. The Proposed Site and the Alternative Sites

NO-ACTION ALTERNATIVE

The No-Action Alternative would result in leaving the existing Acid Site with an interim designation. The Ocean Dumping Regulations (Section 228.12 (a)) state that the site was "...approved for dumping the indicated materials on an interim basis pending completion of baseline or trend assessment surveys and designation for continuing use or termination of use ... The sizes and use specifications are based on historical usage and do not necessarily meet the criteria [for site designation] stated in this Part".

Taking no action toward a final determination of the sites' status -- either continued use or termination of use - would violate the intent of Section 102 (a) of the MPRSA since the interim sites may not comply with the site selection criteria mandated by the MPRSA and outlined in the Ocean Dumping Regulations. Therefore, the no action alternative has been rejected because of the need for a decision on the fate of this site - final designation or end of dumping.

CONTINUED USE OF THE PROPOSED SITE

This section presents a detailed summary of the projected impacts of the proposed action, which forms the basis for comparison with the other alternative sites considered.

The Acid Site was established in 1948 for the disposal of acid wastes generated from industries in the New York and New Jersey areas. The site is 14.5 nmi (27 km) from the New Jersey and Long Island coasts, covers 12 nmi^2 (41 km^2) and is on the Continental Shelf (Figure 2-1 #4). The boundaries of the site are latitudes 40°16' to 40°20'N and longitudes 73°36' to 73°40'W. Topographically, the bottom is relatively flat, with an average depth of 25.6 m (84 ft), ranging from 22.6 m (74 ft) to 28.3 m (93 ft). Sediments are predominantly medium to fine grained sands.

The principal user of the site, since it was first established, has been NL Industries, Inc., which contributes about 95 percent of the total annual volume of waste disposed therein. The only other currently active permittee is Allied Chemical Corporation. Du Pont-Grasselli plant released part of its caustic wastes at this site until 1975, when their entire waste disposal operations were moved by EPA to the 106-Mile Site.

The effects of all wastes released into the Apex of the Bight, including those at the Acid Site, have been extensively investigated by the NOAA-Marine Ecosystems Analysis (MESA) Program, New York Bight Project; the NOAA-National Marine Fisheries Service (NMFS), Sandy Hook Laboratory; and the permittees (Appendix B, Table B-1). The site environment, history of ocean disposal, and the important waste constituents are described in Chapter 3. Chapter 4 includes a description of the environmental consequences of acid waste disposal at this site.

PUBLIC HEALTH AND WATER QUALITY

A winter whiting fishery and some lobster fishing are conducted near the site. During some seasons, bluefish appear to be attracted to the area, so there is concern that disposal of acid wastes may adversely affect these resources; however, there has been no evidence of undesirable effects. The wastes rapidly disperse through the water column and are neutralized within minutes by the tremendous buffering action of sea water. Bioassays have demonstrated that the acidity of the waste is the toxic component; neutralized wastes have low toxicity.

There is a visible impact of one waste type; when acid-iron wastes are released, the ferrous sulfate turns the water a distinctive green color. As the ferrous iron oxidizes to ferric hydroxide (rust), the color turns red-brown. The waste plume is distinguishable, as much as 48 hours after a disposal operation; however, there are no apparent long-term effects on the water quality. Nonetheless, this aesthetic impact may be responsible for attracting bluefish to the area. When the site was originally chosen in 1948, it was an unproductive fishing area. Westman (1958) reported that the area had become popular and, in the early part of the season, bluefish were abundant at the site and the area was heavily used by sport fishermen. Recently (1978) charter boatmen stated that the overall effect on fishing was harmful due to the waste plume drifting outside of the site. The net effects of the waste plume (beneficial or adverse) have not been determined.

ECOSYSTEM

Effects of acid waste on the ecosystem are undetectable. The first investigation of the area was made in 1948, immediately before waste disposal operations began. Since then, studies have been periodically conducted and no adverse long-term effects attributed to the wastes have been detected or documented (Appendix D, Table B-1, p. B-4). The major reports for the site are by Redfield and Walford (1951), Ketchum et al. (1958b,c), Westman (1958), and Vaccaro et al. (1972). NL Industries (1977) has summarized these and other studies made of the site in a document included as part of their permit application.

Investigators have examined several environmental features of the Acid Site which may have been affected by the waste. Concerning the impacts of the waste on the biota, the water quality, and the sediment quality, some of the conclusions are:

- Vaccaro et al., 1972:
  - **"There is no indication of an increase in iron (the most abundant waste constituent) in sediments of the acid grounds over the past 14 years.**
  - **"Although the standing crop of zooplankton and numbers of benthic animals were less on the acid grounds than the control area, we have been unable to attribute these differences to acid waste.**
  - **"A phytoplankton toxicity experiment carried out in a culture containing a 10-4 concentration of acid waste in seawater, a concentration four times greater than that observed in the field, has no effect on phytoplankton growth."**

- Grice et al., 1973:
  "..laboratory experiments ... [indicate] the mortality of zooplankton caused by the release of acid waste is negligible on adult copepod populations because of the very few minutes in which lethal concentrations of low pH occur immediately behind the barge. The iron floc which persists in the acid grounds at great dilutions does not affect adult copepods and probably does not affect their developmental stages."

- Wiebe et al., 1973:
  "... In the laboratory tests, the principal cause of copepod mortality appeared to be the acidity of the waste product rather than some toxic component in the material. Thus the laboratory experiments suggest that the mortality of zooplankton resulting from acid waste discharge is negligible because potentially lethal concentrations of low pH do not persist for sufficient time to produce a noticeable effect in the field. The field observations support this conclusion... acid-waste discharges do not appear to have a systematic effect on zooplankton numbers or biomass which is detectable...Longer term effects on developmental stages of copepods also appear negligible since concentrations of acid waste required to inhibit development do not occur for sufficient time in the receiving waters."

The purpose of monitoring is to ensure that long-term adverse impacts do not develop undetected, especially adverse impacts which are irreversible or irretrievable. Monitoring at this site is simplified since the area is nearshore and shallow, yet difficult because there are so many contaminant inputs to the region (Appendix C, Tables C-1 to C-9). However, the NOAA-MESA-New York Bight Project has coordinated and generated many investigations in the Bight, and this area is one of the best understood oceanic regions in the world. Although effects of acid waste disposal have not been demonstrated, the long history of site-specific studies provides an excellent base from which any changes could be detected.

EPA and NASA have cooperated in programs to develop remote sensing techhniques (aircraft and satellite flights) for monitoring. Recent dumpings of acid-iron can be located to within 0.1 nmi and EPA can determine if the operations conform to permit restrictions (Anderson and Mugler, 1978). Other work on remote sensing of acid wastes determined that iron concentrations in seawater can be estimated using these techniques (Lewis, 1977).

Emergency, or "short", dumping occurs when the waste carrying vessel releases its load before reaching the designated disposal area. Since the Acid Site is close to shore, the probability of a short dump is quite low.

ECONOMICS

For the waste generators and the Federal Government the cost of waste disposal at the Acid Site is low. This section examines the costs of transportation, monitoring, surveillance, and the loss of other resources.

In October 1977, NL Industries, the primary user of the site, reported that the estimated cost for barging to the existing site was $1.84 million per year, equal to $2,900 per trip (estimated 640 trips). Allied Chemical has estimated costs at about five times NL Industries cost. For 12 trips per year, the cost is about $170,000; therefore, the estimated costs for hauling wastes to the site (including tugs, fuel, maintenance and associated shore facilities) are about $2 million per year for the two permittees. The effects of inflation and increased fuel costs have not been estimated; however, NL Industries now barges less frequently to the site. This estimate does not include other costs associated with permit analytical requirements, reporting, and alternative studies required by current permit conditions. Site monitoring costs are discussed below.

Rodman (1977) reported for NL Industries that a round trip takes 12 hours; timing is very important. There are two drawbridges between the waste loading dock and the mouth of the harbor, and the barge can only pass at certain times and under certain tidal conditions. If barging operations have to be postponed, NL Industries has adequate storage facilities for temporarily holding the wastes until barging can resume.

Monitoring costs are difficult to estimate for this site; however, the cost to the Federal Government is low since monitoring programs are required for the other ocean disposal sites in the Apex. Monitoring costs are spread over all the sites. The Acid Site is within the NOAA-MESA sampling grid for trend assessment surveys, and this grid would not change if use of the site were discontinued. The permittees are required to conduct a summer survey each year to evaluate the short-term effects of the waste. These surveys cost approximately $17,000 each. The cost is lower for this nearshore, shallow site than it would be for a site further offshore in deeper water.

The program goal for USCG surveillance at industrial waste sites is 75% of all dumping operations. Surveillance at the Acid Site is effective and costs are relatively low. The site is within the normal cruising range of Coast Guard ships and helicopters, and routine surveillance can be conducted with only infrequent use of shipriders. Vessels assigned to surveillance missions remain available for other, higher priority missions (e.g., rescue).

There are no documented losses of biological or mineral resources in the Apex of the Bight due to acid waste discharges. Potential mineral resources, e.g., sand and gravel, may be contaminated by other waste sources (dredged material, sewage sludge) but are unaffected by acid waste. Table 2-1 lists the economically important fish and shellfish landed from the Bight. Except for whiting, important species are either not present at the site, not affected by acid wastes, or become contaminated by other sources, such as sewage sludge. A whiting fishery exists near the site in the winter. The whiting are apparently unaffected by the waste. Bluefish appear to be attracted to the site because of the iron floc plume in the water: "...it is reported that some fishes tend to congregate in or near the disposal area" (Ketchum et al., 1958b).

USE OF ALTERNATIVE EXISTING SITES

INTRODUCTION

Eight municipal and industrial waste disposal sites (aside from the proposed site) presently exist in the mid-Atlantic area (Figure 2-2), six in the New York Bight and two near Delaware Bay. Only the 106-Mile Chemical Waste Disposal Site is a viable alternative.

The other interim sites were not considered as possible alternative locations for several reasons: Only the Delaware Bay Acid Site (inactive since March 1977) has been used for acid waste disposal. The other sites are for the disposal of construction debris (cellar dirt), wrecks, or sewage

TABLE 2-1. FISH AND SHELLFISH LANDINGS BY STATES - 1974

Landings	New York		New Jersey		Total	
	000 lb	$000	000 lb	$000	000 lb	$000
Fish						
Fluke	2,487	846	3,499	1,153	5,986	1,999
Menhaden	576	18	107,307	2,735	107,883	2,753
Scup	3,635	852	6,040	880	9,675	1,732
Whiting	1,955	250	7,022	587	8,977	837
Shellfish						
Lobsters	731	1,396	1,191	1,916	1,922	3,312
Surf Clams	3,951	719	22,657	2,948	26,608	3,667
Scallops	884	1,158	344	531	1,228	1,689

Note: Landings are shown in round (live) weight except for clams, lobsters (total meat), and scallops (edible meat).

Source: Adapted from NOAA-NMFS, 1977a

sludge. Combining acid wastes with other materials violates the tenet of segregating generic wastes by disposal site. Disposal of different types of wastes at the same site could cause problems such as:

- Synergistic interactions at sites where the wastes are not chemically inert. The effects of the combined wastes might be worse than the sum effects of individual materials. In 1974, EPA required that all industrial chemical wastes dumped at the New York Sewage Sludge Site be transported to the 106-Mile Site.

- Monitoring would be more difficult since the effects of the individual wastes would be extremely difficult to differentiate.

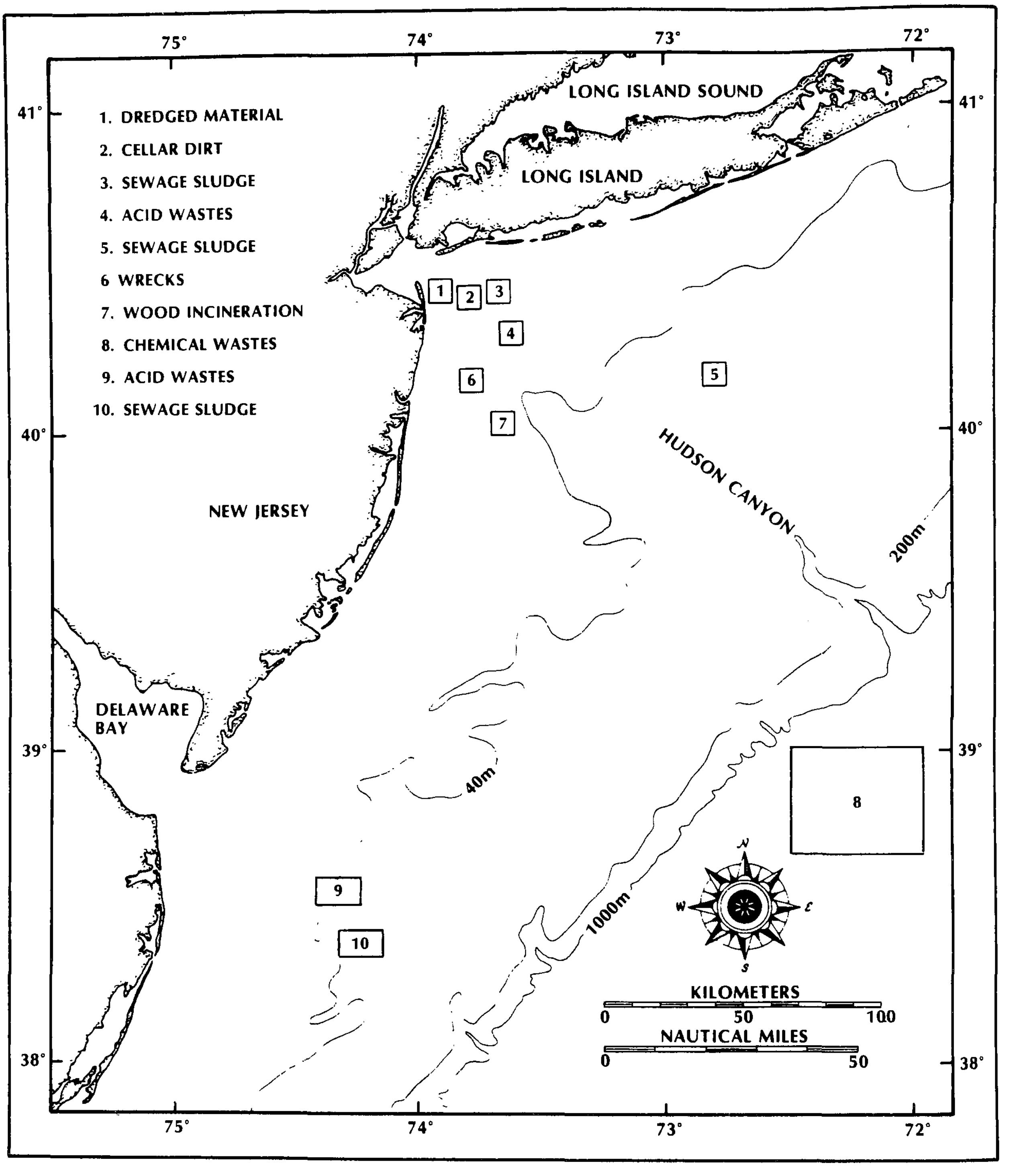

Figure 2-2. Disposal Sites in the mid-Atlantic Area

- Some of these interim sites have already experienced adverse impacts due to waste disposal operations (e.g., New York Bight Sewage Sludge Site and Delaware Bay Sewage Sludge Site); the situation could be aggravated by increasing the load or changing the character of part of the waste load.

- Increased traffic to the nearshore sites would increase navigational hazards and could cause logistic difficulties in coordinating disposal operations.

The Delaware Bay Acid Site (Figure 2-2, #9) was not considered as an alternate site for several reasons: (1) it has been inactive since March 1977 and, when sewage sludge disposal ends at a nearby site, there will be no anthropogenic inputs to the area, (2) the site is more distant from New York Harbor than the 106-Mile Site, which would add to transportation costs, logistics difficulties, and fuel requirements, and (3) if acid waste disposal should adversely affect the benthos at a shallow site, moving the disposal operations to another shallow, coastal site would not be logical, especially when a very deep site (106-Mile Site) could be used.

Consequently, the other disposal sites in the mid-Atlantic region were not considered acceptable alternative locations for acid waste disposal. Only the 106-Mile Site is considered here and compared with the Acid Site.

106-MILE CHEMICAL WASTE DISPOSAL SITE

The 106-Mile Site was established in 1965 for the disposal of industrial wastes for which there were no suitable land-based disposal methods. It is 106 nmi (196 km) southeast of Ambrose Light, New York and 90 nmi (167 km) east of Cape Henlopen, Delaware. The site covers 400 nmi^2 (1,648 km^2) on the Continental Slope and Continental Rise and its boundaries are 38°40'N to 39°00'N, and 72°00'W to 72°30'W. Water depths at the site range from 1,440 m in the topographically rugged northwest corner to 2,750 m in the relatively flat southeast corner. An inactive munitions waste disposal site is located within the site boundaries, and an inactive low-level radioactive waste disposal area is 5 nmi (9 km) due south.

NOAA, assisted by other government agencies and academic institutions, has been studying this site for several years and has published survey results in two summary reports (NOAA, 1975; 1977), several memoranda, public hearing testimony, and the annual report to Congress (NOAA, 1978). A private company, under contract to the permittees, has been monitoring the site for several years. The permittees have submitted the results of these monitoring cruises to EPA-Region II (e.g., Hydroscience, 1978). A Draft Environmental Impact Statement on designation of the 106-Mile Site has been issued (EPA, 1979b).

PUBLIC HEALTH AND WATER QUALITY

Waste disposal at the 106-Mile Site will not directly endanger human health. This site is not located in a commercially or recreationally important fishing or shellfishing area. Although NOAA resource assessment surveys do not extend out to the site, it is known that the density of fish eggs and larvae is low beyond the edge of the Continental Shelf. Foreign fishermen may be near the site in the late winter to early spring, but they usually catch highly migratory fish. The probability of migratory fish remaining in the site and accumulating toxic levels of contaminants from the waste is extremely unlikely.

Navigational hazards due to the use of the site are minimal. Barges can use the Ambrose-Hudson Canyon Traffic Lane for most of the journey. The greatest danger of collision is in the Precautionary Zone through which all the vessel traffic for New York Harbor must pass (Figure 3-10, p. 3-22). All waste barges will pass through this area, irrespective of any designated disposal site.

ECOSYSTEM

The short-term effects of the waste will be similar to those observed at the Acid Site. Long-term adverse effects are improbable, since these have not been demonstrated for the Acid Site. The potential for adverse effects on the indigenous biota and existing water and sediment quality, although remote, is even less at this site because the organism density is much lower and the site is larger and in deeper water. The natural variability of the water at the site, caused by the interactions of three different water masses, causes greater changes in the biotic assemblages of the site than acid waste disposal. Consequently, only immediate, short-term (minutes) changes can be related to the wastes (Chapter 3).

Monitoring at a site off the Continental Shelf is much more difficult than at a shallower, inshore site. NOAA (1977) observed:

> **"In the case of the 106-Mile Site, this situation [the difficulty of measuring and predicting the effects of waste disposal] is further complicated by the interactions of major water masses, Shelf Water, Slope Water, and Gulf Stream eddies. The [site] is a complex oceanographic area in which to assess natural environmental conditions and the impact of man's activities upon those conditions."**

Long-term impacts would be nearly impossible to document, since potentially affected animals will probably have moved out of the area, either carried by currents (plankton) or actively swimming (nekton).

The use of a distant offshore site causes increased risks of emergencies and short dumping. The effects of a short dump of waste materials would depend upon the location of the dump, and particularly water depth. Since acid wastes are liquid and are rapidly diluted after discharge, a single cargo of dumped waste would cause local, immediate acute effects, but no long-term effects. If emergency disposal is necessary, during inclement weather, the effects would be mitigated by the rapid dilution caused by storm turbulence.

ECONOMICS

NL Industries estimated operating costs to barge to the 106-Mile Site at $9.25 million per year. This is about $14,500 per trip, or about five times more expensive than present costs. Assuming that Allied Chemical's costs also increase five times, their annual expense would be $850,000, and the total cost would be about $10.1 million. This estimate may be low. EPA (1978a) estimated that the cost of hauling sewage sludge to the 106-Mile Sewage Sludge Site would be from 6.4 to 8 times more expensive than to the 12-Mile Sludge

Site. Assuming that a similar relationship exists for acid wastes, the cost for hauling acid wastes to the 106-Mile Site would be from $12.8 to $16.0 million annually.

Logistically, the use of this site would be extremely difficult for the primary waste generator. NL Industries, Inc., submitted a report (Rodman, 1977) to EPA-Region II concerning the problems of moving out to the 106-Mile Site. The barge round trip transit time would increase from 12 to 38 hours. Barging from the present loading dock would be unfeasible due to increased travel time, higher probability of weather delays, the requirement to pass through two drawbridges during certain tidal conditions, and a need for increased temporary land storage facilities. NL Industries investigated the possibility of building new loading facilities below the drawbridges and did not believe that the required construction permits could be obtained, especially since the facility would be located in a wetlands area. If the permits were granted, the estimated capital costs would be $30 million.

The cost of monitoring the 106-Mile Site is high compared to other areas due to the complexity of the environment and distance from shore. NOAA is responsible for assessing long-term changes through biological monitoring. A cost of $1 million per year has been estimated for conducting baseline surveys, two of which have been completed (Breidenbach, 1977). The Ocean Pulse Program, based at the National Marine Fisheries Service Laboratory at Sandy Hook, New Jersey, monitors the entire mid-Atlantic, including the 106-Mile Site. The cost to permittees for a monitoring program is also high, due to the site's distant location. These costs would be moderately increased if acid wastes were released at the site; however, the bulk of the monitoring costs are due to ship time and crew costs.

Surveillance Costs

The current Coast Guard Instruction regarding surveillance and enforcement of ocean disposal sites (Commandant Instruction 16470.2B, dated 29 September 1976) requires 75% surveillance of chemical waste disposal operations. Surveillance activities include a shiprider aboard the vessel to observe the disposal operation, with random spot checking before the barge leaves port, and checking the vessel log for departure and arrival times. The Coast Guard presently assigns several full-time personnel to the surveillance of disposal activities in the Bight, including the 106-Mile Site.

Shipriders are presently the only effective on-site surveillance method for the 106-Mile Site. In 1978, 7,247 man-hours were expended in providing shiprider surveillance, excluding the time that shipriders were awaiting departure due to delays caused by mechanical failures or weather and tidal conditions (Schubert, 1979). Since the Acid Site is in the Apex of the Bight and within the normal range of Coast Guard ships and aircraft, shipriders are not normally used.

Surveillance of acid waste disposal activities at the 106-Mile Site would represent a significant, additional requirement for personnel, particularly since NL Industries barges wastes at least daily. Assuming 400 trips per year to the site, surveillance of approximately 300 disposal operations would be required.

<u>Loss of Biotic or Mineral Resources</u>

Only fluke and lobster may be present at or near the site, where they may be affected by the waste materials. (Table 2-1 lists the most economically important finfish and shellfish in the mid-Atlantic Bight.) Since liquid wastes would be diluted and dispersed in the water column and not reach the bottom at this deepwater site, stocks would not be adversely affected by disposal operations. Almost all U.S. fishing activities are located over the Shelf, and would not be directly affected by the wastes. Foreign ships fish along the edge of the Continental Shelf from Georges Bank to Cape Hatteras, especially during the late winter and early spring; however, the site is not a uniquely productive location for foreign fishermen, and does not obstruct migration routes of commercially valuable species. Therefore, the probability of fish stocks accumulating toxic levels of waste constituents is extremely low.

Oil and gas development is possible near the site (Figure 3-9). Waste disposal would neither interfere with drilling operations nor with oil field development. The only navigational hazard would be due to the barge traffic to and from the site. To date, there has been no known lost income resulting from existing disposal operations at the 106-Mile Site, and if acid wastes were also released there, it does not appear that income or resources would be adversley affected.

OVERALL COMPARISON WITH THE ACID SITE

There would not be significant adverse environmental effects from acid waste disposal at the 106-Mile Site. Effects on public health and water quality are minimal and effects on the ecosystem would be limited to short-term changes. However, an increase in monitoring activities would be required, and the probability of short dumping is greater because the site is so distant from New York Harbor.

The economic impact of moving waste disposal to this site would be severe. Barging costs would increase five to eight times over present levels and barging may not be feasible for the dominant waste generator. Surveillance requirements by the Coast Guard would increase substantially since surveillance would be required for approximately 300 barge trips a year. Shipriders would be required frequently, whereas they are used infrequently at the Acid Site. If acid wastes are released at this site, the probability of biological or mineral resource losses is low.

USE OF NEW SITES

In addition to the use of an existing interim disposal site, new sites on or off the Continental Shelf are alternatives to disposal at the Acid Site. The area under consideration is the New York Bight and the Continental Slope along the eastern edge of the Bight. A feasible alternative site for ocean disposal must meet the criteria for "selection of ocean disposal sites" (Sections 228.5 and 228.6 of the Ocean Dumping Regulations). The criteria require that the site must not: (1) conflict with other uses of the area, such as resource development or commercial fisheries, and (2) endanger human health or amenities. If possible, the site should be located within the range of the present fleet of waste disposal vessels in order to make ocean disposal economically feasible.

LOCATIONS ON THE CONTINENTAL SHELF

The New York Bight is one of the busiest coastal and oceanic regions in the world. Activities include extensive commercial shipping, fishing, shellfishing, recreation, resource development, and waste disposal. In selecting a site within the Bight for ocean waste disposal, other activities in the area must be evaluated for potential effects on disposal operations and vice versa. In addition, adequate background environmental information on the area should be collected, so that potential effects of waste disposal can be predicted.

Most of the survey work in the Bight has centered around existing disposal sites; however, two candidate areas for sewage sludge disposal, the so-called Northern and Southern Areas, have been extensively studied. These areas were selected for study by NOAA, partly to avoid conflict with living marine resources (NOAA, 1976) and are, therefore, the most reasonable alternative locations for acid waste disposal. Within the greater areas suggested by NOAA for consideration, two smaller areas were studied in detail and are discussed below.

The Northern and Southern areas are representative of the marine environment on the Continental Shelf off New Jersey (Southern area) and Long Island (Northern area). If another location were evaluated as an alternative site, the same considerations discussed below would be valid. The advantage in considering these particular areas is that surveys have been completed and site-specific data are available. If another location were chosen for acid waste disposal, predisposal surveys would be required.

SOUTHERN AREA

Public Health and Water Quality

The Southern Area is adjacent to commercially exploitable shellfish resources. Surf clams and ocean quahogs are numerous in and shoreward of this area, and sea scallops are present, but abundance estimates were not made (EPA, 1978a).

Since other contaminant inputs do not exist in this area, there is a risk (although low) that the bivalves may concentrate contaminants from the acid wastes. Preliminary work by Pesch et al. (1977) indicated that the tissues of sea scallops accumulated vanadium from acid wastes released by Du Pont-Edge Moor at the Delaware Bay Acid Waste Site. However, other metals present in high concentrations in the waste (e.g., iron, manganese, and titanium) were not accumulated by the animals. Simpson (1979), working with other bivalves (mussels), found that the uptake and loss of trace metals varied with the body weight of the animal and the phase of its reproductive cycle. Additional work is needed to establish if benthic organisms can accumulate contaminants from these liquid wastes.

Since the site is not visited by sport fishermen due to distance from shore, the undesireable visual effect of temporarily discolored water resulting from the release of acid-iron wastes would not be noticed at this site; however, if bluefish are attracted to the waste plume, the sportfishing value would be lost. In addition, if other pelagic fish avoid the waste plume, these pelagic fisheries could be adversely affected.

Ecosystem

The short-term effects of acid waste on the water column biota would be similar to changes already documented for the Acid Site (i.e., minor effects on the plankton, but no irreversible changes). As noted above, there is a small possibility of changes in benthic populations due to waste constituents. These changes would be simple to detect, since the site is outside the Apex of the Bight where multiple contaminant inputs exist.

Monitoring would require an additional program since none of the existing surveys concentrates on the area. Due to the existence of the NOAA data based on predisposal conditions in the Southern Area, monitoring is feasible. This site is outside the heavily contaminated Bight Apex, and there are no contaminants from other sources. Thus detecting changes caused by waste disposal at the site would be simplified.

Economics

The economic consequences of moving acid waste disposal to this area are important. Neither permittee has estimated the costs of using this area. However, EPA (1978a) estimated that the cost of hauling sewage sludge to this area would be 3.2 to 4 times more expensive than the cost of hauling to the existing 12-Mile Site. Assuming that the same relationship is valid for acid wastes, the cost for hauling acid wastes to the Southern Area would range from $6.4 to $8 million per year. For NL Industries, logistic difficulties due to using a more distant site (as for the 106-Mile Site), are increased. If ocean disposal is not feasible, the company would have to find alternative treatment methods. According to reports submitted to EPA-Region II in compliance with previous interim permits, land-based alternatives are less environmentally preferable and economically unfeasible for the large volumes of waste liquid generated by NL Industries (NL Industries 1975a, 1975b, 1975c 1977; Ryckman/Edgerly/Tomlinson and Associates, 1977).

Monitoring costs would increase at this site. The cost to the waste generators would probably be about the same as existing costs, since the short-term effects of the waste would be similar. NOAA, however, would be required to establish additional surveys in the site to evaluate the long-term biological effects of waste disposal.

Surveillance costs and difficulties would increase at this site. It is located beyond the normal operating range of Coast Guard 82-foot and 95-foot patrol boats and helicopters normally used for surveillance, so multiple missions are not possible. As for the 106-Mile Site, the much higher number of barge trips would require shipriders. The overall time would be less than at the 106-Mile Site since the transit time is less to this site. However, the use of shipriders for acid waste would be a new requirement for the Coast Guard.

The possible loss of biotic resources is probably the most important cost of using this site. As shown in Table 2-1, economically important finfish (scup and whiting) and shellfish (lobster, surf clams, and scallops) are found in the area. The site contains an important and established fishery resource.

Ocean quahogs, shellfish which may be exploited in the future, are abundant in the area (EPA, 1978a). The area is shallow so that wastes may reach the bottom and shellfish may be contaminated. Finfish may avoid the area; consequently, use of this site could cause a significant adverse economic impact on these living resources. The potential economic impact cannot be quantified because the actual amounts of fish and shellfish taken from the area are unknown.

Use of the Southern Area would not affect sand and gravel deposits which could be mined in the site vicinity, since the wastes are not sufficiently toxic to require decontamination of the mined materials. Barging operations should not interfere with exploration and development of oil and gas resources.

Overall Comparison with the Acid Site

The possible effects on the areas of public health and water quality and on the ecosystem are much higher at a site in the Southern Area. Since there are no other contaminant inputs to the area, existing resources are not adversely affected. The possibility of acid waste constituents contaminating economically important resources does exist. Use of this area is less economically desirable. The transportation costs to the waste generators would increase 3.2 to 4 times, as would both monitoring and surveillance costs to the Federal Government.

NORTHERN AREA

Public Health and Water Quality

Minimal or no effects on public health and water quality would be expected as a result of acid waste disposal at this site. Although surf clams, sea scallops, and ocean quahogs are present in the vicinity, commercial possibilities are probably less than in the Southern Area (EPA 1978a). Aesthetically, the effects of waste disposal should be minimal, the same as in the Southern Area.

Ecosystem

Since the oceanographic features of the two areas are similar, effects on the ecosystem would be similar to those in the Southern Area, i.e., short-term effects on the water with the possibility of waste constituents accumulating in the sediments or benthic organisms. NOAA would be required to initiate a new long-term monitoring program in addition to those already planned for other sites. If sewage sludge were released at the Alternative Sewage Sludge Site (Figure 2-2, #5) it would be difficult to differentiate between the effects of acid waste and sludge contaminants.

Economics

The Northern Area is almost the same as the Southern Area as to transportation costs, the logistics difficulties related to a more distant site, and monitoring and surveillance costs. These costs would be higher for the permittees and the Federal Government. Although the Northern Area is within the normal distribution of surf clams, they are not abundant at the site. The density of sea scallops is not known, but ocean quahogs are abundant, and acid waste disposal could possibly interfere with the development of these potentially valuable marine resources. This adverse effect would be mitigated because the net dispersive flow appears to be offshore, away from the Continental Shelf (EPA, 1978).

Ocean disposal at a site in the Northern Area would not interfere with development of mineral resources. It is approximately 60 nmi (110 km) northeast of the oil and gas lease tracts identified on the mid-Atlantic Shelf. Acid waste disposal could not possibly interfere with petroleum exploration or development located near the Southern Area.

Overall Comparison with the Acid Site

There are few economic resources in the Northern Area, thus it is preferable to the Southern Area. The effects on the ecosystem would be similar to those predicted for the Southern Area and potentially more severe than the documented effects at the Acid Site.

Economic considerations make use of the Southern Area much less desirable than continued use of the Acid Site. Hauling costs for the permittees would increase 3.2 to 4 times, thus ocean disposal may not be possible for NL Industries, which generates the largest volume of wastes requiring ocean disposal. Monitoring and surveillance costs to the Federal Government would increase.

LOCATIONS OFF THE CONTINENTAL SHELF

Information on the mid-Atlantic Continental Slope and Continental Rise is lacking (TRIGOM, 1976). The 106-Mile Site is located at the closest point to New York Harbor beyond the Continental Shelf (Figure 2-1). Due north of the site is the Hudson Canyon, a major migratory route for fish entering the New York Bight. (See Chapter 3.) Waste disposal nearer the Canyon would be environmentally unacceptable, primarily because migrating organisms could accumulate toxic constituents of the waste, and become a potential health hazard to humans consuming infected animals.

Little background environmental information exists for the Slope beyond the 106-Mile Site. The environment immediately southwest of the 106-Mile Site along the Continental Slope is also unknown. Designating a site for waste disposal in that area would require extensive baseline survey work.

There are no data indicating that the 106-Mile Site is located on or near an especially unique portion of the Shelf. The same physical processes affect this entire region and the benthos is fairly uniform over great horizontal distances at these depths. Other localities, further northeast or south of the 106-Mile Site, would add considerably to the round trip time and distance without any clear environmental benefit. In addition, the increased travel time increases the probability of emergencies and thus increases the probability of short dumps.

If a site off the Shelf is used for acid waste disposal, the 106-Mile Site is the best alternative for a number of reasons. Unlike other areas off the mid-Atlantic Shelf, the 106-Mile Site has been studied extensively, thus adequate information exists for projecting effects of disposal activities. Use of any other Continental Slope site would require extensive new survey work to produce as much data as are presently available for the 106-Mile Site. The site is on the portion of the Continental Slope closest to New York Harbor, and highly accessible to potential users of the site. Finally, no environmental advantage would be gained by choosing another off-Shelf location over the 106-Mile Site.

SUMMARY

Several alternative locations on and off the Continental Shelf have been evaluated as potential disposal sites. A number of features of the Acid Waste Site make it the most desirable location among all alternatives examined:

- It conforms to the Ocean Dumping Regulations' recommendation to use either historical sites or sites off the Continental Shelf whenever feasible.
- It has been studied extensively for more than 30 years.
- Only minor, short-term, adverse environmental changes and no long-term effects caused by acid waste disposal have been demonstrated at the site.
- Moving acid waste disposal from the New York Bight Apex would not create a measurable environmental benefit, nor would areas closed to shellfishing be reopened.
- The site is convenient to New York Harbor.

Considering all reasonable alternatives to the proposed action, the designation of the New York Bight Acid Waste Disposal Site for continued use is the most favorable alternative. Although there are risks involved in this action, the environmental risk of waste disposal at this site is considered to be less serious than the risk of disposing of wastes at a different location on or off the Continental Shelf (Chapter 4). If subsequent monitoring of the site shows that adverse effects resulting from the wastes are greater than anticipated, EPA may discontinue or modify use of the site in accordance with Section 228.11 of the Ocean Dumping Regulations.

Table 2-2 summarizes a comparative evaluation of the possible effects of acid wastes at the four alternate sites and outlines the effects on three major components: (1) public health and water quality, (2) ecosystem, and (3) economics.

DETAILED BASIS FOR SELECTION OF THE PROPOSED SITE

Part 228 of the Ocean Dumping Regulations and Criteria describes general and specific criteria for selection of sites to be used for ocean waste disposal. In brief, the general criteria state that site locations will be chosen:

- "...to minimize the interference of disposal activities with other activities in the marine environment"
- "...[So] temporary perturbations in water quality or other environmental conditions during initial mixing...can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary or known geographically limited fishery or shellfishery."
- "[site sizes] will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts."
- "EPA will, whenever feasible, designate ocean dumping sites beyond the edge of the Continental Shelf and other such sites that have been historically used."

The New York Bight Acid Waste Disposal Site satisfies all of the above criteria.

TABLE 2-2. SUMMARY EVALUATION OF ALTERNATIVE DISPOSAL SITES FOR ACID WASTES

AFFECTED COMPONENT	NORTHERN AREA SITE	NEW YORK BIGHT ACID WASTE SITE	SOUTHERN AREA SITE	106-MILE CHEMICAL WASTE SITE
PUBLIC HEALTH & WATER QUALITY	None to very slight short-term potential effects.	None to very slight short-term potential effects.	Slight potential effects.	None to very slight short-term potential effects.
Commercial Fishing	No effects as commercial stocks either do not exist (shellfish) or are not unique (finfish) to the area.	No effects documented after 30 years of disposal activities.	Slight potential for contamination of exploitable resources.	No effects as exploitable resources are not found in this area.
Recreational Fishing	No effects as the site is beyond the normal range of most fishermen.	Slight effects.	No effects as the site is beyond the range of most fishermen.	No effects as the site is well beyond the range of fishermen.
Navigational Hazards	Very slight potential effects as site is further from shore.	Very slight potential effects as site is located over part of a traffic lane. No increased hazard over present practice.	Slight potential effects as site is further from shore and potential resource development in area.	Moderate potential effects as site is much further from shore.
Aesthetics	No effects as area is not frequented.	Very slight effects when waste is released. Discolored water does not reach shore.	No effects as area is not frequented.	No effects as area is not frequented.
ECOSYSTEM	Slight potential effects.	Very slight effects.	Slight potential effects.	Very slight potential effects
Biota				
• Plankton	Very slight toxic effects when waste released. None to very slight potential for modifying the population structure.	Very slight toxic effects when waste released. None to very slight potential for modifying the population structure.	Very slight toxic effects when waste released. None to very slight potential for modifying the population structure.	Very slight toxic effects when waste released. None to very slight potential for modifying the population structure.
• Nekton	Very slight potential for uptake of waste contaminants.	Very slight potential for uptake of waste contaminants.	Very slight potential for uptake of waste contaminants.	Very slight potential for uptake of waste contaminants.
• Benthos	Moderate potential for modifying the population structure or contaminant uptake.	Very slight potential for further changes.	Moderate potential for modifying the population structure or contaminant uptake.	No potential for bottom effects.
Water Quality				
• Trace Metals	Slight short-term increase of concentrations.	Slight short-term increase of concentrations.	Slight short-term increase of concentrations.	Slight short-term increase of concentrations.
Sediment Quality				
• Trace Metals	Slight potential for detectable accumulation.	Very slight potential detectable accumulation. Cannot distinguish from other waste sources.	Slight potential for detectable accumulation.	No potential for detectable accumulation.
Monitoring	No difficulty in following short-term changes.	No difficulty in following short-term changes.	No difficulty in following short-term changes.	Very slight difficulty in following short-term changes.
Short Dumping	Slight short-term effects along the Nantucket Navigational Lane.	Very slight short-term effects in the Precautionary Zone.	Slight short-term effects along the Hudson Canyon Navigational Lane.	Slight short-term effects. More probable occurrence as site is so far from shore.

TABLE 2-2. (Continued)

AFFECTED COMPONENT	NORTHERN AREA SITE	NEW YORK BIGHT ACID WASTE SITE	SOUTHERN AREA SITE	106-MILE CHEMICAL WASTE SITE
ECONOMICS	Slight to moderate increase in effects over present practice.	Present practice. Very slight effects.	Moderate increase in effects over present practice.	Moderate to severe increase in effects over present practice.
Transportation Costs	Moderate increase over present practice.	No increase in costs.	Moderate increase over present practice.	Large increase over present practice.
• Logistics	Moderate difficulty due to increased barging distance and location of loading facilities.	No difficulty over current practices.	Moderate difficulty due to increased barging distance and location of loading facilities.	Severe difficulty due to much increased barging distance and location of loading facilities.
• Energy Requirements	Moderate increase over current requirements.	No increase over current requirements.	Moderate increase over current requirements.	Large increase over current requirements.
Monitoring	Increased effort as site is further from shore.	No increased effort over current requirements.	Increased effort as site is further from shore.	Substantially increased effort as site is much further from shore.
Surveillance	Moderate difficulty as site is outside range of normal Coast Guard activities.	No difficulties as site is well within range of normal Coast Guard activities.	Moderate difficulty as site is outside range of normal Coast Guard activities.	Moderate difficulty as site is well outside range of normal Coast Guard activities.
Loss of Resources				
• Fisheries	No loss of non-commercial resources.	Very slight effects on recreational fishing. No loss of commercial resources.	Slight potential loss of commercial resources.	No loss of commercial or recreational resources.
• Mineral Resources	No potential resources identified.	Resources contaminated by other waste sources.	Very slight change of loss of potential resources.	No potential resources identified.

Eleven specific site selection criteria are presented in Section 228.6 of the Ocean Dumping Regulations. The following eleven subsections consolidate the information for the Acid Site and show that the site complies with the eleven site selection criteria. Additional information is in Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences).

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

The New York Bight Acid Waste Site is on the Continental Shelf at the Apex of the New York Bight. (Figure 2-1.) Its coordinates are latitudes 40°16'N to 40°20'N and longitudes 73°36'W to 73°40'W. The water depth averages 25.6 m (84 ft) and ranges from 22.6 to 28.3 m (74 to 93 ft). The site is approximately 15 nmi south of Long Beach, Long Island and east of Long Branch, New Jersey.

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

All of the above activities occur throughout the entire coastal area of the mid-Atlantic Bight. The site is not uniquely important for any species and no stage in the life history of valuable organisms occurs primarily at or near the Acid Site. The site is just north of the Hudson Canyon, which is an important migratory route for some animals. However, studies have not shown that aqueous acid wastes affect the benthos; conditions in the Canyon are primarily affected by ocean disposal activities at other sites and shore contaminant inputs.

LOCATION IN RELATION TO BEACHES AND OTHER AMENITY AREAS

The distance from the site to the shore precludes the possibility of danger to beaches or other amenity areas. Swanson (1977), Manager of the NOAA-MESA - New York Bight Project, stated that, "...we have no evidence to suggest that waste materials from the Apex Acid Waste Dumpsite have reached shore".

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

Wastes released at the site must meet the EPA environmental impact criteria specified in the Ocean Dumping Regulations and Criteria, Part 227 Subparts B,D, and E. In all cases, in accordance with Part 227 Subpart C, a need for ocean disposal must be demonstrated before issuance of a permit. At this time, permit applications from compa ies not presently (1979) barging wastes to the ocean are not anticipated.

All wastes expected to be released following final site designation will be aqueous acid wastes transported by vessels. The wastes will be discharged below the surface into the vessel's wake. None of the wastes are proposed to be containerized or packaged in any way.

FEASIBILITY OF SURVEILLANCE AND MONITORING

Both surveillance and monitoring activities are quite simple at the site. The site is close to shore and well within the areas regularly patrolled by the Coast Guard with 82- and 95-ft patrol boats. The site is within the patrol range (25 miles from shore) of the Coast Guard's HH-52A helicopter.

The New York Bight has been extensively studied by researchers from the EPA, NOAA, universities, industries, and others. One goal of the NOAA-MESA project is to develop waste management plans and monitoring strategies for the Bight (MESA, 1977). The existing monitoring plan for the Acid Site is presented in Appendix E.

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

The physical oceanographic features of the Acid Site are described in detail in Appendixes A and B. The waste behavior immediately after release is discussed in Appendix D.

Wastes from both permittees are diluted and dispersed well within the allowable 4-hour mixing period. Even if a direct current traveled from the site to the shore, the concentration of the most abundant waste constituent would be well below ambient levels. One waste type forms an iron hydroxide (rust) floc which is persistent; a colored waste plume may be detectable up to 48 hours after a disposal operation.

Surface currents in the Bight often move in an anticyclonic (clockwise) eddy around the Bight. At the site, surface and bottom currents tend to move in northerly and westerly directions. These directions, however, are neither constant nor predictable, and the details of the circulation within the Apex of the Bight have not been resolved.

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

Numerous studies have failed to detect significant, long-term, adverse effects caused by the acid wastes at this site. Redfield and Walford's (1951) conclusion is still valid:

> **"Consideration of the general rate of exchange of water between the New York Bight and the adjacent parts of the ocean make it extremely unlikely that the quantity of waste discharged during more than a few days could be found in the region at any one time. No evidence has appeared which indicates that undesirable effects of any sort have arisen from these waste disposal operations."**

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

Mineral extraction, desalination, and fish and shellfish culture do not occur at or near the site. The site is not located in a unique area of the Bight and is not an area of special scientific significance other than the evaluation of acid waste disposal. Although the site is in one of the outbound traffic lanes from New York Harbor, the disposal operations have not interfered with shipping. When in the traffic lane, the barge moves parallel to it; otherwise, it moves at right angles to the traffic. In the 30 years of operations at the site, there has never been a collision of a waste-discharging barge and another vessel, although a collision did occur in 1976 between a ship and a barge bound for the 106-Mile Site (P. Anderson, personal communication*).

Recreational fishermen in both private and charter boats use the site. Numerous studies have been made on the effects of acid waste disposal on finfish of the area. The conclusions of Ketchem et al. (1958), that the waste is nontoxic and rapidly diluted, are still valid. No deleterious effects of waste disposal on the plankton populations have beeen demonstrated and, in fact, some fish may be attracted to the area.

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

The large numbers of surveys made at or near the site have been summarized above, in Chapter 4, and in Appendix B. Adverse effects resulting from acid waste disposal have not been documented.

Both NL Industries and Allied Chemical Corporation have evaluated the influences of their respective wastes on the existing water quality of the site (ERCO, 1978a,b). The wastes of both industries comply with the marine water quality criteria for all constituent materials. Concerning the ecology of the site, Swanson (1977) stated:

> "Hydrated, iron oxide precipitates from acid wastes coat suspended particles, including biota. It might be suspected that coatings could adversely affect some membrane transport functions. No observational evidence can be found to indicate any effects on biota from such coatings. Surveys of benthic populations in the immediate vicinity of the Apex Acid Waste Dumpsite have not demonstrated an observable impact of waste acid. Such an observation at the site would not be expected for two reasons: first, the acid waste materials do not accumulate in the sediments at the site; and second, any impacts would be the sum of all activities affecting the site, and could not be attributed to acid wastes alone. Long-term, sublethal, toxic effects on organisms at and near the Apex site have not been investigated."

* P. Anderson, Chief, Marine Protection Branch, EPA, Region II, Edison N.J.

Swanson's last statement refers to comprehensive, in situ, studies. Vaccaro's group (Vaccaro et al., 1972; Grice et al., 1973; Wiebe et al., 1973) did investigate chronic effects of acid waste in the laboratory and concluded that biologically significant effects did not occur. If adverse effects due to waste disposal are detected, the Ocean Dumping Regulations state that appropriate mitigating measures must be taken ranging from reducing the discharge rate, frequency of dumping, or annual volume to relocating the disposal operations or prohibiting ocean disposal (40 CFR 228.11).

POTENTIAL FOR THE DEVELOPMENT OR RECRUITMENT OF NUISANCE SPECIES IN THE DISPOSAL SITE

Based on 31 years of disposal, it can be stated that acid waste does not promote or attract nuisance species in the area. Extensive phytoplankton blooms in the Bight which cause adverse effects, usually result from an excess of nutrients combined with anomalous physical conditions (Sharp, 1976). Acid wastes do not contain constituents which promote phytoplankton growth.

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

No such features are known to exist at or near the site. The site is sufficiently distant from shore so that wastes do not affect state or national parks or beaches.

CONCLUSIONS AND PROPOSED ACTIONS

EPA has determined that the interim Acid Waste Disposal Site should be placed in Impact Category II. This area is the most preferred location for disposal of some acid wastes generated in the Northeastern United States.

All future use of the Acid Site for acid waste disposal must comply with the EPA Ocean Dumping Regulations and Criteria, a requirement which brings disposal into compliance with the MPRSA and the Ocean Dumping Convention. EPA determines compliance with the Regulations on an individual basis during evaluation of applications for disposal permits. General guidelines for determining the acceptability of wastes proposed for release at the Acid Site follow.

TYPES OF WASTES

Waste materials similar to those previously released at the site are acceptable since significant adverse environmental effects from these wastes have not been demonstrated. If adverse effects are observed in later monitoring, disposal must be altered (reduced or stopped) until such effects cease (Ocean Dumping Regulations, Section 228.11). Provisionally, industrial wastes with the following characteristics may be released at the site:

- Aqueous acid wastes with low solid phase content
- Neutrally buoyant or slightly denser than seawater
- Low toxicity (after neutralization) to representative marine organisms
- Containing no materials prohibited by the MPRSA
- Limiting permissible concentration for all waste constituents will not be exceeded outside the disposal site during initial mixing (4 hours) nor will it be exceeded anywhere in the environment after initial mixing.

Essentially, these are liquid wastes which comply with the Ocean Dumping Regulations concerning environmental impact, need for ocean disposal, and impact on aesthetic, recreational, economic, and other uses of the ocean.

WASTE LOADINGS

Since cumulative adverse effects of past waste loading have not been demonstrated at the site, no upper limit can be assigned beyond which adverse effects could occur. The maximal historical input, about 5.45 million tonnes of acid wastes in 1963, did not cause observable adverse effects. It is certain that historical average volumes are acceptable (about 2.3 million tonnes per year). Existing (1979) permits allow a maximum of 2.2 million tonnes annually to be released at the site. However, the total annual input is not the critical element in evaluating the effects of waste loading at the site; rather, an individual barge load is important because the waste constituents do not accumulate, but are dispersed below detectable levels by currents. The rate of release of each waste load must not be greater than the ability of the water to dilute it to acceptable levels within a short period of time. Compliance with Section 227.8 of the Ocean Dumping Regulations (limiting permissible concentration) should ensure that the marine environment will not be adversely or irreversibly affected.

The total assimilative capacity of the site or area is not known for these wastes since long-term adverse effects have not been demonstrated. Since the current patterns in the Bight are highly complex and have large, unpredictable variations, even the short-term (days) transport of the waste cannot be predicted. Therefore, estimating maximal seasonal or annual waste loadings is not possible at this time. Each waste proposed to be released must be evaluated individually and relative to other waste inputs, for dispersal characteristics and input of toxic elements to the Apex environment. Waste loadings above the present level may be permitted as long as the site is carefully monitored for adverse effects. However, the amount of material released in each barge load must not be greater than can be reduced to acceptable levels by dispersal and dilution at the site. The size of barge loads and release rates of materials at the site are established by EPA to satisfy this objective.

DISPOSAL METHODS

Present disposal techniques are acceptable and will be required for future permittees. The wastes are transported to the site in specially constructed rubber-lined barges. Wastes are discharged from 30-cm diameter underwater ports at a specified rate while the barge is under way (5 to 7 kn). The turbulence created by the wake of the barge causes immediate dilution of the waste (from 1:250 to 1:1,800). The acid is neutralized by the buffering action of seawater; pH changes are detected only occasionally behind the barge and rarely exceed 0.2 pH units below ambient conditions, even a few minutes after discharge. This method (or another method that maximizes initial dilution upon discharge) will be required for all future disposal.

DISPOSAL SCHEDULES

Since only two companies are using the site, there have not been any scheduling problems. Allied Chemical Corporation makes 12 to 18 trips per year to the site, while NL Industries barges at most twice (usually once) a day. Only one barge will be allowed in the site during a 4-hour period. This requirement prevents additional hazards from shipping and the possibility that conditions within the site would still show the influences of the previous dump.

SPECIAL CONDITIONS

Current permits have ten special conditions, which will remain part of future permits issued for waste disposal at the Acid Site:

- Special Condition 1 is the time period the permit is in force. Current permittees are:

    - NL Industries, Inc., April 10, 1979 to April 9, 1981

    - Allied Chemical Corp., April 10, 1979 to April 9, 1981

- Special Condition 2 is a description of the material to be transported for ocean dumping. This condition requires quarterly reports from both the waste generator and waste transporter on the volumes of waste delivered or transported. Allowable volumes (1979) are:

    - NL Industries - not to exceed 2,147,000 tonnes per year (2,370,000 wet tons) or 2,721,000 tonnes (3,000,000 wet tons) during the term of the permit of liquid sulfuric acid and gangue solids slurry.

    - Allied Chemical - 51,700 tonnes (57,000 wet tons) per year of by-product hydrochloric acid generated in the manufacture of fluorocarbons.

- Special Condition 3 specifies the disposal site. Present permittees both release wastes at the New York Bight Acid Waste Disposal Site.

- Special Condition 4 lists the barges to be used and requires that navigational overlays of the dump vessel's trackline during any disposal operation be submitted to the Coast Guard. The waste transporter must notify the Captain of the Port, U.S. Coast Guard, of his departure time from the port and the time of actual discharge. Discharge rates are also indicated. Current barges used are:

  - NL Industries: MORAN 102 (633,000 gal capacity)
MORAN 108 (990,000 gal capacity)

  - Allied Chemical: AC-5 (456,000 gal capacity)

  Discharge rates are presently:

  - NL Industries: 100,000 gal/nmi
(378,500 l/nmi)

  - Allied Chemical: 12,000 gal/nmi
(45,400 l/nmi)

- Special Condition 5 specifies the waste constituents to be monitored, the approved analytical procedures, and some requirements for laboratory quality control practices. Samples are taken monthly for analyses.

- Special Condition 6 requires the continuation of the EPA approved monitoring program to determine the short-term environmental impacts of the ocean disposal of acid waste. Details of the monitoring program are in Appendix E.

- Special Condition 7 pertains to the implementation of alternative disposal methods. Both current permittees have submitted reports to demonstrate that their respective wastes are in compliance with 40 CFR 227. This condition requires further research and evaluation of alternative disposal methods with the objective of ending ocean disposal. The conditions in the current permits are:

  - NL Industries:

    (1) After publication of the proposed national effluent guidelines for the titanium dioxide industry, the company will submit a plan committing it to cease ocean dumping within 18 months of promulgation of final guidelines.

    (2) Evaluate the feasibility of three process changes:
      (a) Chloride process
      (b) Ishihara process (ammonia neutralization)
      (c) Malazsian Titanium Corp., process

    (3) For the acid wastes, report amounts produced, amounts discharged to municipal treatment plants, amount recycled, and amounts sold.

    (4) Plan and implement a land-based disposal method for the insoluble gangue and ore slurry. Anticipated cessation of the ocean dumping of this material is June 30, 1981.

    (5) Continue research and development on alternative land-based disposal techniques for the acid phase of the waste.

  - Allied Chemical:

    (1) Submit a detailed report prepared by an independent consultant evaluating economic and environmental effects of several alternative technologies recently (1977-1978) studied by the company.

(2) Report amounts of by-product acid produced and amounts sold.

(3) Continue research and development in alternative land-based disposal techniques.

- The EPA has required the waste generators to evaluate several land-based alternatives in previous permit requirements. To date, these alternative disposal methods have not been economically and/or technically feasible, nor would they have provided significant environmental protection. Recycling or upgrading and selling the wastes is done to the maximum possible extent. Listed below are the alternatives to ocean disposal considered by the permittees:

  - NL Industries:

    (1) Neutralize the acid waste with caustic soda, landfill sludge solids, and discharge effluent into the Raritan River.
    (2) Neutralize the acid waste producing usable by-products and landfill sludge solids.
    (3) Change to the chloride process to produce less waste.
    (4) Neutralize the acid waste before ocean disposal.

  - Allied Chemical:

    (1) Neutralize the acid waste, landfill sludge solids, and discharge clarified effluent to Newark Bay.
    (2) Upgrade and sell a portion of the acid waste, and neutralize the excess-producing sludge for landfill and a clarified effluent.
    (3) Convert by-product hydrochloric acid to chlorine using the Kel-chlor process, which produces a less toxic waste.
    (4) Neutralize the acid waste before ocean disposal.

- Special Condition 8 details procedures for notifying the U.S. Coast Guard that dumping is to occur. This notification is required to facilitate USCG surveillance of disposal operations.

- Special Condition 9 details information relative to correspondence and reports required by the special and general conditions of the permit.

- Special Condition 10 specifies the liabilities for compliance related to the special conditions of the permit as applicable to the waste generator, waste transporter, or both.

These special conditions will continue to be part of all permits authorized for wastes to be released at the Acid Site.

Chapter 3

AFFECTED ENVIRONMENT

The environmental characteristics of the proposed New York Bight Acid Waste Disposal Site and three alternative sites (106-Mile Chemical Waste, Northern Area, and Southern Area) were assessed in terms of oceanographic features (physical, geological, chemical, and biological), the history of waste disposal at the sites, the effects of wastes at the sites, and other activities near the sites which may be affected by waste disposal. The proposed site, located nearshore at the Apex of the New York Bight, has been used since 1948 with no adverse effects on the environment or on activities in the area. The 106-Mile Site, located beyond the Continental Shelf in deep water, has been used since 1961 primarily for aqueous chemical waste disposal with no detected adverse effects. The Northern and Southern areas, located in shallow water near Hudson Canyon with oceanographic features similar to the proposed site, have never been used for waste disposal. The Acid Site is preferred for designation because of (1) the greater distance to the 106-Mile site and the difficulty of detecting effects in deep water, (2) the absence of other contaminant inputs and the additional expense of surveillance and monitoring at the Northern and Southern sites, and (3) the lack of adverse effects at the proposed New York Bight Acid Waste Disposal Site.

PROPOSED SITE - NEW YORK BIGHT ACID WASTE SITE

SITE ENVIRONMENT

The Acid Site (Figure 3-1) is not unique when compared with the rest of the New York Bight Apex. Physical processes operate over broad areas, the chemical and biological features of the water being nearly uniform over the entire Apex. The sediments and associated biota in the Apex and at the site are typical of the sandy bottom assemblages found throughout the mid-Atlantic Bight. Although anthropogenic inputs (dredged material, sewage sludge, and cellar dirt) have extensively modified the sediments in some areas, acid waste, which is liquid, does not appear to affect the bottom. (See Appendix B for details.)

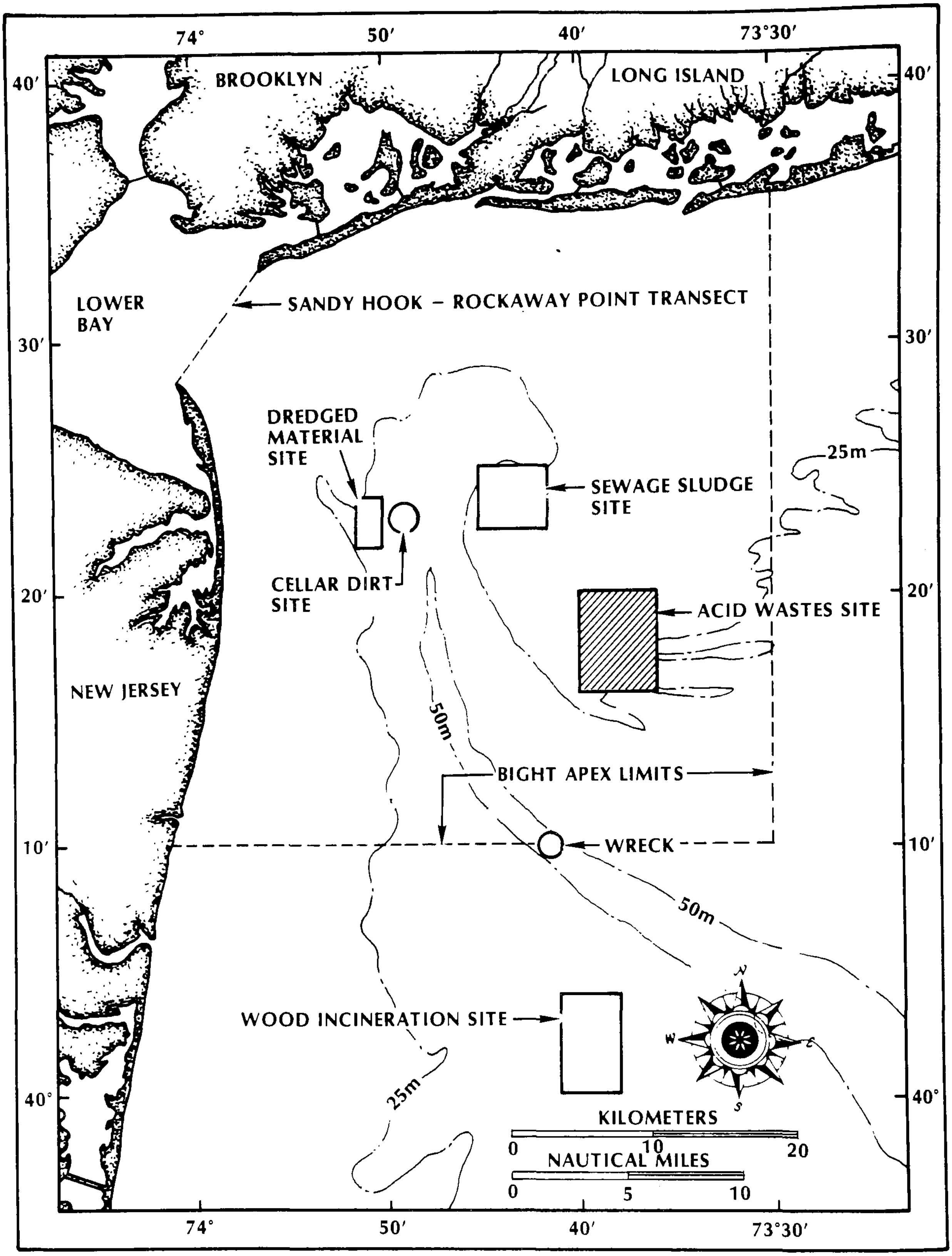

Figure 3-1. Location of New York Bight Acid Waste Disposal Site

PHYSICAL CONDITIONS

The physical characteristics of the New York Bight are complex. Seasonal patterns of temperature, salinity, insolation, and river runoff are complicated by strong meteorological events and intrusions of Slope Water (Bowman and Wunderlich, 1977). The hydrography of the New York Bight exhibits clear seasonal cycles in temperature, salinity, and density structures. Two distinct oceanographic regimes, with short transition periods between them, prevail during an annual cycle. Early winter storm mixing and rapid cooling at the surface create well-mixed, unstratified water. A moderate stratification develops in the early spring and intensifies through the summer (Charnell and Hansen, 1974). The rapid formation of the seasonal thermocline divides the water into an upper and lower layer. Bottom waters retain their characteristics with little modification until storms break up the thermocline in late autumn.

The major feature of Bight circulation is a slow flow to the southwest over most of the outer Continental Shelf; an anticyclonic (clockwise) eddy is often present in the inner Bight. Exchange circulation, characterized by seaward surface flow of estuarine waters and landward flow of bottom waters, occurs through the Sandy Hook-Rockaway Point Transect. All of these features can be masked by stronger but variable wind-driven currents on a day-to-day basis, and may be drastically altered for periods of several weeks. Alterations are more common during the summer, when there may be sustained periods of strong southerly winds (Hansen, 1977).

GEOLOGICAL CONDITIONS

The Continental Shelf surface of the New York Bight is a vast, sandy plain, underlain by clay (Emery and Schlee, 1963; Milliman et al., 1972). While sand is the most abundant textural component on the Shelf, significant deposits of gravel and mud are also present. Sediments at the Acid Site are 96 to 98% sand and gravel with the remainder being silt. The site is at the edge of the Hudson Canyon where the predominant sediments are silts and clays.

Suspended particulate matter (SPM) includes fine material from natural and man-made sources. SPM may be transported for some distance by waves and currents before sinking to the bottom, and may be resuspended by bottom currents and transported to another area. SPM can cause several adverse environmental effects: higher levels of this material can increase turbidity, in turn decreasing the depth light penetrates in water, thereby limiting the depth at which plants can photosynthesize and the amount of primary production in the ocean. Suspended particulates can be toxic or can bind or adsorb toxic materials which are eventually carried to the bottom. While suspended in water or lying on the bottom, the toxic material can be consumed by marine organisms.

The Acid Site has concentrations of SPM typical of other Apex areas and higher than areas further offshore. Acid-iron waste does contribute to the elevated levels of SPM in the Apex; the ferric hydroxide floc forming after waste release remains in suspension for many hours. Additional significant sources of SPM to the Apex are material from other ocean disposal sites (Dredge Material, Cellar Dirt, and Sewage Sludge Sites), atmospheric fallout, and outflow from New York Harbor through the Sandy Hook-Rockaway Point Transect. SPM, however, is not a major environmental problem in the Bight. After considering the effects from all sources, Pararas-Carayannis (1973) concluded that, "turbidity associated with ocean dumping does not appear to have an adverse lasting effect on the sediment and water quality of the Bight."

CHEMICAL CONDITIONS

The coastal metropolitan area is the primary source of heavy metals entering the New York Bight (Benninger et al., 1975; Carmody et al., 1973). The concentrations of dissolved heavy metals in the water of the New York Bight vary seasonally. Background (natural) concentrations however, are generally higher than those reported for the open ocean (Brewer, 1975). Heavy m tal concentrations in bottom sediments are not uniformly distributed throughout the Apex; elevated levels of metals in the sediments of the Bight are associated with Hudson Canyon, and the Dredged Material and Sewage Sludge Sites. Levels of iron (the most abundant waste constituent) were similar at the Acid Site and a control area, but were half the level of metals in samples from the Hudson Canyon. Although some material may reach the bottom during unstratified (winter) conditions, there is no indication of a buildup of contaminants from acid waste in the sediments.

Surface values of dissolved oxygen are usually at or near saturation levels. Below the seasonal thermocline, saturation may fall to 30% in the vicinity of the Sewage Sludge Site (O'Connor et al., 1977). There is no indication of abnormally depressed oxygen levels near the Acid Site. Levels of trace metals in the water are higher than in samples from the outer Bight, but there are no indications of consistently higher levels near the ocean disposal sites (Segar and Contillo, 1976). Acid waste disposal only causes short-term perturbations in the water. Since the flushing time for the entire Apex of the Bight is 6 to 14 days, the waste is being continually diluted and transported from the region.

Particulate organic carbon, which may act as a transport agent for toxic substances, has the highest concentrations near areas of wastewater discharge (outfalls) and the Sewage Sludge and Dredged Material Sites. No comprehensive studies of chlorinated hydrocarbons in the New York Bight have been made, but dredged material and sewage sludge disposal are probably the major sources of these materials (EPA, March 25, 1975; Raytheon, 1975a, 1975b; West et al., 1976).

BIOLOGICAL CONDITIONS

During most of the year, the ranges of daily phytoplankton production for inshore and offshore areas of the New York Bight do not differ significantly from one another. Total annual production, however, is higher in coastal waters.

Phytoplankton populations are dominated by diatoms in cold months, and by chlorophytes during warm months, in the Hudson River estuary and Apex, and by diatoms year-round in the outer Bight. Zooplankton populations are dominated by copepods and larvae of vertebrates and invertebrates (summer only) in the estuary, and by copepods in the outer Bight. However, the high degree of spatial and temporal variation inherent in plankton populations makes studies of their abundance, composition, and distribution extremely difficult. Even though plankton have been studied for about 75 years, the data are insufficient to assess the effects of man's activities on plankton populations in the Bight (Malone, 1977).

Many finfish of commercial and recreational importance are found in the New York Bight. Their diversity and abundance are due to the geographical location of the Bight which is the northern limit of tropical and subtropical migrants and the southern limit of boreal migrants (Grosslein, 1976). Some species are found inshore, others offshore, and some migrate from inshore to offshore. However, because of wide seasonal fluctuations in the Bight (especially temperature, which ranges from 2°C in the winter to 25°C in the summer), the important fish species are migratory, and not unique to the Apex of the Bight.

There is a rich mixture of species in the Bight, with each species occupying wide areas over the Shelf. Eggs, larval stages, and immature forms can be found all year round throughout the area. Since spawning and larval growth usually spreads over a broad geographic area, it is difficult to assess man's effects on the stock. Grosslein indicated that there are no Shelf areas free from potential changes induced by waste disposal activities.

Commercial fishing activities are minor around the Acid Site. A seasonal whiting fishery exists north of the site along the edge of the Hudson Shelf Valley during the winter, and lobster are taken inshore from the site. Most of the Bight Apex is closed to shellfishing because of contamination. For commercially important shellfish, some species are evenly distributed over the Bight, while others, such as the sea scallop, show a more patchy distribution (Figure 3-2).

The inshore benthic fauna are dominated by organisms characteristic of a high-energy coastal marine environment; bivalves Tellina agilis and Spisula solidissima, and the sand dollar, Echinarachnus parma (Pearce, 1972). Benthic

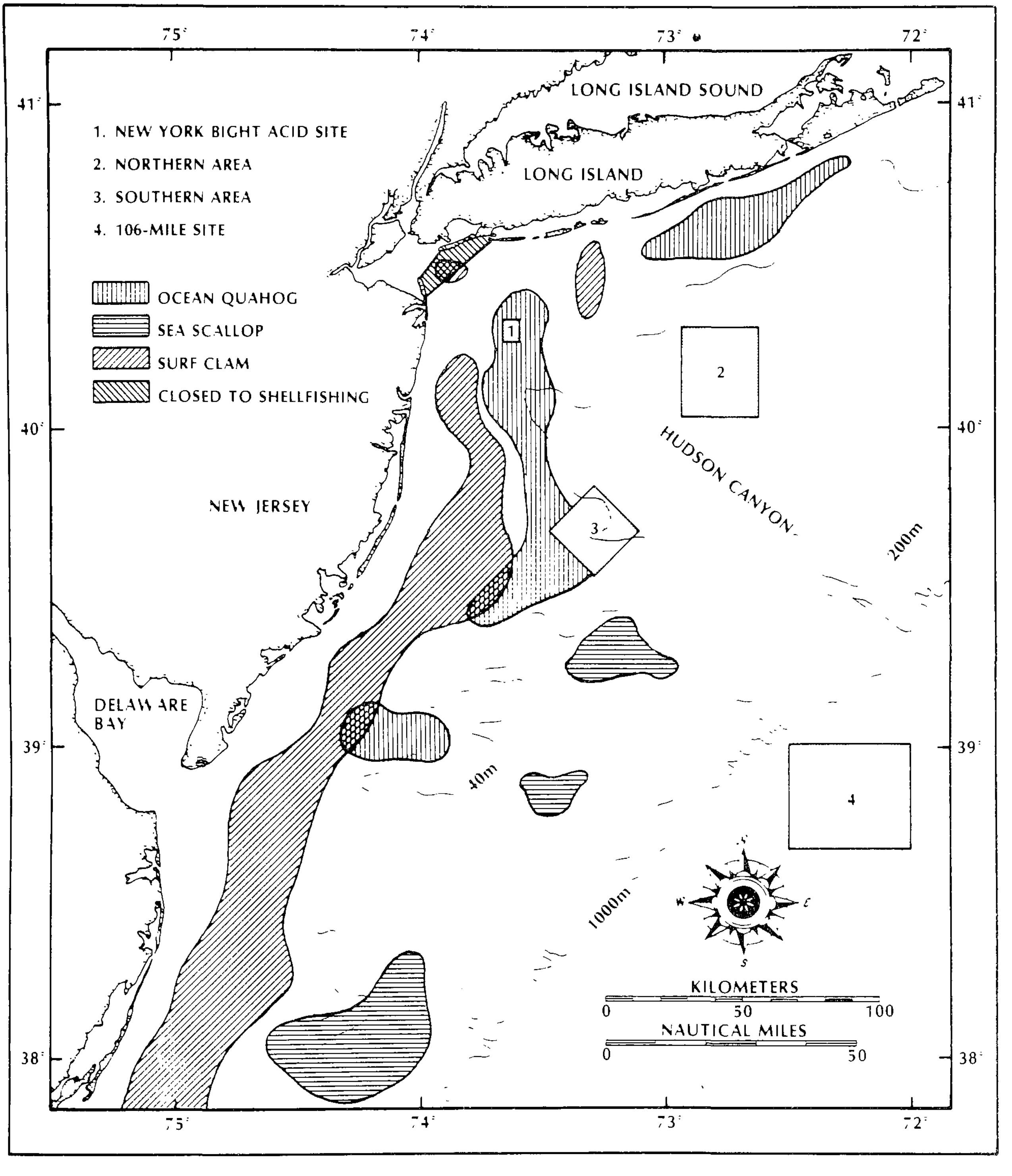

Figure 3-2. Distribution of Surf Clams, Ocean Quahogs, and Sea Scallops in the New York Bight (NOAA-NMFS, 1974c)

populations in the Bight are not static and substantial annual changes occur due to natural causes. The benthic fauna change from a sand bottom assemblage to silty-sand and then silty-clay fauna further offshore in the Bight (Figure 3-3).

WASTE DISPOSAL AT THE NEW YORK BIGHT ACID WASTE DISPOSAL SITE

The Acid Site was established in 1948 for disposal of aqueous waste produced by industries in the New Jersey and New York areas. The site location was specifically chosen to avoid conflict with fisheries. The Interim Site, established by EPA in 1973, is bounded by 40°16'N to 40°20'N and 73°36'W to 73°40'W. Waste disposal at the site is discussed in detail in Appendix D, and summarized below.

RECENT WASTE DISPOSAL ACTIVITIES

Two permittees: NL Industries, Inc., and Allied Chemical Corp. are now (1979) using the Acid Site. NL Industries liquid waste material consists of approximately 8.5% (by weight) sulfuric acid (H_2SO_4) and 10% (by weight) ferrous sulfate ($FeSO_4$) dissolved in fresh water. Insoluble materials (e.g., silica and unrecovered titanium dioxide) are present in the waste. When the waste is discharged, the ferrous sulfate colors the water light green. The barge's wake then turns brown as the ferrous iron is oxidized to form ferric hydroxide (rust). NL Industries' waste represented 97% of the total amount discharged at the site between 1975 and 1978.

Allied Chemical's waste material consists of approximately 30% by volume hydrochloric acid (HCl), 2% by volume hydrofluoric acid (HF), and trace constituents in aqueous solution. Allied Chemical wastes represented 3% of the total material released at the Acid Site between 1975 and 1978.

WASTE CHARACTERISTICS

Several studies have shown that the acid wastes do not remain together as a cohesive mass but are diluted rapidly after discharge. Redfield and Walford (1951) reported that the maximum volume of water having an acid reaction was

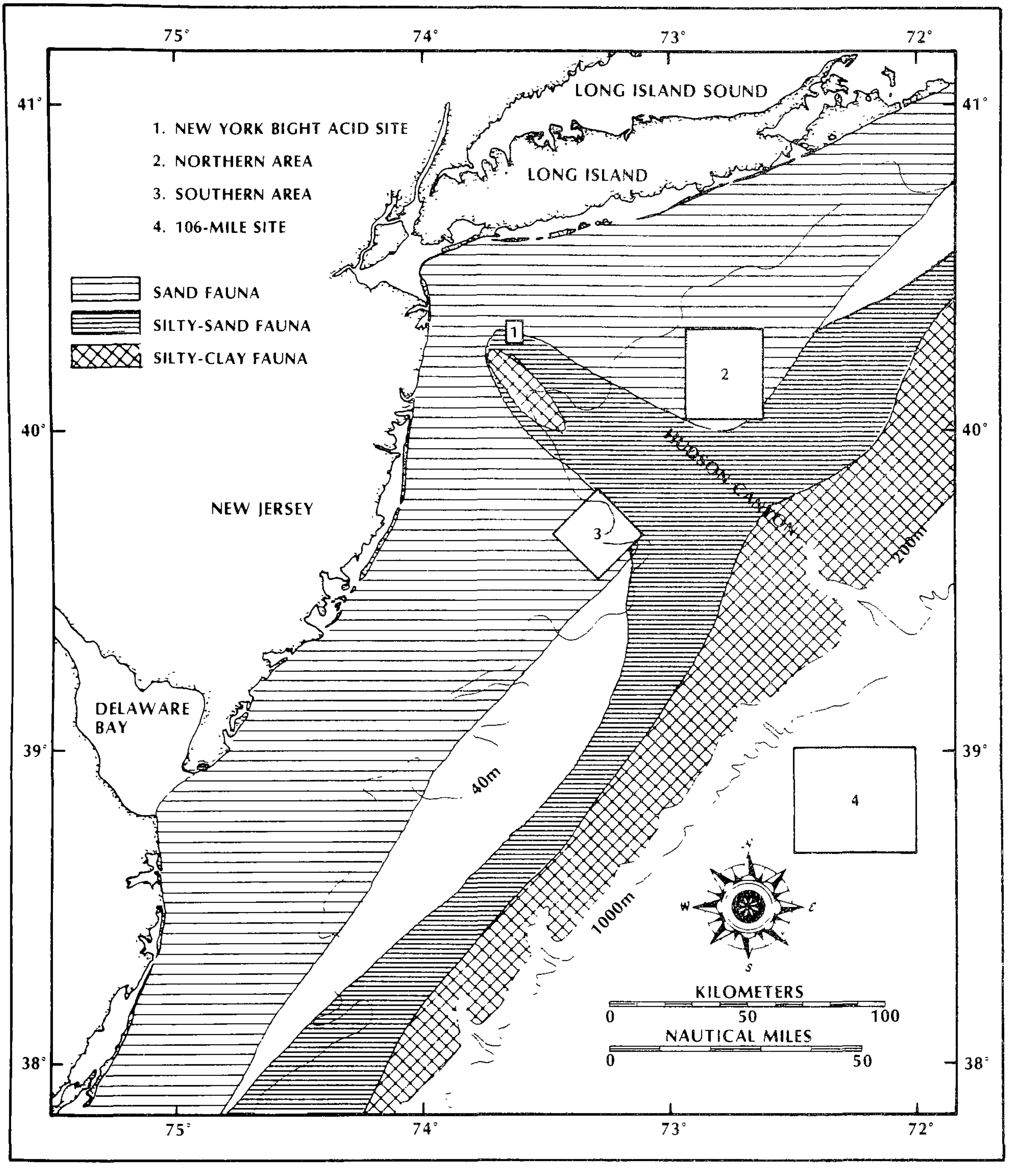

Figure 3-3. Benthic Faunal Types in the mid-Atlantic Bight (Pratt, 1973)

162,000 m^3 (640 m long, 23 m wide, and 11 m deep); the acid was neutralized within 3-1/2 minutes after discharge. They calculated that at discharge, the sulfuric acid would be immediately diluted to 0.02 µg/l and the seawater pH would not fall below 4.5. The actual pH depression observed 2 minutes after discharge was only 1.3 pH units (from 8.2 to 6.9).

Trace metals in acid waste are insignificant sources of contaminants to the Bight Apex. In all cases, the acid wastes contribute less than 1% of the total input and usually much less than the input from atmospheric fallout (Figure 3-4).

EFFECT ON ORGANISMS

Before ocean dumping was regulated by the EPA, numerous laboratory and field toxicity studies had been performed on the wastes dumped at the Acid Site. Observations of minor effects were reported by Redfield and Walford (1951), PHSSEC (1960), Ketchum et al. (1958a,b), Vaccaro et al. (1972), Wiebe et al. (1973), Grice et al. (1973), and Gibson (1973). In contrast, the NMFS-Sandy Hook Laboratory (1972) reported severe effects due to acid waste disposal; however, the NMFS method and conclusions were criticized by Buzas et al. (1972).

A variety of phytoplankters and zooplankters have been collected in the wake of an acid waste discharge. Animals may be immobilized immediately after disposal, but recover quickly when the waste is diluted with an equal volume of seawater. The gastrointestinal tracts of copepods and ctenophores collected at the site after a discharge were full of iron particles from the waste, but the animals did not appear to show ill effects.

Laboratory work indicated that phytoplankton were unaffected by a concentration of acid waste four times higher than concentrations observed in the field. Zooplankton were chronically affected by concentrations of one part waste in 10,000 parts seawater. Reproduction was impaired and development slowed over an 18-day period. These results, however, are not biologically important since this concentration of waste only persists for a few minutes after disposal. When the toxicity of neutralized acid waste and the toxicity

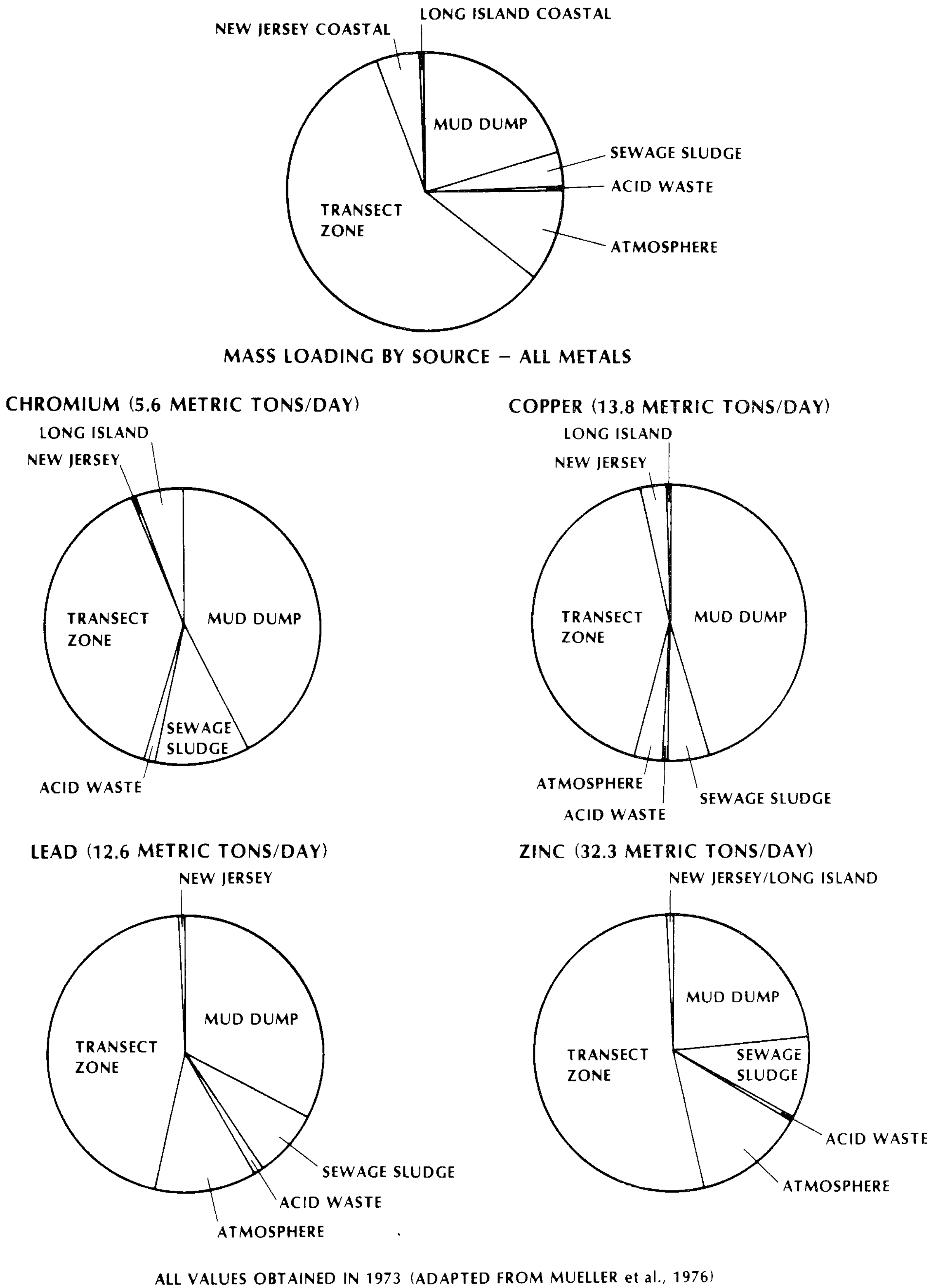

Figure 3-4. Inputs of Metals to the New York Bight
(Adapted from Mueller et al., 1976)

of the pH change were determined, the pH change appeared to cause lethal effects rather than the toxic elements in the waste. Neutralized acid waste was not toxic to test organisms.

When the site was first established (1948), there was controversy over possible effects on the migratory fish in the New York Bight. NL Industries sponsored the first comprehensive studies of the effects of acid-iron waste which concluded (Redfield and Walford, 1951), that there was no conflict between the waste disposal operations and sportfishing activities in the Bight Apex. Since this work, Westman has periodically surveyed the site and other fishing areas in the Bight (Westman, 1958, 1967, 1969; Westman et al., 1961), and concluded that bluefish and yellowfin tuna were attracted to the site, and that an active pelagic fishery had begun in the area. He did not observe adverse effects caused by the waste dispossal.

The waste does not appear to be toxic to the bottom-dwelling animals (benthos). The site supports a typical sand-bottom community; the biomass and species diversity are comparable to a control area (Vaccaro et al., 1972) although the number of animals is significantly less. Other investigators (Westman, 1967, 1969; NMFS, 1972) have reported anomalous benthic conditions at the site. Recent samples (Pearce et al., 1976a,b, 1977) showed that there were wide natural variations at stations in and around the site. Such variability is common for sand-bottom assemblages of animals.

CONCURRENT AND FUTURE STUDIES

Scientific Investigations of the Area

The NOAA-MESA program is responsible for identifying and measuring the impact of man on the marine environment of the New York Bight and its resources. This program began in 1973 and is scheduled to end in 1981. After that date, a smaller monitoring program will be maintained to provide the data necessary for management decisions about use of the resources in the Bight. The MESA project has sponsored and conducted numerous investigations of all the oceanographic features of the Bight; these data provided much of the information used in the EIS.

The Sandy Hook Laboratory (SHL) of the National Marine Fisheries Service (NMFS) conducts continuous studies of the area, primarily with respect to man's impact on commercial fish and shellfish resources. Their Ocean Pulse Program is designed to monitor and assess the health of the ocean's living resources on the Continental Shelf of the Northwest Atlantic Ocean. This program includes the study of effects of pollutants on important marine species.

Area-Wide Planning

The Interstate Sanitation Commission (ISC) conducts research, monitoring, and regulation activities in the New York-New Jersey area. They are primarily concerned with monitoring water quality and verifying compliance with existing interstate regulations by sanitary waste dischargers. The ISC is developing a combined management plan for municipal waste and have begun to monitor air quality in the New York Bight. Although this work is not directly pertinent to the Acid Site, it is close enough to the site to produce important information for evaluating effects of acid wastes on the marine environment.

Monitoring

The EPA Region II requires permittees to monitor the respective sites to determine if disposal operations have a short-term adverse impact. Monitoring surveys are made at the Acid Site once a year (1979) and at the Sewage Sludge Site daily during the summer. Monitoring plans have been developed for the Cellar Dirt Site and are being developed for the Dredged Material Sites.

OTHER ACTIVITIES IN THE SITE VICINITY

COMMERCIAL FISHERIES

Extensive fin- and shellfishing activities are conducted in the New York Bight. Most of the finfish grounds lie over the inner Continental Shelf or near the edge of the Shelf. Most species of shellfish are found throughout the Bight, while others, such as lobster, are most abundant nearshore in the Hudson Canyon or at the edge of the Continental Shelf.

DOMESTIC FISHERIES

Table 3-1 shows the total yield and dollar value in 1974 for the five major species of commercial finfish in the New York Bight. Although the stock of most commercial species is still substantial, there has been a general decline in annual yields of finfish over the last two decades (Figure 3-5), with commercial landings of over-fished species (e.g., menhaden) declining. The yield of the domestic shellfishery has greatly increased since 1960 (Figure 3-6) with the developing surf clam fishery. While surf clams are becoming increasingly scarce, other shellfish species have only recently begun to be exploited (e.g., red crab), and potential resources still exist, such as ocean quahog. Table 3-2 shows the total annual values in 1974 and 1976 for the more important shellfish species. The American lobster is the most important species fished in the Continental Slope area, and is becoming the most important fishery resource of the New York Bight (Chenoweth, 1976).

FOREIGN FISHERIES

Nearly all foreign fishing in the north and mid-Atlantic region of the United States is in the Continental Shelf area, vessels being mainly concentrated in the outer Shelf region south of Georges Bank (Figure 3-7). Peak foreign fishing activity in the New York Bight occurs during spring and early summer when the fleet moves south from the winter fishing grounds on the Georges Bank. An average of 1,000 foreign vessels fish along the mid-Atlantic coast annually (Ginter, 1978). Foreign fishing in the New York Bight is dominated by the Soviet Union, followed by East Germany, Spain, and Japan. Major foreign fisheries are herring, silver and red hake, and mackerel. The seasonal migrations of these species account for the north-to-south movement of the foreign fleet throughout the year. Recently, fishing efforts have also been directed towards squid, butterfish, tuna, and saury.

TABLE 3-1. TOTAL LANDINGS IN 1974 OF FIVE MAJOR COMMERCIAL FINFISHES IN THE NEW YORK BIGHT

Species	New York		New Jersey		Total	
	000 lb	$000	000 lb	$000	000 lb	$000
Fluke	2,487	846	3,499	1,153	5,986	1,999
Menhaden	576	18	107,307	2,735	107,883	2,753
Scup	3,635	832	6,040	880	9,675	1,712
Striped Bass	1,409	533	714	177	2,123	710
Whiting	1,955	250	7,022	587	8,977	837

Source: Adapted from NOAA-NMFS, 1977

Table 3-2. TOTAL COMMERCIAL LANDINGS IN 1974 AND 1976 OF IMPORTANT SHELLFISH SPECIES IN THE NEW YORK BIGHT (NEW YORK-NEW JERSEY)

Species	1974		1976	
	000 Lb	$000	000 Lb	$000
American Lobster	1,922	3,312	1,117	2,368
Hard Clams	9,769	15,164	10,072	19,396
Surf Clams	26,608	3,667	9,493	3,299
Oysters	2,563	4,778	2,256	5,642
Sea Scallops	1,228	1,689	1,953	3,170
Blue Crabs	2,864	725	407	123

Source: From NOAA-NMFS, 1977a, 1977b

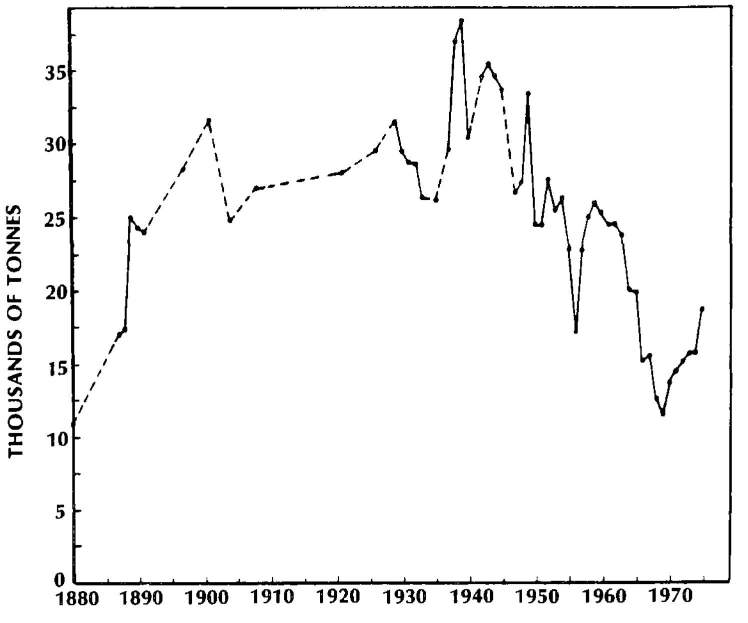

Figure 3-5. Total Landings of Commercial Marine Food Finfishes in the New York Bight Area, 1880-1975 (From McHugh and Ginter, 1978)

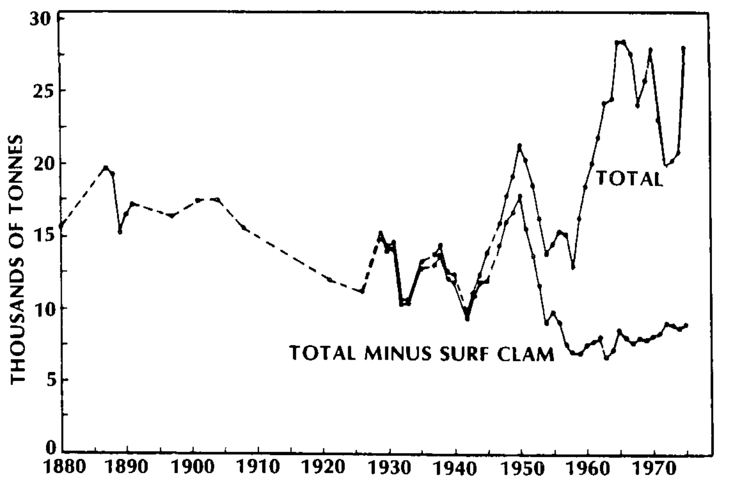

Figure 3-6. Total Commercial Landings of Marine Food Shellfishes in the New York Bight Area, 1880-1975 (From McHugh and Ginter, 1978)

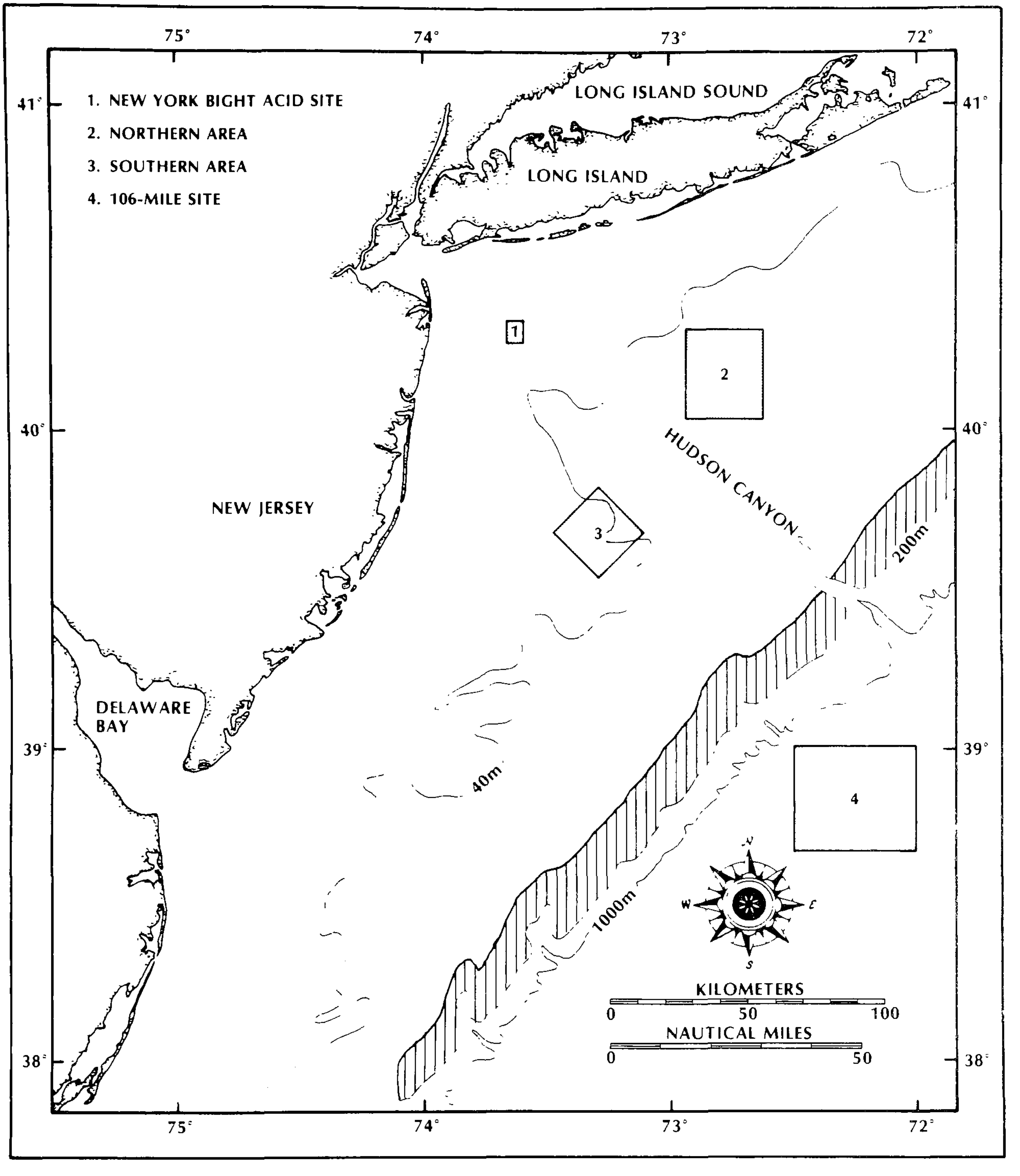

Figure 3-7. Location of Foreign Fishing off the East Coast of the U.S. (Adapted from McHugh and Ginter, 1978)

RECREATIONAL FISHERIES

The majority of recreational fishing in the New York Bight is confined to the inner Shelf Waters, which is most accessible to the public, and more sport species are found there than in the outer Bight (Chenoweth, 1976). The important species are striped bass, weakfish, bluefish, and mackerel. Recreational species fished further offshore are bluefin tuna, marlin, and swordfish. The sport catch often equals or surpasses the commercial landings of certain species (e.g., striped bass) and significantly contributes to the economics of several coastal areas. In 1970, 1.7 million anglers caught 1.3 million kilograms (2.7 million pounds) of fish from the North Atlantic coast.

SAND AND GRAVEL MINING

Sanko (1975) states that "sand deposits in the Lower Bay of New York Harbor have been the largest single source of commercial sand for the New York City metropolitan area since 1963." Although this is the only area in the New York Bight where sand is presently mined, recent geological surveys show that sand could be mined nearly anywhere in the New York Bight, with current technology limiting the outer boundary to the 50 m (165 ft) isobath.

There is an estimated area of over 2,680 km^2 (777.2 nmi^2) suitable for sand mining between the 50 m isobath and the Long Island shoreline (Schlee, 1975). Most of this sand is of uniform grain-size and contains a low percentage of fine particles. Gravel deposits in the New York Bight are much more limited than sand. Potential mining areas for gravel are few, mainly off the northern coast of New Jersey (Figure 3-8).

OIL AND GAS DEVELOPMENT

No existing or planned oil and gas lease tracts are located in any interim or designated ocean disposal site. Figure 3-9 is an EPA (1978a) summary of oil and gas development in the New York Bight.

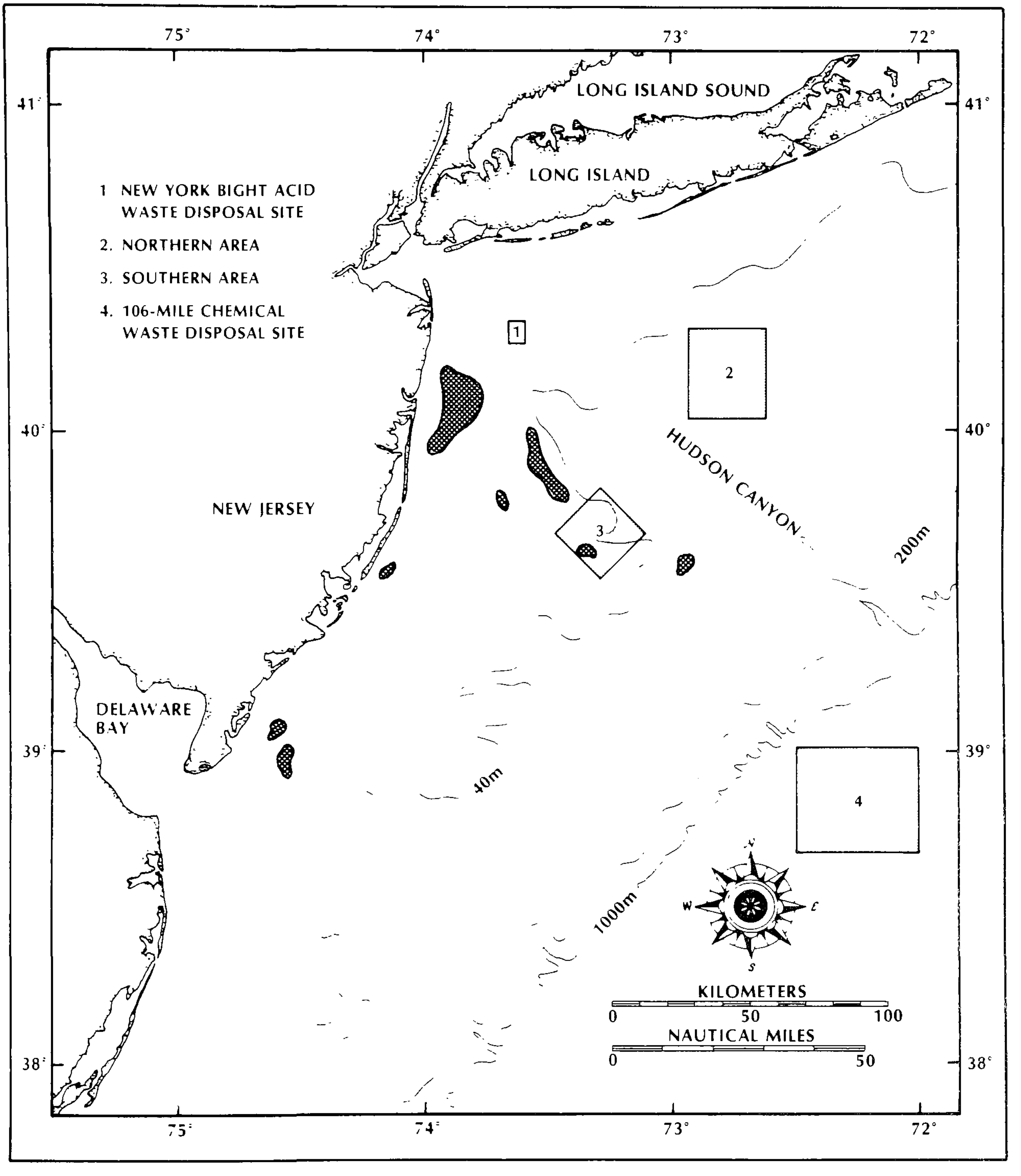

Figure 3-8. Gravel Distribution in the New York Bight (Schlee, 1975)

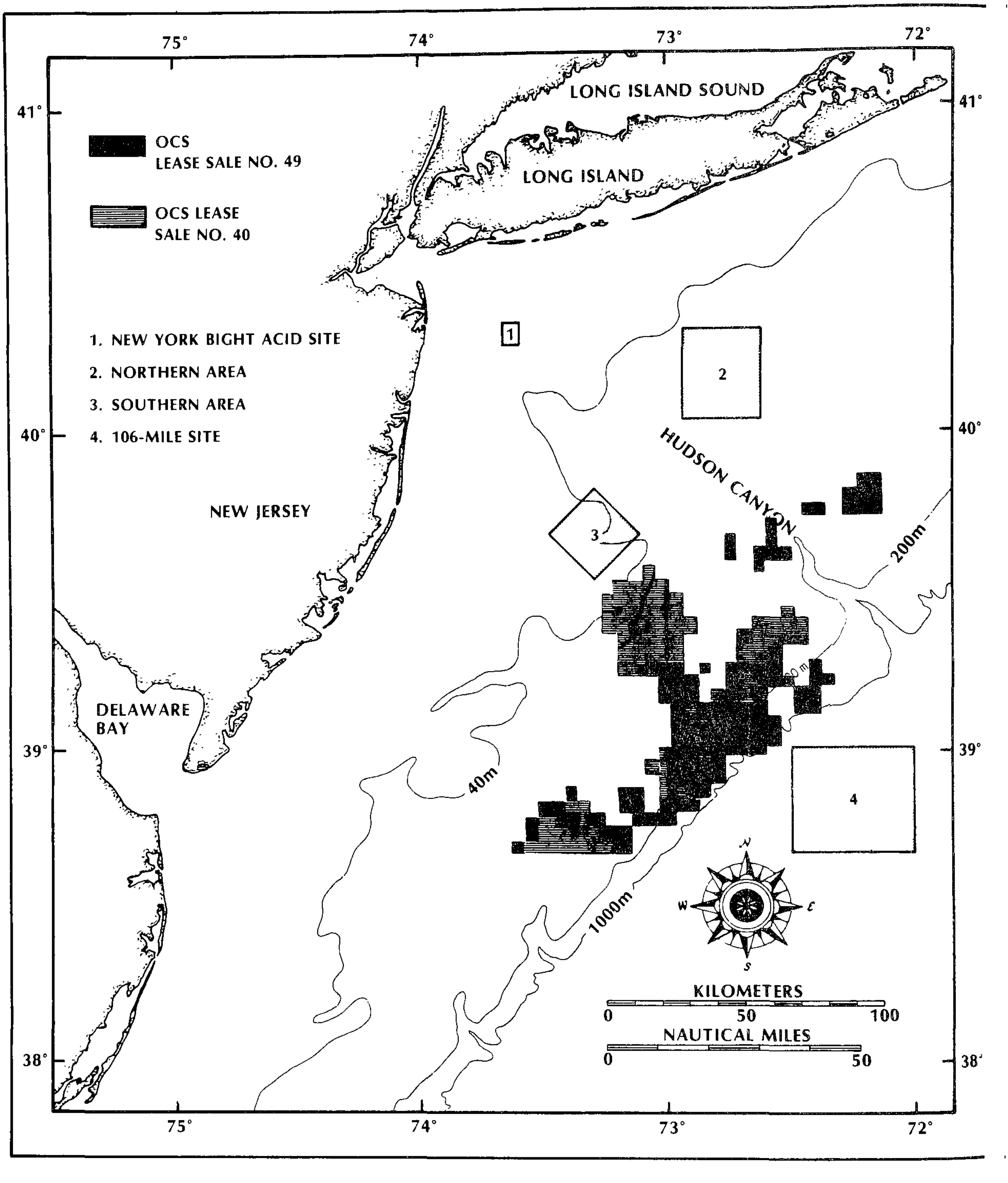

Figure 3-9. Oil and Gas Leases in the mid-Atlantic Bight
(Adapted from EPA, 1978a)

The U.S. Department of the Interior's Bureau of Land Management (BLM) completed its first sale of oil and gas leases in the mid-Atlantic Baltimore Canyon trough in August 1976 (Outer Continental Shelf [OCS] Sale No. 40). Exploratory drilling at 6 of the 93 tracts leased in OCS Sale No. 40 began in the spring and summer of 1978. On May 19, 1978, BLM published a draft EIS on the OCS Sale No. 49, including most of the Baltimore Canyon trough. Sale No. 49 was held in May 1979. A third sale (No. 59) is under consideration and is tentatively scheduled for August 1981 (BLM, 1978).

SHIPPING

The major trade routes identified by NOAA, (TRIGOM, 1976) to serve the New York-New Jersey area coincide with the three traffic lanes into New York Harbor: the Nantucket, Hudson Canyon and Barnegat Traffic Lanes (Figure 3-10). Barnegat Lane lies across the Acid Site, and the other lanes straddle the Northern and Southern Areas.

OCEAN WASTE DISPOSAL

The EPA (1979) permits municipal or industrial waste disposal at six locations in the New York Bight, and the CE permits dredged material disposal at other sites (Figure 3-11). This section briefly describes activities at the six sites, but not the Acid Site (Figure 3-11, #4).

SEWAGE SLUDGE SITE

Sewage sludge is composed of residual municipal sewage solids from primary and secondary treatment plants. The present sewage sludge site was established in 1924 (Figure 3-11, #5). There are 25 permittees currently (1979) disposing of sewage sludge at this site, with the City of New York discharging more than any other permittee. The total volume of sewage sludge to be discharged in 1979 is estimated to be 7,770 m^3 and is predicted to be 9,890 m^3 in 1981.

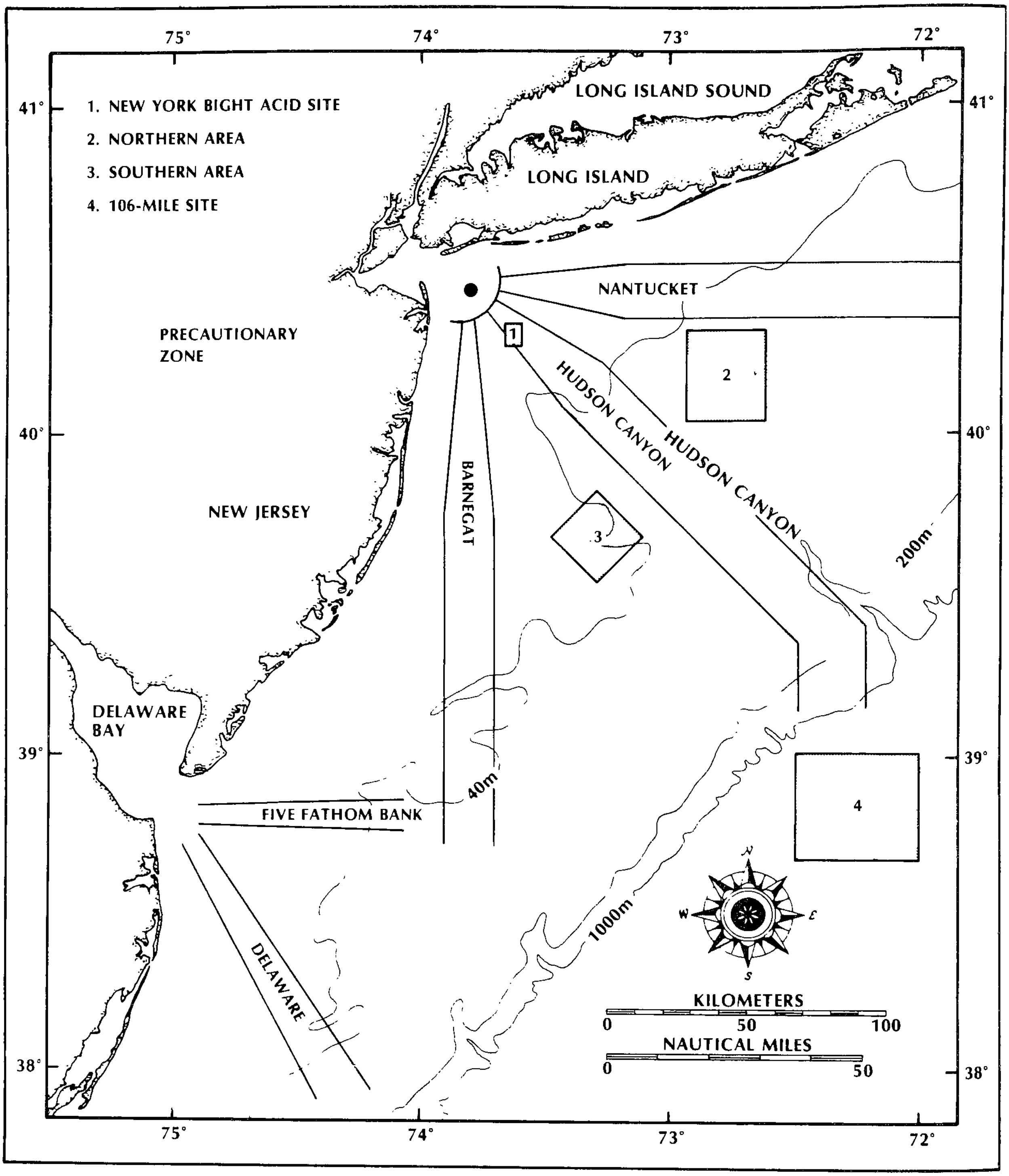

Figure 3-10. Traffic Lanes in the mid-Atlantic Area

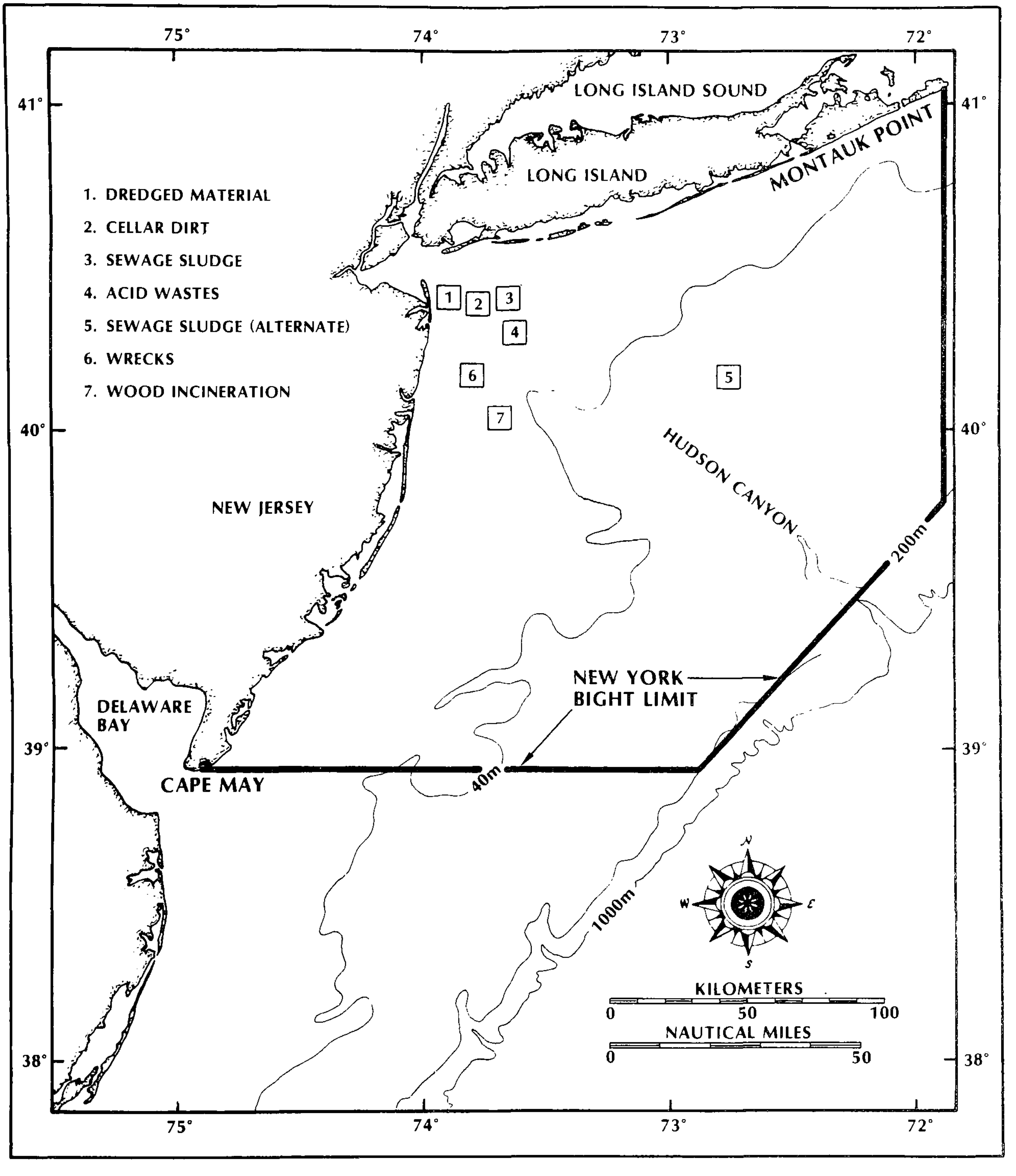

Figure 3-11. Ocean Disposal Sites in the New York Bight

The alternate sewage sludge site (Figure 3-11, #5) was designated in 1979 for use if the existing site cannot handle the increased volumes of sludge before ocean disposal ends in 1981. No sludge has yet been released at this site.

DREDGED MATERIAL SITE

Several sites have been used for the disposal of material dredged from navigable waterways in the New York-New Jersey Metropolitan area. Use of the present site (Figure 3-11, #1) began in 1940. Until 1973, fly ash residues from fossil-fueled power plants were released at the site.

Each year, the volume of dredged material exceeds that of any other waste. The average annual volume of dredged material for the period 1960 to 1977 was approximately 6 million m^3. The annual volume is estimated to increase by another 46,000 to 54,000 m^3. Some dredged material is contaminated because particulate solids carried in the Hudson River settle in the harbor.

Other dredged material sites exist just outside the inlets along the Long Island and New Jersey shoreline (not shown in Figure 3-11). Much lower volumes of sediment are released at these sites and this material is relatively uncontaminated sand.

CELLAR DIRT SITE

The Cellar Dirt Site (Figure 3-11, #2) has been relocated several times to prevent excessive moundings of the waste. The site has occupied its present location since 1940. Inert materials from land-based construction projects (demolition wastes), including excavated earth, broken concrete, rock, and other nonfloatable materials, are dumped at the site. The average annual volume of cellar dirt released at the site from 1960 to 1977 was 450,000 m^3. The annual volume will fluctuate from year to year according to the activity of the construction industry and the availability of alternate disposal methods.

WRECK SITE

The Wreck Site (Figure 3-11, #6) has been designated by the EPA for derelict and wrecked vessels. The site has been used infrequently since 1962, and in 1977 was moved slightly to avoid interference with shipping.

WOOD INCINERATION SITE

The EPA has designated the Wood Incineration Site (Figure 3-11, #7) for burning and disposal of scrap wood from harbor debris, pier pilings, and waterfront construction sites. The site is used as needed and only the combustion products reach the ocean. The remaining ash is buried in sanitary landfills.

MARINE RECREATION

The shorelines of Long Island and northern New Jersey support an estimated $2-billion per year beach industry (Interstate Electronics Corporation, 1973). The popularity of the low, sandy beaches is due to their quality and accessibility. Beach property in the New York-New Jersey metropolitan area is both publicly and privately owned. In the metropolitan area, the 1976 beach attendance, at state and national parks alone, was over 20 million (Table 3-3).

ALTERNATIVE SITE OFF THE CONTINENTAL SHELF - 106 MILE CHEMICAL WASTE SITE

SITE ENVIRONMENT

The 106-Mile Chemical Waste Disposal Site (Figure 3-12) is in an area typical of the Atlantic Continental Slope and upper Continental Rise. The physical and chemical characteristics of the site are highly complex, with great, natural variability. The sediments and benthic biota are typical of deep-water, silt-sand sediments. Although disposal of chemical wastes began at the site in 1961, measurable changes caused by the wastes have not occurred.

TABLE 3-3. BEACH ATTENDANCE AT STATE AND NATIONAL PARKS IN THE NEW YORK-NEW JERSEY METROPOLITAN AREA 1976

Park	Attendance
Island Beach State Park, N.J.*	194,223
Gateway National Recreation Area	
Breezy Point, N.Y. (Jacob Riis State Park)+	3,800,000
Sandy Hook, N.J.+	2,000,000
Staten Island, N.Y.+	1,240,000
Smith Point Co. Park, Fire Island, N.Y.**	735,256
Robert Moses State Park, Fire Island, N.Y.**	2,122,200
Captree State Park, Long Island, N.Y.++	500,000
Fire Island National Seashore, N.Y.**	702,194
Fire Island "Other," N.Y.***	2,301,000
Jones Beach State Park, N.Y.++	7,000,000
Total	20,594,873

Sources:
* New Jersey Department of Environmental Protection, Bureau of Parks, 1978.
+ National Park Service, May 1978.
** Fire Island National Seashore Headquarters, 1978.
++ Long Island State Parks and Recreation Commission Headquarters, June 1978.
*** National Park Service, 1975.

PHYSICAL CONDITIONS

The site is located within the influence of the Gulf Stream and three different water masses (Shelf Water, Slope Water, Gulf Stream Water), each having distinctive physical, chemical, and biological characteristics, which may be present in the site.

Slope Water normally occupies the site; however, when the Shelf/Slope ocean front migrates eastward, Shelf Water of equal or lower salinity and temperature mixes with Slope Water. The differing densities of the water masses causes formation of separate layers. Therefore, the mixing of waters at the site can be quite complex, influenced by highly unpredictable factors and normal seasonal changes (Warsh, 1975).

Occasionally, warm-core rings of water (called eddies) break off from the Gulf Stream and migrate through the site, entraining Gulf Stream water or warm Sargasso Sea water. Both are of higher temperature and salinity than Slope

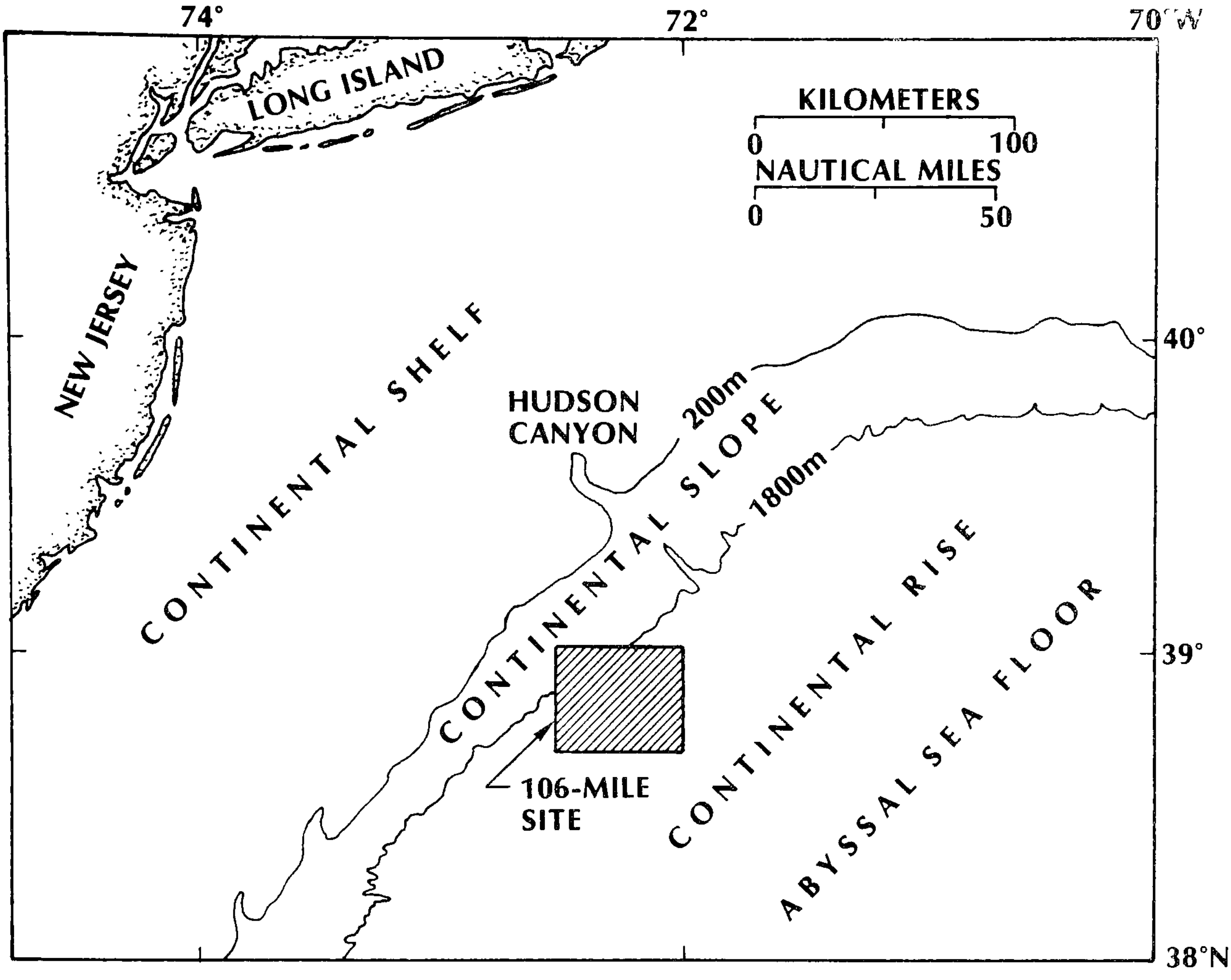

Figure 3-12. Location of the 106-Mile Site

Water. Eddies do not pass through the site on a seasonal basis; they occupy part or all of the site about 70 days a year (Bisagni, 1976).

As the surface waters of the site warm in late spring, they stratify within the top 10 to 50 m forming layers of water with differing temperatures, salinities, and densities. This stratification (thermocline), which can occur within one water mass without any mixing with another water mass, persists until September/October, when cooling and storm activity destroy it. From autumn to early spring, the temperature of the water column is the same from the surface to a depth of approximately 200 m. At 200-m depth, however, a permanent stratification exists. Deeper water always has a lower temperature. These characteristics are important because they greatly influence the ultimate fate of liquid waste discharges.

Although few ocean-current measurements (1979) exist for the site, the literature indicates that water at all depths in this area tends to flow southwest, generally following the boundary of the Continental Shelf and Continental Slope (Warsh, 1975). Changes in the direction of flow are usually associated with Gulf Stream eddies. The flow direction may change even in deep water. Water motion is important because it provides information as to the directions waste discharges may follow.

The physical and chemical characteristics of the site cause biological complexity because each water mass possesses characteristic associations of plants and animals.

GEOLOGICAL CONDITIONS

The Continental Slope within the disposal area has a gentle (4 percent) grade, leveling off (1 percent) outside the site, in the region of the upper Continental Rise. Sediments within the site are principally sand and silt, with silts predominating (Pearce et al., 1975). The sediment composition is an important factor which determines the types of animals found in an area. Generally, greater diversity and abundance of fauna is associated with finer sediments (e.g., silt), although unusual physical conditions will alter this. Fine-grained sediments commonly have higher concentrations of heavy metals. Sand, gravel, and rocky bottoms rarely contain such elements in high concentrations.

Continental Slope sediments across the site are subject to different dynamic forces; the upper Continental Rise is an area of tranquil deposition, and the lower Continental Rise is an area of shifting deposition. Erosional areas (caused by bottom currents) lie between these two provinces. These different processes would largely determine the ultimate fate of any waste products (probably insignificant) which reach bottom. In areas swept by currents, waste products would be carried out of the disposal site, greatly diluted before being buried. In erosional and shifting depositional areas, the waste material may be temporarily deposited before being moved. In areas of tranquil or slow deposition, waste products would be slowly buried.

CHEMICAL CONDITIONS

Dissolved oxygen concentrations at the 106-Mile Site follow the temperature gradients; the permanent stratification level at 200 m divides the water into upper and lower regimes. The different water densities of these regimes (due to differences in temperatures and salinities) keep the two layers distinctively different, and no mixing occurs. Dissolved oxygen levels decline from surface levels to a natural minimum between 200 to 300 m, then slowly increase with depth. Figure 3-13 illustrates that summer and winter dissolved oxygen gradients are similar, with slightly higher surface concentrations during winter. Acid wastes, which have not caused oxygen depletion problems in the Apex, would not significantly change these natural conditions.

Chemical surveys and monitoring programs at the 106-Mile Site have studied trace metal levels in sediments, water, and selected organisms. Metals in the sediments and water represent contaminants potentially available to site fauna, and may possibly be assimilated (bioaccumulated) and concentrated by them in toxic quantities.

Since metals are naturally present in seawater, only concentrations of metals which exceed natural background levels and approach known or suspected toxic levels threaten the marine fauna or man. The most recent studies of trace metal currents in the water of the 106-Mile Site found near-background levels typical of other Shelf-Slope regions (Kester et al., 1977; Hausknecht and Kester, 1976a, 1976b).

Trace metals in sediments all along the Continental Slope and Rise (including the site area) are elevated in comparison to Continental Shelf values (Greig et al., 1976; Pearce et al., 1975). However, these values are widespread, thus they cannot be attributed to waste disposal activities at the site.

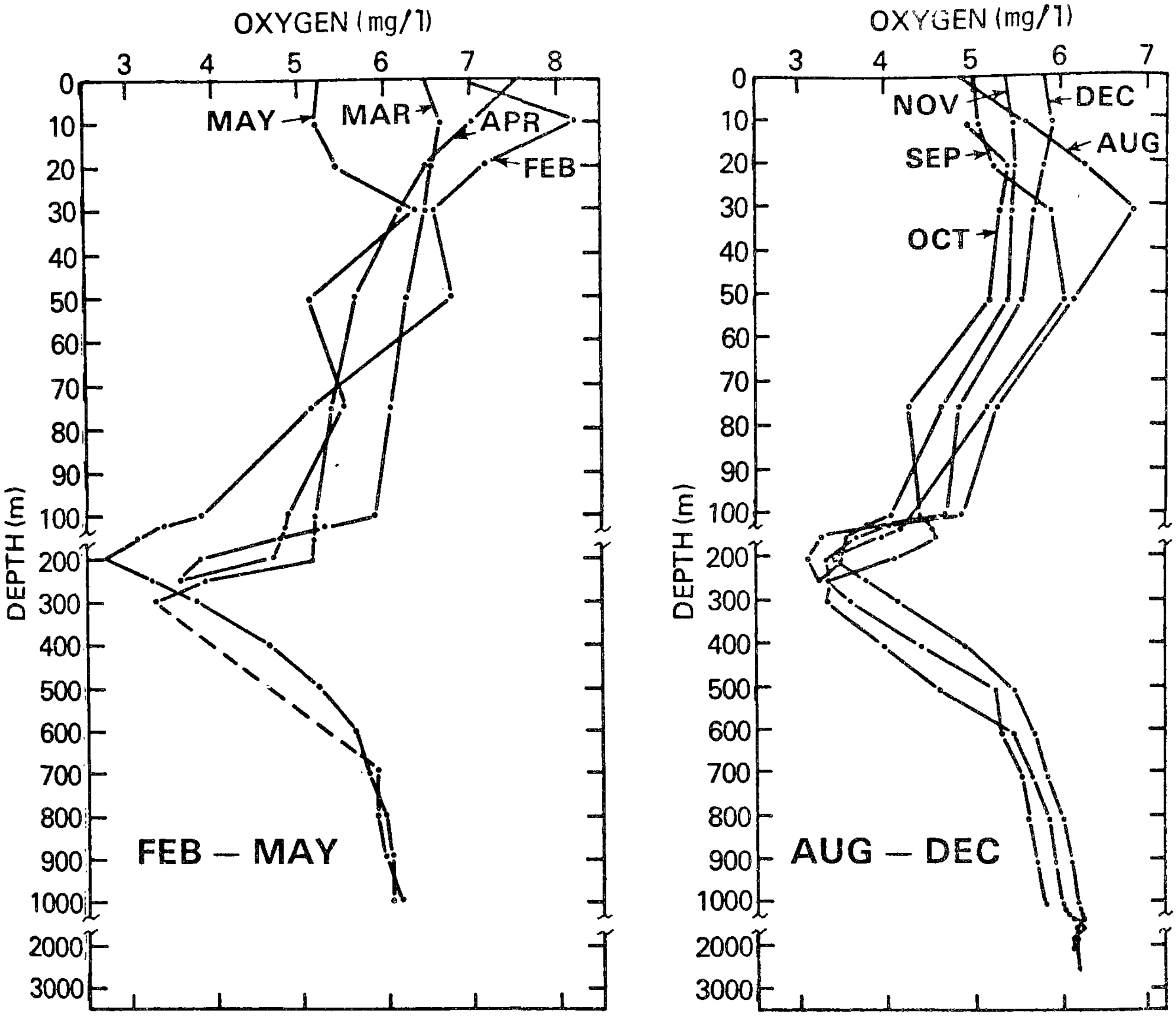

Figure 3-13. Monthly Averages of Oxygen Concentration Versus Depth at the 106-Mile Site (from Warsh, 1975)

Analyses of trace metal concentrations in finfish caught at the site revealed high cadmium levels in three swordfish livers, mercury levels above the Food and Drug Administration action level ("unfit for human consumption") in most fish muscle samples, and low to moderate copper and manganese concentrations, similar to those in New York Bight finfish (Greig and Wenzloff, 1977; Greig et al., 1976). However, since the fish were migratory and transient species, and the levels in benthic organisms were similar over a large area, waste disposal was not suggested as the "cause" of the elevated metal concentrations; other factors were important (Pearce et al., 1975).

BIOLOGICAL CONDITIONS

Plankton are microscopic plants and animals which drift passively with the current or swim weakly. Plankton are divided into plants (phytoplankton) and animals (zooplankton). Since the plankton are the primary source of all food in the ocean, their health and ability to reproduce is of crucial importance to all life in the ocean, including fish and shellfish of commercial importance.

Plankton populations at the 106-Mile Site are highly diverse due to the influence of the Shelf, Slope, and Gulf Stream Water masses. Diatoms dominate in Shelf Waters while coccolithophorids, diatoms, dinoflagellates, and other mixed flagellates are important in the low-nutrient Slope Waters (Hulburt and Jones, 1977). Mixed assemblages of zooplankters (common to the different water masses) occupy the site during winter, spring, and summer (Sherman et al., 1977; Austin, 1975).

Fish have been surveyed at various depths within the site. The diversity and abundance of near surface fish is similar inside and outside the disposal site (Haedrich, 1977). Fish occurring primarily at mid-depths (mesopelagic fish), are dominated by Slope Water species with anticyclonic (clockwise) eddies bringing in some north Sargasso Sea species (Kreuger et al., 1975, 1977; Haedrich, 1977). For some depths, particularly in the lower water column, the density of mesopelagic fish may be lower at the site when compared with nondisposal site areas (Krueger et al., 1977). Several migratory oceanic fish, usually associated with the Gulf Stream, are found in midwater regions of the site. The diversity and abundance of benthic (bottom) fish in the site area are similar to those in other Slope areas (Musick, et al., 1975; Cohen and Pawson, 1977). Fifty-five species have been reported at the site. Numbers of individuals and numbers of species decrease with depth.

At the bottom, the abundance and diversity of invertebrates at the 106-Mile Site are similar to other Slope localities of the mid-Atlantic Bight. Invertebrates living on the surface of the bottom (the epifauna) of the 106-Mile Site are dominated by echinoderms (such as starfish and sea urchins), while segmented worms (polychaetes) are the dominant burrowing organisms.

WASTE DISPOSAL AT THE SITE

PERMITS AND WASTE VOLUMES--1973 to 1978

The 106-Mile Chemical Waste Site was proposed for use in 1965 by the U.S. Fish and Wildlife Service as an alternate to inland discharge of industrial/ chemical wastes which might contaminate potable water supplies. However, chemical wastes were released in the area during 1961, 1962, and 1963. From 1961 to 1978, approximately 4.6 million tonnes of chemical wastes and 400,000 tonnes of sewage sludge were released at this site, an average of 275,300 tonnes per year.

When ocean waste disposal came under EPA regulation in 1973, there were 66 permittees at the site. Since then, the number of permittees has steadily declined until, as of November 1979, only four permittees remain: American Cyanamid (Linden, N.J.), E.I. du Pont de Nemours and Co., Inc. Edge Moor Plant (Edge Moor, Del.) and Grasselli Plant (Linden, N.J.), and Merck & Co. (Rahway, N.J.). The volume of waste released, however, increased from 299,000 tonnes in 1973 to 735,000 tonnes in 1977. The increase was due to four factors: (1) the relocation of industrial waste generators from the Sewage Sludge Site in 1974, (2) Du Pont-Grasselli's move from the Acid Site in 1975, (3) Du Pont-Edge Moor's move from the Delaware Bay Acid Site in 1977, and (4) the relocating by court order, of waste disposal operations of the City of Camden, New Jersey to the site in 1977. Camden, however, contributed only 48,000 tonnes. In 1978, the volume of waste dumped totalled 612,000 tonnes, representing a 16% decrease from the higher volume in 1977. Overall, approximately 80% of the waste discharged from 1973 to 1978 was from three industrial sources: Du Pont-Edge Moor, Du Pont-Grasselli, and American Cyanamid. The actual dumping volumes of each permittee appear in Table 3-4. Table 3-5 shows the projected inputs to the site from 1979 to 1981.

TABLE 3-4. WASTE VOLUMES, 1973 - 1978 AT 106-MILE CHEMICAL WASTE SITE IN THOUSANDS OF TONNES

Permittee	1973	1974	1975	1976	1977	1978	Totals	Average
American Cyanamid Co.	118	137	116	119	130	111	731	122
Camden, N.J.	--	--	--	--	48	54	102	51
Chevron Oil Co.	25	26	22	--	--	--	73	24
Du Pont-Edge Moor	--	--	--	--	380	372	752	376
Du Pont-Grasselli	116	155	264	164	107	172	978	163
Hess Oil Co.	7	--	--	--	--	--	7	7
Mixed Industries*	34	35	78	67	85	72	371	62
Mixed municipalities**	41	93	96	25	16	16	287	48
Totals	341	446	576	375	766	797	3,301	

* Crompton and Knowles, Merck and Co., and Reheis Chemical Co.
** Permittees using New York Bight Sewage Sludge Site (sewage sludge digester cleanout residue).

Source: Data from EPA Region-II permit files

TABLE 3-5. PROJECTED VOLUMES, 1979 - 1980, AT 106-MILE CHEMICAL WASTE SITE (THOUSANDS OF TONNES)

Permittee	Scheduled Phaseout Date	Year		
		1979	1980	1981
American Cyanamid	April 1981	123	123	30
Du Pont-Edge Moor	May 1980	299	136	0
Du Pont-Grasselli	None	295	295	295
Merck	April 1981	36	36	10
Annual totals:		753	590	335

WASTE TYPES AND CONTAMINANTS

The types of wastes, physical characteristics, authorized discharge rate, and dispersion factors are summarized in Table 3-6. The averages and ranges of concentrations of selected trace metals are presented in Table 3-7. Table 3-6 shows that the different wastes have some common characteristics. The wastes are heavier than seawater, although American Cyanamid wastes are almost neutrally buoyant. Minimal dilution after initial mixing ranges from 20,000 to 25,000:1 up to 75,000:1. The authorized discharge rates have been established by EPA-Region II to prevent long-term adverse effects caused by the waste discharges. Comparing the mean and maximal trace metal concentration (Table 3-7) with the minimal dilution factors (Table 3-6) shows that, with few exceptions, even maximal concentrations of waste constituents are diluted well below predischarge ambient levels within 4 hours after a waste disposal operation.

TOXICITY

Periodic toxicity bioassays are required of each permittee at the 106-Mile Site. Table 3-8 summarizes the results for the remaining waste generators. These results show the variability common to tests of this type and probable variability in the toxicity of different bargeloads of waste. The EPA established the discharge rates (Table 3-6) based upon the more conservative bioassay results.

TABLE 3-6. PHYSICAL CHARACTERISTICS FOR THE WASTES AT THE 106-MILE CHEMICAL WASTE SITE

Company	Waste Produced From the Manufacture of:	Number of Barge Trips Per Month	Mean Specific Gravity (Range)*	pH (Range)**	Authorized Discharge Rate (per nautical mile)	Minimum Dilution and Dispersion 4 Hours After Waste Release
American Cyanamid	Rubber, mining and paper chemicals, nonpersistent organophosphorus pesticides and surfactants	7	1.028 (1.010-1.055)	2.7 to 8.3	113,400 liters (30,000 gallons)	25,000:1
Du Pont-Edge Moor	Titanium dioxide (chloride process) iron chloride and hydrochloric acid	7	1.135 (1.085-1.218)	0.1 to 1.0	140,000 liters (37,000 gallons)	75,000:1
Du Pont-Grasselli	DMHA and Anisole	7-9	1.109 (1.036-1.222)	12.4 to 13.6	197,000 liters (52,000 gallons)	30,000:1 to 55,000:1
Merck & Company	Thiabendazole (pharmaceuticals)	1-2	1.115 (1.022-1.132	5.2 to 10.3	492,000 liters 130,000 gallons)	20,000:1 to 52,000:1

Sources: Data from EPA-Region II permit files
* Specific Gravity of seawater = 1.025
** pH of seawater = 7.8 to 8.4

TABLE 3-7. AVERAGE METAL CONCENTRATIONS (in ug/l) FOR THE WASTES AT THE 106-MILE CHEMICAL WASTE SITE

Metal	Seawater Concentration	Reference	American Cyanamid		Du Pont-Edge Moor		Du Pont-Grasselli		Mixed Industries	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Arsenic	2-3	Kopp, 1969	620	20-2,600	140	5-525	7	1-30	30	1-130
Cadmium	0.15	Fleischer et al., 1974	4	1-150	320	20-900	170	3-700	3,200	20-15,600
Chromium	1	EPA, 1976	550	45-4,900	270,200	52,600-900,000	330	10-3,500	21,170	4-170,000
Copper	3.0	Mero, 1964	350	1-4,100	3,250	4-7,400	3,150	25-154,700	10,900	1-115,000
Lead	0.03	Horne, 1969	120	1-1,000	40,540	2,700-76,000	900	10-4,900	8,840	8-62,000
Mercury	0.05-0.19	Robertson et al., 1972	30	1-200	30	1-500	7	1-20	300	21-3,830
Nickel	5-7	NAS, 1974	1,100	145-6,400	29,060	200-65,000	730	30-2,000	4,900	20-31,500
Zinc	10	EPA, 1976	560	7-5,150	100,960	110-530,000	540	30-2,700	163,800	15-1,400,000

Source: Data from EPA Region-II permit files

TABLE 3-8. TOXICITY BIOASSAYS FOR WASTES AT THE 106-MILE CHEMICAL WASTE SITE

Company	*Menidia menidia* (Minnow 96-h TL_{50})		*Skeletonema costatum* (Phytoplankton-diatom)	*Acartia tonsa* (Zooplankton-copepod)
	Aerated	Unaerated	96-h EC_{50}	96-h TL_{50}
American Cyanamid	0.24 to 2,900	0.10 to 2,900	10 to 1900	19.5 to 3,500
Du Pont-Edge Moor	5,000	5,000 to 14,400	712 to 3,450	No data
Du Pont-Grasselli	1.8 to 6,950	1.7 to 6,170	29 to 8,600	57 to 238
Mixed Industries (includes wastes other than Merck)	650 to 100,000	150 to 100,000	65 to 12,000	29.7 to 5,300

Source: Data from EPA - Region II permit files

In addition to these bioassays, the Du Pont plants have sponsored additional laboratory work on the toxicity of their wastes. For wastes from the Edge Moor Plant, Falk and Phillips (1977) concluded that:

- In 200-day chronic toxicity tests, the "no-effect" level for Mysidopsis bahia (opossum shrimp) and Cyprinidon variegatus (sheepshead minnow) ranged from 25 to 50 ppm.
- pH-neutralized waste (which rapidly occurs in seawater) produces mortalities only at concentrations several orders of magnitude above the unaltered waste.
- Pulsed exposure of Palaemonetes pugio (grass shrimp) to initial wastewater concentrations of 250 ppm (v/v)* followed by dilution slower than that observed in the barge wake produced no mortalities.
- Maximum waste concentrations in the barge wake were calculated to be approximately 150 ppm within 2 hours, and about 5 ppm within 8 hours. The 2-hour calculated wake concentrations is about half the acute LC_{50} value range of 240 to 320 ppm and the 8-hour wake concentration is a fifth of the calculated chronic no-effect level of 25 to 50 ppm for unaltered waste.

Based on these results, Falk and Phillips (1977) concluded that the Edge Moor wastewaters can be discharged into the marine environment over a 5-hour period, at a barge speed of 6 kn, without adverse impact and without violating the requirements of Section 227.8 of the EPA Ocean Dumping Regulations.

For wastes from the Grasselli plant, Falk and Gibson (1977) concluded:

- Under oceanographic conditions least likely to enhance dispersion, peak wastewater concentration in the barge wake is about 450 ppm (v/v) 1 minute after release.
- Wastewater concentrations decline to a maximum of 80 ppm 4 hours after release, and to about 60 ppm after 12 hours.
- In 178-day chronic toxicity tests, the no-effect level for Mysidopsis bahia (opossum shrimp) and Cyprinodon variegatus (sheepshead minnow) was 750 ppm.
- The wastewaters are not selectively toxic to a particular life stage of Cyprinodon or Mysidopsis.
- There is little difference in the toxicity of the wastewater to several species of marine organisms.

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* v/v - volumetric ratio

These results supported the discharge of Grasselli waste into the site over a 5-hour period, at a barge speed of 5 kn without adverse impact, and without violating the requirements of Section 227.8 of the EPA Ocean Dumping Regulations.

CONCURRENT AND FUTURE STUDIES

The NOAA Ocean Dumping Monitoring Division will continue monitoring the 106-Mile Site to detect any long term changes due to the chemical wastes released. All permittees are required to monitor the short-term effects of their waste discharges. Present permittees have contracted with a private company to conduct continuous monitoring, and twelve reports (as of 1979) have been submitted to EPA-Region II.

OTHER ACTIVITIES IN THE 106-MILE SITE VICINITY

Few activities occur in the site vicinity other than waste disposal operations at the site itself. A large area immediately south of the site has been proposed as an ocean incineration area; however, there are no other active ocean disposal sites in the vicinity. Oil and gas lease tracts are located west and north of the site, along the outer Continental Shelf (Figure 3-9). While the Hudson Canyon Navigational Lane crosses the Continental Slope to the north of the site, major traffic lanes are not near the 106-Mile Site.

Limited fisheries resources occur at the 106-Mile Site and vicinity. Due to the abyssal depths at the site, none of the shellfish common to shallower Shelf-Slope areas are found at the site. Lobsters, which are a valuable fisheries resource in the New York Bight, are confined to areas shallower than 500 m. The red crab (a potential fishery resource) is most abundant at depths between 310 and 914 m; its depth range is to 1,830 m. Small individuals may occur at the site; however, liquid wastes would not affect bottom dwelling animals.

Existing population data show that commercially important species of finfishes in the New York Bight vicinity are most abundant in Shelf areas and along the Continental Shelf-Slope break (MESA, 1975; BLM, 1978; Chenoweth et al., 1976). Consequently, most foreign and domestic fish trawling is conducted at depths shallower than 1,000 m, much shallower than the 106-Mile Site. Nearby waters have been used for the commercial longline fishing of marlin, swordfish, and tuna (Casey and Hoenig, 1977). However, only 1,041 of these fish were taken in 1973 and 1974 in a large area including the 106-Mile Site. In general, catch statistics for Continental Slope areas are unavailable because landing records do not separate Shelf species from Slope species.

ALTERNATIVE SITES ON THE CONTINENTAL SHELF

In addition to existing disposal sites, the so called Northern and Southern Areas were evaluated as alternative sites for the release of acid wastes. These sites might be considered if disposal operations were moved out of the New York Bight Apex, but not off the Continental Shelf due to environmental or economic considerations. The Alternate Sewage Sludge Disposal Site is in the northeast corner of the Northern Area, but anthropogenic wastes have never been released in either location.

The main environmental features of the two areas are similar to those discussed earlier in this chapter for the Acid Site, and detailed in Appendix A. This section emphasizes the most significant differences between the areas, and the general oceanography of the New York Bight. The information is taken from NOAA (1976).

The flow of waters is generally southwestward, following depth contours, although (as in the Apex) this flow is highly variable and subject to intense meteorological events. Flow in the Hudson Canyon is both up and down the canyon, but the long-term flow is distinctly up-canyon, towards the Bight Apex.

Surface sediments are mostly clean, medium-sized sands. The most prominent feature of the bottom sediment in the Southern Area is a band of coarse, gravelly sand near the northeast rim of the site, parallel to the Hudson Shelf Valley. The motion in both areas is generally towards the southwest, especially during winter "northeaster" storms.

Dissolved oxygen concentrations in surface, mid-depth, and bottom waters in the Northern and Southern Areas are moderately to highly saturated under winter, spring, and critical summer conditions. The saturation value for oxygen at these sampling depths probably does not fall below 50% at any time of year, and is usually much higher (75% to 110%).

The concentrations of heavy metals in the sediments and waters of the Northern and Southern Areas are low compared to those found in the Bight Apex, but all levels of chemical parameters are typical of the New York Bight. Concentrations of suspended particulate matter are lower in these areas since they are further removed from shore influence.

The living marine resources are typical of those along the mid-Atlantic and New England Continental Shelf. NOAA (1976) reported surf clams and sea scallops at each site. Commercial possibilities were not determined. Ocean quahogs were also present in both areas. Figure 3-2 shows the distribution of these three species.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

The release of acid waste at any of the alternative sites would produce similar environmental consequences. There will be minor, short-term, adverse effects on the plankton and minimal effects on bottom-living organisms. Effects on the benthos are most probable and would be easiest to demonstrate at the Southern or Northern Areas; effects (if present) at the Acid Site are obscured by the multiple contaminant sources, while no effects are expected at the 106-Mile Site, which is located in water depths of 2,000 m.

Adverse effects from acid waste disposal on the public health and water quality will be minimal except for a site in the Southern Area, where acid waste disposal might interfere with development of exploitable shellfish resources. Demonstrable, adverse effects on the ecosystem are most probable at a new site in the Northern or Southern Areas since wastes have never been released in these regions.

Most importantly, 30 years of study at the existing New York Bight Acid Waste Disposal Site have not demonstrated any adverse effects resulting from the disposal of these wastes. There may be a beneficial effect of waste release if bluefish, a popular sport fish, are attracted to the area by the discolored water caused by waste discharge. The alternative sites are too distant from shore to support an active sportfishery.

This chapter details environmental effects of waste disposal at various alternative disposal sites outlined in Chapter 2. Included are unavoidable environmental consequences which would occur if the proposed action takes place. The effects discussed first are environmental changes which directly affect public health, specifically, commercial or recreational fisheries and navigational hazards. Secondly, the environmental consequences of acid waste disposal at each alternative site, which cover effects of short dumping in nondesignated areas, are discussed. Finally, the chapter concludes with descriptions of unavoidable adverse effects and mitigating measures, the relationships between short-term uses of the environment, maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources which would occur if the proposed action is implemented.

Much data and other information was examined to evaluate potential effects of acid waste disposal at the sites. The principal data sources for each area are:

- New York Bight Acid Waste Disposal Site: NOAA-MESA studies beginning in 1973. NMFS/Sandy Hook Laboratory study from 1968 to 1972. Site-specific studies sponsored by NL Industries, Inc., beginning in 1948. Routine monitoring surveys sponsored by the permittees.

- 106-Mile Site: NOAA surveys, starting in 1974. Waste dispersion studies and monitoring of short-term disposal effects sponsored by the permittees. Public hearings concerning relocation of sewage sludge disposal sites and issuing of new permits.

- Southern Area: NOAA survey in 1975. Public hearings concerning the disposal of sewage sludge in the New York Bight.

- Northern Area: NOAA and Raytheon Corporation surveys in 1975. Hearings concerning the disposal of sewage sludge in the New York Bight.

Information from these and other sources was collected and compiled into an extensive data base entitled Oceanographic Data Environmental Evaluation Program (ODEEP) (Appendix D). The following discussion is based on an evaluation of the available data.

EFFECTS ON PUBLIC HEALTH AND SAFETY

A primary concern in ocean waste disposal is the possible direct or indirect link between contaminants in the waste and man. A direct link may affect man's health and safety. An indirect link may cause changes in the ecosystem which, although not apparently harmful to man, could lead to a decrease in the quality of the human environment.

COMMERCIAL AND RECREATIONAL FISH AND SHELLFISH

The most direct link between man and waste contaminants released into the marine environment is via consumption of contaminated seafood. Shellfishing, for example, is automatically prohibited by the FDA around sewage sludge disposal sites or other areas where wastes are dumped which may contain disease-producing (pathogenic) microorganisms. Thus, the possibility of consuming shellfish which may be contaminated by pathogens, is eliminated or minimized. Harmful effects caused by eating fish containing high levels of mercury, lead, or persistent organohalogen pesticides have been documented. Certain compounds (e.g., oil) have made fish flesh and shellfish unhealthy and unpalatable. Therefore, wastes containing heavy metals, organohalogens, oil, or pathogens must be carefully evaluated with respect to possible contamination of commercially or recreationally exploitable marine animals.

Foreign long-line fisheries exist on the Continental Slope, but U.S. fishing in the mid-Atlantic is mostly restricted to waters over the Continental Shelf. Commercial fishing and sportfishing activities on the Shelf are widespread and diverse; finfish and shellfish (mollusks and crustaceans) are taken. The New York Bight is one of the most productive coastal areas in the North Atlantic, and the region may be capable of even greater production as new fisheries develop.

Important spawning grounds and nursery areas lie within the Bight, but critical assessments of the effects of man-induced contamination on fish and shellfish populations are lacking. Many factors complicate the collection and assessment of these data. For example, normal short-term and long-term population cycles are not well understood, catch data may not be adequate, and the complete life cycle and distribution of the stock may be unknown. Natural population fluctuations, overfishing, and unusual natural phenomena may have a greater influence on the health and extent of the fisheries' resource than does man-induced contamination. Therefore, assessing the effects of ocean disposal includes uncertainties due to the weaknesses of existing fisheries information.

NEW YORK BIGHT ACID WASTE DISPOSAL SITE

There is an extremely low potential for endangering public health from continued acid waste disposal at this site. The site location was chosen 30 years ago because it was not a point of concentration for fish or fishing and because the sandy sediments of the site are seldom associated with productive fishing. Ironically, the site has become a sportfishing area because the discoloration of the water caused by acid-iron waste disposal apparently attracts bluefish, a prized sport fish, to the area (Westman, 1958). However, fishermen in the New Jersey and Long Island areas claim that the discolored water hurts the fishing for other pelagic sport fish. In winter a commercial whiting fishery exists near the Acid Site, and lobstering may occur northeast of the site.

Effects of acid waste disposal on these resources are practically nonexistent. The area nearer shore is closed to shellfishing because of the material released at the Sewage Sludge and Dredged Material Sites.

Acid waste contains only small amounts of tainting substances, such as oil and grease. Relative to total inputs of oil and grease to the Bight, acid waste is an insignificant contributor of these contaminants. Waste constituents may reach the bottom and be assimilated by organisms, but other sources of contamination are probably more significant. (The New York Bight Sewage Sludge Site is only 2.8 nmi from the Acid Site.)

No health problems associated with sport fish caught at the site have been reported. Although adverse effects have been observed in mackerel eggs exposed to moderately high concentrations of acid waste (Longwell, 1976), tainting or harmful accumulations of waste components in the flesh of fish taken from the area have not been reported. Long-term damage to the resources resulting from acid waste disposal have not been documented (EG&G, 1977e; ERCO, 1978a,b).

106-MILE SITE

Commercial or recreational fishing is infrequent at this site; consequently, acid waste disposal will not directly endanger human health.

Although the NOAA resource assessment surveys do not extend beyond the Shelf, densities of fish eggs and larvae are low beyond the edge of the Shelf. Foreign fishermen are near the site in the late winter, but usually catch highly migratory fish. The probability of these fish accumulating toxic levels of contaminants from the waste is extremely unlikely.

A small fishery for the deep sea red crab (Geryon quinquedens) exists near the Shelf-Slope break in the mid-Atlantic. Immediately north of the 106-Mile site, crabs are found in moderate abundance (33 per half hour otter trawl), but the water depth is much shallower than at the site (311 to 732 m). At a station 70 nmi (130 km) northeast of the site, at a comparable depth, no crabs were taken (Wigley et al., 1975). Although the site is within the range of smaller crabs, none of commercial size were taken deeper than 914 m. As with finfish, the probability of liquid wastes affecting a benthic animal is extremely low. Therefore, disposal at this site does not directly endanger human health by contaminating edible organisms.

SOUTHERN AREA

Although numerous surf clams, ocean quahogs, and scallops are found in the Southern Area, most commercial shellfishing is presently to the west, near the New Jersey coast. However, declining harvests may cause the Southern Area to be exploited in the future (EPA, 1978a). Recreational fishing is unlikely at this site due to its distance from shore and the competition from more attractive sportfishing areas closer inshore. If this area were used as a disposal site for wastes similar to those presently being released at the Acid Site, a real but low potential for an accumulation of waste constituents in the flesh of shellfish would exist.

NORTHERN AREA

Disposal of aqueous acid wastes in this area would probably not directly endanger public health. This site is not in a known commercially or recreationally important fishing or shellfishing area. Resource assessment surveys show that this area has a similar, or lower, density of fish eggs and larvae when compared with other Shelf sites (NOAA, 1975). Shellfish are not abundant in the area. Since the area supports no commercially or recreationally exploitable finfish or shellfish, a health hazard from eating animals contaminated by waste materials is unlikely.

NAVIGATIONAL HAZARDS

Navigational hazards may be separated into two components: (1) hazards resulting from the movement of transport barges to and from a site, and (2) hazards resulting from barge maneuvers within the site.

If an accident occurred involving the release of wastes, the effects from the dumped waste would probably be equivalent to a short dump. The effects from the other ship would depend on the cargo and could be severe if the barge collided with an oil or liquefied natural gas (LNG) tanker. There is the possibility of loss of life in any collision. Sites further offshore have a longer search and rescue response time than sites closer to shore.

For all sites, barges must pass through the Precautionary Zone centered around Ambrose light, where traffic is densest and hazards are greatest. Once through the Precautionary Zone, the potential for problems increases with increasing distance from shore. Table 4-1 shows the distance and estimated transit time for the four alternate sites.

NEW YORK BIGHT ACID WASTE DISPOSAL SITE

The New York Bight Acid Waste Disposal Site is situated across the outbound section of the Hudson Canyon Traffic Lane from New York Harbor, but the barging operations are designed to minimize interference with traffic. In 30 years of use at the Acid Site, no collision between a barge discharging waste and a ship has ever occurred. In April 1976, a collision did occur near the Acid Site between a ship and a barge outbound for the 106-Mile Site. The permittees now using the site barge wastes about once a day. Any accident would be close to New Jersey or Long Island beaches.

TABLE 4-1. DISTANCES AND TRANSIT TIMES (ROUND TRIP) TO ALTERNATE SITES

Site	Distance*		Transit Time (Hours)**	
	nmi	(km)	5 kn (9 km/hr)	7 kn (13 km/hr)
New York Acid Waste	17	(31)	7	3
106-Mile Chemical Waste	113	(209)	46	32
Southern Area	53	(98)	22	16
Northern Area	50	(93)	21	16

* Measured from the Rockaway - Sandy Hook Transect
** Does not include time in transit from the loading dock to the Rockaway-Sandy Hook Transect (New York Harbor), nor time spent at the sites.

106-MILE SITE

Barges in transit to the 106-Mile Site from New York Harbor use the Ambrose-Hudson Canyon Traffic Lane for most of the journey. There is a slightly greater possibility for problems during the round-trip transit to the 106-Mile Site than to a site closer inshore.

Hazards resulting from maneuvers within the site are negligible. The site is extremely large, and permittees are required to use different quadrants of the site if there are simultaneous disposal operations. The frequency of existing barging is only two to three times per week. Increased frequency of use would not significantly increase navigational difficulties.

SOUTHERN AREA

The Southern Area lies outside traffic lanes for New York Harbor, thus its use would cause few navigational hazards. Barges could use the Ambrose-Barnegat Traffic Lane for most of the trip. However, increased ship traffic resulting from offshore oil and gas resource development would slightly increase the hazard. The degree and extent of such hazards would depend on the speed and magnitude of oil and gas development in the area. Any accidents would likely occur in the heavily fished coastal waters off New Jersey.

NORTHERN AREA

The Northern Area lies outside traffic lanes for New York Harbor thus its use would cause few navigational hazards. Barges could use the Ambrose-Nantucket Traffic Lane for most of the trip. Mineral resources are not located in the area, so there is no possibility of increased hazards from future resource development. Any accidents would be near coastal waters off Long Island.

EFFECTS ON THE ECOSYSTEM

The adverse effects of ocean disposal on the ecosystem (the interacting living and non-living components of the environment) can be subtle, and may not exhibit obvious direct effects on the quality of the human environment. However, subtle adverse impacts can accumulate and combine, to cause long-term consequences which are as serious as any readily observed direct impacts. For example, an organism may accumulate waste constituents in its tissues at concentrations that do not cause its death immediately, but instead act at a sublethal or chronic level. Sublethal effects may reduce reproduction, reduce health of eggs and larvae, slow development of juveniles, or affect other facets of the life cycles of individual organisms followed by adverse changes in the entire population of this organism. The population may eventually be eliminated from an area, not because it was immediately killed by a single waste discharge but because of long accumulations of sublethal effects. If that population were a major human food source or a food source for an organism that was commercially exploited, man could lose the resource. This scenario is vastly simplified and is not a projection of what is currently resulting from acid waste disposal in the ocean; however, it does illustrate that man, as an integral part of a complex ecosystem, may ultimately feel the results of adverse impacts on other parts of the ecosystem.

The magnitude of the effects of waste disposal on the marine ecosystem depends upon several factors: (1) the types of waste constituents, (2) the concentrations of toxic waste materials in the water and sediments, (3) the length of time that high concentrations are maintained in the water or the sediments, and (4) the length of time that marine organisms are exposed to high concentrations of these materials. Current disposal techniques for aqueous chemical wastes maximize the dilution and dispersion of the wastes, and minimize chances for wastes to remain in the water column or to reach the bottom in high concentrations.

BIOTA

PLANKTON

Plankton consists of plants (phytoplankton) and animals (zooplankton) which spend all or part of their lives floating or weakly swimming in the water. Since aqueous wastes primarily affect the water column, plankton represent the first level of the ecosystem where the effects of waste disposal could be observed. Accordingly, numerous studies of the effects of wastes on planktonic organisms have been conducted.

Acid Waste

The effects of waste disposal on plankton at the Acid Site have been extensively studied. Field studies during waste discharges have shown that acid-iron waste does not harm zooplankton populations (Wiebe et al., 1973; Redfield and Walford, 1951). Evidence of chromosomal damage in mackerel eggs collected in the vicinity of the site has been reported (Longwell, 1976), but the cause of the damage cannot be definitely linked to the disposal of acid wastes. Interpretation of field results from this site is difficult; changes in plankton populations resulting from acid waste disposal at the Acid Site cannot be reliably distinguished from changes caused by pollutants from other sources introduced into the New York Bight.

Laboratory studies show that acid wastes released at this site can cause chronic effects in zooplankton after prolonged exposure to waste concentrations which are much greater than those encountered under field conditions (Grice et al., 1973). Sublethal effects (e.g., failure to reproduce and extended developmental times) have been demonstrated in the laboratory after 21 days of exposure to waste concentrations which persist for only minutes after actual discharge of wastes at the site (Vaccaro et al., 1972).

Additional release of acid wastes at the Acid Site would not be expected to cause effects different from those presently seen there. However, releasing wastes with characteristics different from wastes previously dispersed may have unpredictable effects.

106-Mile Site

Numerous field and laboratory studies on the 106-Mile Site have investigated the effects of dumped wastes on the plankton. Some of these wastes are aqueous by-product acids, similiar to those at the Acid Site. Field studies of populations have shown great numerical variations, mainly due to the presence of several water masses, each with different species (Austin, 1975; Sherman et al., 1977; Hulburt and Jones, 1977). NOAA (1977) recognized these factors at the 106-Mile Site:

> **Plankton undergo large natural variations with changing water type and for this reason, assessment of the plankton of the region was difficult. Coastal waters are characterized by high nutrient concentrations and populations with wide seasonal variations in abundance and diversity. Oceanic waters have reduced nutrient levels and population densities, but photosynthetic processes extend to much greater depths. Mixing water types will produce a complex combination of these conditions.**

Since plankton data demonstrate high natural variabilities in populations, changes in species composition, abundance, and distribution data due to waste disposal may never be demonstrated. Variations induced by waste disposal are obscured by variability created by natural events.

The adverse effects of acid waste disposal at this site should be localized and short term.

Southern and Northern Areas

Use of either the Southern or Northern Areas for chemical waste disposal would not be expected to have significant long-term effects on plankton. These areas are outside the highly stressed New York Bight Apex, thus their biota are unlikely to have had the opportunity to adapt to man-induced environmental stresses. However, specific effects would depend upon the nature and volume of wastes and frequencies of disposal. Based upon existing wastes and volumes, any effects would be difficult to demonstrate since plankton populations are so variable.

NEKTON

The nekton include animals, such as fish and mammals, capable of strong swimming and migrating considerable distances.

None of the numerous studies on nekton at the New York Bight Acid Waste Disposal Site have detected long-term effects attributable to acid waste disposal. Many contaminant inputs to the Bight Apex, other than those at the Acid Site, make it unlikely that any deterioration of fish health or populations could ever be proven as caused by acid waste disposal. Therefore, any effects on fish populations by additional acid waste disposal at this site are difficult to predict, based on information obtained as a result of the present disposal operations. However, considering (1) the dilution and dispersions of wastes presently released, (2) the absence of dead fish in the wake of disposal barges, and (3) the ability of fish to move away from temporarily stressed areas, it is unlikely that disposal of acid wastes at the Acid Site would have any demonstrably adverse consequences.

One possible effect under investigation is a relationship between acid waste disposal and mutagenesis in fish eggs (Longwell, 1976). Kinne and Rosenthal (1967) suggested the possibility, while investigating the effects of sulfuric acid wastes on the larvae of the Atlantic herring (Clupea harengus); however, even this effect would be insignificant. No species spawn only in the vicinity of the site or only in the Bight Apex. Fish eggs and larvae are spread over the entire New York Bight. Concentrations of acid waste are rapidly diluted to nontoxic levels and would not affect more than a small number of eggs or larvae.

106-Mile Site

The results of field investigations of effects of chemical waste disposal on fish at the 106-Mile Site have been inconclusive. Field work has usually occurred during the infrequent presence of Gulf Stream eddies, therefore non-eddy conditions have not been studied. NOAA (1977) reported:

> **Total fish catches within and without the dumpsite were not significantly different, although midwater fish were most abundant outside the dumpsite. The highest rate of fishless tows occurred the night after a dump, but whether the tows were still in water affected by the dumped material is not known.**

The histopathology of fish collected from the disposal site area (NOAA Pathobiology Division, 1978) has been inconclusive. Lesions were observed in some fish, but the sample size was small. High cadmium levels were found in the livers of three swordfish from the site area, and high mercury levels were observed in muscles of almost all fish analyzed (Greig and Wenzloff, 1977). However, the elevated concentrations were not attributed to disposal operations at the 106-Mile Site because of the low amounts of these metals added to the area by disposal and the migratory nature of the large swordfish.

Disposal of acid wastes at this site should not significantly affect nekton other than possibly causing them to avoid the affected area temporarily.

Alternative Sites

Conditions at the Northern and Southern areas are similar to the Acid Site, and the same lack of effects would probably occur. Even if fish did avoid the waste plume after disposal, this would only happen for an hour or so, until the waste constituents are diluted to ambient levels.

BENTHOS

Benthos consists of animals living on (epifauna) and in (infauna) the sediments. Epifauna are dominated by larger echinoderms and crustaceans while the infauna primarily include small, segmented worms (polychaetes) and mollusks. Benthic organisms are important as indicators of waste-related impacts because many are sedentary and incapable of leaving a stressed environment. They are also important because many are commercially valuable (e.g., shellfish), or are food sources, such as worms, for valuable species (demersal fish).

Acid Site

The New York Bight benthos shows a natural temporal and spatial variability substantially greater than any changes resulting from the disposal of acid wastes (Pearce et al., 1976). Any effects from acid waste disposal would probably be overshadowed by effects from the numerous other contaminants introduced to the New York Bight, particularly the Sewage Sludge and Dredged Material Sites. This complex interplay between natural variability and contaminants introduced by other sources makes it extremely difficult to isolate and quantify effects at the site solely due to the disposal of acid waste. All on-site investigations of the effects of waste disposal have led to similar conclusions.

The first comprehensive study of the site by Redfield and Walford (1951) reported that, "biological observations have failed to produce any direct evidence that the populations of fish or of bottom-living animals are being damaged or excluded from the area by the disposal of waste." Vaccaro et al. (1972) stated that "Our synoptic sampling was planned to detect alterations in the biota of the acid grounds which could be attributable to discharge of approximately 50 million tons of acid waste over a period of 22 years. We have been unable to detect major effects of acid-iron waste on the sediment and biotas (phytoplankton, zooplankton, and benthos) of the region, although we have indications in our observations of possible minor effects of this waste." More recently, Swanson (1977) concluded that although "observational evidence of the impact of dumping on the biota at the [site] is limited...

past studies indicate no reduction of primary productivity or phytoplankton mortality...surveys of benthic populations in the immediate vicinity of the Apex Acid Waste Dumpsite have not demonstrated an observable impact of waste acid....existing scientific evidence indicates so far that ocean dumping [of waste at the Acid Site] has had minor adverse impacts on the ecology."

106-Mile Site

No effects of chemical waste disposal have been observed in the benthos at the 106-Mile Site. The species composition and diversity at the site are similar to those observed in nearby Continental Slope areas (Pearce et al., 1975; Rowe et al., 1977). Analyses of trace metal content in benthic invertebrates have shown values well within the range of background values (Pearce et al., 1975). These results are not surprising since it is unlikely that the low-density liquid waste could reach bottom in measurable concentrations. There is tremendous dilution due to the depth and movement of water at the site. Therefore, readily-dispersed, low-density aqueous wastes should not affect benthic organisms at or near the site.

Southern Area

The Southern Area benthos resembles that of the Delaware Bay Acid Waste Site (Figure 2-2, #9). Preliminary work indicated that disposal of acid wastes at the Delaware Bay Acid Site caused measurable accumulation of vanadium in the tissues of sea scallops (Pesch et al., 1977). Vanadium is not known to be toxic to humans and probably does not have an effect on the sea scallops, yet this does show the possibility of accumulating other, more toxic waste constituents. This would be an adverse long-term impact from acid waste disposal. These effects are observable because of: (1) the relative shallowness of the site (45 m), permitting some solid waste fractions to reach bottom, (2) the lack of other contaminant inputs to obscure the effects of waste disposal, (3) the presence of the shellfish, and (4) the ability of the scallops to concentrate some metals in their tissues at levels much higher than the levels in the surrounding water or sediment. Since the sites are similar, especially the shallow-water depth factor, similar effects are anticipated at the Southern Area if acid waste disposal is initiated.

Accordingly, use of the Southern Area for disposal of acid wastes carries the risk of contaminating commercially valuable shellfish populations, or otherwise changing the benthic community structure.

Northern Area

Acid waste disposal at this site may have the same effects as at the Delaware Bay or Southern Area Sites. Commercially exploitable shellfish resources, however, are not present at or near the site, thus the effects on humans would be neglible. This site could be used for disposal if the benthos is monitored carefully for changes related to the wastes.

WATER AND SEDIMENT QUALITY

ACID SITE

Investigations of the effects of waste disposal at the Acid Site have continued for more than 30 years, but no changes in the water or sediment chemistry have been positively linked to acid waste disposal. The New York Bight Apex is a difficult region in which to assess impacts because of the variety of contaminant sources and the existing high levels of most parameters resulting from the populations and heavy industrialization of the region.

Most seawater measurements at the Acid Site are well within the background values of the Bight Apex. Vaccaro et al. (1972) reported reduced surface salinity at the site when compared with a control area. Turbidity is usually greater at the site, caused by the iron-floc which forms when acid-iron waste reacts with seawater (NOAA-MESA, 1975).

Trace metal (e.g., mercury, copper, lead, cadmium, and zinc) concentrations in sedimenta have been reported. High metal concentrations in the Bight Apex occur in the area of the nearby Dredged Material and Sewage Sludge Sites (Ali et al., 1975). Values at the Acid Site are much lower than at other disposal sites. Some workers have reported higher concentrations of trace metals in Acid Site sediments than in sediments from supposedly uncontaminated areas

(Vaccaro et al., 1972; EG&G, 1978c); however, these values have generally been within the range of values from other locations in the Bight (SHL, 1972), described below (Appendix B).

The potential addition of disposal-related metals on the "background" levels at the Acid Site have been estimated (Table 4-2). Only zinc (0.04 tonnes/day) represents a significant input; but considering the total input of zinc to the Apex (33 tonnes/day), any effects from the acid waste metal content would not be measurable. The 14-day residence for water, used in the calculations, is for the entire Apex. Water into which waste was released moves from the site before the next disposal operation; therefore, the calculations are extremely conservative.

Wastes presently permitted at the site satisfy criteria for evaluating environmental impact (ERCO, 1978a,b), thus no significant changes in the site's water quality are anticipated. Ambient concentrations of the waste constituents are not exceeded beyond site boundaries. The concentrations return to ambient levels within the period allowed for initial mixing (4 hours). In fact, except for the most abundant constituents (fluorides and iron), concentrations usually return to ambient conditions within 1 hour. There is one noticeable harmless change in the water quality at the site. The ferric hydroxide floc which forms when acid-iron waste is released persists for at least twelve hours (Charnell et al., 1974; ERCO, 1978c) and has been reported to persist for several days (Vaccaro et al., 1972).

Continued use of the site for acid waste disposal will probably produce similar results for measurements of the water and sediments. Background values at the site of trace metals are in the milligrams-per-liter range. Sample collection, storage, treatment, and analytical procedures can accidentally introduce contamination, which affects analytical results. Therefore, values slightly above background levels, resulting from disposal, may be masked by the contamination introduced from sample handling. Consequently, projections of disposal effects on the water and sediments must be based on the present knowledge, allowing for the inherent weaknesses. (This also applies to trace metal chemistry work at the other disposal sites).

TABLE 4-2. WORST-CASE CONTRIBUTION OF WASTE METAL INPUT TO THE TOTAL METAL LOADING AT THE NEW YORK BIGHT ACID WASTE DISPOSAL SITE

	Cadmium	Copper	Lead	Mercury	Zinc
Background Concentration (ug/l)*	3.1	8.0	140	0.04	11.0
Total amount (g) in 7.7×10^{11} liters†	2.4×10^6	6.2×10^7	1.1×10^8	3.1×10^4	8.5×10^6
Estimated Input (g) from 1978 Waste Volumes and Mean Concentrations	1.47×10^5	3.08×10^6	1.25×10^6	4.3×10^3	1.52×10^7
Estimated Input in 7 Days (g)**	4.02×10^2	8.44×10^3	3.42×10^3	1.18×10^2	4.16×10^4
Percent of Loading due to Waste in 1 day	0.1	0.1	0.1	0.1	0.5

Source:

* From Klein et al., 1974
† The total volume of the Site to 10-m depth
** The estimated flushing time for the Site (Redfield and Walford, 1951).

106-MILE SITE

A similar lack of effects is anticipated for the 106-Mile Site. Table 4-3 shows maximal metals additions due to acid waste, and the amounts are insignificant (2% in all cases). Investigations of dissolved oxygen, pH, organic carbon, and trace metals after waste disposal at the 106-Mile Site have shown that within four hours after disposal the values are within the normal range of values reported from this site and similar oceanic regions (Hydroscience, 1977).

TABLE 4-3. ESTIMATED WASTE METAL INPUT TO THE TOTAL METAL LOADING AT THE 106-MILE SITE

	Cadmium	Copper	Lead	Mercury	Zinc
Background Concentration (ug/l)*	0.37	0.9	2.9	0.72	8.0
Total Amount (g) in 3.1×10^8 liters†	2.8×10^6	6.9×10^6	2.2×10^7	5.5×10^6	6.2×10^7
Estimated Input (g) from 1978 Waste Volumes and Mean Concentrations	1.47×10^5	3.08×10^6	1.25×10^6	4.3×10^3	1.52×10^7
Estimated Input in 14 Days (g)**	5.64×10^3	1.18×10^5	4.79×10^4	1.65×10^2	5.83×10^5
Percent of Loading due to Waste in 14 Days	0.02	1.7	0.2	0.1	0.9

Sources:

* From Hausknecht (1977)

† The volume of a quadrant of the site to 15-m depth

** The maximum length of time for residence of any water parcel in the site, assuming a 10-cm/sec current and a 32 nmi (diagonal) distance across the quadrant.

NOAA (1977) summarized the results of 1974 and 1976 investigations on trace metals at the 106-Mile Site and at similiar nondisposal areas:

> **Results of the May 1974 cruise indicate that some metals were significantly elevated compared to normal ambient concentrations [Brezenski, 1975]. However, normal concentrations are only a very few parts per billion, and great care must be taken to avoid errors in measured values. A variety of factors can lead to misleading results, among them sample contamination during collection, storage, or analysis. More recent observations support the conclusion that heavy metal concentrations in the...[site]...water column are typical of shelf-slope regions [Kester et al., 1977; Hausknecht and Kester, 1976ab]. Moreover, calculations show that the total amount of metals added in dumping contributes less than 1 percent to the total normal amount of metals in the water at**

the dumpsite region [Hausknecht, 1977]. None of the observations occurred near the time of or in the immediate vicinity of dumping, so that ambient concentrations would be expected to be typical of the background for the region.

Therefore, investigations by NOAA and Hydroscience of effects from waste disposal on the water chemistry of the site have not detected concentrations elevated above ambient conditions after the initial mixing period.

Metal concentrations in sediments of the 106-Mile Site were measured in 1974 by Pearce et al. (1975), and in 1976 by Greig and Wenzloff (1977). The metal concentrations reported for 1976 are consistent with those for 1974. Sediment metal concentrations varied little in samples from depths greater than 180 m. Although the heavy metal content of sediments taken beyond the Continental Shelf appears to be elevated relative to sediments on the Shelf/Slope break, the elevated metal concentrations cannot be attributed to present disposal practices at the 106-Mile Site, since they are not unique to the site vicinity. Therefore, there is no evidence that the wastes released at the site have affected the sediments (Pearce et al., 1975).

NORTHERN AND SOUTHERN AREAS

The Northern and Southern Areas, which have never been used for waste disposal, share a number of environmental features in common with the New York Bight Acid Waste Disposal Site, except that they are deeper. Disposal of acid wastes at these sites will probably have little effect on water chemistry, but effects on the benthos (similar to those observed at the Delaware Bay Acid Site) may occur. Such effects in the Southern Area would adversely affect humans since exploitable shellfish exist near the site. If a new site were established for acid waste disposal, the environmental consequences of disposing the wastes would be much less in the Northern Area.

As with the Acid Site, the potential effects of disposal-related metal input on the concentrations at these sites have been estimated (Tables 4-4 and 4-5). Since the near-surface currents in these areas are quite strong (16-20 cm/sec), and the residence time is short, acid waste constituents would not measurably raise the ambient concentrations.

TABLE 4-4. ESTIMATED WASTE METAL INPUT TO TOTAL METAL LOADING AT THE SOUTHERN AREA

Metal Concentration	Cadmium	Copper	Lead	Mercury	Zinc
Background Concentration (ug/l)*	1.6	7.0	2.7†	0.08†	18.3
Total amount (g) in 2.1×10^{12} liters**	3.4×10^6	5.7×10^6	1.7×10^5	3.8×10^5	3.8×10^7
Estimated Input (g) from Waste Volumes and Mean Concentrations	1.47×10^5	3.08×10^6	1.25×10^6	4.3×10^3	1.52×10^7
Estimated Input in 2 Days (g)††	8.05×10^2	1.69×10^4	6.85×10^{35}	2.36×10	8.33×10^4
Percent of Loading due to Waste in 2 days	0.02	0.1	0.1	0.01	0.2

Sources:

* From NOAA, 1976

† From EPA, 1976

** The volume of the site to 10 m depth

†† Based on the lowest observed current velocity at the site

EMERGENCY DUMPING

Ocean disposal regulations specify that, in emergency situations, the master of a transport vessel may discharge the waste load at any location and in any manner to safeguard life at sea. Such emergency situations may result from: (1) severe weather conditions that are typical in the North Atlantic in late fall, winter, and early spring, and (2) vessel breakdowns, equipment failure, or collisions with other vessels or stationary objects.

TABLE 4-5. ESTIMATED WASTE METAL INPUT TO TOTAL METAL LOADING AT THE NORTHERN AREA

	Cadmium	Copper	Lead	Mercury	Zinc
Background Concentration* (ug/l)	3.3	4.4	2.7†	0.08	33.3
Total amount (g) in 2.1×10^{12} liters	6.9×10^6	9.2×10^6	5.7×10^6	1.7×10^5	7.0×10^7
Estimated Input (g) from 1978 Wastes Volumes and Mean Concentrations	1.47×10^5	3.08×10^6	1.25×10^6	4.3×10^3	1.52×10^7
Estimated Input in 2 Days (g)††	8.05×10^2	1.69×10^4	6.85×10^3	6.85×10	8.33×10^4
Percent of Loading due to Waste in 2 Days	0.01	0.2	0.1	0.01	0.1

Sources:
* From NOAA-MESA 1976
† From EPA, 1976
** The volume of the site to 10-m depth
†† Based on the lowest observed current velocity at the site

The potential for illegal short dumping exists. The USCG ocean disposal surveillance program discourages such illegal activities through a system of shipriders, patrol vessels, aircraft overflights, and checking of vessel logs. The procedures for administering ocean dumping permits also discourage these activities by requiring notification of departures and commencement of disposal, providing overlays of the barge's track, and examining ships' logs. If violations do occur the permit provides for civil and criminal penalties ranging from revocation of the permit to a $50,000 fine.

Twenty-four possible violations of permit regulations sufficient to cause follow-up actions were reported to EPA-Region II between 1973 and 1977. Three were for the Acid Site and seven were for the 106-Mile Site. Of the three violations at the Acid Site, one was upheld and a civil penalty assessed; one had the charges withdrawn, and one is pending (EPA, 1978a). At the 106-Mile Site, four citations were upheld and civil penalties assessed, one was dismissed, and two had the charges withdrawn. No enforcement actions were initiated against permittees at either site in 1978 (EPA, 1979).

The probability of an emergency rises as the round-trip transit time increases. (See Table 4-1 for estimated transit times). The decision to locate a site far from shore carries with it the increased risk of emergencies resulting in short dumping. The effects of a short dump of toxic waste materials would depend on the location of the dump. Since acid wastes are liquid and rapidly diluted upon discharge, a single load of waste in a new area might cause local immediate acute effects, but should not cause any long-term adverse effects. Effects of emergency dumping during inclement weather would be mitigated by the rapid dilution caused by storm activity.

Use of any of the alternative sites involves the possibility of legal or illegal short dumping. Based on distance of a site from port, the probability of a short dump is highest for the 106-Mile Site and lowest for the Acid Site. Except for the Acid Site, however, the effects of a short dump would be short-term and the ecosystem would rapidly recover. Short dumping at the Acid Site causes more concern because of close proximity to shore and the possibility of waste constituents reaching the New Jersey or Long Island shorelines.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

Some unavoidable adverse environmental effects of disposal of liquid acid wastes will occur in all sites designated. Field and laboratory observations show the most important short-term adverse impacts to be:

- Acute mortality in plankton
- Rise in waste constituent concentrations in the water
- Lowering of pH
- Possible avoidance of the area by fish

These effects occur immediately upon release of the wastes, but do not persist beyond the period allowed for initial mixing.

The most important potential long-term adverse impacts are:

- Possible accumulation of waste constituents by the benthos in shallow waters
- Sublethal effects on zooplankton and fish. These have been observed only in the laboratory at higher waste concentrations than occur at the site.

The volumes and rates of waste discharges specified in disposal permits have been established to reduce possibility of short-term effects persisting. The continuous monitoring program, by permittees and the Federal government, was established to determine if short-term or long-term effects are occurring.

None of the effects described in this section apparently persist for more than a few hours after the waste is discharged; consequently, none of these impacts are irreversible and additional mitigating measures are not required.

RELATIONSHIP BETWEEN SHORT-TERM USE OF THE SITE AND LONG-TERM PRODUCTIVITY

For some of the alternative sites, there appears to be conflict between the short term use of the area as a waste disposal site and the area's long term productivity as part of the mid-Atlantic bight ecosystem. Exploitable shellfish and possible mineral resources in the Southern Area Site would cause conflict. Adverse effects are probably reversible, but it is not certain. Neither the 106-Mile Site nor the Northern Area Site appear to offer conflicts between short-term use and long-term productivity. The Northern Area Site is more likely to show any adverse effects than the 106-Mile Site since it is closer to shore and shallow.

The Apex of the New York Bight is affected by many waste inputs, and additional released wastes would not be readily detected. For the long-term, these wastes could exceed the total assimilative capacity of the New York

Bight Apex. However, continual monitoring should detect any changes, and EPA, the permitting authority for the site, can halt or modify disposal practices at the site. The magnitude of the contaminant inputs from acid waste must be kept in perspective; they are generally less than the inputs from the atmosphere. Acid waste disposal activities at this site over the past 30 years have not interfered with shipping, fishing, recreational activities, or the development of other resources. There is no evidence that the long-term productivity of the area has been adversely affected by the wastes.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Several resources will be irreversibly or irretrievably committed by the proposed action:

- Loss of energy (i.e., fuel for transporting barges to and from the site). Transport to distant sites requires more fuel.

- Loss of constituents in the waste, (e.g., acids or metals). Present-day technology or markets are not adequate to permit economical recovery.

- Loss of economic resource due to costs associated with ocean disposal. Ocean disposal costs, however, are almost always lower than the costs of land-based disposal methods.

Chapter 5
LIST OF PREPARERS

Preparation of this EIS was a joint effort employing many members of the Interstate Electronics Corporation scientific and technical staff. This chapter summarizes the background and qualifications of the primary workers on the document (Table 5-1).

The principal author wishes to thank those people who assembled background information, wrote or commented upon short sections, and performed the data analysis for the EIS. The document has benefited greatly from their assistance.

TABLE 5-1. LIST OF PREPARERS

Responsible Person	Summary	Chapter					Appendix				
		1	2	3	4	5	A	B	C	D	E
M. Holstrom*	A		A	A	A	A	A	A			A
R. Lewis									A	A	
B. Knudtson							A	A			
K. King		A									

*EIS Coordinator and principal author
A=Author

MARSHALL HOLSTROM

Mr. Holstrom is the principal author of the EIS. He is a marine biologist and staff EIS coordinator within the Biological Sciences Branch of the contractor's Oceanic Engineering Division. He holds B.A. and M.A. degrees in Biological Sciences from Stanford University and has completed additional graduate work in marine biology at the University of Southern California.

Mr. Holstrom prepared the Summary; Chapters 2, 3, 4, and 5; and Appendices A, B, and E. As the coordinator for this EIS, he directed the writing efforts on other sections, edited the entire document, and maintained liaison with EPA Headquarters and EPA-Region II.

ROBIN LEWIS

Mr. Lewis, a biological oceanographer at Interstate received his B.S. degree in Marine Biology from California State University, Long Beach, and is presently a candidate the M.S. degree.

Mr. Lewis prepared Appendixes C and D of this EIS and performed the analyses of the waste loading data.

BRUCE KNUDTSON

Dr. Knudtson obtained his B.A. from the University of California, Santa Barbara, and his M.S. and Ph.D. from the University of Southern California.

Dr. Knudtson assisted in writing Appendixes A and B and performed some of the analyses used to evaluate alternative disposal sites.

KATHLEEN M. KING

Ms. King is a marine biologist holding the B.S. in Biological Sciences from the University of California and an M.A. in Biology (with emphasis on marine biology) from California State University, Long Beach.

Ms. King prepared Chapter 1 of this EIS.

Chapter 6

GLOSSARY AND REFERENCES

GLOSSARY

Abundance	The number of individuals of a species or taxon inhabiting a given area.
Abyssal	Pertaining to the great depths of the ocean beyond the limits of the continental slope, from 2,000 to 5,000 m.
Acute effect	The death or incapacitation of an organism caused by a substance within a short time (normally 96 hours).
Adsorb	To adhere in an extremely thin layer of molecules to the surfaces of solid bodies.
Aesthetics	Pertaining to the natural beauty or attractiveness of an object or location.
Alkalinity	The sum of anions of weak acids in seawater, plus hydroxide ions (OH^-), minus the hydrogen ion (H^+) concentrations. Alkalinity is usually calculated by the empirical equation meq/kg = 0.061 x salinity (g/kg).
Ambient	Pertaining to the undisturbed or unaffected conditions of the surrounding environment.
Amphipods	A large order of predominantly marine crustaceans, ranging from free-living, planktonic forms to benthic, tube-dwelling forms, which usually have laterally compressed bodies (sand fleas, etc.).
Anaerobic digestion	Digestion of organic matter by bacterial action in the absence of oxygen.
Anthropogenic	Relating to the effects or impacts of man on the ecosystem.
Anticyclonic	A rotation about the local vertical that is clockwise in the Northern Hemisphere.
Anticyclonic eddies	Mesoscale (50 to 100 km) features of oceanic circulation in which water flows in a circular (clockwise) pattern around warm core waters.

Apex	See New York Bight Apex.
Appropriate sensitive benthic marine organisms	Species representing different feeding types (filter-feeding, deposit-feeding, and burrowing), chosen from the most sensitive species accepted by EPA as being reliable test organisms to determine the anticipated impact on the site.
Appropriate sensitive marine organisms	At least one species each, representative of phytoplankton or zooplankton, crustacean or mollusk, and fish species chosen from the most sensitive species documented in the scientific literature, or accepted by EPA as being reliable test organisms to determine the anticipated impact of the wastes on the ecosystem at the disposal site.
Aqueous	Similar to, containing, or dissolved in water.
Assemblage	A recurring group of organisms having a common habitat.
Background level	The naturally occurring (or ambient) level of a substance within an environment.
Baseline data	Data collected prior to the initiation of actions which have the potential of altering an existing environment.
Baseline surveys	Surveys conducted to collect information prior to the initiation of actions which have the potential of altering an existing environment.
Benthos	All marine organisms (plant or animal) living on or in the bottom; also, the floor of the ocean.
Bight	A slight indentation or bend in shoreline, river, open coast, or bay.
Bioaccumulate	The intake and assimilation of materials, e.g., heavy metals, leading to an elevated concentration of the substance within an organism's tissue, blood, or body fluid.

Bioassay — Determination of the strength (potency) of a substance by its effect (on growth or survival) upon an organism--plant or animal.

Biochemical Oxygen Demand (BOD) — The amount of oxygen consumed by microorganisms while assimilating and oxidizing organic (and some nitrogenous) materials in water or wastewater under specified environmental conditions and time periods.

Biomass — The amount (weight) of living organisms inhibiting a given area or volume.

Biota — Collectively, plants and animals of a region.

Biotic groups — Organisms which are ecologically, structurally, or taxonomically grouped.

BLM — Bureau of Land Management.

Bloom — Relatively high concentrations of plankton in water resulting from their rapid growth and reproduction.

Boreal — Pertaining to the higher northern latitudes, as opposed to tropical.

°C — Degrees Celsius, formerly centigrade.

C/N — Carbon/nitrogen ratio.

Carcinogen — A substance or agent producing cancer.

CE — U.S. Army Corps of Engineers.

Cephalopods — Squid, octopus, or cuttlefish. Members of the phylum Mollusca.

CFR — Code of Federal Regulations.

Chaetognaths — A phylum of small, elongate, free-swimming transparent, wormlike invertebrates, also known as arrow-worms, which are important carnivores in the zooplankton community, with chaetae (bristles) curved on each side of the mouth.

Chlorophyll — A group of green plant pigments which function as photoreceptors of light energy for photosynthesis.

Chlorophyll a	A specific green plant pigment used in photosynthesis, and used as a measure of phytoplankton biomass.
Chronic effect	A sublethal effect of a substance on an organism which reduces the survivorship of that organism after a long period of exposure to low concentrations of the substance.
cm	Centimeter(s).
cm/sec	Centimeters per second.
Coccolithophorid	Ultra-microscopic planktonic algae, the cells of which are surrounded by an envelope of small calcareous discs.
Coelenterate	A animal phylum which includes hydroids, sea anemones, jellyfish, and corals.
Compensation depth	The depth at which photosynthetic oxygen production equals oxygen consumed by plant respiration.
Continental margin	The zone between the shoreline and the deep ocean floor; generally consists of the Continental Shelf, Continental Slope, and the Continental Rise.
Continental Rise	A transitional portion between the Continental Slope and the ocean floor which is less steeply sloped than the Continental Slope.
Continental Shelf	The continental margin extending seaward from the coast to a variable depth, generally 200 m.
Continental Slope	The steeply descending slope lying between the Continental Shelf and the Continental Rise.
Contour line	A chart line connecting points of equal depth above or below a reference plane, generally sea level.
Copepod	A large subclass of usually small crustaceans; they are an important link in the oceanic food chain.

Coriolis effect — An apparent force acting on moving particles resulting from the earth's rotation. In the northern hemisphere moving particles are deflected to the right, and in the southern hemisphere to the left.

Crustaceans — Animals with jointed appendages and a segmented external skeleton composed of a hard shell (chitin). The group includes barnacles, crabs, shrimps, and lobsters, copepods, and amphipods.

Ctenophores — An animal phylum superficially resembling jellyfish, ranging from less than 2 cm to about 1 m in length. These planktonic organisms are commonly referred to as comb jellies or sea walnuts.

Cuesta — An asymmetrical ridge with one slope gentle and the other steep.

Current meter — Any device for measuring and indicating flow rate, velocity, or direction (often all three) of flowing water.

Current shear — The measure of the spatial rate of change of current velocity with units of cm-sec/sec/m^1.

Decapod — The largest order of crustaceans in which the animals have five pairs of locomotory appendages, each joined to a segment of the thorax. Includes crabs, lobsters, and shrimp.

Demersal — Living at or near the bottom of the sea. Applies mainly to fish.

Density — The mass per unit volume of a substance.

Diatom — Single cell, usualy planktonic plant with a cell wall of silica. Abundant world wide.

Diffusion — The process whereby particles in a liquid intermingle spontaneously; net motion is from an area of higher concentration to an area of lower concentration.

Dinoflagellate	Single-celled, planktonic organisms with flagella, which are an important part of marine food chain.
Discharge plume	The region of seawater affected by a discharge of waste which can be distinguished from the surrounding water.
Dispersion	The movement of discharged material over large areas by the natural processes of mixing (turbulence and currents).
Dissolved oxygen	The quantity of oxygen dissolved in a unit volume of water; usually expressed in mg/liter.
Dissolved solids	Solid matter in solution, such as salt dissolved in water.
Diversity	A measure that usually takes into account the number of species and the relative abundance of individuals in an area.
Dominance	A species or group of species which strongly affect a community because of their abundance, size, or control of energy flow.
Dry weight	The weight of a sample of materials and/or organisms after all water has been removed; a measure of biomass.
EC_{50}	In bioassay studies, the concentration of a substance which causes a 50 percent reduction in the growth rate of the test organisms (usually phytoplankton) during a unit time (usually 96 hours).
Echinoderms	A phylum of benthic marine animals having calcareous plates and spines forming a rigid articulated skeleton or plates with spines embedded in the skin. This group includes starfish, sea urchins, sea lilies and sea-cucumbers.
Economic resource zone	The oceanic area within 200 nmi from shore in which the adjacent coastal state possesses exclusive rights to the living and non-living marine resources.

Ecosystem	A functional system which includes the organisms of a natural community or assemblage together with their physical environment.
Eddy	A generally circular water current moving contrary to the direction of the main current.
EIS	Environmental impact statement.
Endemic	Restricted or peculiar to a locality or region.
Entrain	To carry along with (e.g., eddies entrain other waters).
EPA	U.S. Environmental Protection Agency
EPA Region II	U.S. Environmental Protection Agency, Region II, New York, N.Y.
Epifauna	Animals which live on the surface of the sea bottom.
Epipelagic	Ocean zone extending from the surface to 200 meters in depth.
Estuary	A semienclosed coastal body of water, which has a free connection to the sea and within which the sea water is measurably diluted with fresh water.
Euphausiids	Shrimp-like, planktonic crustaceans which are widely distributed in oceanic waters. These organisms, also known as krill, may grow to 8 cm in length and are an important link in the oceanic food chain.
°F	Degrees Fahrenheit.
Facies	Any observable attribute of a stratigraphic unit, such as overall appearence or composition.
Fauna	The animal life of a particular location, region, or period.
FDA	Food and Drug Administration.
Flagellum (pl. -a)	Whip-like appendage(s) used for swimming.

Flocculate	The process of aggregating a number of small, suspended particles into small masses.
Flora	The plant life of a particular location, region, or period.
FWPCA	Federal Water Pollution Control Act.
g/cm^3	Grams per cubic centimeter.
Gangue	Mineral matrix, useless rocks.
Gastropods	Mollusks that possess a distinct head (generally with eyes and tentacles) and a broad, flat foot, and which usually have a spiral shell (snails, etc.).
Geostrophic current	A stable current due to gravitational forces and the Coriolis force.
Gulf Stream	A warm, swift, northward flowing ocean current flowing through the Caribbean, Gulf of Mexico and up the North American East Coast.
Heavy metals or elements	Elements with specific gravities of 5.0 or greater.
High-level radioactive waste	The aqueous or solid wastes from reprocessing irradiated fuel of nuclear power reactors.
Histopathology	The study of tissue changes associated with disease.
H'values	Shannon-Wiener species diversity index.
Hydrography	The measurement and description of the physical features of bodies of water.
Ichthyoplankton	Fish eggs and weakly motile fish larvae.
IEC	Interstate Electronics Corporation.
Indigenous	Having originated in and being produced, grown, or naturally occurring in a particular region or environment.
Infauna	Animals which live or burrow below the sea bottom.
In situ	(Latin) in the original or natural setting.

Insolation	Solar radiation received at the earth's surface.
Invertebrates	Animals without backbones.
ISC	Interstate Sanitation Commission.
Isobath	A line on a marine chart joining points of equal depth below sea level.
kg	Kilogram(s).
kg/day	Kilograms per day.
km	Kilometer(s).
kn	Knot(s), nautical miles per hour.
LC_{50} (Lethal concentration 50)	In bioassay studies, the lethal concentration (LC) of a substance which causes 50 percent mortality in the population of the test organisms during a given time (usually 96 hours).
Limiting permissible concentration (LPC)	A concentration of a waste substance which after initial mixing, does not exceed marine water quality criteria or cause acute or chronic toxicity.
Loran-C	Long Range Aid to Navigation (Type C).
m	Meter(s).
m^3	Cubic meters.
m/sec	Meters per second.
μ	Micron(s), 10^{-6} m.
μg/kg	Micrograms per kilogram, or millionth gram per kilogram.
μg/l	Micrograms per liter, or millionth gram per liter.
μm	Micron, micrometer, millionth of a meter.
Macrozooplankton	Planktonic animals which can be seen by the unaided eye.
Marine	Pertaining to the sea.

Massif	A mountainous mass or group of connected heights, more or less clearly marked off by valleys (land or submarine).
Mesopelagic	Relating to depths of 200 to 1,000 m below the ocean surface.
mg	Milligram(s), or thousandth(s) gram.
MGD	Million gallons per day (3.785 million liters per day).
mg/l	Milligrams per liter.
mi	Mile(s), 5,280 ft.
Micron	Millionth(s) of a meter.
Microorganisms	Microscopic organisms including bacteria, protozoans, and some algae.
Mid-Atlantic Bight	The Continental Shelf extending from Cape Cod, MA. to Cape Hatteras, NC.
Mixed layer	The upper layer of the ocean which is well mixed by wind and wave activity.
ml	Milliliter(s), or thousandth(s) liter.
ml/m^2/hr	Milliliter(s) per square meter per hour.
mm	Millimeter(s), or thousandth(s) meter.
Monitoring	As used herein, to observe environmental effects of disposal operations through biological, chemical, geological, and physical data collection and analyses.
mph	Miles per hour.
MPRSA	Marine Protection, Research, and Sanctuaries Act.
Mutagen	A substance which increases the frequency or extent of mutations.
Myctophids	A group of small mesopelagic fish which possess light-emitting organs and undergo large-scale vertical (deep to near-surface) migrations daily.

Nannoplankton	Minute planktonic plants and animals which are 50 microns or less in size. Individuals of this size will pass through most plankton nets and are therefore usually collected by centrifuging water samples.
NAS	National Academy of Science.
NASA	National Aeronautics and Space Administration.
Nekton	Free swimming animals which move independently of water currents.
NEPA	National Environmental Policy Act of 1969.
Neritic	Pertaining to the region of shallow water adjoining the seacoast and extending from low-tide mark to 200 m depth.
Neuston	A community of planktonic organisms which are associated with the surface film of water; mainly composed of certain copepods and the eggs and larvae of fish.
New York Bight	The continental shelf which extends from Montauk Point, Long Island to Cape May, New Jersey.
New York Bight Apex	A portion of the New York Bight bounded at the south by latitude 40°10'N and at the east by longitude 73°30'W.
NJDEP	New Jersey Department of Environmental Protection.
nmi	Nautical mile(s), 6,080 ft or 1.852 km.
NOAA	National Oceanic and Atmospheric Administration.
NOAA-MESA	National Oceanic and Atmospheric Administration-Marine EcoSystems Analysis.
NOAA-NMFS	National Oceanic and Atmospheric Administration-National Marine Fisheries Service.
NSF	National Science Foundation.

Nuisance species	Organisms with no commercial value which outcompete, oust, or harm commercially important species.
Nutrient	Any substance which promotes growth or provides energy for biological processes.
OCS	Outer Continental Shelf.
ODSS	Ocean Dumping Surveillance System.
Organophosphate Pesticides	A phosphorus-containing organic pesticide, such parathion or malathion.
Ortho-phosphate	One of the possible salts of orthophosphoric acid, an essential nutrient for marine plant growth.
Oxygen minimum layer	The depth in the water column where the lowest concentration of dissolved oxygen naturally occurs.
Parameters	Any of a measurable set of physical, geological, chemical, or biological properties whose values determine the characteristics of the area under certain conditions.
Particulates	Fine solid particles which are individually dispersed in water.
Parts per thousand (ppt; o/oo)	A unit of concentration of a mixture indicating the number of parts of a constituent contained per thousand parts of the entire mixture.
Pathogen	Producing or capable of producing disease.
PCB('s)	Polychlorinated biphenol(s).
Pelagic	Pertaining to water of the open ocean beyond the shore and above the abyssal zone.
Perturbation	Disturbance of a natural or regular system.
pH	Numerical range (0-14) used to describe the hydrogen ion activity; 0-7 is acid, 7 is neutral, 7-14 is alkaline.

Photic Zone	The layer in the ocean from the surface to the depth where light is reduced to 1.0% of its surface value.
Phytoplankton	Planktonic plants; the base of most oceanic food chains.
Plankton	Passively floating or weakly motile plants or animals in a body of water.
Polychaetes	The largest class of the phylum Annelida (segmented worms) distinguished by paired, lateral, fleshy appendages provided with setae on most segments.
ppb	Parts per billion.
ppm	Parts per million.
ppt	Parts per thousand.
Precipitate	A solid which separates from a solution or suspension by chemical or physical means.
Predator	A carnivorous animal which uses other animals as a source of food.
Primary Production	The amount of organic matter synthesized by plants from inorganic substances per unit time per unit area or volume. The plant's respiration may (net productivity) or may not (gross productivity) be subtracted.
Protozoa	Microscopic, single-celled organisms of extremely diverse characteristics.
Qualitative	Pertaining to the nature, being, attribute, trait, character, or status.
Quantitative	Pertaining to the numerical measurement of a parameter (quantity, mass, extent, range).
Recruitment	Addition to a population of organisms by reproduction or immigration of new individuals.
Redox potential	Measurement of the state of oxidation of the system.

Release zone — An area 100 meters on either side of the disposal vessel extending from the point of first waste release to the end of the release.

Runoff — That portion of total surface precipitation on land that ultimately reaches streams or the ocean.

Salinity — The amount of dissolved salts in water usually measured in parts per thousand.

Sea state — The numerical or written description of ocean roughness.

sec — Second(s).

Shelf water — Water which originates in or can be traced to the Continental Shelf. It has characteristic temperature and slainity values which identify it.

Shellfish — Any aquatic invertebrate having a shell or exoskeleton, especially any edible mollusk or crustacean.

Shiprider — An observer aboard a vessel, assigned by the Coast Guard to ensure that ocean disposal operations are conducted according to permit specifications.

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

Significant wave height — The average height of the one-third highest waves in a given wave group.

Slope water — Water which originates from, occurs at, or can be traced to the Continental Slope. It has characteristic temperature and salinity values which identify it.

Sludge — Precipitated solid matter from sewage and chemical waste treatment processes.

Species — A group of individuals which closely resemble each other structurally and physiologically and interbreed in nature, producing fertile offspring.

Specific gravity	The ratio of the density of a substance relative to the density of pure water at 4°C.
SPM	Suspended particulate matter.
sq	Square.
SS	Suspended solids.
Standing stock	The biomass or abundance of living material per unit volume or area of water.
Stressed	A stimulus or series of stimuli which disrupt the normal ecological functions of an area.
Surfactant	An agent which lowers surface tension of a liquid, (in water - soap, bile and certain detergents).
Surveillance	Systematic observation of an area by visual, electronic, photographic, or other means for the purpose of ensuring compliance with applicable laws, regulations and permits.
Suspended solids	Finely divided particles of a solid temporarily suspended in a liquid, e.g., soil particles in water.
Synergism	The interaction between two or more agents which produces a total effect greater than the sum of the independent effects.
Taxon (pl. taxa)	A group or entity sufficiently distinct to be distinguished by name and to be ranked in a definite category (adj. taxonomic).
TCH	Total carbohydrate content.
Temporal distribution	The distribution of a parameter over time.
Teratogen	A chemical agent which causes developmental malformations and monstrosities.
Terrigenous sediments	Shallow marine sedimentary deposits composed of eroded terrestrial material.

Thermocline	A sharp temperature gradient which separates a warmer surface water layer from a cooler subsurface layer, most pronounced during summer months.
TKN	Total Kjeldahl nitrogen.
TOC	Total organic carbon.
Trace metal or element	An element found in the environment in extremely small quantities.
Trend assessment Surveys	Surveys conducted over long time periods to detect shifts in environmental conditions within a region.
Trophic level	A feeding level in the food chain of an ecosystem through which the passage of energy proceeds.
Turbidity	A reduction in transparency which, in seawater, may be caused by suspended sediments or plankton growth.
Turnover rate	The time necessary to replace the entire standing stock of a population; generation time.
USCG	U.S. Coast Guard.
Water mass	A body of water usually identified by its temperature, salinity and chemical content and containing a mixture of water types.
Water type	Water defined by a narrow range of temperature and salinity.
Wet weight	The weight of organisms before drying them to remove the internal water.
yd^3	Cubic yard(s)
Zooplankton	Usually small, passively floating or weakly swimming animals which are important in many marine food chains.

UNITS OF MEASURE (ENGLISH EQUIVALENTS OF METRIC UNITS)

Metric	English	
centimeter (cm)	0.4	inches (in)
meter (m)	1.1	yards (yd)
kilometer (km)	0.62	statute miles (mi)
	0.54	nautical miles (nmi)
square meter (sq m; m^2)	1.2	square yards (sq yd; yd^2)
square kilometer (sq km; km^2)	0.29	square nautical miles (sq nmi; nmi^2)
gram (g)	0.035	ounces (oz)
kilogram (kg)	2.2	pounds (lb)
metric ton (tonne)	1.1	short tons; (short ton = 2,000 lb)
liter (l)	0.26	gallons (gal)
cubic meter (cu m; m^3)	1.3	cubic yards (cu yd; yd^3)
centimeters/second (cm/sec)	0.39	inches/second (in/sec)
kilometers/hour (km/hr)	0.54	knots (kt), nautical miles/hour
celsius (°C)	(9/5 °C + 32) Fahrenheit (°F)	

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Appendix A
NEW YORK ACID SITE

CONTENTS

ILLUSTRATIONS

TABLES

Appendix A

ENVIRONMENTAL CHARACTERISTICS OF THE NEW YORK BIGHT

An understanding of the oceanographic features of the New York Bight is essential for an evaluation of the effects of acid waste disposal. The Bight is adjacent to the most heavily populated, highly industrialized section of the eastern seaboard, and is a heavily used and environmentally "stressed" coastal area. It receives wastes from 20 million people and a number of major industries. Municipal and industrial wastewater effluents, urban runoffs, atmospheric fallout, and materials dispersed at different dumpsites add large quantities of heavy metals, nutrients, organic matter, and chlorinated hydrocarbons to the Bight waters. The Bight supports important commercial and recreational fisheries and other activities (MESA, 1977).

Records are extensive for the region. The MESA New York Bight Atlas and Monograph series describe the area excellently. Other MESA-sponsored works exist as data reports, technical reports, and technical memos (MESA, 1978b). A detailed technical summary resulted from a symposium (Gross, 1976c) sponsored by the American Society of Limnology and Oceanography in November 1975. Earlier, workers from the Atlantic Oceanographic and Meteorological Laboratory had assessed the nonbiological aspects of the Bight (Charnell, 1975).

METEOROLOGY

Seasonal meteorological events affect man's use of the New York Bight for waste disposal, shipping, resources, and recreation. Meteorology is an important influence on physical characteristics of the area, which determine dispersion of wastes. Sufficient knowledge and predictability of meteorology exist to permit site designation for waste disposal, with minimal danger to workers on disposal operations. Excellent sources for the conditions in the Bight are Williams and Godshell (1977), Mohnen (1977), and Lettau et al. (1976).

WINDS AND STORMS

Winds

Bryson and Lahey (1958) defined the natural seasons of the New York Bight as winter (November to March) and summer (July to August). Wind speeds are usually moderate. During the winter, winds are offshore breezes with average speeds of 9 to 13 kn while summer winds are onshore with average speeds of 5 to 9 kn. Strong winds (between 28 and 40 kn) are more common in the winter (10% of all observations) than in summer (1% of all observations) but strong winds (greater than 40 kn) have occurred during every month.

Highest recorded winds for New York Bight were due to tropical storms. In 1960, wind speeds recorded from hurricane Donna were 61 kn (70 mph) from the northeast at La Guardia Airport; wind speeds of 98 kn (113 mph) from hurricane Hazel were recorded at The Battery in 1954 (Lettau et al., 1976).

Storms

Seasonal storms are characteristic of the New York Bight area. Extra-tropical (northeasterly) storms are common from November until April (Pore, Richardson, and Perroth, 1974) while tropical storms (hurricanes) usually occur in the late summer or early autumn (Pore and Barrientos, 1976). Pore and Barrientos (1976) reported that an average of 6.8 storms per year cause moderate to severe coastal damage. The recorded frequency of northeasters (10 to 14 days) is greater than hurricanes (4 to 7 years). Storms may restrict a particular disposal operation, but frequencies or severities are not sufficient to restrict all disposal operations.

VISIBILITY

Visibility in the New York Bight is influenced by fog, smoke, and haze. Thick fogs occur, but not frequently enough to restrict sailing to and from the site.

Fog

The maximal incidence of fog occurs from May to July, when the greatest differences between sea and air temperatures exist. Fog is not generally frequent between October and March, but heavy fogs occasionally occur. The monthly frequency of restricted visibility in the New York Bight is summarized in Table A-1.

TABLE A-1. INCIDENCE OF FOG IN THE NEW YORK BIGHT

Limit Of Visibility	Average Days/Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1/4 Mile	1.1	0.8	3.3	0.8	7.4	4.0	4.6	0.3	0.6	1.9	1.8	0.5
1 Mile	4.2	3.6	5.6	3.0	11.5	7.7	6.6	4.2	3.0	3.3	2.9	1.6

Source: Modified from Williams and Godshall, 1977.

When necessary, disposal operations can be performed under conditions of restricted visibility and fog, smoke or haze (see below), and these do not constitute important factors which restrict use of sites in New York Bight.

Smoke and Haze

Smoke is an anthropogenic product, and its effects decrease offshore. Haze often comprises dust and salt particles, and haze frequencies are evenly distributed over the Bight. Maximal peaks of haze are associated with southwesterly winds, while minimal values are usually recorded when there are northwesterly winds (Lettau et al., 1976). Neither smoke nor haze significantly restrict navigation in the Bight area.

AIR TEMPERATURE

Air temperatures in the New York Bight range from a mean low of 2°C (36°F) in February, to a mean high of 22°C (approximately 72°F) in August (Lettau et al., 1976). Only a slight icing potential occurs between December and March (Table A-2).

TABLE A-2. ICING CONDITIONS IN THE NEW YORK BIGHT

Icing Potential	Percent Per Month			
	Dec	Jan	Feb	Mar
Light	---	4.8	6.2	1.3
Moderate	---	0.9	0.3	---

Source: Modified from Williams and Godshall, 1977.

PRECIPITATION

The winter months (November to March) have the highest incidences of combined precipitation (rain and/or snow), which occur more frequently in winter, but average monthly Bight values indicate only slight seasonal changes (Table A-3).

TABLE A-3. AVERAGE PRECIPITATION PER MONTH
(Nearest 1.0 inch)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3	3	4	4	4	3	4	5	3	3	4	4

Source: Modified from Lettau et al., 1976.

PHYSICAL OCEANOGRAPHY

Physical characteristics of the New York Bight are complex. Seasonal temperature, salinity, insolation, and river runoff are complicated by meteorological phenomena and intrusions of slope water (Bowman, 1977).

New York Bight hydrography exhibits clear seasonal cycles in temperature, salinity, and density parameters. Two distinct oceanographic regimes, with short intervening transition periods prevail annually. Early winter storm mixing and rapid cooling at the surface create a well-mixed, unstratified water column. A moderate stratification develops in early spring due to heavy runoff from the Hudson, Raritan, and other rivers. With increasing vernal warming, stratification changes rapidly from a saline to a thermally maintained formation. Transition is rapid, usually occurring within one month (Charnell and Hansen, 1974). Rapid formation of the seasonal thermocline divides the water column into upper and lower layers. Bottom waters retain specific characteristics with little modification until storms break up the thermocline in the late autumn.

Familiarity with physical characteristics of New York Bight helps to understand waste disposal since these factors determine immediate dilution and dispersion of wastes and the transposition of contaminants. Excellent sources for physical oceanographic patterns in the Bight are Hanson (1977) and Hardy et al. (1976).

WATER TYPES

Three water types have been identified in the New York Bight shelf waters by Hollman (1971): (1) Inlet Water (hereafter called Hudson River Plume Water, after Bowman and Wunderlich, 1977), (2) Surface Shelf Water, and (3) Bottom Shelf Water.

HUDSON RIVER PLUME WATER

The combined discharge of the Hudson and Raritan rivers flows from the Lower Bay into the northwest corner of the Bight Apex as a low-salinity plume, less dense than the Shelf Waters. Consequently, Hudson River Plume Water floats over the Shelf Waters in the Bight. Discharge volumes are maximal in April and minimal in August. Approximately half the annual discharge occurs during March, April, and May (Bowman and Wunderlich, 1976). This river flow lasts as a plume all year, the extent and depth being highly dependent on flow rates in the Hudson and Raritan Rivers (McLaughlin et al., 1975). Generally, the plume flows southward between the New Jersey coastline and the axis of the Hudson Shelf Valley. During the winter, however, the plume may flow eastward between the southern coast of Long Island and the axis of the Hudson Shelf Valley, or, in some instances, the plume may split and flow both eastward and southward.

SURFACE SHELF WATER

With the onset of heavy river discharge in the spring, surface salinities in the Bight decrease and a moderate saline-maintained stratification occurs, separating Surface Shelf Water from Bottom Shelf Water. Decreasing winds and increasing insolation, however, cause a stronger thermocline to develop (Charnell and Hansen, 1974). This two-layer system reaches its maximum strength by August. Surface Shelf Water is characterized by moderate salinity and high temperature.

BOTTOM SHELF WATER

During winter, the water is essentially homogeneous over the Bight Shelf. With the rapid formation of the thermocline and separation of Surface Shelf Water in the spring, bottom waters become isolated until the next winter. Bigelow (1933) found that this "cool pool" (temperatures typically less than 4°C) extended from south of Long Island to the opening of Chesapeake Bay. This cold water persists even after the surface layers have reached the summer maximum. Bigelow (1933) also found that the cool pool was surrounded on all sides by warmer water. The upper layer of the Bottom Shelf Water is usually found between 30 and 100 m during the summer (Bowman and Wunderlich, 1977). Seaward, near the Shelf edge, steep temperature, salinity, and density gradients prevent large-scale mixing from occurring between Shelf and Slope Waters.

CURRENT REGIMES

Currents in the New York Bight are characterized by large temporal variability, which makes it impossible to resolve the "average" current patterns. This great variability results from several competing influences (namely, tidal currents, estuarine and Shelf valley circulation, and local wind effects). The currents may be so random that only their statistical effects, not their organized patterns, can be predicted (Hansen, 1977).

TIDAL CURRENTS

The flow of the tidal current in the middle-Shelf region of the New York Bight is anticyclonic (clockwise). Velocities decrease offshore and the tidal ellipse is on a northwest/southeast axis. Tidal currents are important in the initial distribution (mixing and dispersion) of dumped materials on the bottom. They may also resuspend settled solids. Although bottom tidal current velocities are low, about 10 cm/sec, coupled with wind-driven currents during storms, they can resuspend and subsequently redistribute sediments.

SURFACE CURRENTS

The synergistic effects of temperature, salinity, river runoff, prevailing winds, and tides produce complex and variable circulation patterns within the Bight (Hardy et al., 1976). Seaward of the 100-m contour, geostrophic drift induces westerly to southwesterly currents having an average speed of 10 cm/sec. Within the 100-m isobath, surface currents are highly variable and strongly influenced by winds and surface runoff. Currents within 30 km of shore still depend on winds for direction but have consistently higher velocities than the distant offshore areas. The southerly flow of the Hudson River plume along the coast forces an opposing northward flow of more saline waters to the east. Consequently, the nearshore water often contains a small anticyclonic (clockwise) gyre (Hardy et al., 1976).

In general, average surface currents inshore of the 100-m isobath (which includes the entire Apex) flow alongshore southward from Cape Cod to Cape Hatteras at mean speeds of about 5 cm/sec (Bumpus, 1973), except during periods of strong southerly winds and low runoff (Bumpus, 1969). Flows in the outer Bight are characteristically southwest with speeds of 4 to 5 cm/sec at the surface decreasing to 2 cm/sec, or less, closer to the bottom.

BOTTOM CURRENTS

Near the Hudson estuary, classical estuarine circulation occurs with low-salinity surface water flowing offshore and more saline water flowing onshore along the bottom. Hansen (1977) reports that average shoreward current speeds as great as 5 cm/sec have been observed in the Hudson Shelf Valley over periods as long as a month. Bumpus (1973), summarizing 10 years of sea-bed drifter returns, has inferred that onshore Bottom Shelf current speeds average 0.9 to 1.3 cm/sec.

The axis of the Hudson Canyon separates the general bottom currents. East of the canyon, flow is westerly; west of the canyon, flow is northerly. This cooler, more saline bottom water, may reach the Hudson River estuary, dependent upon the season and amount of surface runoff; bottom water may reach the surface during periods of southwesterly winds which cause upwelling south of Long Island (Hardy et al., 1976).

TEMPERATURE DISTRIBUTION

Water temperatures in the Bight follow well-defined seasonal cycles. Surface waters usually reach a minimum (2°C) in January when strong vertical mixing and low river runoff create a vertically homogeneous water mass. In April, the surface waters begin to warm with a thermocline developing during the late spring and early summer. The thermocline is strongest in the late summer, with surface temperatures peaking (24°C to 26°C) in early August. The thermocline begins to decay with normal cooling and by late October, the isothermal layer is 20 m thick. By mid-November further cooling and winter storms produce an almost homogenous water mass within the 80-m contour (Bowman, 1972 and 1977).

SALINITY DISTRIBUTION

The salinity cycle is more complex than the temperature cycle because of three factors which influence salinity: (1) the influx of river runoff, (2) evaporation minus precipitation, and (3) the advection and mixing of more saline Slope Water (Bowman, 1977). Maximum salinities (33 to 34 ppt) are found inshore during the winter (February and March) when subfreezing conditions reduce river runoff. River runoff during the spring thaw reduces the surface salinity and strong vertical gradients may develop. In summer, surface salinities are at their minimum (27 to 31 ppt) and bottom salinities are 27 to 29 ppt. In the late summer, when the fresh water input decreases, salinities begin to increase towards their winter maximum (Bowman and Wunderlich, 1977).

WAVES AND WINDS

SURFACE WAVES AND WINDS

Waves are beneficial in diluting and dispersing the waste more rapidly until they become too high and restrict disposal operations. Figure A-1 shows the distribution of the percentage frequency of waves greater than or equal to 1.5 m (solid lines) and greater than or equal to 3.7 m (dashed lines) for the mid-Atlantic Bight. Wave energies are greater in winter. The contours parallel the coast and most of the higher frequencies seaward. Wave directions parallel the wind patterns over the northeast United States. There is a distinct reversal in the prevailing wind pattern between summer and winter. During the summer (May through August) wind and waves derive most frequently from the southwest. In the winter (September through April), wind and waves are most frequently from the northwest.

Wave heights greater than 6.1 m occur about 2% of the time in the winter months of December, January, and February. The median significant wave height for this region is about 1.2 m in winter and about 0.6 m in summer. The Middle Atlantic Bight is generally not subject to unusually high waves (U.S. Naval Weather Service Command, 1970).

INTERNAL WAVES

Internal waves on the Continental Shelf and in the Hudson Shelf Valley have been identified in satellite imagery studies (Apel et al., 1974). Stratified water conditions must be present for the generation of internal waves which can contribute to sediment resuspension and must be considered in evaluating bottom sediment transport.

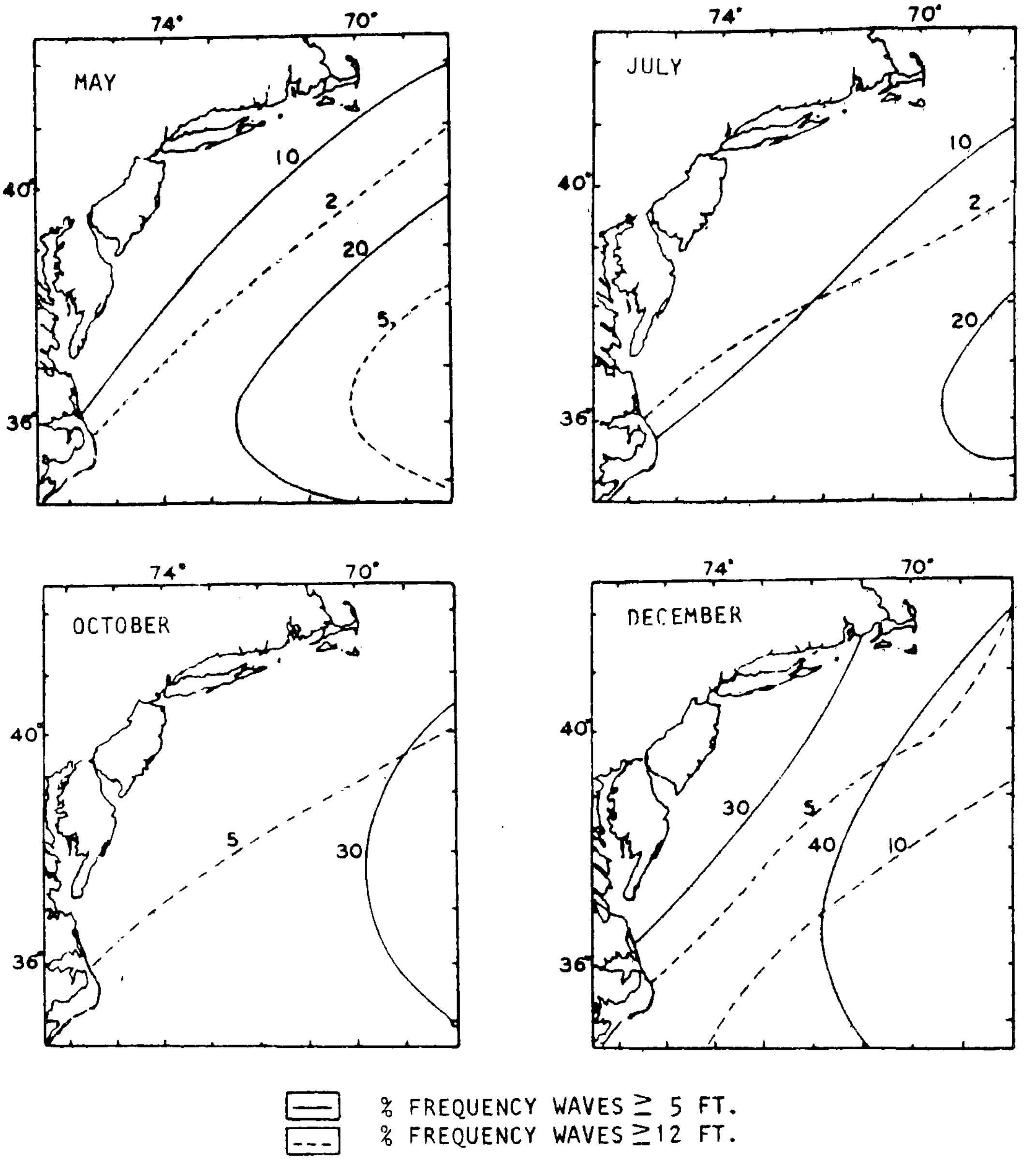


Figure A-1. Frequency of Waves on a Percentage Basis from Month to Month (Bumpus et al., 1973)

GEOLOGY

The New York Bight extends 430 nmi (800 km) from Cape May, New Jersey to Montauk Point, Long Island. Offshore New York City, the Continental Shelf extends 100 nmi (180 km) seaward, and a series of Shelf valley complexes has formed because of the postglacial sea-level rise (Swift et al., 1976). The Bight Apex is north of 40°10'N (Shark River, New Jersey) and west of 73°30'W (Jones Beach, Long Island).

The most common sediments in the Bight are fine to medium sands. Isolated patches of coarse sand and gravel occur near the Long Island and New Jersey shores. The Continental Shelf contains numerous ridges and troughs which resemble remnant barrier islands. The Hudson Channel, a relict submarine canyon, transverses the shelf and extends from the mouth of New York Harbor south to the head of Hudson Canyon. The Hudson Canyon runs in a southeast direction, to the edge of the Shelf (Williams, 1974). Stubblefield et al, (1977) reported that the sediments in the Bight are in textural equilibrium in the existing hydraulic climate. Silts and muds may accumulate only below depths of 24 m.

BATHYMETRY

The well-defined Shelf valley complexes, which are narrow or broad shallow depressions, are scoured by currents and often terminate in delta-like terraces. Sand transported by littoral drift from nearby coasts frequently forms sills across valley heads. More extensive sand banks (called sand massifs) form on seaward shoals near estuary mouths (Figure A-2). The morphology of the Delaware, Great Egg, Hudson, and Block Shelf Valleys in the Bight follows this pattern (Swift et al., 1976).

Plateau-like expanses (stretching between Shelf valleys) vary from nearly flat plains to patterns of undulating sand ridges reaching 10 m high and 2 to 4 km apart. The ridges appear highest on the northeastern sides of the shoal massifs. This sand ridge and swale topography is characteristic of the mid-Atlantic Bight.

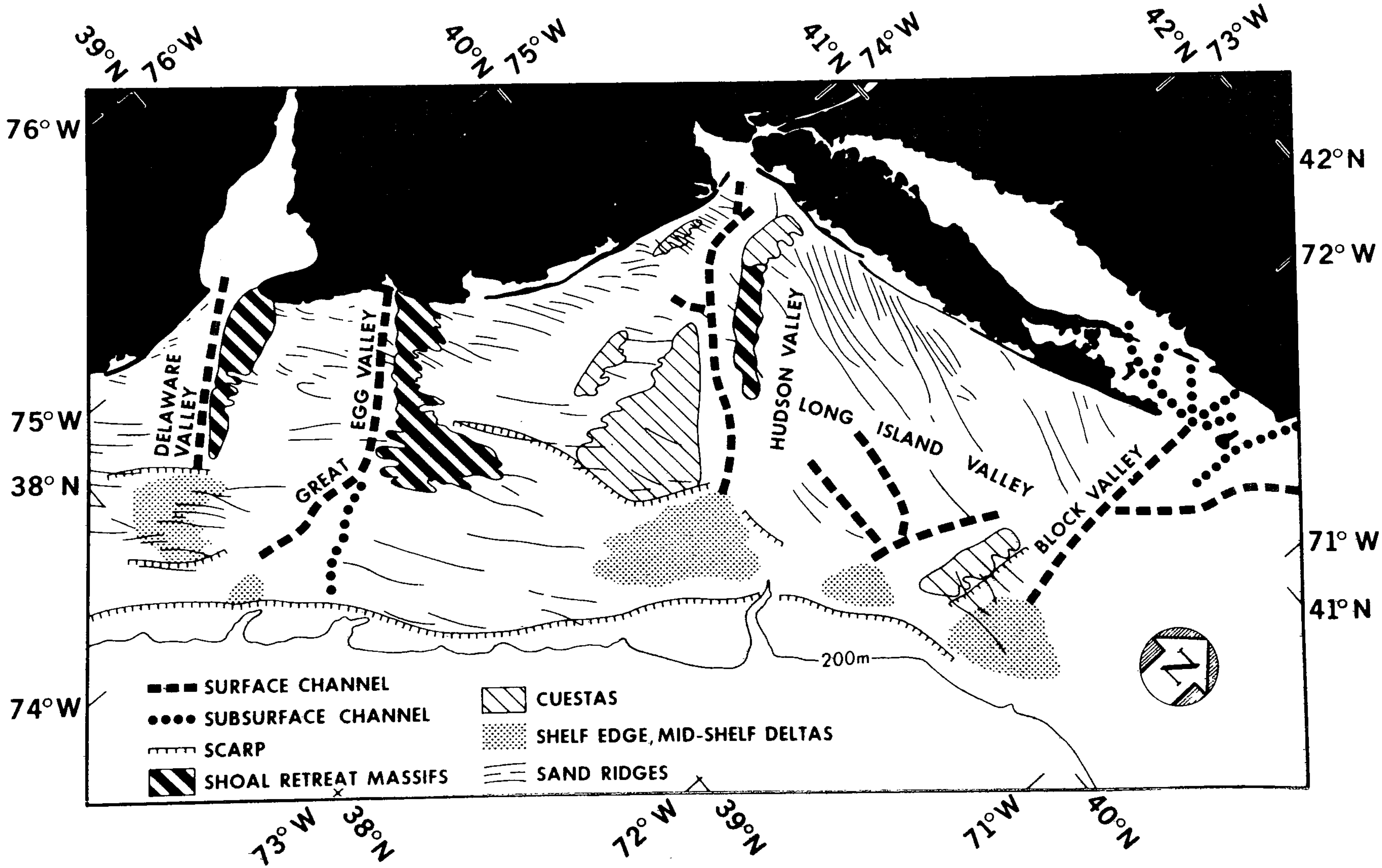


Figure A-2. Morphologic Framework of the New York-New Jersey Shelf (Modified from Swift et al., 1972)

SEDIMENT TYPES

Clean sand facies occur in the Inner and Middle Shelf, and muddy sand facies on the Outer Shelf (McKinney and Friedman, 1970). Occasionally, remnants of the mud facies on the Middle Shelf are found embedded in shell fragments buried in the clean sand, indicating that the muds were deposited prior to the clean sand (Biscaye and Olsen, 1976).

The Shelf off New York is covered by sand-sized particles with isolated gravel patches (Schlee, 1973, 1975). Silt dominates seaward of the 60-m isobath and in the Hudson Shelf Valley. Silt is also present in lagoons and estuaries with only light wave activity. Small mud patches, often seasonal in nature, occur in the nearshore areas of Long Island to the west of Fire Island.

Sediment types have been mapped in the Apex of the Bight (Freeland et al., 1976) (Figure A-3). The topographically low Hudson Shelf Valley and the Christiaensen Basin contain fine-grained sediments; the other areas contain variously sized sands and both artifact and natural gravel deposits. The most common sediments are silty fine sand and slightly gravelly fine to medium sand (Harris, 1976).

SUSPENDED PARTICULATE MATTER

The sizes of inorganic particles in the Bight Apex are similar to fine silt or clay. Suspended fluvial sediments discharged onto the Shelf are composed of 85% inorganic and 15% combustible organic materials (Hathaway, 1971). The inorganic constituents are carried from the Hudson River. The organic combustibles are from anthropogenic sources and are introduced via river outflow, surface runoff, atmospheric fallout, and ocean disposal. In general, particulate concentrations decrease with distance from the shore, especially in surface waters. Vertical mixing of suspended particles, however, is limited by the seasonal thermocline (Biscaye and Olsen, 1976).

Only about 10% of the riverborne suspended solids reach the coastal waters, and the solids are carried in the less saline, surface layer plume. Some SPM

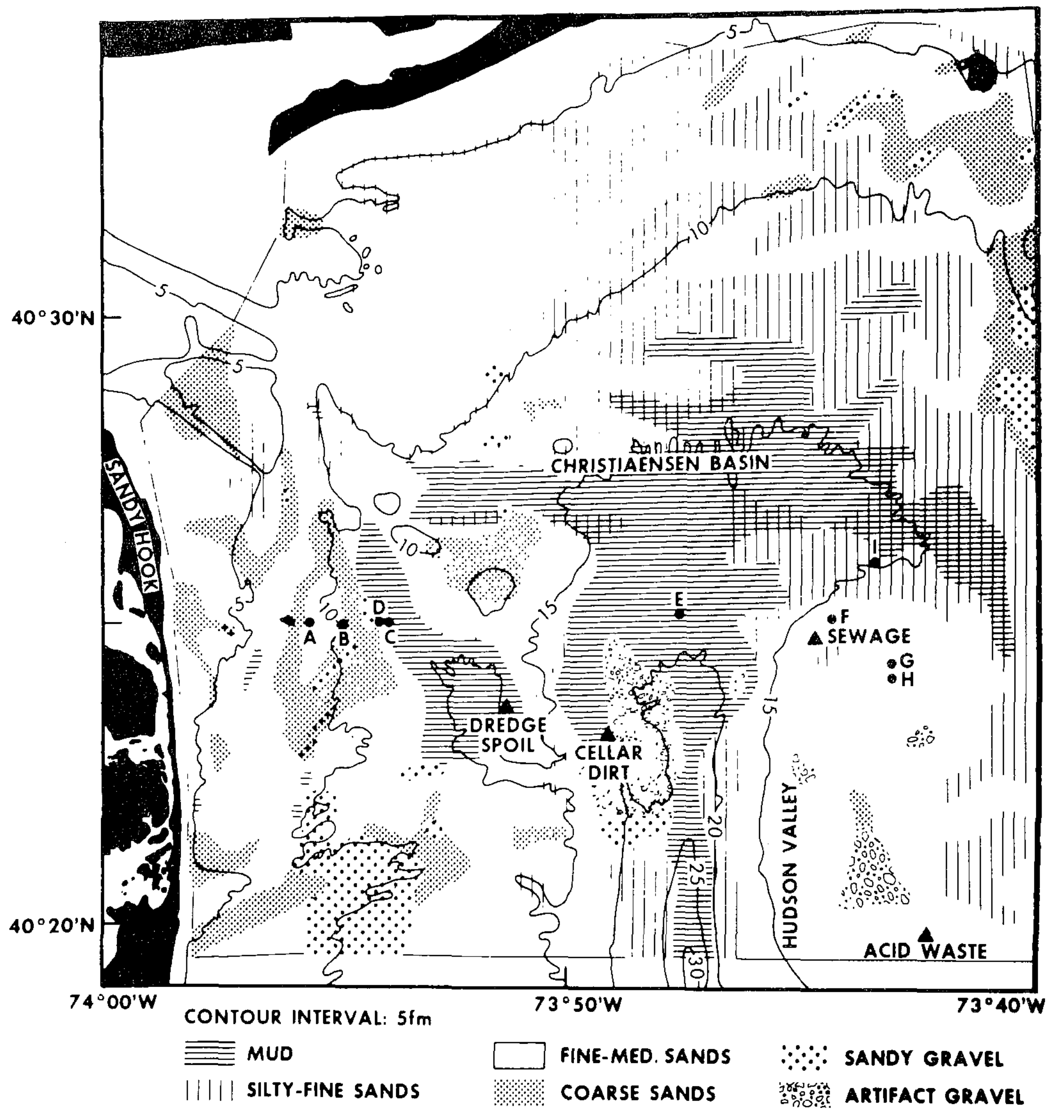


Figure A-3. Distribution of Surficial Sediment Based on Visual Sample Examination. Bathymetry from 1936 Data. (Freeland et al., 1976)

is carried back into the Lower Bay by the onshore bottom flow (Meade et al., 1975). The resuspension of fine, inorganic sediments near estuary mouths is related to the effects of wave surge and wind-drift currents in these shallow waters. Drake (1974) estimates that a single November storm resuspended 10,000 tonnes of fine sediments throughout the water column in the Bight Apex, indicating the great influence of storms in sediment resuspension.

GRAIN SIZE

Medium-coarse sands predominate on the inner and middle Shelf, whereas silts are the major components of the Outer Shelf. Inner Shelf sediments off Long Island are of uniform size (well sorted), while Middle and Outer Shelf areas are more poorly sorted. This indicates that sediments on the Inner Shelf have undergone more mixing and transport than sediments in deeper water.

Stubblefield et al. (1977) identified two sand provinces in the Bight: the New Jersey Platform sand province and the Cholera Bank sand province, where medium-grain sands predominate. Finer and coarser sands stretch out in a north- to northwest-trending band off New Jersey while the Cholera Bank sands are more homogeneous.

The topographic highs surrounding Christiaensen Basin are covered by a medium-grain sand, while towards New Jersey, sand ribbon patterns with 10- to 200-m spacing appear. Stubblefield et al. (1977) report that mud facies occur only in the tributary channel of Christiaensen Basin and on the western side. They also reported that the basin floor deposits become coarser toward shallow water.

TRANSPORT

Sediment transport is produced by two basic phenomena: tidal flow which stores sand in estuary mouths, and storm wave action which moves sand between estuary mouths. Sand discharges from surf zones off the Long Island and New Jersey coasts move towards the New York harbor mouth and have built Sandy Hook and Rockaway spits (Swift et al., 1976).

On the Shelf proper, westward and eastward currents measured from bottom, mid-depth, and surface locations showed that surface flows have an offshore component in both east and west directions (Lavelle et al., in press). However, with increasing depth, the westward bottom flows begin to parallel isobaths and the eastern flows tend to move shoreward. The result is a net southwest migration of sand particles along the bottom.

Lavelle et al. (1975) concluded that transport occurred during brief, intense transport events separated by vast periods of quiescence. As a function of excess velocity, more efficient transport occurs during intense rather than mild storms. The potential consequences are that if bottom currents in any of the dump sites exceed the threshold velocity and overcome the fractional components of the waste material (e.g., during storms), the dumpsite may be scoured clean of waste. This sequence may have occurred in the Sewage Sludge Site, where only traces of sewage sludge can be found.

Harris (1976) reported that substrate mobility is greatest near Long Island and northern Christiaensen Basin and varies seasonally. Mud dominates in the late spring and early summer and may even cross intervening sand-wave crests. Trough areas are mud-free in early fall until early spring because of bottom current scour. The mud facies moved to within 5.0 km of Long Island between winter and summer, but later moved back to 9.3 km from Long Island. The distribution of muds are very important in evaluating the effects of waste disposal since trace metals and other waste constituents are present in higher concentrations in muds than in sands.

CHEMICAL OCEANOGRAPHY

The New York Bight receives wastes from a large metropolitan area. The sources of these wastes include ocean disposal, sewage outfalls, river discharge, groundwater seepage, land runoff, petrochemical processes, and atmospheric fallout.

It is difficult to determine effects of any particular type of waste disposal since contaminant sources are so varied and inputs are large. Contaminants may be changed from one chemical state to another by synergistic interactions with seawater, biologically assisted changes, or oceanographic events which affect mixing and sediment turnover (MESA, 1974).

This section covers the spatial and temporal variability in the water column, sediments, and biota relevant to the wastes presently released at the Acid Site. References are made to various sources for those parameters (e.g., nutrients) unaffected by acid waste disposal. Sufficient chemical data are available for site designation and future decision-making for wastes released at the site.

Excellent overview sources for chemical features of the Bight are Alexander and Alexander (1977) and Segar and Cantillo (1976).

WATER COLUMN

DISSOLVED OXYGEN

Dissolved oxygen concentrations in the surface waters of the Bight are greater than or equal to the saturation level (Corwin, 1970). At a 20-m depth (66 ft) in the Apex, the percentage of saturation in control areas located outside the disposal sites was 55% to 90%.

In contrast, at 20-m depth near the edge of the Sewage Sludge Site, the oxygen concentration was 1.6 mg/l (26% saturation), and at the center of the site the saturation was 10% (Pearce, 1969). It is not known if this oxygen depression was due to sewage sludge disposal.

Subsurface oxygen concentrations may vary seasonally (Corwin, 1970). Below 10 m (33 ft), concentrations are lower in September than in November, due to stratification of the water column in the summer and higher biological and chemical oxygen demands. In April, oxygen concentrations usually approach saturation.

Garside and Malone (1978) suggest that the near-surface variation in dissolved oxygen is not significantly above zero. Oxygen production from photosynthesis in the Apex is sufficient to balance organism respiration or the degradation of organic material and anthropogenic sources from naturally occurring. With respect to total carbon respired in the Apex, 77% is derived from naturally occurring sources, sewage sludge contributes another 7%, surface runoff 7%, and the Hudson Estuary about 9% (Garside and Malone, 1978). Since the Apex-derived carbon supply is about three times greater than all other external carbon sources, normal oxygen production has been adequate to balance the respiration demands of the system. Local anoxic conditions, which occurred in some deep Bight areas during the summer of 1976, are only likely below the thermocline, when the surface (oxygenated) and subsurface (oxygen depleted) waters do not mix.

pH

The pH of Bight waters ranges from 7.6 to 8.4; surface values are usually higher than bottom values because of the dynamic relationship with atmospheric CO_2 at the surface (which increases alkalinity) and the decomposition of organic material (which increases acidity) in subsurface waters (Alexander and Alexander, 1977).

Seawater is an extremely well-buffered solution. Changes in pH are temporary and usually the pH returns to normal ambient values almost immediately after it is perturbed (Duxbury, 1971) (Appendix B).

TRACE METALS

The effects of trace metals in the water column are determined by the concentrations, chemical species, and availability to the biota. Certain metals may stimulate or depress biological activity or may become concentrated in the food chain (Alexander et al., 1974). Segar (1975) noted large temporal and geographic variations of trace metal concentrations in the Bight, caused by river discharges, ocean waste disposal, or complex oceanographic and meteorological events. Normal levels of trace metals in unpolluted seawater samples are listed in Table A-4.

Two conclusions can be drawn from these data. The values for metal concentrations in the Bight are higher than in uncontaminated sea water samples, but, apart from manganese, the ocean disposal sites do not raise actual levels in the overlying water.

These data (Table A-4) can be compared to trace metal levels in the Apex and offshore control sites (Segar and Cantillo, 1976; Table A-5). The area of disposal influence indicated in Table A-3 refers to all potential sources of contamination (acid waste, dredged material, sewage sludge, and cellar dirt).

TABLE A-4. MEAN TRACE METAL LEVELS IN UNPOLLUTED SEAWATER SAMPLES

	µg/liter (ppb)								
	Cadmium	Chromium	Copper	Iron	Mercury	Manganese	Nickel	Lead	Zinc
(1)	0.1	0.05	3	10	0.03	-	500	0.03	10
(2)	--	--	3	10	--	2	--	--	10
(3)	0.1	0.05	3	6	--	2	--	0.03	10

Source: (1) Goldberg, 1963; (2) Riley and Skirnow, 1965; (3) Buelow et al., 1968).

TABLE A-5. MEAN TRACE METAL CONCENTRATIONS IN THE NEW YORK BIGHT (Standard Deviation) µg/l (ppb)

Metal	Cadmium	Copper	Iron	Manganese	Zinc
Surface Disposal Sites' Influence	0.6 (0.42)	4.3 (1.98)	15.3 (8.38)	5.3 (1.38)	32.5 (8.66)
Control	0.8 (0.40)	4.6 (1.62)	18.6 (16.5)	3.7 (1.50)	35.0 (12.25)
10 Meters Disposal Sites' Influence	0.6 (0.28)	4.7 (1.60)	16.4 (9.88)	9.6 (5.19)	32.5 (13.23)
Control	0.5 (0.19)	4.0 (2.08)	17.1 (8.09)	4.7 (1.70)	30.0 (10.80)

Source: Modified from Segar and Cantillo, 1976. Means are for 7 months between May 1974 and March 1975.

NUTRIENTS

Acid wastes do not contain significant levels of the elements required for phytoplankton growth (Appendix D, Table D-2). Consequently, the disposal of acid waste does not markedly affect the distribution or concentration of nutrients in the water column. Therefore, seasonal and spatial variabilities of the nutrients are not discussed in this EIS. The interested reader is referred to Corwin (1970), or Alexander and Alexander (1975 and 1977) for discussions of nutrients, and to Mueller et al. (1976) for discussions of the sources and mass loads of nutrients from anthropogenic sources into the Bight.

ORGANIC COMPOUNDS

Acid waste does not contain significant amounts of organic compounds. Disposal operations, however, may affect the phytoplankton in the barge's wake. Chlorophyll *a* concentrations in seawater can be used as indicators of phytoplankton abundance, thus changes in concentrations can be used to interpret micronutrient fluctuations. In general, chlorophyll *a* concentrations are greater in the upper water column because of increased productivity in the euphotic zone and, particularly in the Apex, because of large nutrient inputs. An increase in surface water concentrations of chlorophyll *a* from 0.5 to 8.0 μg/l in September 1969, to greater than 4.0 to 8.0 μg/l in April 1970, was associated with a spring plankton bloom (Hardy, 1974).

Corwin (1970) and McCarthy (1970) have additional information about particulate carbon and organic nitrogen in the Bight.

SEDIMENTS

TRACE METALS

Elevated concentrations of iron, manganese, titanium, copper, tin, chromium, zinc, lead, and nickel have been measured in many areas of the New York Bight (Biscaye and Olsen, 1976; Pearce et al., 1977). Iron and magnesium are common throughout the Bight; the other metals are more common in sediments near the Sewage Sludge and Dredged Material Disposal Sites and in areas of river discharge.

Grieg et al. (1974) investigated trace metal concentrations in the Bight Apex and concluded that there were insignificant seasonal variations in the levels of copper, chromium, lead, nickel, and zinc, except near the Dredged Material Site. Elevated sediment concentrations were not observed near the Acid Site. Decreases in trace metal concentrations away from the center of disposal sites, and areas of elevated concentrations to the northeast of the sites and in the Hudson Shelf Valley, imply dispersal of wastes by water currents (Carmody et al., 1973).

ORGANIC CARBON

Acid waste contains no significant amounts of organic carbon, nor does it affect the distribution of organic carbon in the Apex. The total organic carbon (TOC) content of sediments is important since sediments with different levels of TOC may support different biotic communities. Trace metals are more abundant in sediments which have a high TOC content. Harris (1976) and Hatcher and Keister (1976) discuss TOC in New York Bight sediments.

CHLORINATED HYDROCARBONS

Persistence and toxicity of chlorinated hydrocarbons, e.g., DDT (dichlorodiphenyltrichloroethane) and PCB (polychlorinated bi-phenyl), cause great concern about their abundance and distribution in marine environments. However, acid waste does not contain chlorinated hydrocarbons (ERCO, 1978a,b). West et al. (1976) have information about the distribution of PCB's and DDT near the Dredged Material and Sewage Sludge Sites.

BIOTA

TRACE METALS IN ZOOPLANKTON

Extensive species lists and zooplankton abundance measurements, including studies by Grice and Hart (1962), Jeffries and Johnson (1973), Falk et al. (1974) and Gibson (1973) exist for the New York Bight. Several species of Apex zooplankton were examined for trace metal contaminants. Levels of copper and lead varied among species examined, and zinc varied according to the location of the sample. It has not been possible to determine the source of the contaminants (Greig et al., 1977). At the Delaware Bay Acid Waste Site (where the waste characteristics are similar to those at the Apex Acid Site), Johnson and Lear (1974) reported extreme variability in the concentrations of trace metals in the zooplankton, probably due to the complex nature of contaminant inputs and the dispersal of planktonic organisms by water column movement and mixing.

Contaminants which accumulate in the eggs and in developing larvae of marine fauna can cause chromosomal mutagenesis at subtoxic levels (Longwell 1976; Westerhagen et al., 1974). Longwell (1976) determined that there was a significant increase in the number of chromosomal aberrations in eggs and larvae of the Atlantic mackerel, Scomber scombrus, near the Acid Site. Away from the dumpsite in the general area of the apex, a lower percentage of abnormalities was observed.

TRACE METALS IN BENTHIC BIOTA

Levels of trace metals in benthic macrofauna of New York Bight are reported in NMFS (1972), Pratt (1973), and Pararas-Carayannis (1973). Sedentary benthic organisms are the preferred indicators of the effects of environmental contamination, because they are directly exposed to sediment-bound trace metals and unable to move from stressed areas (Pararas Carayannis, 1973). NMFS (1972) reported that some specimens contained levels of lead, chromium, and mercury above the normal range of values for the animals. These animals were in the vicinity of the Dredged Material and Sewage Sludge Sites.

Vaccaro et al. (1972) measured elevated trace metal concentrations in some benthic animals collected from New York Bight Acid Waste Disposal Site. Elevated concentrations of iron were detected, but no documented lethal or chronic effects exist for the epifauna and macroinfauna at the Acid Site. Earlier work by Redfield and Walford (1951) and Westman (1958) led to the same conclusion.

Pearce et al. (1976d) noted that disposal areas, characterized by large heavy metal and/or organic concentrations, showed a decline in the number of benthic individuals from 1973 to 1974; however, the species composition did not vary significantly during the same period. They concluded that the Bight biota are reasonably dynamic in abundance, and that correlations of abundance to trace metal concentrations must be made with caution.

BIOLOGICAL CHARACTERISTICS

The biota in the New York Bight demonstrate complex diurnal, seasonal, and longer-term cycles of species composition and abundance. Several factors contribute to these cycles: the influence of various water masses, each with its characteristic biota, the location of the Bight, between the boreal fauna (found to the north) and the temperate to subtropical fauna (found to the south), the effects of unusual or a periodic physical conditions, and the varying locations and amounts of anthropogenic input.

The Bight is biologically heterogeneous. This section, however, only discusses those environmental aspects of the region which are directly relevant to the specific conditions at the Acid Site. The water is described first, then the benthic biota are characterized. For the benthos, organisms characteristic of a sandy bottom are treated in the most detail. Since the bottom type at the Acid Site is medium to fine sand, the biota typical of other sediment types (muds, canyon slopes, rocky outcrops, artificial structures, or coarse sand and gravel) in the Bight are not pertinent to this EIS. Appendix B describes the environmental characteristics and biota of the site proper.

WATER COLUMN

The dynamics of the water and its biota affect the entire Apex. The plankton (microscopic plants and animals moving passively with the water) have patchy distributions in space and time. Quantities of individual species vary seasonally; different species may be abundant in successive years, and species composition is not predictable. Physical and chemical parameters which influence plankton are known, but because the seasonal changes in species cannot be reliably predicted, it is difficult to determine why a species is present or absent in an area. Consequently, individual species are poor indicators of pollution. Since the plankton move with the water throughout the Bight, it would be extremely difficult, if not impossible, to relate long-term changes in the populations to any specific disposal site or other pollutant source.

The nekton contain several species of commercially or recreationally important fish. As with the plankton, the motility of the fish makes it difficult to demonstrate that changes in the population dynamics are related to a specific dump site or pollutant source. However, fish have been extensively surveyed and are economically important. Fish are the most direct link with man, via the food chains to toxic contaminants in the acid waste.

MICROBIOTA

The waste released at the Acid Site does not contain pathogenic organisms, nor does the disposal of acid-iron waste significantly affect the distribution and abundance of the microfauna in the Bight.

PHYTOPLANKTON

Phytoplankton in the New York Bight have been extensively investigated for the past 75 years. Work has concentrated on the seasonal changes and the major physical and biochemical factors controlling primary production in the Bight. The information in this section is taken from monographs by Malone (1977) and Yentsch (1977). Additional information, including species lists, can be found in Barber and Krieger (1970), Esaias (1976), Falkowski and Howe (1976), Freudenthal and Lee (1963), Hulburt (1963), Martin (1928, 1929a,b), Riley (1952), Ryther (1954), and Smayda (1973). Table A-6 shows the more abundant species in the Bight.

TABLE A-6. PHYTOPLANKTON SPECIES WITH CELL DENSITIES GREATER THAN TEN THOUSAND PER LITER IN THE NEW YORK BIGHT

Species	Month	Maximum Observed Density x 10,000
Skeletonema costatum	Dec	50 to 60
Thalassionema nitzschioides	Dec	7
Rhizosolenia alata	Dec	2
Asterionella japonica	Feb	10
Rhizosolenia delicatula	Feb	2
Rhizosolenia alata	Sept	1
Chaetoceros socialis	Mar	10 to 90
Calycomonas gracilis	Apr	9

After Hulburt 1963, 1966, 1970; Hulburt and Rodman, 1963

Phytoplankton in the New York Bight Apex have strong similarities to those found in estuarine and bay waters. The chloroplyte, Nannochloris atomus, and the dinoflagellate, Ceratium tripos, dominate the phytoplankton assemblage from the late spring until middle to late summer. Diatoms dominate during the colder autumn and winter months. Skeletonema costatum, Thalassiosira spp. and Leptocylindrus danicus are frequently, although not always, the dominant species.

Although they cannot be used as indicators of water quality, some phytoplankton species do reflect man's influence on the Bight. According to Smayda (1973), Nannochloris atomus is an indicator of eutrophication. Excessive population growth of Ceratium or Nannochloris has caused oxygen depletion in bottom waters, besides reducing the populations of more desirable phytoplankton food species for oysters and clams. Oxygen depletion of the bottom waters and associated fish kills had been reported earlier (Smayda, 1973), yet the most extensive oxygen depletion and benthic mortality occurred in the late summer of 1976. Apparently, unusual meteorological events, a large population of Ceratium tripos, and a lack of herbivorous zooplankton produced the condition (Sharp 1976; Steimle 1976). Barged ocean disposal of sewage sludge and dredged material may have contributed to the event, but Segar and Berberian (1976) stated that nitrogen input from the rivers (caused by waste water discharge) is the greatest single problem in the New York Bight.

ZOOPLANKTON

The distribution and abundance of zooplankton populations in the Apex of the Bight have been extensively studied for many years. The material in this section is primarily from the monographs by Malone (1977) and Yentsch (1977). Further information and data are found in Austin and Dickinson (1973), Bigelow and Sears (1939), Deevey (1956), Grice and Hart (1962), Herman et al. (1968), Jeffries and Johnson (1973), and Sandy Hook Laboratory (1972). Table A-7 lists species for the major seasons in the Bight.

Unlike phytoplankton, the zooplankton in the Apex have strong similarities to those found offshore in the outer Bight. Copepods (Oithona similis, Paracalanus parvus, Pseudocalanus minutus, Temora longicornis, and Centropages typicus) dominate the population throughout the year. Warm water oceanic species are often present during the summer and autumn months, but have not been reported in the Hudson estuary.

Seasonal peaks in abundance are usually bimodal with the highest numbers found in July and November (after the spring and autumnal phytoplankton blooms). Cropping by herbivorous zooplankton reduces the size of the summer phytoplankton population. Zooplankton densities are lowest during the winter months; the decline from the fall peak is accompanied by a rise in the numbers of carnivorous ctenophores.

Zooplankton are important biological components in assessing the impact of man's activities in the Bight. They may concentrate contaminants from the phytoplankton or the water and many fish feed directly upon zooplankton. This feeding provides a direct link with such contaminants to humans. Grey et al. (1977), determined the levels of several trace metals in the zooplankton in the Bight, but could not determine any differences in metal levels which were related to the geographical locations of sampling.

NEKTON

Many finfish of commercial and recreational importance are found in the New York Bight. Their diversity and abundance is due to the geographical location of the Bight which is the northern limit of temperate and subtropical migrants and the southern limit of boreal migrants. Some species are found inshore, others offshore, and some migrate from inshore to offshore. Significant numbers of adults, planktonic eggs, and larvae can be found over the entire mid-Atlantic Shelf throughout the year. Consequently, waste disposal activity in any area of the Shelf carries a potential risk of adversely affecting the fish (Grosslein, 1976).

Numerous surveys of pelagic and demersal fish have been made (Table B-1). However, because of the large area these surveys cover (usually Cape Cod to Cape Hatteras), the number of stations is limited, so the precision of each survey is low and only major changes in the fish populations are detectable.

TABLE A-7. SEASONAL OCCURRENCE OF ZOOPLANKTON IN THE NEW YORK BIGHT APEX

Species	Season			
	Winter	Spring	Summer	Autumn
HOLOPLANKTON				
Copepoda				
Oithona similis	A	A	A	A
Paracalanus parvus	A	A	A	A
Paracalanus crassirostris	A	A	A	A
Pseudocalanus minutus	A	A	A	A
Centropages hamatus	A	A	A	A
Centropages typicus	A	A	A	A
Temora longicornis	A	A	A	A
Tortanus discaudatus	B	A	A	B
Acartia clausi	B	A	A	A
Acartia tonsa	B	A	A	A
Labidocera aestiva	B	A	-	A
Corycaeus	B	B	-	A
Calanus finmarchicus	B	A	A	A
Eurytemora	B	B	B	-
Canadia	-	-	-	-
Eucalanus	-	-	-	B
Metridia	-	B	-	B
Rhincalanus	-	-	-	B
Clytemnestra	B	B	B	B
Cladocera				
Podon	-	-	A	B
Evadne	A	A	A	A
Penilia	-	-	A	A
Siphonophora	B	A	A	A
Ctenophora	-	-		B
Mysidacea	B	-	B	B
Amphipoda				
Gamaridae	-	-	B	B
Hyperidae	-	-	-	B
Tunicata				
Thalacen	-	-	B	A
Oikopleura	B	B	B	A
Polychaetea				
Tomopteridae	B	-		-
Nematoda	-	B		B
Ectoprocta	B	A	B	A
Chartoynatha	A	A	A	A
MEROPLANKTON				
Polychaeta	A	A	A	A
Gastropoda	A	A	A	A
Bivalve	A	A	A	A
Barnacle	B	B	B	B
Decapoda	B	B	A	A
Phoronida	-	B	B	B
Echinodermata	-	B	B	A
Fish larvae	-	B	B	B
Fish eggs	B	A	A	B

- = No occurrence
A = Present at 50% or more of stations sampled
B = Present at less than 50% of stations sampled

Source: After Gibson 1973

In the Bight Apex, the finfish are potentially affected by the widespread and varying inputs of contaminants; consequently, relating even major changes in the fish populations to a specific source is very difficult.

The broad distribution and migration patterns of two important sport fish - bluefish and Atlantic mackerel, are known. The National Marine Fisheries Service has three categories for the North Atlantic Fishery Resources: based on the importance to man, bluefish are in the high category, while mackerel are in the medium category (Gusey, 1976). Whiting, which are fished commercially near the site, are in the low category. The first two species are occasionally abundant at the Acid Site.

Bluefish

The bluefish (Pomatomus saltatrix) is a warm-water fish which winters and spawns offshore and moves inshore during the summer months (Gusey, 1976). Wide fluctuations in its abundance have been reported since colonial times. The bluefish is a voracious predator on other fish, and both sea temperature and the availability of prey are important determinants of bluefish distribution. They are much sought after as sport fish, and the value of bluefish taken by sport fisherman may be a multiple of the commercial catch (Saila and Pratt, 1973). This makes landings even more difficult to estimate because the recreational fisheries in New York are largely unregulated; the amount of the catch and the fishing effort is not known (Ginter, 1974).

Atlantic Mackerel

The Atlantic mackerel (Scomber scombrus) is a wide ranging fish with its distribution centered in the mid-Atlantic Bight. Spawning is in the spring and early summer, but the fish do not prefer a particular region. Therefore, the location of greatest egg production can vary from year to year, depending on the local concentrations of the fish (Bigelow and Schroeder, 1953).

Mackerel quantities fluctuate widely from year to year. The determining factor for this fluctuation appears to be the comparative success of reproduction, but little is known about the factors which promote the production and survival of larvae (Saila and Pratt, 1973). Young mackerel have higher survival rates when there are few adults and higher mortality when the adults are abundant (Gusey, 1976).

Mackerel are not as important commercially at this time as they were in the 1940's because demand is low (McHugh, 1977). Landings are now 1 to 4 million kilograms (2 to 8.9 million lbs) against the peak harvest of 33.5 million kilograms (74 million lbs) in 1944 (Gusey, 1976). Mackerel are still an important sport fish, but, as with bluefish, the recreational value of the catch cannot be estimated.

BENTHOS

Benthos includes marine species which burrow into bottom sediments, species attached to the bottom, and species which live and move about on the bottom. Due to their ubiquitous nature, limited mobility, and comparatively long lifespan, benthic organisms are frequently used as indicators of water and sediment quality. They are often sources of food for fish and man.

Shellfish are not treated here, since the the Acid Site environs do not have commercially or recreationally important numbers of surf clams, ocean quahogs, or sea scallops. The site is next to the area closed to shellfishing (Figure A-4). Lobsters are taken northeast of the site. However, as shown in Appendix B, acid waste does not measurably affect the bottom.

The Bight Apex benthos is composed of several different communities. Pratt (1973) recognizes three level-bottom faunal groups widespread on the mid-Atlantic Continental Shelf: sand, silty sand, and silt-clay fauna (Figure A-5). Since Bight Apex sediments range from sandy gravel to mud (Freeland et al., 1976), elements of all three biotic communities can be, and are, within the Bight. The following discussion concentrates on sand fauna, the dominant community in the Bight Apex, which is found at the Acid Site. Table A-8 lists the species and feeding types characteristic of the sand-bottom fauna.

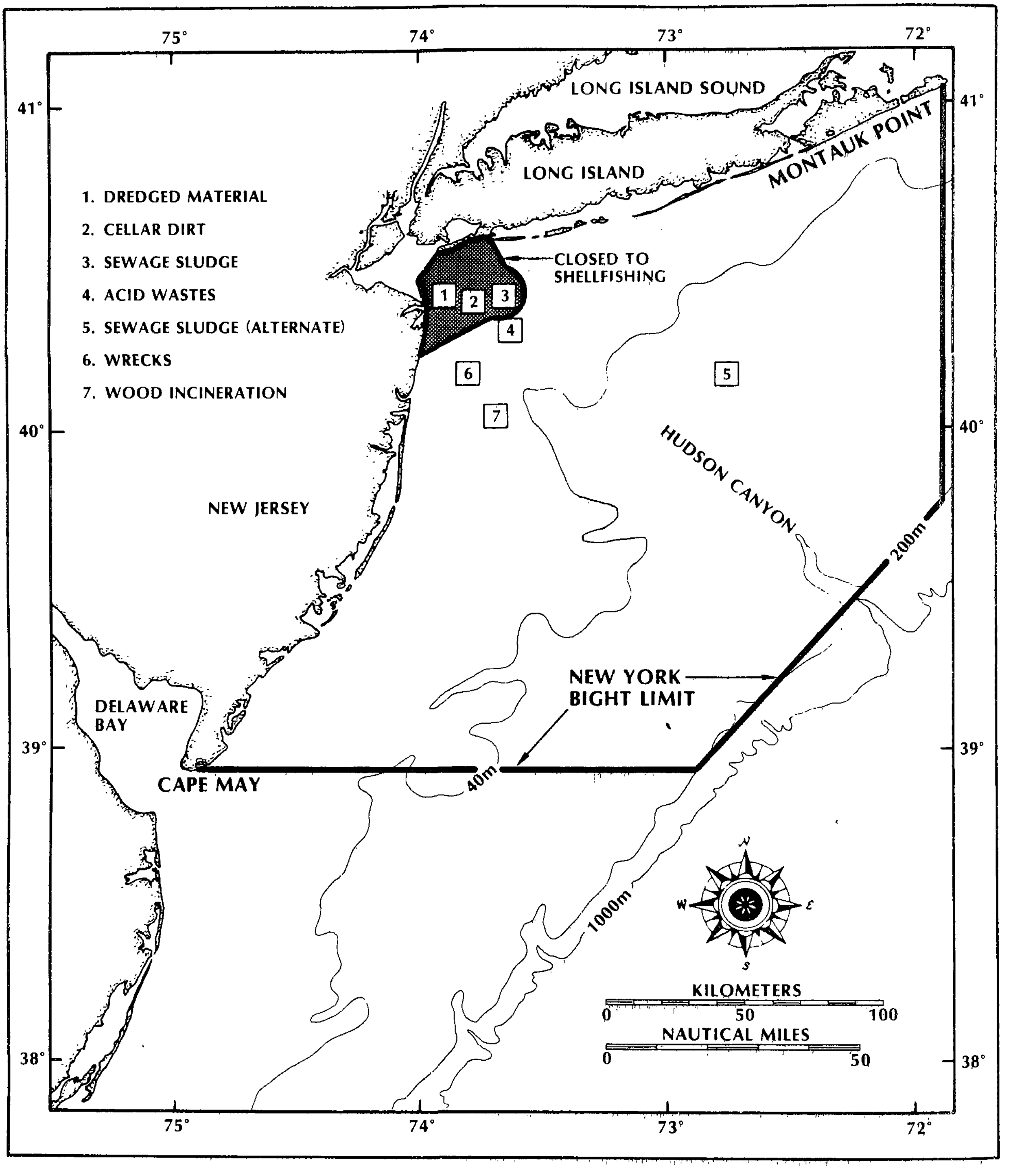


Figure A-4. Area Closed to Shellfishing in the New York Bight (FDA, 1973)

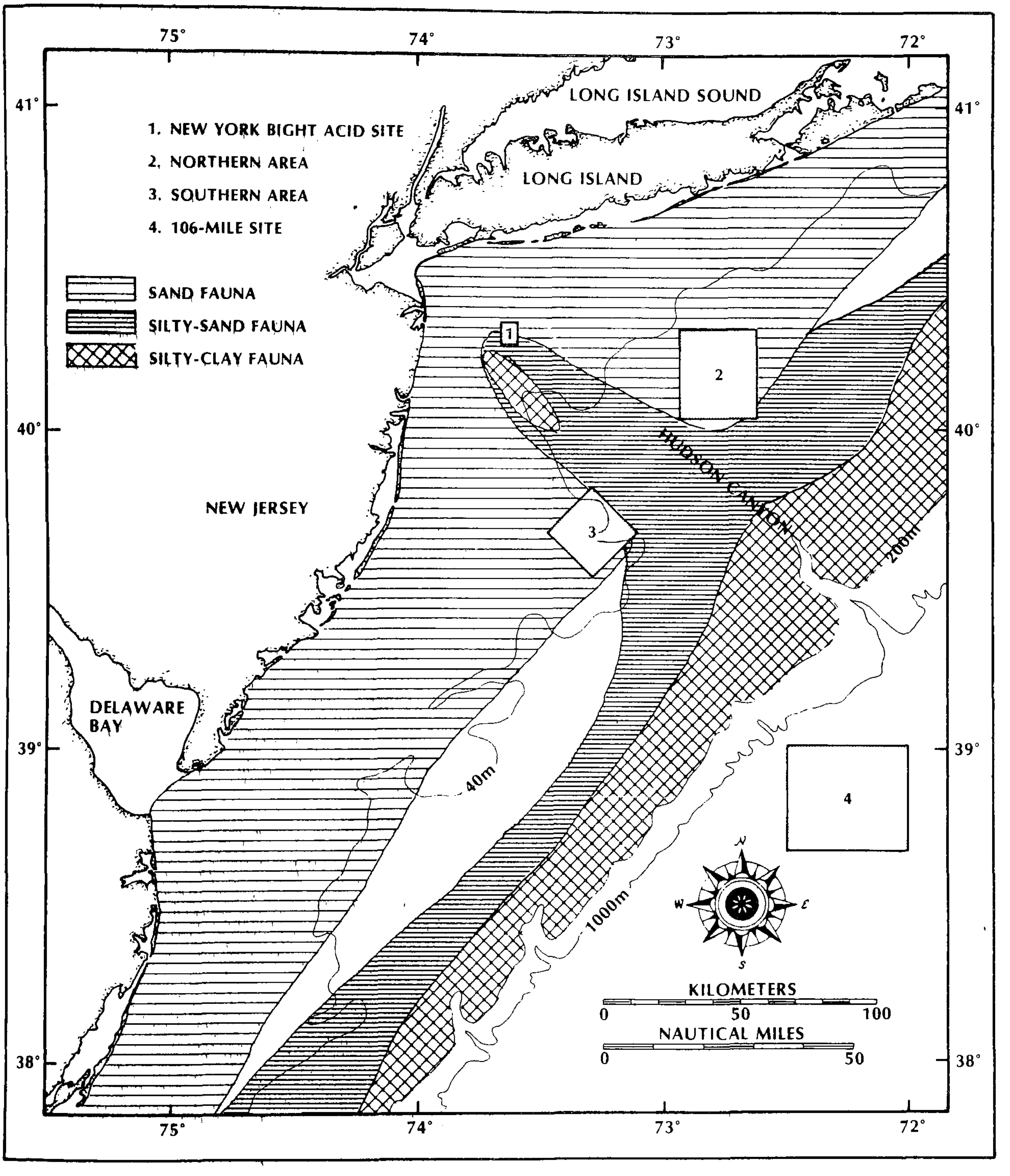


Figure A-5. Benthic Faunal Types in the Mid-Atlantic Bight

TABLE A-8. BENTHIC SPECIES CHARACTERISTIC OF THE SAND FAUNA IN THE MIDDLE ATLANTIC BIGHT

Species	Deposit Feeders	Suspension Feeders	Predators of Bivalves	Scavengers
Polychaetes:				
Scoloplos fragilis	X			
Nephtys bucera	X			
Nephtys picta	X			
Nereis arenaceodonta	X			
Sthenelais limicola	X			
Spiophanes bombyx	X			
Prinospio malmgreni	X			
Ophelia	X			
Goniadella	X			
Clymenella sp.	X			
Aricidea sp	X			
Magelona sp.	X			
Bivalves:				
Spisula solidissima (surf clam)		X		
Astarte castanea		X		
Ensis directus (razor clam)		X		
Tellina agilis	X			
Gastropods:				
Polinices duplicatus			X	
Lunatia heros			X	
Amphipods:				
Haustorids		X		
Phoxocephalids	X			X
Lysianassids	X			X
Decapods:				
Crangon septemspinosus (shrimp)				X
Cancer irroratus (crab)				X
Echinoderm				
Echinarachnius parma (sand dollar)	X			
Ascidians				
Amaroucium (sea pork)		X		
Mogula arenata (sea squirt)		X		

Source: After Pratt, 1973.

Sandy bottom sediments have low organic carbon content, large grain-size, and high mobility. Animals living on or in the sand are adapted to move within the sediment and to recover from burial; the communities are usually dominated by suspension feeders, although species with other feeding habits can be important (Pratt, 1973). In the Bight, deposit detrital feeders and scavengers are also present. Invertebrate carnivores are rare and do not appear to have an important role in this community type. Demersal fish are probably the important carnivores.

Productivity in this sediment type is usually low, although, if the surf clam, Spisula solidissima, is present, sandy bottoms can be extremely productive. Thomas et al. (1976) measured the seabed oxygen consumption over the entire Apex and found that the rates were comparable to other enriched coastal areas.

The inshore benthic fauna are dominated by organisms characteristic of a high-energy coastal environment; bivalves Tellina agilis and Spisula solidissima, the sand dollar Echinarachnius parma, and polychaetes (e.g., Spiophanes bombax and Prinospio malmgreni) (Pearce, 1972). Benthic populations in the Bight are not static. Pearce et al. (1976a, 1976b) report substantial annual variations in the distribution and abundance of benthic assemblages in the Bight Apex, when compared to earlier surveys (Pearce et al., 1976c).

Most analytical studies of the Bight benthos investigated effects of use of the Sewage Sludge and Dredged Material Sites. Buelow et al. (1969) investigated the distribution of coliform bacteria in the Bight. As noted earlier, acid waste does not contain bacteria. The FDA has continued to monitor coliform bacterial levels (Verber, unpublished). Other benthos investigators are: Frey (1973, 1974), New York Ocean Science Laboratory (1973), Pararas-Carayannis (1971, 1975), Ropes and Merrill (1976), SHL (1972), and Buzas et al. (1972).

Rowe (1971), NMFS (1972), Pararas-Carayannis (1973), and Buzas et al. (1972) have evaluated some of the ecological effects of the pollution of the New York Bight. O'Connor (1975) summarized those impacts as:

- High prevalence of diseases in several species of finfish and shellfish.
- Alterations in the distribution and abundance of bottom living organisms.
- Widespread distribution in exceptionally high numbers of coliform and fecal coliform bacteria indicate the presence of pathogenic bacteria.
- Presence of bacteria which are resistant to a broad spectra of heavy metals and antibiotics.
- Noxious concentrations of suspended particulate material, flotsam, and surface slicks.

These effects are the result of all contaminant inputs to the Apex and most strongly associated with three sources: outflow from New York Harbor and ocean disposal at the Dredged Material and Sewage Sludge Sites (Appendix C).

Appendix B

ENVIRONMENTAL CHARACTERISTICS OF THE NEW YORK BIGHT ACID WASTE SITE

CONTENTS

TABLES

Appendix B

ENVIRONMENTAL CHARACTERISTICS OF THE NEW YORK BIGHT ACID DISPOSAL WASTE SITE

The New York Bight Acid Waste Disposal Site was established in 1948 for the disposal of waste generated from industries in the New Jersey area. At present (1979), the Acid Site is used by only two companies, NL Industries and Allied Chemical, both located in New Jersey. Before 1974, Du Pont disposed of caustic wastes from its Grasselli plant, New Jersey at the site; now, these wastes are dumped at the 106-Mile Chemical Waste Site. The Acid Site is 10.6 nmi (20 km) southeast of Ambrose Light, and 14.5 nmi (27 km) off the New Jersey and Long Island coasts. Covering an area of 41.2 km^2 (12 nmi^2) and located on the Continental Shelf, the site is bounded by latitudes 40°16'N to 40°20'N, and longitudes 73°36'W to 73°40'W. Topographically, the bottom is almost flat, with an average depth of 25.6 m (84 ft), ranging from 22.6 m (74 ft) to 28.3 m (93 ft). The site abuts the northeastern edge of the Hudson Canyon (Figure B-1).

Until 1947, industrial acid waste was deposited either at the Sewage Sludge Site or in Raritan Bay. In April 1948, a separate acid waste site covering 2 nmi was established at 40°15'24"N, 73°46'42"W. In March 1949, the dumpgrounds were moved south of 40°20'N, and east of 73°40'W. In January 1950, seasonal dumping locations were established. The summer track was south of 40°20'N, and east of 73°40'W. The winter track was south of 40°20'N, and east of 73°43'W (PHSSEC, 1960). The present site is over the summer track. The Acid Site is only 2.75 nmi (5.1 km) southeast of the Sewage Sludge Site and 7.9 nmi (14.6 km) from the Dredged Material Site (Figure B-1).

Table B-1 lists the major studies which have analyzed samples from the Acid Site. Other surveys in the Bight have encompassed the entire Apex, or concentrated on the Sewage Sludge or Dredged Material Sites. Agencies conducting or sponsoring most of the work in this area include the NMFS Laboratory at Sandy Hook, New Jersey, and the NOAA-MESA New York Bight

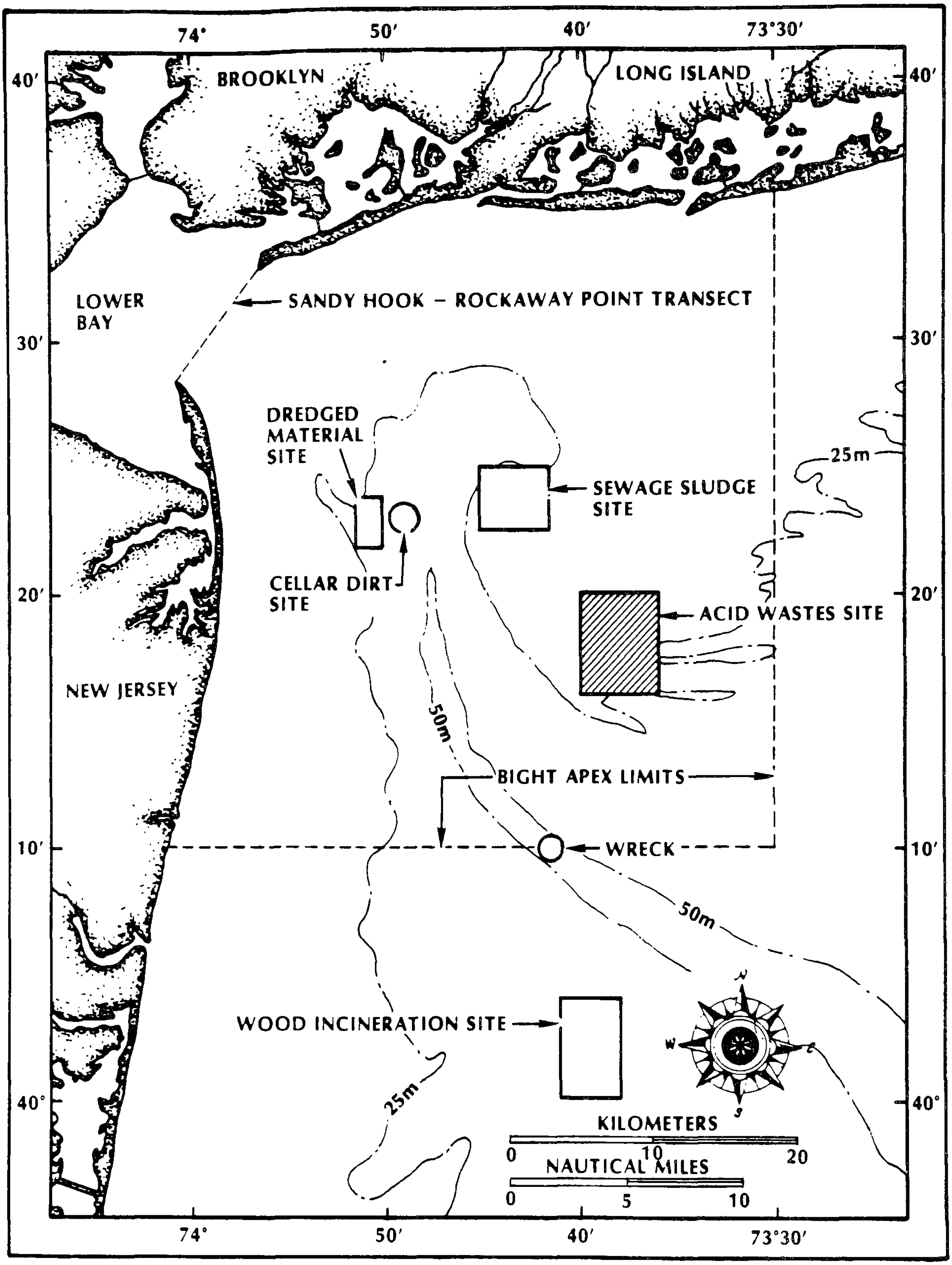


Figure B-1. Location of New York Bight Acid Waste Disposal Site

TABLE B-1. HISTORICAL SURVEYS IN THE VICINITY OF THE ACID SITE
(Abbreviations Listed at the end of this table)

Date	Sponsor/ Investigator	Purpose	Citation
Sept 16-18, 1978	Allied Chemical & NL Industries/ERCO	Chemical monitoring cruise	ERCO, 1978c
Mar 13-14, 1978	Allied Chemical & NL Industries/EG&G	Chemical monitoring cruise	EG&G, 1978b
Nov 14-16, 1977	Allied Chemical & NL Industries/EG&G	Chemical monitoring cruise	EG&G, 1978a
Aug 15, 16, 18, 1977	Allied Chemical & NL Industries/EG&G	Chemical monitoring cruise	EG&G, 1977c
Aug 13, 1977	Allied Chemical/ EG&G	Dispersion study of byproduct HCl wastes	EG&G, 1977b
Aug 12, 1977	NL Industries/ EG&G	Dispersion study of acid-iron wastes	EG&G, 1977a
Sept 1976	NOAA*/AOML	Water column characterization cruise**	Hazelworth, et al., 1977a
July-Sept 1976	NOAA/NMFS	Investigate the oxygen depletion phenomena	Steimle, unpubl.
June 1976	NOAA*/AOML	Water column characterization cruise**	Starr et al., 1977
Apr 1976	NOAA*/AOML	Water column characterization for water movement analysis	Hazelworth, et al., 1977b
Dec 1975	NOAA*/AOML	Water Column characterization cruise**	Kolitz et al., 1976b
Sept 1975	NOAA*/Raytheon	Baseline survey of the New York Bight	Raytheon, 1975

TABLE B-1. (continued)

Date	Sponsor/ Investigator	Purpose	Citation
Sept-Oct 1975	NOAA*/AOML	Water column characterization cruise**	Starr et al., 1976b
May-June 1975	NOAA*/AOML	Water column characterization cruise**	Kolitz et al., 1976a
Apr 1975	NOAA*/AOML	Water column characterization cruise**	Hazelworth and Darnell, 1976
Mar 1975	NOAA*/NMFS	Obtain data on demersal finfish	Azarovitz, et al., 1976f
Mar 1975	NOAA*/NMFS	Obtain data on demersal finfish	U.S. Dept. Commerce, 1975
Feb-Mar 1975	NOAA*/AOML	Water column characterization cruise**	Hazelworth and Darnell, 1976
Jan 1975	NOAA*/AOML	Water column characterization cruise**	Starr et al., 1976a
Oct 1974	Allied Chemical/ Int'l. Hydronics Corp.	Determination of immediate effect of HCl-HF waste disposal on seawater	International Hydronic Corp. Nov 1974
Sept-Oct 1974	NOAA*/NMFS	Study of demersal finfish catches by by species and station	Azarovitz et al, 1976e
Aug-Sep 1974	NOAA*/NMFS	Determine distribution and abundance of benthic invertebrates	Pearce et al., 1976a
July-Nov 1974	NOAA*/AOML	Water column characterization cruise**	Hazelworth et al., 1975b
June 1974	EPA	Collected salinity, temperature, dissolved oxygen and coliform data	EPA, 1974a

TABLE B-1. (continued)

Date	Sponsor/ Investigator	Purpose	Citation
Mar-May 1974	NOAA*/AOML	Water column characterization cruise** with recovery of bottom pressure gauges	Charnell et al., 1976
May 1974	NOAA*/NMFS	Fish egg mutagenesis	Longwell, 1976
Apr-Jun 1974	NOAA*/AOML	Water column characterization cruise**	Hazelworth et al., 1975a
Apr-May 1974	NOAA/NMFS	Obtain data on demersal finfish	U.S. Dept. of Commerce, 1974b
Apr-May 1974	NOAA*/NMFS	Study of demersal finfish catches by species and station	Azardvitz et al., 1976d
Mar 1974 Feb 1975	NOAA*/NMFS	Determine baseline seabed oxygen consumption	Thomas et al., 1976
Mar-May 1974	NOAA*/AOML	Water column characterization cruise** with deployment of bottom pressure gauges	Charnell et al., 1976
Jan-Aug 1974	NOAA*/MSRC	To provide data on sea surface movements	Hardy et al., 1976
Jan-Feb 1974	NOAA/NMFS	Collected phytoplankton, benthos, heavy metals, salinity and temperature data	U.S.Department of Commerce, 1974a
Oct-Nov 1974	NOAA*/NMFS	Study of demersal finfish catches by species and station	Azardvitz et al., 1976c
Sept-Nov 1973	NOAA/MESA	A study of suspended particulate matter	Drake, 1974
Aug-Nov 1973	NOAA*/AOML	Water column characterization cruise**	Hazelworth, 1974
Aug 1973	NOAA*/NMFS	Determine abundance and distribution of benthic invertebrates	Pearce et al., 1976b

TABLE B-1. (continued)

Date	Sponsor/ Investigator	Purpose	Citation
June 1973	NOAA*/NMFS	Determine abundance and distribution of benthic invertebrates	Pearce et al., 1978
May 1973 -June	NOAA*/NMFS	Study of demersal finfish catches by species and station	Azarovitz et al., 1976b
Oct-Dec 1972	NOAA*/NMFS	Study of demersal finfish catches by species and station	Azarovitz et al., 1976a
Nov 24, 1972	Allied Chemical	Studies on acid-fluoride wastes	Westman, 1972
Sept 1971	New York Ocean Sci. Lab.	Determine baseline data for physical, chemical and biological characteristics of the New York Bight	NYOSL, 1973
June 25-29, 1970	NL Industries/WHOI	Detect relationships between the chemical and biological parameters of the area.	Vaccaro, et al., 1972
Oct 9, 1969	NL Industries	Benthic study of the Acid Dump Ground	Westman, 1969
July 26, 1967	NL Industries	Benthic study of the Acid Dump Ground	Westman, 1967
Summer 1961	NL Industries	Determine the fishery conditions of the area	Westman, et al., 1961
Sept 16-19, 1958	WHOI	Evaluate the effects of acid waste on sport fisheries	Ketchum et al., 1958ab
July 24- Sept 9, 1958	NL Industries	Study the acid grounds in relation to certain fisheries of the area	Westman, 1958
Oct 1956	NL Industries/WHOI	Benthic photo-survey of the acid waste site	Owen, 1957

TABLE B-1. (continued)

MULTIPLE-YEAR PROJECTS

Date	Sponsor/ Investigator	Purpose	Citation
June 1974- June 1975	NOAA/NMFS	Determine distribution and densities of fish	Wilk et al., 1977
Aug 1973- Sept 1974	NOAA*/SHL	Five cruises to determine distribution of benthic invertebrates	Pearce, et. al., 1977
Aug 1968- Dec 1971	NOAA*/NMFS	Determine distribution and abundance of benthic invertebrates	Pearce, et al., 1976c SHL, 1972; vol. 2
1968 - 1970	USACE/SHL	Collect data to determine the effects of ocean disposal on the environment	SHL, 1972
1965 - 1974	NOAA*/NMFS	Historical data on bivalve molluscs	Ropes and Merrill, 1976
July 1964 May 1977	USPHS/NETSU	Collect coliform counts to determine safe shellfish fishing grounds	Verber, unpub.
Feb 1948- Jan 1950	NRC + USFWS/WHOI + MIT	Assess the hydrographic processes of the area	Ketchum, et al., 1951
1950	NL Industries/WHOI	Study the dispersion rates of barge discharges	Ketchum & Ford, 1952
1950	USDI	Observe effects of acid-iron waste on populations	Arnold and Royce, 1950

Sources:

* Cosponsored with the Marine EcoSystems Analysis Program (MESA)

** Data collected consisted of salinity, temperature, dissolved oxygen, nutrients, meteorology, and density.

TABLE B-1. (continued)

AOML = Atlantic Oceanographic and Meteorological Laboratories
EPA = Environmental Protection Agency
MSRC = Marine Science Research Center
NETSU = North East Technical Support Unit, FDA
NMFS = National Marine Fisheries Service
NOAA = National Oceanic and Atmospheric Administration
NRC = National Research Council
SHL = Sandy Hook Laboratory
USACE = U.S. Army Corps of Engineers
USPHS = U.S. Public Health Service
USFWS = U.S. Fish and Wildlife Service
WHOI = Woods Hole Oceanographic Institution

Project. NOAA's goals were to develop a clearer understanding of the nature of the forces driving this complex marine ecosystem, and to assess man's impacts in the area. EPA has concentrated on specific effects of ocean disposal.

METEOROLOGY

Appendix A summarizes the meteorological conditions in the Bight. Conditions at the site itself are, of course, the same as those prevailing in the Bight. Meteorological conditions in the Bight are not sufficient (either by themselves or in combination with other factors) to preclude or restrict use of the site for a significant length of time.

PHYSICAL OCEANOGRAPHY

WATER MASSES

Water mass characteristics at the Acid Site and in the Bight are generally the same, except that the site is probably not often influenced by the low salinity outflow from the Hudson estuary. This water is usually restricted to the area west of the Hudson Canyon. Refer to Appendix A for a discussion of water mass characteristics in the Bight.

CURRENT REGIMES

Hardy et al. (1976) conducted a seabed drifter study to determine the bottom current patterns in the New York Bight. Sixty nine drifters were released at the Acid Site and sixteen (23%) were eventually recovered. Eleven drifters landed on Long Island, five landed in New Jersey; no drifters were recovered at sea or from within the New York Harbor. It was concluded that the Hudson Canyon appears to form a boundary of divergence where the bottom drift east of the Canyon (where the Acid Site is located) is northwest to northeast towards Long Island. The fact that only 23% of the drifters released at the site were recovered suggests that many of the remainder may have been trapped in the Hudson Canyon. The canyon is a "trap" for wastes released at the Dredged Material and Sewage Sludge Sites. Most of the denser waste components disposed at the Acid Site probably end up in the canyon as well.

GEOLOGICAL OCEANOGRAPHY

Several reports have examined the sediments of the New York Bight e.g., Stubblefield et al., 1977, Freeland and Merrill, 1976. In addition, six reports, Pearce et al. (1977), Vaccaro et al. (1972), Ali et al. (1975), Owen (1957), and EG&G (1978a, 1978b), discuss sediments within the Acid Site boundaries.

The bottom sediments are medium to fine sand, with patches of silty-fine sand intruding from the northeast (Stubblefield et al., 1977). Mean grain size is 2.80 ±0.32 mm for 14 samples taken at two of the MESA sample stations within the site (Pearce et al., 1977). Divers have reported the bottom as fine sand and silt, overlaid by a flocculent brown particulate material which collected in the troughs of ripple marks (Vaccaro et al., 1972). Owen (1957) reported that the bottom sediments were medium-grained sand, with greenish-gray sand predominating. A dark or greenish ooze (not characterized) was reported at three sample stations.

EG&G (1978a) reported that the surficial sediments varied from gray, to dark gray, to brown, to dark brown in color. Texture was fine-grained sand, round to well-rounded grains, mainly quartz, with a dark mineral assemblage (glauconite or quartz sand) of 5 to 10%. In one case, the sediment was overlaid by a "soupy" black layer. EG&G (1978b) reported the bottom surface sediments as varying in color from brown, to brown with some black. Texture was very fine-grained quartz sand, well-sorted and rounded, with some silt present. The presence of a "pasty, tar-like" material is reported in one sample. None of the investigators analyzed the characteristics of these "oozes," "soups," or "tar-like" material, but speculated that these materials may have been sewage sludge, or the slops discharged from ship's bilges or fuel tanks.

SEDIMENT TRACE METAL CONTENTS

It has not been consistently demonstrated that the sediments within the confines of the Acid Site have significantly higher levels of trace metals than do sediments in surrounding "control" areas. Ali et al. (1975), separated the sediments in the Bight into four "clusters", on the basis of their trace metal content and location. The one Acid Site sample fell into their cluster facies IV, a group containing only a few, widely separated samples, and which the authors were unable to characterize adequately. They suggested that cluster facies IV corresponded to some relict sedimentary feature of the area. Aside from relatively high silver (17 mg/l) and lead (220 mg/l) values, cluster facies IV was not comparable to their cluster facies I, which corresponded to sediments sampled at the Sewage Sludge and Dredged Material Sites.

Vaccaro et al. (1972) reported higher concentrations of iron, zinc, cobalt, copper, lead, chromium, nickel, and cadmium in sediment samples taken from the Acid Site as compared with a control site. However, there is some doubt as to whether these results (which represent a single sampling time) reflect statistically significant differences between Acid Site and control site sediments. Samples from the Hudson Canyon contained substantially greater quantities of these metals than did the samples from either the Acid Waste or control sites. Vaccaro and his coworkers (1972) concluded that "...the implication is that most of the heavy metal contamination of the New York Bight, other than the iron, is derived from sources other than the acid-iron dump."

EG&G (1978a) found that zinc, titanium, and copper concentrations in sediments from the site were significantly higher than the concentrations at one reference (control) station. However, copper concentrations from the Acid Site (2 ppm) and control site (1 ppm) sediments were more than one order of magnitude less than those found in other sediment samples from the New York Bight (68 ppm, range: 23 to 620 ppm for samples taken between 1968 and 1972; NMFS, 1972), and from other nearshore sites (46 ppm; Chester, 1965). Two sediment samples from the Acid Site contained titanium; one had a concentration of titanium significantly higher than that of the reference sample, and one had approximately the same concentration as the reference sample. Titanium concentrations in all samples ranged from 71 to 210 ppm. Wide variations in zinc concentrations occurred between control site and Acid Site sediments. In some instances, zinc concentrations at the Acid Site were significantly higher than those in the reference sediments; at other times, the reverse proved true. However, all zinc concentrations (range: 17.5 to 105 ppm), were less than the mean reported for other samples from the New York Bight (142 ppm, range: 3 to 900 ppm for samples taken between 1968 and 1972; NMFS, 1972).

The fact that significant accumulations of metals have not been documented is not surprising. As shown in Appendices C and D, the relative contribution of metal contaminants released at the Acid Site is extremely low when compared with the total input to the Apex. Iron and titanium are significant inputs at the Acid Site, but both of these metals are nontoxic. One toxic metal, vanadium, is present in high concentrations in the waste. However, within minutes of discharge into seawater, the vanadium complexes with other material (e.g., other ions, suspended particulates, organic ligands) and becomes biologically unavailable. The conclusion of Vaccaro's group (1972) is still valid: "...there is no clear indication that enhanced disposal activity has caused a significant build-up of iron within the sediments immediately below the acid grounds... Thus, the distribution of iron on the seabottom still appears to be regulated by natural phenomena."

TRANSPORT

Sediment transport away from the immediate area of the Acid Site can be derived from bottom topography, current patterns in the Bight, and the distribution of ferric hydroxide particles, which are excellent tracers of suspended solids originating in the Acid Site. Net transport of coarse sediment away from the Acid Site is dominated by the "sink" provided by the proximity of the Hudson Submarine Canyon. Movement towards the Canyon is accelerated by storm flow transport, which is the most important force in coarse sediment movements. Fine sediments, such as ferric hydroxide particles, may move north towards shore, under influence of the surface gyre (MESA, 1975).

The Hudson Canyon is the sediment trap for coarse and fine sediments from the Acid Site. The Hudson Canyon also serves as a sink for suspended solids, sediments originating in other disposal sites, and from the Hudson River outflow. It is impossible to determine the relative contribution that each of these sites makes to the total contaminant load reaching the Canyon.

CHEMICAL CHARACTERISTICS

WATER QUALITY

EG&G (1978a) found no significant differences in water column pH values between the Acid Site and control samples taken to the northeast, irrespective of depth. In all cases, bottom waters were more acid (pH 7.70 to 7.86) than were surface waters (pH 8.18 to 8.26). This is normal and is caused by the oxidation of organic matter. Variations of mean pH values with depth during the summer are partially due to density stratification and the presence of a strong thermocline. Dissolved oxygen levels did not vary significantly between the Acid Site and control site.

Westman (1958) described the water color in the Acid Site area as green and somewhat turbid, in contrast with the blue and clear appearance of adjacent waters. Towards the center of the site, the water color was brown to brownish green. Water discoloration, a characteristic of the site, is the basis for locating water transport stations during recent monitoring cruises. The green discoloration is caused by the reaction of the ferrous sulfate in NL Industries waste reacting with seawater. As the ferrous iron is oxidized to ferric hydroxide (rust), the color changes to a brown to reddish brown (Redfield and Walford, 1951).

IRON

Ferric hydroxide (rust) particles, introduced at the Acid Site through regular disposal activities, provide excellent tracers for the movement of suspended waste material away from the site, and indicators of the degree of incorporation of waste components in the sediment or biota (pelagic and benthic; Biscaye and Olsen, 1976). The particles range in size from colloidal to sand sizes (>62 μ) as orange and red aggregates having the appearance of floccules (MESA, 1975). Particle distribution varies with depth in the water column. Those at the surface are carried by the clockwise surface gyre. Those near the bottom are under the influence of the Shelf Valley and the saline bottom water flow towards shore (MESA, 1975). EG&G (1978a) reported no significant differences in dissolved iron concentrations between the Acid Site and the control sites.

Iron in Sediments

Table B-2 summarizes data on iron content (ppm) of the Acid Site and control site sediments. The iron concentrations in sediment are highly variable, and no clear distinction can be made between the Acid Site and control site parameters. Acid Site sediments do not always contain more iron than do control site sediments; on occasion they contain less. The conclusion from these data is that acid waste disposal cannot be consistently related to the concentration of iron in sediments since other sources are equally important. Vaccaro et al. (1972) concluded that there was no indication of an increase of iron in the sediments of the Acid Site over a 24-year period (1948-1972).

TABLE B-2. IRON CONCENTRATION IN SEDIMENTS

Sediment	Range of Values ppm	Reference
Acid Site	2,200 - 2,500	ERCO, 1978c
	2,100 - 2,600	EG&G, 1978c
	9,000 - 10,000	EG&G, 1977b
	3,100 - 3,200	EG&G, 1977c
	3,000 - 12,500	Vaccaro et al., 1972
	0.16% ash	Vaccaro et al., 1972
	0.38% ash	Corwin and Ketchum 1956
Control Areas	3,100	ERCO, 1978c
	8,300 - 8,800	EG&G, 1978c
	37,000 - 58,000	EG&G, 1978b
	8,400 - 15,000	EG&G, 1977c
	2,200 - 3,300	Vaccaro et al., 1972
	0.15% ash	Vaccaro et al., 1972
Hudson Canyon	31,300	Vaccaro et al., 1972

Vaccaro et al. (1972), Redfield and Walford (1951), and Corwin and Ketchum (1956) found that the highest concentration of iron occurs in the soft sediments of the Hudson Canyon. Vaccaro et al. (1972) suggested that the distribution of iron in sediments was regulated by natural phenomena favoring an accumulation of fine sediments in the Canyon.

Iron in Biota

Zooplankton - Vaccaro et al. (1972) reported iron concentrations of 120 to 867 ppm in dried samples of zooplankton taken from the Acid Site and concentrations of 130 to 380 ppm iron in similar samples taken at a control site. Zooplankton from an oceanic site 120 km south of the Acid Site contained 730 ppm iron. It was concluded that the iron precipitated in the discharge area does not appreciably affect the zooplankton. Ketchum et al. (1958) found that the intestines of zooplankton collected in the discolored water of the Acid Site were packed with precipitated ferric hydroxide particles. Following a series of feeding experiments, it was further concluded that the particles were passed through the intestinal tracts of the animals with little or no change, and apparently without harmful effects.

Vaccaro et al. (1972) reported iron concentrations of 6,800 and 22,000 ppm in two ashed samples of benthos from the Acid Site, and 2,900 ppm in a sample from a control site. A sample from the Hudson Canyon contained 5,600 ppm iron. These data suggest that iron may be accumulated by the benthic biota of the Acid Site. However, it is not possible to test this conclusion statistically, since replicate samples were not taken at the control site.

Nekton - Westman (1958) analyzed the stomach contents of ten chub mackerel (*Pneumataphorus colias*), five taken in the water of the Acid Site, and five taken near the waters of the Dredged Material Site. He reported the following values:

Stomach Contents	Dredged Material Site	Acid Site
Iron content (mg)/stomach	0.37	3.5
Percent iron in total stomach contents	0.66	0.47
Percent ash	4.08	5.03
Total contents (mg)/stomach	57.1	744

These data do not clearly indicate that iron was assimilated by the fish, since differences in stomach iron content could be due entirely to the great variations in total stomach contents.

BIOLOGICAL CHARACTERISTICS

WATER COLUMN BIOTA

Vaccaro et al. (1972) found zooplankton biomass (both in terms of dry weight and displacement volumes) to be approximately 30% higher in the control area than in the area of the Acid Site. This difference could be due entirely to the patchy distribution of zooplankton in the Bight.

Wiebe et al. (1973) were unable to observe a trend in the spatial distribution of zooplankton which would suggest that acid wastes were an important factor in forming such distributions. Gibson (1973) concluded that "...under present conditions the disposal of acid waste ... in the New York Bight is having no discernible effect on the local zooplankton population."

Longwell (1976) found that developing mackerel eggs, collected from the waters near the Acid Site, showed an appreciably higher incidence of chromosome abnormalities (60.6%, compared to a control site value of 12.7%). A sample taken southwest of the Acid Site showed 38.6% abnormalities while a sample taken to the south showed 52.1% abnormalities. Longwell implied that these abnormalities were due to the mutagenic properties of heavy metals. Chemical mutagenesis of fish egg chromosomes was first suggested by Kinne and Rosenthal (1967) in their studies of sulfuric water pollutants and larvae of the Atlantic herring, Clupea harengus. However, danger to fish eggs was noted only up to a dilution of waste by ocean water of 1:32,000 (NOAA, 1972). Minimal dilution of acid waste after initial mixing is 1:67,000 (ERCO, 1978a).

Westman (1958, 1967, and 1969) reported that acid waste disposal actually enhances fishing in the Acid Site area. The "acid grounds" did not exist as a recognized fishing area until acid waste disposal started. It was concluded that darkening of the water (increased turbidity) due to the presence of suspended iron particles provided a sheltering environment attractive to fishes, particularly bluefish.

Trawl data (Table B-3) obtained by Wilk et al. (1977) do not clearly substantiate Westman's belief that there is improved fishing at the "acid grounds." These data are highly variable and do not indicate whether there is an impoverishment or enrichment of fish populations at the Acid Site.

Swanson (1977) concluded that although "... observational evidence of the impact of dumping on the biota at the (site) is limited.... past studies indicate no reduction of primary productivity or phytoplankton mortality.... surveys of benthic populations in the immediate vicinity of the Apex Acid Waste Dumpsite have not demonstrated an observable impact of waste acid.... existing scientific evidence indicates so far that ocean dumping (of waste at the acid-waste disposal site) has had minor adverse impacts on the ecology."

BENTHIC BIOTA

Much quantitative data on benthic biota of the Acid Site is summarized in Table B-4. There is no consistent trend in species diversity values (H'), and

TABLE B-3. FISH IN THE VICINITY OF THE ACID WASTE SITE
(mean ± std. dev.)

Area	Number of samples*	Number of individuals*	Weight of catch (kg)*	Number of species*
Acid Site	3	201 ± 172	28.8 ± 32.3	11 ± 4
Near Acid Site	6	114 ± 89	47.0 ± 52.8	11 ± 3
Control site	5	511 ± 255	101.2 ± 47.8	13 ± 4

* ± One standard deviation

no clear indication that the benthic fauna of the Acid Site are particularly enriched or reduced, with respect to surrounding control areas. However, Vaccaro et al. (1972) did find significant differences between mean densities of benthic animals at the Acid Site and control site. Rowe (1971) noted that there was a decrease in the species diversity values from deep water towards the Acid Site, and that values for the Acid Site were lower than those in the control area. Evaluating the data from Pearce et al. (1977), showed that differences in mean diversity values from the Acid waste Site and control site were not statistically significant. These data did not demonstrate any significant geographic trends which would support the findings of Rowe (1971). Pearce et al. (1976d) noted that there is a close correlation between the distribution of benthic organisms and sediment type, yet no correlation was found between the diversity value and either mean grain-size or percentage of organic material in 81 samples taken at MESA sampling sites in the Bight. However, two low-value samples from within the Acid Site were associated with high values for percentage of organic material. These findings and others in Table B-4 support the general conclusion that there is a high degree of spatial and temporal variability in the benthic fauna of the New York Bight (Pearce et al., 1976d).

TABLE B-4. COMPARISON OF SPECIES DIVERSITY AND ABUNDANCE VALUES FOR ACID WASTE AND CONTROL SITES IN THE NEW YORK BIGHT

Site	S	N	H'	Source
Control	-	$2984/m^2$	2.13	Vaccaro et al., 1972
Acid Site	-	$1694/m^2$	2.08	
Acid Site	6	73+	0.87	Westman, 1967
	7	120+	0.56	
	7	72	1.15	
	7	21	1.20	
Acid Site	6	24	1.39	Westman, 1969
	6	37+	0.80	
	7	80+	1.08	
	5	104+	0.24	
Acid (pre-dump)	9	512	1.09	Arnold and Royce, 1950
Control (pre-dump)	2	38	0.63	
Acid (post-dump)	4	548	0.94	
Control (post-dump)	4	178	0.78	
Control (35 samples)	-	-	2.08 ± 0.91	Pearce et al., 1977
Acid (14 samples)	-	-	1.55 ± 0.87	
Coastal (10 samples)	-	-	1.65 ± 0.52	

H' = Shannon-Wiener species diversity index
N = Total number of individuals
S = Total number of species

Appendix C

CONTAMINANT INPUTS TO THE NEW YORK BIGHT

CONTENTS

ILLUSTRATIONS

TABLES

Appendix C

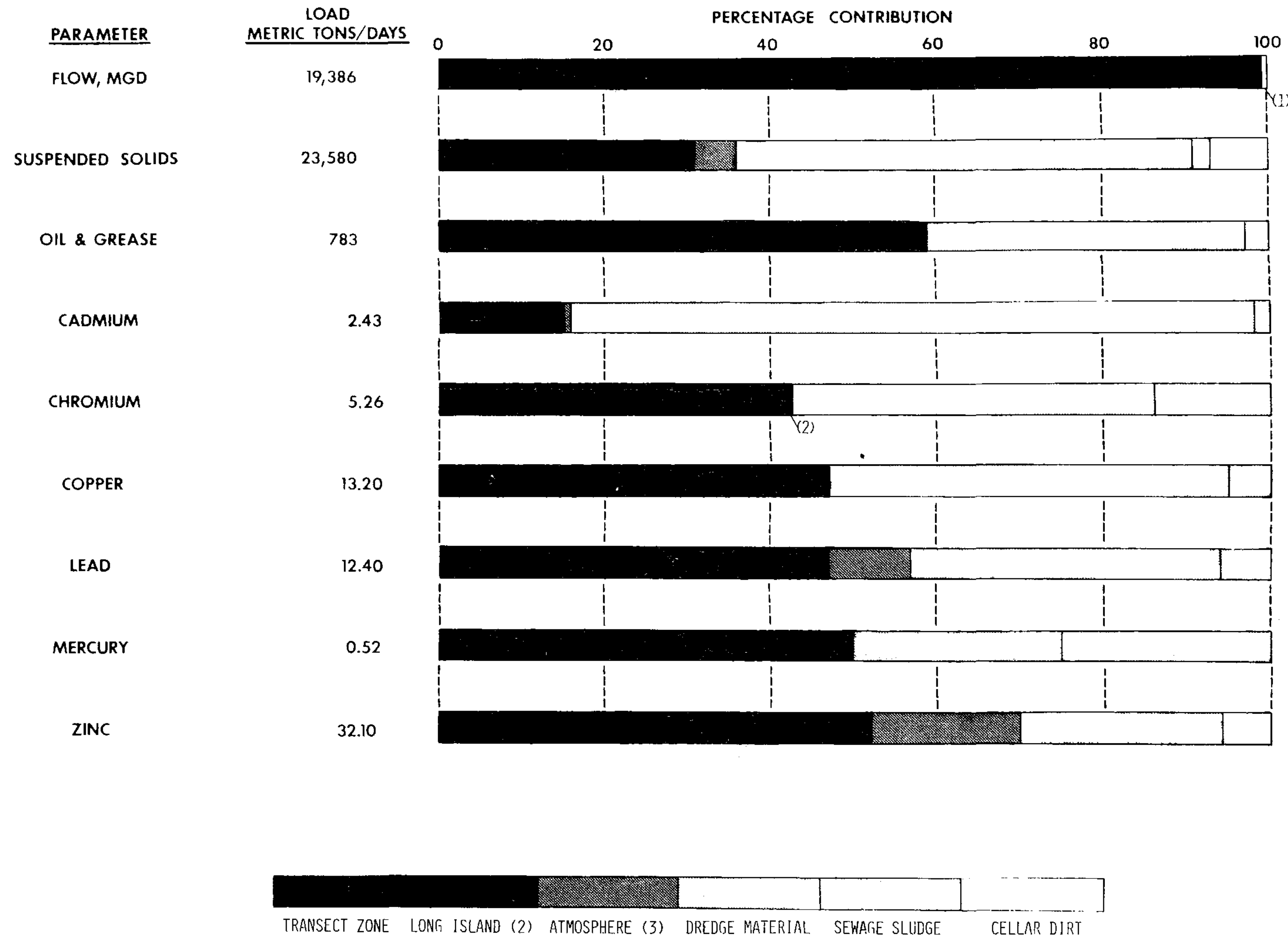
CONTAMINANT INPUTS TO THE NEW YORK BIGHT

Large volumes of waste discharge enter the Bight Apex by direct disposal operations, e.g., barge disposal, coastal discharge, rivers, or outfall effluents. Indirect waste inputs, e.g., atmospheric fallout, add to the total (Figure C-1). The largest single source of discharge (by volume) into the Apex region derives from the New York Harbor across the Sandy Hook-Rockaway Point Transect (Mueller et al., 1976).

Acid waste introduces a limited variety of contaminants to the New York Bight--several trace metals found in inorganic acids and compounds, suspended solids, and oil and grease (Figure C-1). Consequently, the discussion of contaminant inputs to the Bight is restricted to these same contaminants and an analysis of the relative contribution of sources other than the Acid Site.

In this Appendix, the relative contribution of sources of contaminants will be examined and, based on the available data, the mass loading (amount) of these contaminants will be estimated for the Bight Apex. Trace metals are important contaminants. Some trace metals (e.g., lead and mercury), are extremely toxic to living organisms. Others, namely chromium, copper, and zinc are essential to life processes of living organisms, but may be toxic in high concentrations or in certain chemical forms (Segar and Cantillo, 1975). Cadmium, chromium, and mercury are discussed because of their significance as toxic contaminants. Iron, the principal metal contaminant introduced with acid wastes, is a fairly nontoxic metal, but its release in large quantities may influence activities of other more toxic metals. Suspended solids are discussed because of their importance in trace metal transport to, and removal from, waters of the Apex. Oil and grease, which cause chronic effects on organisms, are present in the waste.

In 1978, a panel of marine experts identified contaminants that are, or are likely to be, the most serious problems in the Bight (MESA, 1978). In comparing contaminants present in acid waste with those identified by the



1. Following the Transect Zone, all remaining contaminant sources contribute only about 0.5% of the total daily volume.
2. Long Island contributes only chromium above the 0.5% level.
3. Atmospheric input has been estimated by Duce et al., 1976, for suspended solids, cadmium, lead and zinc over an area 4 times the apex area.
4. The Acid Waste Site was considered, but all contaminants are below the 0.5% contribution level and do not appear.

Figure C-1. Source Inputs of Selected Contaminants in the New York Bight (Adapted from Mueller et al., 1976)

experts, only mercury and cadmium are considered to be "major perceived threats." Arsenic, chromium, and lead are considered to be "substances not requiring priority attention", thus most of the contaminants discussed in this Appendix are not even considered to be potential problems and, as documented in Appendix D, acid wastes are insignificant sources of the five trace metals mentioned.

This Appendix is divided into three sections. The first section briefly describes the sources of contaminant inputs to the Bight, and the second and third sections present the same data, from different viewpoints. The second section discusses each source and the contaminants it provides, while the third discusses the contaminants in terms of the major sources.

SOURCES

Five sources of contaminants are considered in this section - the Transect Zone (representing outflow from New York Harbor), barged ocean waste disposal, atmospheric fallout, surface and effluent discharges from New Jersey and Long Island coastlines (Figure C-2). The Transect Zone contributes over 99% of the total volume while barged wastes and for some metals, atmospheric fallout are important sources of contaminants.

The information presented in this section is based largely on data presented in Mueller et al. (1976); however, reliability of these data has been questioned by Lee and Jones (1977). According to Lee and Jones, the estimated quantities of dredged material contaminants reported by Mueller et al. (1976) are of questionable accuracy. The information presented by Mueller et al. (1976) represents the best data presently available for total Apex contaminant input estimates, although contaminant input estimates for dredged material may be inaccurate. Lee and Jones (1977) cannot state if these estimates are high or low for each contaminant. Furthermore, Lee and Jones (1977) point out that contaminants are not entirely released into receiving water when dredged materials are disposed, hence Mueller's estimates represent the worst-case condition.

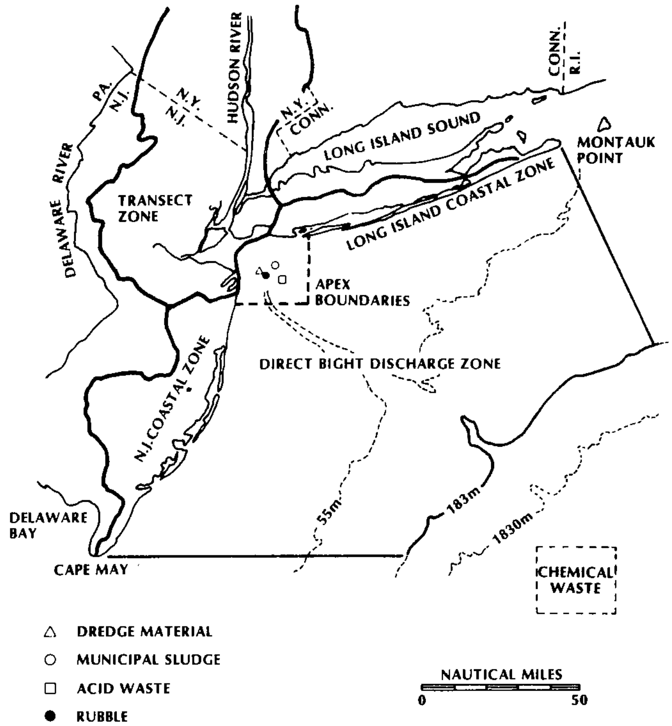


Figure C-2. Geographical Zones in the New York Bight (from Mueller et al., 1976)

TRANSECT ZONE

The Transect Zone of the lower New York Harbor is delineated across the channel entrance, from the tip of Sandy Hook peninsula to Rockaway Point. New York Harbor is fed by numerous rivers of New York and New Jersey. The Hudson River and its drainage basin is the largest source of water to the lower bay, and it drains approximately 34,630 km^2. The Hackensack, Passaic, and Raritan Rivers in New Jersey drain approximately 6,790 km^2.

These rivers and their tributaries provide most of the municipal and industrial water requirements of approximately 15 million people (Mueller et al., 1976). Most contaminants in these waters ultimately reach New York Harbor and enter the New York Bight Apex either by the surface outflow across the Transect or by dredging operations which release materials at the Dredged Material Site.

OCEAN DISPOSAL SITES

Ocean disposal of waste materials within the New York Bight started before 1900. The Acid Waste Disposal Site was designated for use in 1948. Other sources of great volumes of waste materials are the Dredged Material Disposal Sites; the first DMDS was designated in 1888. The Dredged Material Disposal Site considered here has been in use since 1940 (Gross, 1976). The Sewage Sludge Disposal Site was first used in 1924 and the Cellar Dirt Disposal Site was established in 1940. Large volumes of trace metals, suspended solids, organic wastes, and nutrients are introduced into the marine environment at these sites.

A fifth site, located over the Hudson Canyon at the edge of the Apex, is used for disposal of wrecks. Only eight ships have been reported sunk at this site, and none since 1973 (EPA, 1978). Since the ships are stripped of potential contaminants prior to disposal, this site does not measurably contribute to anthropogenic inputs to the Bight.

Two disposal sites are beyond the Apex of the New York Bight. A sixth site was designated for toxic chemical wastes in 1965. However, this site is 106 nmi southeast of Ambrose Light at the edge of the Continental Shelf. The 106-Mile Chemical Waste Site is, therefore, outside the sphere of influence of the inshore Apex region. An area south of the Apex (at approximately 40°N, 73°40'W) has been used for the incineration of driftwood, harbor pilings, and other wood debris from harbor wharf construction. Possible contaminants from this source can be neglected since the site is outside the Apex and the burning does not affect the water column, with the possible exception of minute amounts of atmospheric loading. The ash and other residue is returned for land disposal.

ATMOSPHERE

Contaminant inputs from the atmosphere have only recently been evaluated. Estimates provided by Duce et al. (1976) are based on samples taken near the New Jersey and Long Island coasts of the Bight (Table C-1). Their estimates are calculated on the assumption that no atmospheric contaminant gradient occurs from nearshore to the outer Bight, i.e., atmospheric concentrations of contaminants are equally dense at 100 km offshore and at 1 km offshore. Settling velocity estimates of atmospheric particles do not conform to this assumption. Duce et al. (1976) concluded that their calculations probably overestimate metal inputs from atmospheric fallout. Direct measurements of trace metal inputs throughout the New York Bight are required for reasonably accurate estimates of atmospheric source loading by precipitation and dry fallout. These measurements should include at least one seasonal cycle.

Duce and Hoffman (1976) concluded that as much as 10% of the total anthropogenic vanadium injected into the atmosphere in North America may be deposited in the central North Atlantic by northern hemisphere westerlies. Three models, which may be accurate only to within one order of magnitude, were compared in deriving this estimate.

TABLE C-1. TOTAL MASS LOADING - NEW YORK BIGHT APEX
(Tonnes/Day)

Input*	Cadmium	% Contrib.	Chromium	% Contrib.	Copper	% Contrib.	Iron	% Contrib.	Mercury	% Contrib.	Lead	% Contrib.	Zinc	% Contrib.
Transect Zone	0.36	14.8	2.2	41.8	6.2	47.0	35.0	16.0	0.26	49.9	5.8	46.8	17.0	52.9
Ocean Disposal**	2.04	83.9	3.03	57.6	7.0	53.0	180.0	81.0	0.26	49.9	5.4	43.5	9.1	28.3
Atmosphere†	0.03	1.2	††	--	††	--	6.1	3.0	††	--	1.2	9.7	5.9	18.4
Long Island Coastline	<0.01	<0.5	0.03	0.5	0.01	<0.5	0.6	<0.5	<0.01	<0.05	<0.01	<0.05	0.1	<0.5
Total	2.43		5.26		13.2		221.7		0.52		12.4		32.1	

Sources:
* All estimates, except atmospheric, from Mueller et al., 1976.
† Duce et al., 1976.
** Includes all ocean dumping activities.
†† Not measured.

Atmospheric input of most metals is an insignificant contribution in comparison to the Transect Zone and ocean dumping (Table C-1). This source of input can be neglected when evaluating the effects of contaminants in the Bight because of the diffused input from this mode of contaminant entry.

NEW JERSEY

Contaminant inputs along the coast of New Jersey were examined by Mueller et al. (1976). They listed 5 industrial wastewater sources, 50 municipal wastewater sources, and surface runoff water contaminants. Contaminants in groundwater are included in the surface runoff.

The New Jersey coastline is an unimportant source of contaminants (Table C-2). Mueller et al. (1976) reported values only from the coast south of the Shark River (at the edge of the Apex). Contaminants north of the Shark River are included in the Transect Zone figures. Surface currents usually move south along the New Jersey shoreline (see Appendix A), thus contaminants are transported out of the Apex and do not add to its contaminant load. Therefore, New Jersey coastline contaminants are not included in total mass loading figures in Tables C-1 and C-4.

LONG ISLAND

Contaminant sources along the Long Island coastline were examined by Mueller et al. (1976), including sources between Pines Brook in western Nassau County and Montauk Point. Six municipal and 20 industrial (duck farm) waste sources were considered in waste loading estimates. Groundwater produced a significant flow, but contained insignificant waste loads.

Approximately 85% of the Long Island coastline is beyond the borders of the Apex. Therefore, in evaluating Long Island's importance as a contaminant source, a linear relationship between the total contaminant loading from Long Island coastline and that portion of the coastline inside the Apex region was included. Table C-3 represents the estimated total average daily input

TABLE C-2. CONTAMINANT INPUTS FROM THE NEW JERSEY COASTLINE
(Tonnes/Day)

Input	Municipal & Industrial Wastewater	Surface Runoff	Total
Volume (MGD)	105	3,300	3,400
Suspended Solids	55	79	134
Oil and Grease	6.6	69.0	75.6
Metals			
Cadmium	0.0036	0.0084	0.012
Chromium	0.026	0.0064	0.032
Copper	0.057	0.065	0.12
Iron	0.22	5.2	5.4
Mercury	0.017	Nil	0.017
Lead	0.055	0.012	0.067
Zinc	0.067	0.26	0.33

Source: From Mueller et al., 1976

TABLE C-3. CONTAMINANT INPUTS FROM THE LONG ISLAND COASTLINE
(Tonnes/Day)

Input	Municipal & Industrial Wastewater	Surface Runoff	Groundwater	Total
Volume (MGD)	88.0	225.0	280.0	593.0
Suspended Solids	11.3	5.4	0.0	16.7
Grease & Oil	4.8	0.55	0.0	5.4
Metals				
Cadmium	0.00091	0.00066	0.00003	0.0016
Chromium	0.19	0.0005	0.0	0.19
Copper	0.024	0.0036	0.0009	0.029
Iron	0.096	0.27	0.023	0.39
Mercury	0.0017	Nil	Nil	0.0017
Lead	0.014	0.0052	0.0003	0.02
Zinc	0.66	0.022	0.0024	0.68

Source: Mueller et al., 1976.

TABLE C-4. TOTAL MASS LOADING - NEW YORK BIGHT APEX
(Tonnes/Day)

Input	Volume (MGD)	Percent Contrib.	Suspended Solids	% Contrib.	Oil & Grease	% Contrib.
Transect Zone	19,291	99.5	7,300	31.0	460.0	59.0
Ocean Disposal	10	0.5	15,108	64.0	322.0	41.0
Atmosphere	NA	--	1,170	5.0	0.0	0.0
Long Island Coastline	85	0.5	2.4	0.5	0.7	0.5
Total	19,386		23,580		732.7	

Source: From Mueller et al., 1976.

contributed by the entire Long Island coastline. Tables C-4 and C-1 represent one-seventh (15%) of the total contribution, estimated to be entering the Apex region from the Long Island coastline. Although currents may bring contaminants from eastern Long Island into the Apex, at other times currents will flow eastward and remove contaminants from the Apex. In either event, Long Island is an insignificant contaminant source.

MASS LOADS BY SOURCE

TRANSECT ZONE

Mueller et al. (1976) estimated the average volume of contaminant loaded water entering the New York Harbor complex from industrial, municipal, urban, and surface runoff to be 850 m^3 per second. This volume and the estimated contaminant mass loads are derived via mean sample values from various records (government, industrial and academic) for the period 1960 to 1974 (Table C-5). Surface runoff contributes approximately 46% of the average daily volume, industries contribute 14% of the daily average, and urban discharge contributes about 40% of the total.

TABLE C-5. CONTAMINANT INPUTS FROM THE TRANSECT ZONE
(Tonnes/Day)

Input	Municipal & Industrial Wastewater	Surface Runoff	Urban Runoff	Total
Volume (MGD)	2,700	15,430	1,160	19,291
Suspended Solids	870	3,500	2,900	7,300
Oil and Grease	193	64	202	460
Metals				
Cadmium	0.14	0.10	0.12	0.36
Chromium	0.92	0.51	0.77	2.2
Copper	2.73	1.24	2.23	6.2
Iron	12.95	9.10	12.95	35.0
Mercury	0.20	0.04	0.02	0.26
Lead	2.67	0.75	2.38	5.8
Zinc	3.23	6.46	7.31	17.0

Source: From Mueller et al., 1976.

Suspended solids constitute the largest amount (by mass) of contaminant materials. The river-suspended load is the single largest source, approximately 3,500 tonnes/day (48%), and urban runoff contributes 40% of the total. Industrial discharge of suspended solids averages only 12% of the contribution (approximately 870 tonnes/day). Urban runoff (44%) and municipal/industrial wastewater (42%) are the main sources of oil and grease.

The input of cadmium (Table C-5) is evenly distributed among the three effluent categories: municipal and industrial wastewater, surface runoff, and urban runoff. Inputs of zinc are nearly equal between surface runoff (38%) and urban runoff (43%).

Industrial and municipal discharges, combined with urban runoff, contribute about three quarters of the total input of other metals. The former averages about 42% of the total input, and urban runoff is about 37% of the total.

An estimated 35 tonnes of iron is discharged into the New York Harbor daily (Mueller et al., 1976; Table C-5). This is the largest amount among all metals studied. Other metals with high inputs are zinc and, to a lesser extent, lead and copper.

Sediments of the harbor complex are not considered here because their contaminants are immobilized, and thus do not influence the Apex region. Harbor sediments are an important contaminant source when dredged and released at the Dredged Material Site.

OCEAN DISPOSAL

Mueller et al. (1976) examined the volume of material dropped at the Dredge Material, Sewage Sludge and Cellar Dirt Sites (Table C-6). The largest volume of waste material is released at the Dredged Material Site, which receives approximately 24,100 m^3/day, or 64.5% of the daily average of material dumped at the three sites. The Sewage Sludge Site receives approximately 31.8% (11,820 m^2/day) and the Cellar Dirt Site receives approximately 3.7% (1,364 m^3/day).

The greatest volume (86%) of suspended solids is introduced at the Dredged Material Site (Table C-6). Mueller's group estimated that the Cellar Dirt Site contributes about 1,300 tonnes/day, or 11% of the total suspended solid load, but the amount is probably only about 300 tonnes/day, or only 2% of the total (Interstate Electronics Corp., 1978). The oil and grease input is primarily from dredged material disposal, with approximately 300 tonnes/day entering the Apex (93% of the total).

For the metals, the Cellar Dirt Site is an insignificant source and the Dredged Material Site contributes from 50% to 98% of all metals examined (Table C-6). Except for mercury, the Dredged Material Site contributes an average of 86% of the metals, and the Sewage Sludge site the remaining 14%. Iron, copper, lead, and zinc are significant contaminant inputs from direct ocean disposal.

TABLE C-6. CONTAMINANT INPUTS FROM OCEAN DISPOSAL
(Tonnes/Day)

Waste Type	Volume (m^3/day)	Suspended Solids	Oil and Grease	Cadmium	Chromium	Copper	Mercury	Lead	Zinc
Dredged Material	24,100	13,000	300	2.0	2.3	6.3	0.013	4.7	7.3
Sewage Sludge*	11,820	450	22	0.044	0.73	0.70	0.013	0.72	1.8
Cellar Dirt	1,364	1,650	--	--	--	--	--	--	--
Total	37,284	15,100	322	2.044	3.03	7.0	0.026	5.42	9.1

*1973 Data only

Source: From Mueller et al. (1976)

Approximately 0.026 tonnes/day of mercury is deposited at the Dredged Material and Sewage Sludge Sites combined (half of the total at each site). However, due to the larger average daily volume of dredged material, these values suggest that sewage sludge is more highly contaminated with mercury.

Mass loading estimates of iron at these sites was not calculated by Mueller and his co-workers, but an estimate of loading from all dumping activities (including the Acid Site, which is the most significant source of iron) is given as 180 tonnes/day. MESA (1975) estimated that the Acid Site and outflow from the Transect Zone contained about equal amounts of iron. MESA (1975) concluded that the three prominent sources of most metals are the Dredged Material Site, the Sewage Sludge Site, and the Transect Zone.

ATMOSPHERE

The potential atmospheric transport of trace metals into the water of the New York Bight has only recently been examined. Duce et al. (1976) measured atmospheric metal concentrations from samples taken over a 10,000 km^2 area of the Bight. It was found that atmospheric concentrations were generally 10 to 20% of the mean concentrations observed at several locations in New York City over a 2-year period.

Samples collected by Duce et al. (1976) indicated that the quantities of metals entering the Apex from the atmosphere are considerably less than those from all other sources (see Table C-1). Lead, for example, is 15% of the total from the previous two sources but cadmium is only 1% of the total. Dry fallout values are based on sample observations. Wet fallout values (primarily rain) are based on an estimate of 67% removal factor, thus wet fallout is given as double the dry fallout. Duce and his co-workers emphasized that these estimates of atmospheric transport may be high, by a factor of five or more. Long term studies are required to produce reasonably accurate values. However, since the absolute input is low, these are sufficient data for this EIS.

Mueller et al. (1976) calculated input values for airborne metals using measured data collected in a one-year study from the Upper Great Lakes (Table C-7). They considered the entire New York Bight, approximately 39,000 km^2, for estimation purposes. Thus, their input estimates consider an area four times the size sampled by Duce et al. (1976). Comparison of Mueller's estimates to Duce's estimates shows that Mueller's are lower by a factor of about 9 (Table C-7). This emphasizes the approximate nature of these values.

Estimates reported by Duce et al. (1976) are used in this report since these data represent direct source measurement from the area of interest. The primary factor limiting the use of these data is the fact that they represent a small sample from a short sampling period and are, at best, rough estimates.

The sources of these metals are both natural and anthropogenic. Northeasterly and southeasterly winds blowing across the mainland accumulate large quantities of iron in soil, smoke, and ash. Iron is the most abundant metal present. Levels of zinc may be the result of a similar accumulation process.

Atmospheric lead is derived from the combustion of leaded gasoline in internal combustion engines (Zoller et al., 1973) and would therefore be expected in significant quantities.

TABLE C-7. CONTAMINANT INPUTS FROM ATMOSPHERIC FALLOUT (Tonnes/Day)

Input	Cadmium	Iron	Lead	Zinc
Dry Fallout	0.01	3.40	0.55	0.74
Wet Fallout	0.02	6.80	1.10	1.98
Total (Duce et al., 1976)	0.03	10.20	1.65	2.72
Total (Mueller et al., 1976)	0.054	6.10	1.20	5.90

Atmospheric cadmium (for example, from the wear of automobile tires) is present in minute quantities. The source of contamination is not apparent, it may be either natural, anthropogenic, or a result of combined sources.

NEW JERSEY COASTLINE

Contaminant sources from the New Jersey coastline are restricted to two major categories: municipal and industrial wastewater, and surface runoff. In terms of volumes, surface runoff contributes more than 30 times the average amount of municipal and industrial wastewater. But municipal and industrial waters often contain more concentrated amounts of specific contaminants (Table C-2).

Suspended solids are about equally divided between the two sources. Municipal and industrial wastewaters contain approximately 41% of the average daily total. Surface runoff contains about 79 tonnes/day, or 59% of the total. Oil and grease is primarily from the surface runoff (91% of the total).

In metals derived from surface runoff the results are: cadmium (70% of the total), copper (54%) iron (96 percent), and zinc (79%); but primarily found in municipal and industrial wastewater are: chromium (80%), mercury (100%), and lead (72%).

Iron is found almost exclusively in surface runoff. The amount represents about 96% of the average daily total. This implies that the sources of iron are significantly natural, and man's activities contribute iron insignificantly. Mercury is found exclusively in municipal and industrial wastewater. This implies that the mercury contamination is entirely from anthropogenic sources along the New Jersey coastline.

These mass load estimates are provided for comparative purposes only, because these data from the New Jersey coastal region are outside the Apex region and the contaminants are transported to, or deposited in, other areas of the New York Bight.

LONG ISLAND COASTLINE

Contaminants introduced into the New York Bight from the Long Island coastal area are mainly from municipal and industrial wastewater discharge (Table C-3). Surface runoff and groundwater sources contribute minor amounts of most contaminants. The total volume of discharge averages approximately 2,248 m^3 (593 MGD). Of this volume, approximately 15% is of municipal and industrial origin. About 38% is surface runoff, and 47% (1,056 m^3) is ground water.

Sixty-eight percent of suspended solids are from municipal and industrial wastewater; the remainder is discharged with surface runoff. Groundwater does not contribute to the suspended solids load. Eighty-nine percent of the oil and grease is carried by wastewater and the remainder in the surface runoff.

The levels of metal contaminants are low; the majority of the metals are found in the wastewater discharges. Surface runoff contributes an appreciable amount of cadmium (41%) iron (69%) and lead (26%). Groundwater discharge to the Bight contains low levels of all metals and it contributes only slightly to the iron load (6% of the total amount). Natural sources of iron are the most important inputs (75% of the total).

TOTAL MASS LOADING OF THE NEW YORK BIGHT APEX

This section evaluates the total mass loading of contaminants entering the Apex of the New York Bight. Virtually all potentially contaminated material entering the Bight passes through the Transect Zone. Ocean disposal operations are low in volume (less than 0.5% of the total), but contribute a higher proportionate contaminant volume. Dredged material disposal contributes most of the suspended solids. The fate of suspended solids in the Bight is complex and still not well understood. They are important because trace metals and other contaminants are adsorbed by them; these "secondary" contaminants may enter the food chain, either directly via filter feeding shellfish, or indirectly via the plankton.

Monitoring of trace metal contamination is important because of known toxic effects on humans and on the normal biota of the area. Ocean disposal of dredged material and sewage sludge is, in general, the predominant source of metals, and the Transect Zone source is almost equal. Since dredged material is contaminated by the settling of riverborne particles carried into the harbor, the problem of reducing the oceanic loading cannot be separated from reducing the river load. The Acid Site contributes minor amounts of all trace metals except iron (see Appendix D). In the same manner most oil and grease is released at the Dredged Material Site or is part of the outflow through the Transect Zone.

VOLUME

The following estimates of the contaminant volumes entering the Bight are based primarily on reports by Mueller et al. (1976) and Duce et al. (1976). Some sources, such as municipal and industrial wastewater, surface runoff, and ocean dumping are well documented by EPA and Army Corps of Engineers monitoring programs. The least reliable estimates are atmospheric inputs, urban runoff, and groundwater discharge, either because of the difficulty in measurement or simply a lack of sufficient data (Mueller et al., 1976).

The Transect Zone contributes almost all the potentially contaminated water, 99% (Table C-4). However, not all the contaminants which enter the harbor complex are eventually transported to the Apex region. Some of this material probably settles within the harbor where it remains until disturbed and resuspended. Greig and McGrath (1977) concluded that three "metal regimes" existed within Raritan Bay. Western Raritan Bay is an area of high metal concentrations. Concentrations diminish towards the lower New York Harbor area and reach their lowest values (near background levels) at the Harbor entrance (the Transect). However, much of the contamination from the Hudson River is transported to the Dredged Material Site in the Bight when the harbor and channels are dredged.

The Long Island coastline contributes the second largest volume of discharge (Table C-4). The data collected by Mueller et al. (1976) for the Long Island and New Jersey coastlines include areas well beyond the Apex region. Consequently, a large portion of the contaminant inputs from these sources enters the Bight outside the Apex. Data reported by Mueller's group have been modified in Tables C-1 and C-4 based on the assumption that there is a linear relationship between the amount of a given contaminant and the length of the coastline. Thus, since approximately one-seventh of Long Island's coastline lies within the Apex, the contaminant input values for Long Island are divided by seven. This may result in a somewhat low estimate of the mass loading occurring in the Apex from the Long Island coastline. Except for the Shark River (at the edge), the rest of New Jersey's coastline is outside the Apex. Accordingly, contaminant inputs from New Jersey are not included in total mass loading estimates of the Apex. Another assumption is that water motion is directed away from the Apex region along the coastlines. For New Jersey, this assumption is valid; surface waters tend to move south along the coast. Long Island coastal waters may move westerly into the Apex. However, most of the surface runoff and wastewater discharges are into Great South Bay and thus, most contaminants settle to the bottom and are not transported into the Apex.

Ocean dumping provides the smallest volume of all sources, although it is a very important contaminant source, particularly for trace metals. Ocean disposal ranks first or second in percentage contribution for all the parameters examined.

SUSPENDED SOLIDS

Suspended solids are organic and inorganic particulate matter in water (EPA, 1976), which may contain both biogenic and non-biogenic debris (Biscaye and Olson, 1976).

Table C-4 and Figure C-1 illustrate the relative contribution of suspended solid contaminant sources. Ocean disposal (principally dredged material and cellar dirt) is the largest source of suspended solids, approximately two thirds of the daily average. This estimate is high because the value used by Mueller's group in estimating cellar dirt contribution (Table C-4) assumed that all material released at the Cellar Dirt Site was suspended solid material. In 1974, approximately half of the cellar dirt was material six inches or larger; the estimate by Mueller's group is at least 50% too high. Interstate Electronics Corp. (1978) estimated that suspended solids amounted to only about 300 tonnes/day from 1973 to 1977 at the Cellar Dirt Site. Even if Interstate's estimate is more accurate, the total daily loading of suspended solids by ocean disposal will be reduced by less than 10%. This correction still leaves ocean disposal as the single largest contributor of suspended solids.

The Transect Zone provides the second largest source of suspended solids, or about a third of the daily average. Atmospheric fallout contributes the remaining amount; the Long Island coastline contribution is insignificant.

DREDGED MATERIAL AND THE TRANSECT ZONE

Gross (1970, 1976) examined New York Harbor sediments. Metals and other contaminants are adsorbed by particles which, as they settle in the harbor complex, remove these contaminants from the water column (Biscaye and Olsen, 1976). Since material released at the Dredged Material Disposal Site originates in the New York Harbor complex area, contaminants contained in dredged material are originally introduced to the harbor water from the Hudson River and other tributary rivers.

Gross (1972) reported that approximately 160 km^2 (41% of the harbor area) was covered by fine carbon-rich deposits, which were suspended solids entering the harbor from the Hudson River, waste discharges, and surface runoff.

TRANSPORT

MESA (1975) indicates that surface runoff of the Hudson River and the denser saline bottom water each flow in opposite directions across the Transect. In this model suspended sediments move out to sea across the

Transect, then most of the material moves southward along the New Jersey coastline of the Apex, while some moves eastward along the Long Island coastline of the Apex. As these solids would settle into subsurface waters, they may return with the more saline flow into the harbor. Subsurface currents may also move waste materials deposited in the Bight into the harbor. Within the Bight, suspended solids stratify during periods of seasonal sea density stratification. A three-layer system is typically present year-round, but is most pronounced in the spring and summer. It consists of a turbid surface layer, a relatively clear mid-depth layer, and a turbid bottom layer. This turbid lower layer appears to be a permanent feature of the entire Bight Apex (MESA, 1975). This "nephloid layer" is thought to be a result of agitation and resuspension of bottom sediments caused by bottom currents.

Biscaye and Olson (1976) suggest that strong seasonal thermoclines restrict the vertical movement and settlement of suspended solids in surface waters. While organic particles (suspended solids) containing detectable quantities of trace metals are generally most abundant in the Bight Apex, they are occasionally observed in upper and intermediate outer Shelf Waters. Biscaye and Olson suggest that the most likely sources for trace metals bearing suspended solids are sewage sludge and dredged material deposited in the Apex.

Accumulation and resuspension also affect the movement and fate of suspended solids in the Bight. MESA (1975) reported results of sediment sampling over the Apex. Shelf sediments are generally enriched in organic matter and clay particles, and the Apex region has a thin layer of ferrous oxide (Fe_2O_3). Comparing autumnal suspended-solid concentrations with samples after a November storm showed that resuspending bottom sediments resulted in a suspended-solid concentration equivalent to 12 days of sewage sludge dumping. In deeper areas (e.g., the Hudson Channel), muds accumulate due to reduced bottom turbulence. These muds are invariably rich in organic matter (MESA, 1975) with measurable amounts of trace metals (Biscaye and Olsen, 1976).

TRACE METALS

Trace metals occur naturally in the marine environment; however, most metals exist only in minute quantities and accumulate slowly in sediments over long periods. The population density and industrialization of the coastal areas of the New York Bight have caused accelerated introduction of trace metals into the Bight. There are four sources of trace metals into the Bight Apex: (1) New York Harbor (the Transect Zone), (2) ocean dumping, (3) atmospheric fallout, and (4) runoff from Long Island. Metal sources can be estimated from data by Mueller et al. (1976) and Duce et al. (1976). Table C-1 lists these sources and estimated average daily mass loads. Figure C-1 graphically shows the relative importance of each source.

BACKGROUND INFORMATION

Metals may be found in a number of chemical forms. The chemical form of hazardous trace metals is important since this determines the metal's bioavailability and toxicity. Metals can be simple or complex inorganic species, metallo-organic complexes, inorganic and organic colloids and macro-solid particles, which differ in chemical and biological sorptive properties. Unfortunately, these reactions are poorly understood (Segar and Cantello, 1976). However, organic complexing reduces the biological availability of many trace metals (Jenne and Luoma, 1977).

Once metals have been deposited in the sediment, several possible migration mechanisms between the sediment-water interface may occur: bio-oxidation, sorption, dissolution, precipitation, complexation, and diffusion. Iron is released under reducing conditions, and cadmium, copper, lead and zinc are precipitated under reducing conditions. In the oxidizing environment of the Bight, the opposite reactions occur.

Seven metals; cadmium, chromium, copper, iron, lead, mercury and zinc, are either highly toxic or highly concentrated in acid wastes (Appendix D).

Cadmium has no known biological function, but acute and chronic toxic effects have been demonstrated. It exists in solution as a free ion and in complex form (Sarsfield and Marcy, 1977). The redox potential (Eh) of the environment significantly influences the availability of the metal. In oxidizing environments, cadmium is generally found as a carbonate, and its toxicity to three marine decapod crustaceans ranged between 320 µg/l to 420 µg/l (EPA, 1976). Reducing environments generally contain a low solubility cadmium sulfate form (Lu and Chen, 1977).

Chromium is an essential trace element for many living organisms, and is usually present in the reduced hydroxide state. Jenne and Luoma (1977) reported that certain organic chromium compounds may increase the metal's bioavailability by forming more kinetically active species of the metal. Toxic susceptibilities of different animals are highly variable: extremes of 1.0 mg/l (the polychaete Nereis virens) to 200 mg/l (the mummichog, Fundulus heteroclitus) have been observed (EPA, 1976). Hexavalent chromium is more toxic than trivalent chromium; EPA (1976) recommends a maximum concentration of 0.10 mg/l in marine water.

Copper is important biologically because it is essential for synthesizing chlorophyll; it is required in animal metabolism, and is the respiratory pigment used for oxygen transport in some invertebrates. Organic complexing and precipitation decrease copper toxicity (EPA, 1976). At high concentrations (50 to 100 µg/l), photosynthesis is inhibited and marine animals are acutely affected.

Iron is the fourth most abundant element in the Earth's crust, and is required by plants and animals in all habitats (EPA, 1976). In hemoglobin, it is the oxygen transport pigment in the blood of all vertebrates and some invertebrates. In marine environments, iron rapidly forms a floc which may coat gills of fish or invertebrates, and bury or smother eggs (EPA, 1976). Kinniburgh et al. (1977), and Krauskopf (1952) showed that iron hydroxide significantly other metals, e.g., copper, zinc, and lead. Zinc and cadmium are adsorbed more strongly on iron gels as pH increases.

Lead has no known beneficial biological function. It is a toxic metal which accumulates in the tissues of organisms (EPA, 1976). The toxicity of lead in an aqueous environment depends upon pH, organic materials, and other metals. Low pH increases its solubility, whereas organic or inorganic complexing changes its bioavailabilty. Toxicity in sea water is not well known, but concentrations of 100 to 200 μg/l caused severe abnormalities in the oyster Crassostrea virginica (Pringle et al., 1968).

Mercury has no known biological function, and several forms, from elemental to inorganic and organic compounds, occur in nature (EPA, 1976). The most toxic form is methyl mercury accumulated in animals, which can threaten humans. Jenne and Luoma (1977) reported that organic complexing with naturally occurring materials in the marine environment reduces the potential toxicity of mercury.

Zinc is an essential element for all living organisms (Berry, 1977). Excessive levels cause either acute or chronic toxic responses in marine organisms. Acutely toxic concentrations in fish may cause gill breakdowns, and chronic concentrations may inhibit growth and maturation in juvenile fish, or cause general lethargy and histological damage to mature individuals (EPA, 1976). Zinc toxicity is reduced by complexing with organic materials.

SOURCE INPUTS

Table C-1 lists trace metals from the four primary sources. Ocean waste disposal (excluding acid wastes) is the most significant contributor of metals except lead and zinc.

Dredged material (Table C-6) is the largest source of cadmium, copper, chromium, and iron; dredged material and sewage sludge contain approximately equal quantities of mercury.

Sewage sludge is the second largest source of trace metals (see Table C-6) and contributes about 50% of the daily input of mercury, with chromium (24%), lead (13%) and zinc (20%) also high.

Inputs from the Cellar Dirt Site have not been estimated, but are probably insignificant sources of trace metals (Interstate Electronics Corp., 1978).

Passing through the Transect Zone is contaminated water and surface runoff from New York Harbor and Raritan Bay estuary (Table C-1). Many contaminants entering the harbor settle in quiet water areas and remain trapped in bottom sediments. They may be introduced into the Bight after dredging and released at the Dredged Material Site. The Transect Zone contributes the largest volume of wastewater, with the largest average daily quantities of lead (47%), zinc (53%), and the second largest quantities of cadmium (15%), chromium (42%), copper (47%) and iron (16%).

The Long Island coastline contributes only very small quantities of trace metals to the Apex. Of the seven metals examined, the Long Island coastline contributes less than one percent of the daily total in all cases.

IRON

Redfield and Walford (1951) examined iron accumulation in waste discharges at Raritan Bay and the Apex. The iron concentration at the mouth of the Lower Bay was four to six times that of the offshore water concentrations. These high concentrations were associated with low salinity surface outflows from the Lower Bay. In 1951, the Raritan River contributed approximately 45 tonnes/day of iron to the Apex. It was estimated that an equal quantity of iron (45 tonnes/day) was disposed at the "acid grounds".

Segar and Cantillo (1976) reported that most iron is associated with suspended sediments in the lower New York Bay with maximal concentrations occurring just after maximum ebb tide (MESA, 1975). This implies that a significant "pool" of particulate iron exists within the harbor complex. The bulk of this iron is precipitated or dispersed within a short period upon entering the Bight. In addition, Segar and Cantillo (1976) reported a widely distributed nephloid layer containing a high concentration of fine particulate matter, including iron, at the sediment-water interface within the Apex.

New York Harbor sediments show iron as 1.8% of the total dry weight. Samples from the Dredged Material and Sewage Sludge Sites averaged about 1.05% of the total dried sediment weight, which was not greatly different (Gross, 1970).

It is not possible to estimate the iron concentrations at each disposal site, since dredged material and sewage sludge are not analyzed for iron concentrations. In 1977, NL Industries began reporting iron concentrations in its waste. Based on these values and the volumes discharged, Table C-8 shows the approximate amounts of iron released by NL Industries compared to other inputs. Initially, NL Industries contributed about three quarters of the total input of iron. In more recent years, their contribution has decreased to two thirds of the total (Appendix D).

TABLE C-8. AMOUNTS OF IRON RELEASED INTO THE NEW YORK BIGHT (Tonnes/Day)

	1973	1974	1975	1976	1977[1]	1978[2]
NL Industries[3]	182.2	157.1	145.6	111.9	62.5	100.5
Other Sources[4]	51.0	51.0	51.0	51.0	51.0	51.0
Total	233.2	208.1	196.6	162.9	113.5	151.5
Percent NL Industries	78	75	74	69	55	66

Sources:

1 Calculated only for the months NL Industries released waste at the Acid Waste Site.
2 Estimated from eight months of data
3 Data from EPA Region II files
4 Data from Mueller et al., 1976. Sources include the Transect Zone, atmospheric fallout, and the New Jersey and Long Island coastlines.

OTHER TRACE METALS

Toxic trace metals have been examined by numerous researchers. Within the harbor waters, MESA (1975) reported that cadmium, lead, and mercury were below detection limits in waters of the Transect Zone. Particulate and soluble copper varied with the tide and sampling location. Copper was primarily in the soluble form. Alexander and Alexander (1977) reported that particulate lead and cadmium were always less than 0.5 µg/l and 0.1 µg/l, respectively.

Segar and Cantillo (1976) examined trace metals in Apex waters. Copper and cadmium were uniformly distributed during spring, except for isolated areas of increased concentration.

Discharge from New York Harbor contains low concentrations of cadmium and copper. During summer, copper concentrations remain uniform, between 2 µg/l to 4 µg/l. Levels north of the Acid Site were usually higher than other regions of the Apex. Cadmium concentrations over the Apex varied slightly but estuarine and near-bottom samples contained higher concentrations of these metals.

Segar and Cantillo (1976) concluded that summer and mid-winter metal concentrations were higher than spring and autumnal concentrations. During summer, the water column is stratified and restricted circulation increases the water's residence time which leads to higher equilibrium constants. In winter, current and wave energy increase sediment movements, thus releasing metals from resuspended sediments. Iron appears to be found predominantly in the suspended phase while copper, cadmium, and zinc are found predominantly in the dissolved phase. Therefore, copper, cadmium, and zinc are present only in small quantities.

Gross (1976) found that high concentrations of trace metals were widely distributed within New York Harbor sediments. Chromium concentrations were approximately 300 g/tonne in lower harbor sediments. Copper was estimated at 200 g/tonne and lead was estimated at 700 g/tonne of sediment. In comparison, sediment samples from the Dredged Material and Sewage Sludge Sites had concentrations of about 150 g/tonne chromium, 90 g/tonne copper, and 150 g/tonne lead. The dredged material is an important source of contaminants to the Apex, but the ultimate sources of these metals are the contaminated waters flowing into New York Harbor.

Segar and Cantillo (1976) state that much of the solid wastes dumped into the Bight Apex is rapidly dispersed and transported so that flushing of the Apex must be an efficient process. The wastes may move seaward or possibly back towards shore. Freeland et al., 1976, and Freeland and Merrill, 1977, however, concluded that most of the dredged material released into the Apex remains in place. Comparing a 1936 bathymetric survey with a 1973 survey, approximately 87% of the material released at the Dredged Material Site was still in the vicinity of the site. Earlier, Pararas-Carayannis (1973, 1975) had reached similar conclusions. Apparently, those metals which are loosely bound to the sediment are mobilized and quickly carried out of the Bight. The remainder are tightly bound to the sediments and hence have a low bioavailability, but metal bioconcentration can still occur. Gross (1976) reported that deposits from the Hudson Channel south of the disposal sites contain metal-rich sediments and that metal build-up in bottom-dwelling organisms may be occurring.

OIL AND GREASE

Oil and grease is a general category which includes thousands of organic compounds. These contaminants may have either anthropogenic or natural origins, and produce both acute and chronic toxic responses in marine organisms (EPA, 1976). Larval and juvenile stages of marine organism life cycles may be especially sensitive to increased levels of these contaminants. Oil and grease are present in all contaminant sources except the atmosphere and cellar dirt. They enter the Apex at a rate of approximately 780 tonnes/day (Table C-4), constituting the second largest quantity of all contaminants examined (Mueller et al., 1976).

Mueller et al. (1976) estimated that the Transect Zone contributed approximately 460 tonnes/day (57%). Ocean dumping contributed approximately 322 tonnes/day, of which 93% (300 tonnes) is from dredged material, and 7% (22 tonnes) from sewage sludge. The Long Island coastline contributes only about 0.7 tonnes/day, less than 1% of the daily total.

Examinations of the sources of oil and grease indicate that they are entirely of anthropogenic origin. Within the Transect Zone (Table C-5) two primary sources of oil and grease can be identified: (1) municipal and industrial wastewaters, and (2) urban discharge. Each contributes about 200 metric tons/day to the harbor area. By comparison, dredged material (Table C-6) contributes an average of 300 tonnes/day, indicating that much of the oil and grease reaching the harbor is trapped and retained in harbor sediments, and later removed by dredging activity. Coastal discharges (Tables C-2 and C-3) are from municipal and industrial wastes and surface runoff. New Jersey, which is highly industrialized, discharges about 75 tonnes/day along its coast. Presumably, little of this contamination ever reaches the apex region because of prevailing currents moving southerly along the coast. About 90% of the oil and grease from New Jersey is from surface runoff. The remaining 10% is from municipal and industrial wastewater. Long Island, which is much less industrialized, discharges only about 5 tonnes of oil and grease per day, and of this only about 15% (0.7 tonnes) enters the Apex. About 90% of the Long Island discharge is from municipal and industrial waste water. The remaining 10% is from surface runoff.

Appendix D

CONTAMINANT INPUTS TO THE ACID DISPOSAL SITE

CONTENTS

TABLES

Appendix D

CONTAMINANT INPUTS TO THE ACID WASTE DISPOSAL SITE

PERMITS AND WASTE VOLUMES

YEARS 1973 TO 1978

When the Acid Site came under EPA regulation in 1973, three New Jersey companies (Du Pont-Grasselli in Linden, Allied Chemical in Elizabeth, and NL Industries in Sayreville), were using the site for disposal purposes. In 1974, Du Pont-Grasselli moved its entire waste disposal operation to the 106-Mile Chemical Waste Site, as required by EPA. In 1979 only Allied Chemical and NL Industries are disposing of wastes at the Acid Site.

Records of NL Industries' waste disposal activities have been maintained since the late 1950's. However, when the EPA began regulating and monitoring ocean disposal activities in 1973, more detailed analyses were required. NL Industries disposes of waste on a daily basis, occasionally barging wastes twice a day to the site.

NL Industries is the largest waste contributor to the Acid Site in terms of amount of waste. Annual quantities (Table D-1) fluctuated considerably between 1973 and 1978, although the long-term average from 1958 is fairly stable (Figure D-1). This recent fluctuation resulted from a plant shutdown in mid-1976 and start-up again in mid-1977. For approximately nine months, all plant production was halted. The mean annual quantity of waste material dumped between 1973 to 1978, has been 1.8 million tonnes, ranging from 0.605 thousand tonnes in 1977 to 2.3 million tonnes in 1973. Since 1958, NL Industries has contributed over 90% of the total volume of waste material dumped at the Acid Site.

TABLE D-1. DISPOSAL QUANTITIES (TONNES/YEAR)

	1973	1974	1975	1976	1977	1978	TOTAL
NL Industries	2,304,250	1,986,735	1,841,586	1,233,722	604,733	1,233,792	9,204,868
% Contribution	92.0	93.5	97.5	96.5	95.4	97.9	
Allied Chemical	58,967	56,245	48,081	47,174	29,030	26,259	265,806
% Contribution	2.3	2.6	2.5	3.6	4.6	2.1	
Du Pont-Grasselli	142,428	78,018	---	---	---	---	220,446
% Contribution	5.7	3.7	---	---	---	---	
TOTALS	2,505,645	2,120,998	1,889,667	1,280,946	633,763	1,260,101	9,691,120

Records of Allied Chemical waste disposal activities have been maintained since the EPA began regulating and monitoring waste disposal at the Acid Site in mid-1973. Since 1973, Allied Chemical has disposed of approximately 255,000 tonnes of waste material, averaging about 50,900 tonnes/year (data from 1973 to 1978).

Allied Chemical's wastes are less than 5% of all waste material released at the Acid Site. Unlike NL Industries, Allied Chemical disposes of waste material intermittently, only once or twice a month. The total volume of Allied waste barged to the Acid Site has dropped 55% since 1973.

Du Pont-Grasselli discontinued disposal activity at the Acid Site 1974. At that time, they shifted their entire disposal operations to the 106-Mile Chemical Waste Site. During 1973-74 in which Du Pont dumped at the Acid Site, they disposed of approximately 220,000 tonnes of waste material, or about 5% of the annual input.

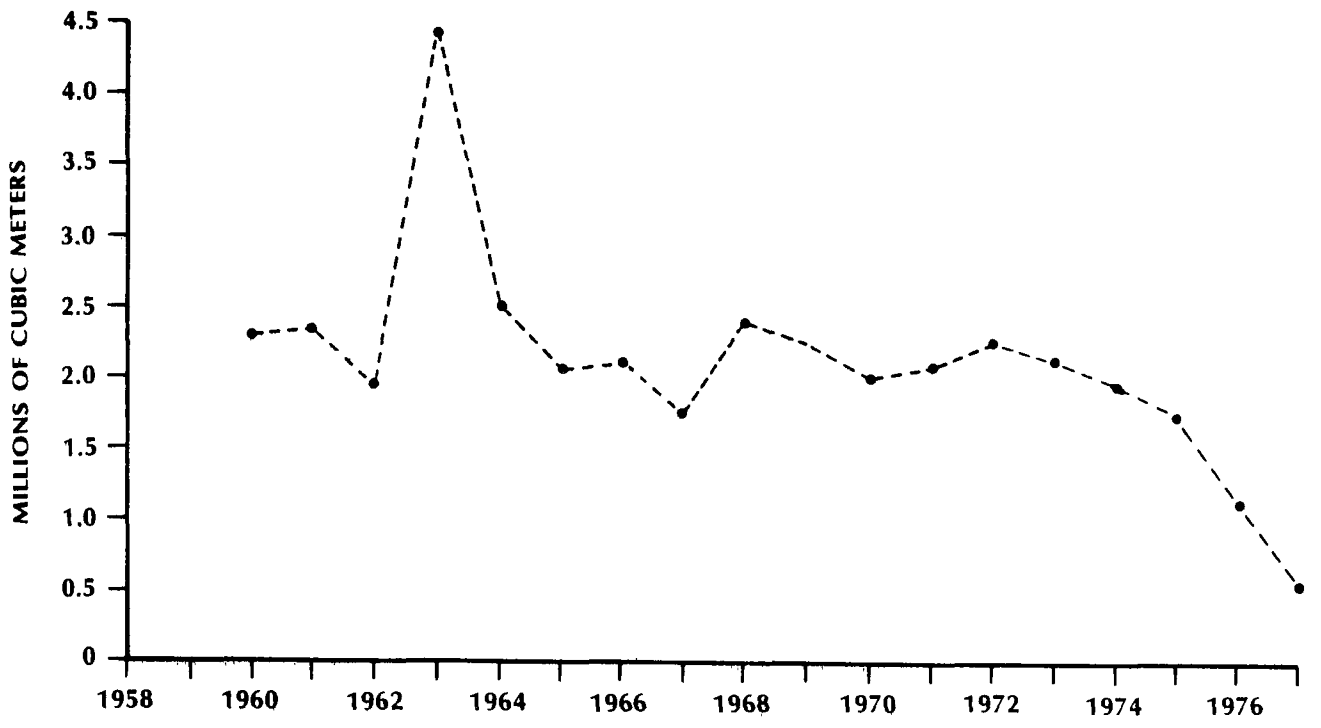


Figure D-1. Reported Dumping Volumes at New York Acid Dump Site (Adapted from EPA, 1978a)

PROJECTED INPUTS

NL Industries' permit which expires 9 April 1981 allows them to dispose of 2.7 million tonnes of acid wastes during the 2-year permit term, or about 1.4 million tonnes per year. This is lower than the previous 5-year average (1.8 million tonnes). The maximum amount permitted in 1 year under this permit is 2.3 million tonnes, which is about equal to the long-term average of 2.2 million tonnes.

Allied Chemical's permit which expires 9 April 1981, allows them to dispose of 52,000 tonnes of acid wastes per year, which is about equal to the previous 5 year average annual input (53,000 tonnes). However, Allied Chemical anticipates that 1979 discharge volumes will be about the same as the 1978 volume (26,000 tonnes) which is about half of the permitted amount (Fitts, 1979).

Consequently, the two permittees are authorized to release approximately 1.4 million tonnes per year, which is 27% less than the previous 5-year average.

WASTE COMPONENTS

Each barge sample analysis (for the Acid Site) since 1973 has been reviewed to estimate the total constituent loading. Interstate Electronics Corporation has developed an automated data handling and analysis system; the Oceanographic Data Environmental Evaluation Program (ODEEP). ODEEP was utilized to evaluate the wastes dumped at the Acid Site. The results of the analyses of NL Industries and Allied Chemical's wastes are presented in this section. Only yearly means and ranges are presented. There were no significant differences in waste characteristics during different seasons; consequently, the yearly values adequately represent what was dumped at the site. Approximately 3,600 data points were used for these analyses. When evaluating this loading, two factors are important:

- The liquid waste does not appear to affect the bottom,
- The waste is neutralized rapidly (in minutes) and environmental effects have been associated only with unneutralized waste.

Since waste constituents do not accumulate in the water column, the material does not remain at the site but is carried out of the bight. The amounts per day of waste constituents are most relevant since these represent roughly the inputs from a single barge load.

NL INDUSTRIES

NL Industries disposes of wastes produced in the manufacture of titanium dioxide, an inert, nontoxic white pigment used in paper, paint, plastic, drugs, and ceramics. Waste material consists of approximately 10.0% (by weight) ferrous sulfate ($FeSO_4$), 8.5% (by weight) sulfuric acid (H_2SO_4), and 1.5 - 2.0 g/l titanium. Other trace metals, and oil and grease are present in minute quantities.

The waste is released below the surface of the water through 30-cm diameter pipes in the wake of a barge. The barge is moving at 5 to 6 kn. The maximum permissible disposal rate is 376,000 liters (100,000 gal) per nmi. Using this discharge rate, an average barge load of 3.7 million liters of waste can be released in approximately 90 minutes, over a distance of about 9 nmi. As the waste is released into the seawater, the acid is neutralized, and the ferrous sulfate stains the water a characteristic green color. The ferrous iron is rapidly oxidized to ferric hydroxide (rust) and this gives the water a "muddy," red-brown color.

PHYSICAL CHARACTERISTICS

Specific gravity of NL Industries waste has, with one exception, ranged between 1.082 and 1.197 (a single value of 1.426 was reported in August 1976). The average specific gravity is 1.132. These densities are greater than seawater (1.025) so the waste sinks and disperses through the water column during periods of homogeneous water column density (winter). During summer months, when distinct thermocline and pycnocline stratifications occur, sinking and dispersion are restricted to the upper mixed layer, which is typically 10 to 15 m in depth.

The speed of the mixing of waste with seawater is a function of prevailing meteorological and oceanographic conditions. Following discharge from the barge, initial mixing occurs rapidly (within the first 15 minutes) primarily as a result of barge generated turbulence. After this period, wind, waves, currents, and density stratification determine the rate and direction of dispersion and dilution. The most recent dispersion study of NL Industries waste was performed by EG&G (1977a) in August 1977. Waste material sank to a depth of 10 m and rapidly dispersed laterally under conditions of high winds and moderate seas.

EG&G (1977a) recorded seawater iron concentrations and pH values to track the waste plume. They determined that a concentration of 2 µg/l (acid-waste) of seawater was equivalent to the ambient seawater iron level and a value of 5 µg/l indicated the presence of the waste plume. Before the disposal operation, iron concentrations in the upper mixed layer and below the thermocline were measured at reference stations. The mean iron concentration of upper mixed layer water was 0.05 µg/l and the mean iron concentration of subsurface layer water was 0.02 µg/l. Immediately following discharge, the surface iron concentration was 25,500 mg/l. This concentration dropped rapidly and 14 minutes after discharge the maximum surface iron concentration was 1.9 mg/l.

By monitoring iron concentration, the dilution factor can be determined. Forty minutes after discharge, the waste was diluted to 9,400:1. After four hours the minimum waste dilution was 90,000:1, and after 18 hours one station showed a minimal dilution of 116,000:1.

Federal environmental standards require that wastes do not change the ambient pH level more than 0.2 pH units beyond accepted limits of 6.5 to 8.5 (EPA, 1976). The EG&G (1977a) study had only one station with a pH change greater than 0.2 pH units below the previously observed ambient value. In this case, two 1 m samples had pH's of 7.95 and 7.99, reduced 0.25 and 0.21 pH units, respectively, from the mean ambient surface value of 8.2. These reduced values occurred about 15 and 35 minutes after discharge and were well within the normal pH range for this area of 7.9 to 8.2 (Hazelworth et al., 1974).

CHEMICAL CHARACTERISTICS

Table D-2 summarizes the characteristics of various waste constituents and the inputs into the Bight Apex. For convenience, the total input from all sources of each constituent are shown for comparison. Obviously, the contaminants present in NL Industries waste are trivial (<1%) sources of total contaminant loading in the Bight. Comments about specific waste characteristics follow.

<u>pH</u>

The extremly low pH of NL Industries' waste is rapidly neutralized by the buffering action of sea water. The time to reestablish ambient pH values has

TABLE D-2. WASTE CHARACTERISTICS - NL INDUSTRIES

Chemical Parameters	Range (ug/l)	Mean (ug/l)	Average Yearly Input (tonnes)	Average Daily Input (tonnes/day)	Average Daily Input-other sources (tonnes/day)	Percent Acid Waste Input
Suspended Solids (ug/l)	2.0 20,500	3,760	2.980	12.6	23,560	0.05
Organics	190 - 50,600	5,440	6.0	0.02	763	0.014
Petroleum Hydrocarbons	200 48,200	4,650	3.7	0.01	no data	
Cadmium	10 500	200	0.3	0.01	2.43	0.03
Chromium	2,000 18,900	10,900	14.2	0.04	5.26	0.6
Copper	123 140,200	4,100	4.8	0.01	13.2	0.08
Lead	270 880	1,670	2.1	0.01	12.4	0.08
Mercury	0.5 8	4.7	0.005	0.01	0.52	0.01
Zinc	480 36,100	2030	26.4	0.07	32.1	0.2
Physical Parameters						
Specific Gravity	1.062- 1.197	1.132				
pH	0.10 1.09					

ranged from minutes (Redfield and Walford, 1951) to 2.5 hours (EG&G, 1977a). Ambient pH levels are never depressed outside the site's boundaries during the 4-hour period of initial mixing (ERCO, 1978a). The extremely low pH values which cause harmful effects to the plankton are present for only a brief period (less than thirty seconds; Redfield & Walford, 1951), and only around the barge's discharge port.

Suspended Solids

Some inert materials, gangue and uncombined titanium ore, are present in the waste, and these are suspended solids reported in Table D-2. The iron floc which forms after waste release is not part of these values. However, even with this additional suspended material, there is no danger that waste constituents could reach the shoreline in measureable amounts. ERCO (1978a) calculated that minimum dilution of the waste, if it moved in a straight line directly to the beach, would be two million to one. The concentration of iron, the most abundant waste component, would be about half of the normal, ambient value.

Trace Metals

Four metals (arsenic, nickel, titanium and iron), in addition to the six in Table D-2, are measured in NL Industries' waste. Although toxic, arsenic forms compounds after release and the organo-metallic complexes do not appear to accumulate in the food chain, and are not highly toxic (EPA, 1976). This conclusion is supported by bioassay results which have shown low toxicity in neutralized acid wastes (see Bioassay Section). Nickel, titanium, and iron in these amounts are considered to be nontoxic to man (EPA, 1976).

Titanium and iron are present in high concentrations in NL Industries' waste; 1.9 g/l and 27.6 g/l respectively. Daily inputs average 8.6 and 148 tonnes/day and represent a major source of these metals at the Apex. Field observations and bioassay results have shown no adverse effects on the plankton from these metals (Appendix B).

TOXICITY

As outlined above, waste from NL Industries is an insignificant source of contaminants to the Apex of the New York Bight. Iron and titanium, which are significant inputs, are nontoxic. However, the waste is released in a small area over a short time and localized effects may occur in the site region. Therefore, the EPA requires bioassays and field studies to evaluate the toxicity of the wastes. This work has demonstrated that wastes are toxic only for a few minutes after discharge; long-term, chronic effects have not been observed.

Bioassays

Bioassays of NL Industries' wastes must include analyses of the effects of various waste concentrations upon organisms indigenous to the disposal site. Bioassays are now conducted under procedures required by Federal standards (EPA, 1978b).

Bioassays have been performed upon waste samples since the permit program started. Representative species in these studies include the phytoplankters, Skeletonema costatum, and fish Menidia menidia. Artemia salina (an estuarine copepod) was used extensively in the past, but the latest bioassay standards require the use of more representative marine organisms.

Phytoplankton test organisms are to be examined for the effective concentration (EC_{50}) which causes a 50% reduction in cell numbers (compared to a control group) after 48 or 96 hours. Zooplankton and nekton are examined for the lethal concentration (LC_{50}) at which 50% of the test organisms die after 48 or 96 hours.

Results of bioassay tests, conducted since 1973, show that the toxicity to Artemia salina varies between LC_{50} values of 100,000 mg/l to 1,155 mg/l. Variations are due primarily to changes in the Federal mandates for tests (before 1977, unneutralized wastes were used) and test organisms, but not because of radical changes in the toxicities of the material. The annual mean LC_{50} values for bioassays ranged from 92.4 mg/l to 302 mg/l in non-aerated, 96-hour tests. Simultaneous bioassays on M. menidia in 96-hour, aerated tests, had mean LC_{50} values of 101 mg/l (1977) and 282 mg/l (1978). Bioassays on Skeletonema costatum had mean 96-hour LC_{50} values of 174 mg/l (1976), 241 mg/l (1977) and 106 mg/l (1978).

Tests demonstrate that waste materials dispersed by NL Industries will be acutely toxic to planktonic organisms for only a few minutes. The dilution of waste occurring immediately after discharge reduces concentrations to values below the levels known to be toxic to representative organisms. The concentration of iron, the most abundant waste contaminant, was 1.9 mg/l fourteen minutes after discharge (EG&G, 1977a). These tests do not, however, evaluate chronic effects which may impair reproductive or behavioral aspects of species at the individual or population levels. Field observations (see below) confirm the low toxicity of waste in the barge wake.

Field Studies

The first biological observations of effects due to acid waste disposal (Redfield and Walford, 1951), showed that fish or benthic populations were not being damaged or excluded from the area. Zooplankton entrained in contaminated wake water were temporarily immobilized but recovered when the contaminated water was diluted, which occurs rapidly in the barge wake.

Ketchum et al. (1958) reported that plankton tows, taken shortly after acid-iron waste disposal, were clogged by flocculent iron precipitate ranging from 5 to 70 microns in diameter. Zooplankton (which normally feed on phytoplankton about this size) captured in the wake did contain large quantities of "brownish material" which was "presumably the iron precipitate." The zooplankton appeared normal and it was stated that the "studies have failed to demonstrate any deleterious effect of this waste disposal on the plankton populations of the area."

The most recent comprehensive study of the effects of acid-iron wastes is reported by Vaccaro et al. (1972). A waste concentration four times greater than values observed in the field produced no adverse effect on phytoplankton growth or diversity. Only the zooplankton showed chronic effects. After eighteen days of exposure, reproduction and growth were affected by a concentration of 1:10,000 waste, showing a "failure of the organisms [zooplankton] to reproduce, or a delay in the time required to transform eggs into adults." These results, however, are not biologically significant since this waste concentration occurs for only a few minutes after disposal.

Field studies discovered dissimilarities in zooplankton communities at the acid site and at control areas. The mean zooplankton abundance was greater in control areas but the ranges of abundance values were similar at the site. It was concluded that differences were due to a transitory, large-scale patchiness and not acid-iron waste toxicity.

Levels of eight trace metals in zooplankton, benthos, and sediments were examined. Concentrations in the Acid Site area were significantly higher than in the control area. However, samples from the Hudson Canyon had the highest assimilations of lead and chromium in benthos and the highest amounts of all eight metals in sediments, suggesting that canyon sediments may be the area of greatest heavy metal enrichment. The control area was located outside of the Apex, thus the results may only show that, in general, metal concentrations inside the Apex are higher than those outside.

Grice et al. (1973) concluded that short-term effects of acid waste disposal are due to short-term acidity fluctuations rather than toxic components of waste material. Mortality during short-term exposure to high concentrations of the waste material is small; it is notable that adults and larvae are not appreciably affected by heavy concentrations. It was noted that reproductive inhibition of adults and reduced survival of young copepods occurred only after 18 days of exposure. The pH was held below 6.5, but these levels occur for only minutes after actual discharges. No mortality was observed when the animals were passed through acid waste dilutions at pH levels and periods comparable to barge dumps. Gibson (1973) confirmed earlier experiments that the acididy of the waste is the toxic factor. Animals held in neutralized acid waste showed no mortality, whereas others kept in sulfuric acid solutions, simulating acid waste, showed high mortality at pH levels less than 5.5.

Some work on biological assimilation of trace metals was performed at the former Du Pont-Edgemoor Industrial Waste Site. Until 1978, Du Pont-Edge Moor discharged an acid-iron waste at this site similar to wastes released by NL Industries. Pesch et al. (1977) investigated trace metals in scallops at two disposal sites: the industrial waste and municipal sewage sludge sites. The input of four metals (iron, manganese, vanadium, and titanium) were due to the acid wastes, not the sewage sludge. Consequently, these four metals can be used as tracers of acid waste accumulations in an area which is isolated from other anthropogenic pollutant sources. Pesch et al. (1977) found an area of high vanadium concentrations in scallops south of the site, in the direction of projected plume transport. Examinations of the other three metals, however, did not follow the same trends; when all four metals were considered, "high" stations existed to the south and north of the site, occasionally near a "low" station. The findings, although indicating possible effects of acid-iron waste upon benthic organisms, require more confirmatory evidence. In the New York Bight such effects would not be observable because of the high inputs of contaminants from other sources.

ALLIED CHEMICAL CORPORATION

Allied Chemical Corporation disposes of wastes resulting from the manufacture of refrigerants. Waste materials consist of approximately 30% (weight) hydrochloric acid, 2% (weight) hydrofluoric acid, and trace constituents in aqueous solution. Trace metals and oil and grease are present in minute quantities.

Wastes are released below the ocean surface through 30 cm diameter pipes into the wake of a barge moving at 5 to 6 knots. The maximum permissible disposal rate is 45,400 liters (12,000 gal) per nmi. Therefore an average waste load of 1.6 million liters can be emptied in approximately six hours, over a distance of about 35 nmi. Allied Chemical's waste does not discolor the receiving water.

PHYSICAL CHARACTERISTICS

Specific gravity (density) of Allied Chemical waste, with two exceptions, has ranged between 1.116 and 1.200 (values of 1.57 and 1.60 were reported March and April 1976). The mean value is 1.170 which is greater than seawater (1.025); thus waste sinks and disperses through the water column during periods of homogeneous water column density. In summer months, when thermocline and pycnocline stratifications occur, sinking and dispersion are restricted to the upper mixed layer stratum, usually about 10 to 15 m deep.

Dispersion studies of Allied Chemical waste were conducted by EG&G, Environmental Consultants (EG&G, 1977b). Waste material sank rapidly to the bottom of the surface mixed layer and remained there. After several hours, no significant penetration of the thermocline was observed. The wastes were tracked by monitoring dye concentration and pH changes.

Waste concentration diminished uniformly with depth during the first few hours of dispersion. The maximum waste concentration was 360 mg/l one minute after discharge, and about 36 mg/l 45 minutes later. After about two hours, vertical waste distribution began to exhibit patchiness, with localized areas of high concentrations above the thermocline and near the surface. After three hours, maximum concentrations were found near the thermocline. Four hours after discharge, maximal waste concentration was 18 mg/l at 5 m.

One minute after discharge, the dilution ratio was approximately 2,700:1, increasing to 15,000:1 in four minutes. Three hours after discharge, the dilution ratio was 83,000:1, and 143,000:1 after four hours.

Current shear was a noticeable factor in waste dispersion. The upper 10 m (mixed layer) appeared to move eastward relative to the subsurface core at 10 m. The entire plume moved with tidal currents approximately 2 nmi (3.6 km) west of the original position.

Marine water quality criteria specify that pH must be maintained between 6.5 and 8.5, and may not be affected by more than ±0.2 pH units. Ambient pH values decreased 0.7 units immediately after discharge, but, as natural neutralizing and dilution continued, the pH within the plume steadily returned to ambient values. Four hours after discharge, pH values had returned to within 0.2 pH units of normal ambient levels.

CHEMICAL CHARACTERISTICS

Table D-3 summarizes characteristics of various waste constituents and inputs to the Bight Apex. Inputs from all sources are shown for comparisons. Obviously, the contaminants present in Allied Chemical's waste are trivial sources (<0.01%) of total contaminant loading in the Bight. Comments about specific waste characteristics follow.

pH

The extremely low pH of Allied Chemical's waste is neutralized by seawater buffering action well within the four-hour period of initial mixing mandated by the Ocean Dumping Regulations. The initial pH value is 7.5 after waste release (EG&G, 1977b), which is 0.7 units less than ambient values and lower than the normal pH range of the site. The pH values rapidly return to ambient levels. Minimal pH's after initial mixing were: 8.07 at 1 m; 7.90 at 5 m; and 8.03 at 10 m. Normal ambient pH range for this area is 7.9 to 8.2 (Hazelworth et al., 1974).

TABLE D-3. WASTE CONSTITUENTS - ALLIED CHEMICAL

Chemical Parameters	Range (ug/l)	Mean (ug/l)	Average Yearly Input (tonnes)	Input per barge * (tonnes)	Average Daily Input-other sources (tonnes)	Acid waste input (%)
Suspended Solids	10 246 mg/l	25 mg/l	0.7	0.06	23,580	0.01
Oil & Grease	100 20,000	4,450	0.2	0.02	783	0.01
Petroleum Hydrocarbons	100 13,000	1,560	0.07	0.01	no data	
Cadmium	2 200	16	0.01	0.01	2.4	0.01
Chromium	10 3,040	199	0.04	0.01	5.3	0.01
Copper	10 2,400	124	0.03	0.01	13.2	0.01
Lead	10 480	102	0.02	0.01	12.4	0.01
Mercury	0.02 170	12.5	0.01	0.01	9.5	0.01
Zinc	2 1,200	156	0.03	0.01	32.1	0.01
Physical Parameters						
Specific Gravity	1.116 1.200	1.170				
ph	0.10 2.20					

* Assume 12 barges/year

Suspended Solids

Allied Chemical waste does not contain insoluble materials, and does not react with seawater to form precipitates. There is no danger of waste constituents reaching the shoreline in measurable amounts. ERCO (1978b) calculated that minimum dilution of the waste, traveling straightly and directly to the beach, would be one million to one. The concentration of fluoride, the most abundant waste component, would be about 2% of the normal ambient value.

Trace Metals

Two metals, arsenic and nickel in addition to the six in Table D-3, are measured in Allied Chemical's waste. Comments applied to NL Industries' wastes are equally applicable to those from Allied. The non-toxic nature of neutralized acid waste is convincingly proven by bioassay results, from which conventional LD_{50} values cannot be derived (ERCO, 1978b).

TOXICITY

Bioassays

Allied Chemical does not dispose of waste daily, unlike NL Industries; Allied Chemical introduces waste in a pulsate manner. Wastes may accumulate for several weeks, and are barged to the site once or twice per month. Redfield and Walford (1951) concluded that total flushing of the entire Apex takes from 8 to 14 days. Therefore, Allied Chemical waste is extensively diluted and, in all probability, flushed from the Apex before any subsequent disposal occurs, thus eliminating the potential for compounds to accumulate in sediments or biota of the Apex.

Results of bioassay tests show annual mean 96 hour LD_{50} values in *Artemia salina* (copepod) ranging from 52,833 mg/l to 97,429 mg/l. Similarly, 48 hour LC_{50} yearly mean values for *A. salina* range from 123 mg/l to 235 mg/l. The differences in lethal concentrations do not suggest extreme toxicological effects, but are rather due to differences in test procedures.

Skeletonema costatum (phytoplankton) have mean 96-hour EC_{50} values ranging from 106 mg/l to 350 mg/l with respective standard deviations of 22 and 342 mg/l.

Menidia menidia (nekton) have annual mean TL_{50} values for 96-hour aerated samples ranging from 203 mg/l to 278 mg/l. TL_{50} values from 48-hour tests have annual mean values ranging from 233 mg/l to 280 mg/l. Non-aerated tests produce approximately equal TL_{50} values for the same waste samples.

Acartia tonsa (an estuarine copepod) had a mean 96-hour LC_{50} value of 72 mg/l in 1975, and a mean 96-hour TL_{50} value of 89 mg/l in 1976.

All tests demonstrated that waste materials disposed by Allied Chemical have only short-term acute effects upon marine organisms. The highest waste concentration was 360 µg/l one minute after discharge, but only 36 µg/l 45 minutes after discharge. Waste dilution several minutes after discharge reduces concentrations to values below the toxic levels of representative organisms. The tests do not, however, confirm chronic effects which may alter or impair reproductive and behavioral aspects of species at the individual or population levels.

Field Studies

Allied Chemical does not dispose of acid waste material as frequently as NL Industries, nor are waste volumes as great as NL in single disposal operations. However, Allied Chemical waste is more acidic, thus necessitating a slower release into receiving waters in order to minimize short-term impacts upon biota.

Chemical analyses have confirmed that the compositions of NL and Allied wastes are similar (except for iron and titanium content), and bioassay studies show similarities in toxicity. Therefore, impacts of the two wastes are assumed to be similar in the dump area.

DU PONT-GRASSELLI

Du Pont-Grasselli produces production wastes from DMHA (N,O-dimethyl hydroxylamine) and Anisole. During 1973 and 1974 when Du Pont-Grasselli was dumping in the Acid Site, the contribution was approximately 5% of the annual input (Table D-1). Since 1975, however, all Du Pont wastes have been released at the 106-Mile Chemical Waste Site.

The primary constituent of Du Pont-Grasselli waste is sodium sulfate (Na_2SO_4), with numerous trace metals, suspended solids, and various organic substances.

Specific gravity of Du Pont waste averaged 1.089, slightly greater than sea water, but less than NL Industries and Allied Chemical wastes.

Du Pont-Grasselli waste was alkaline, with a pH range from 12.5 to 13.3, during two years of waste disposal at the Acid Site. Mass loadings of the inputs are equivalent to those of Allied Chemical i.e., insignificant compared to the total inputs. No adverse effects from Du Pont-Grasselli's wastes were ever noted at the site or in the Apex.

In the same manner as NL Industries' and Allied Chemical's wastes, releases would have been rapidly diluted, dispersed, and transported by currents to other Bight regions. Since Du Pont's liquid waste was diluted, and transported out of the Bight, contaminants did not accumulate in the water; thus Du Pont-Grasselli dumping is important in a historical sense, but is not relevant to current mass loadings.

COMPARISON OF CONTAMINANT INPUTS

Table D-4 compares total inputs of selected contaminants into the New York Bight Apex with total inputs of the two permittees presently (1979) using the Acid Site. All acid waste contaminants are less than 1% of the total (column 7). The materials now being released at the Acid Site do not represent significant sources of contaminants in the receiving waters.

TABLE D-4. MASS LOADING - NEW YORK BIGHT APEX (Tonnes/Day)

Inputs	Suspended Solids	Oil and Grease	Cadmium	Chromium	Copper	Mercury	Lead	Zinc
Total Inputs to Apex	23,580	783	2.41	5.3	13.2	0.5	12.4	32.1
Total Inputs to Acid Site								
NL Industries	12.6	0.02	.01	0.04	0.01	0.01	0.01	0.07
Allied Chemical	0.06	0.02	0.005	0.005	0.005	0.005	0.005	0.00
Total	12.7	0.04	NM	0.04	0.01	NM	NM	0.07
Percentage of Apex Total due to Acid Wastes	0.05	0.01	NM	0.8	0.08	NM	NM	0.2

NM not meaningful

Appendix E
MONITORING

CONTENTS

Appendix E

MONITORING

The Final EPA Ocean Dumping Regulations and Criteria (40CFR 220 to 229) established the following monitoring requirements (Part 228.9):

(a) The monitoring program, if deemed necessary by the Regional Administrator or the District Engineer, as appropriate, may include baseline or trend assessment surveys by EPA, NOAA, other Federal agencies, or contractors, special studies by permittees, and the analysis and interpretation of data from remote or automatic sampling and/or sensing devices. The primary purpose of the monitoring program is to evaluate the impact of disposal on the marine environment by referencing the monitoring results to a set of baseline conditions. When disposal sites are being used on a continuing basis, such programs may consist of the following components;

(1) Trend assessment surveys conducted at intervals frequent enough to assess the extent and trends of environmental impact. Until survey data or other information are adequate to show that changes in frequency or scope are necessary or desirable, trend assessment and baseline surveys should generally conform to the applicable requirements of 228.13. These surveys shall be the responsibility of the Federal government.

(2) Special studies conducted by the permittee to identify immediate and short-term impacts of disposal operations.

(b) These surveys may be supplemented, where feasible and useful, by data collected from the use of automatic sampling buoys, satellites or in situ platforms, and from experimental programs.

(c) **EPA will require the full participation of other Federal and State and local agencies in the development and implementation of disposal site monitoring programs. The monitoring and research programs presently supported by permittees may be incorporated into the overall monitoring program insofar as feasible.**

SHORT-TERM MONITORING

Short-term monitoring surveys are the responsibility of the permittee and are designed to assess the immediately observable effects of the waste (a "special study" as defined in the Ocean Dumping Regulations).

Special Condition No. 6 of the ocean disposal permits issued to Allied Chemical Corporation (Permit No. II-NJ-004) and NL Industries, Inc. (Permit No. II-NJ-014) requires these companies to "continue to implement [their] EPA approved monitoring program as a means of determining the short term environmental impacts of ocean dumping of [their] waste(s)." In May 1977, the companies submitted a site monitoring proposal prepared by EG&G, Environmental Consultants, to fulfill the site monitoring requirements. Four monitoring cruises have been completed at the site (EG&G, 1977, 1978a, 1978b; ERCO, 1978c). The information from these cruises provides a sufficient data base to detect longer term changes at the site resulting from acid waste disposal.

Surveys were made during the summer (strong thermocline) and winter (no thermocline) seasons. Nine stations were originally established: two (now one) permanent reference stations northeast of the site, five permanent stations within the site (a center and four corner stations), and two "waste transport" stations which are established in a waste plume on each cruise (Figure E-1). Two changes were approved in July 1978 (between the third and fourth survey). One reference station was eliminated and vanadium analyses in the water column and sediments were eliminated. For 1979 and 1980, only the summer survey is required. Table E-1 summarizes the parameters measured for the monitoring plan.

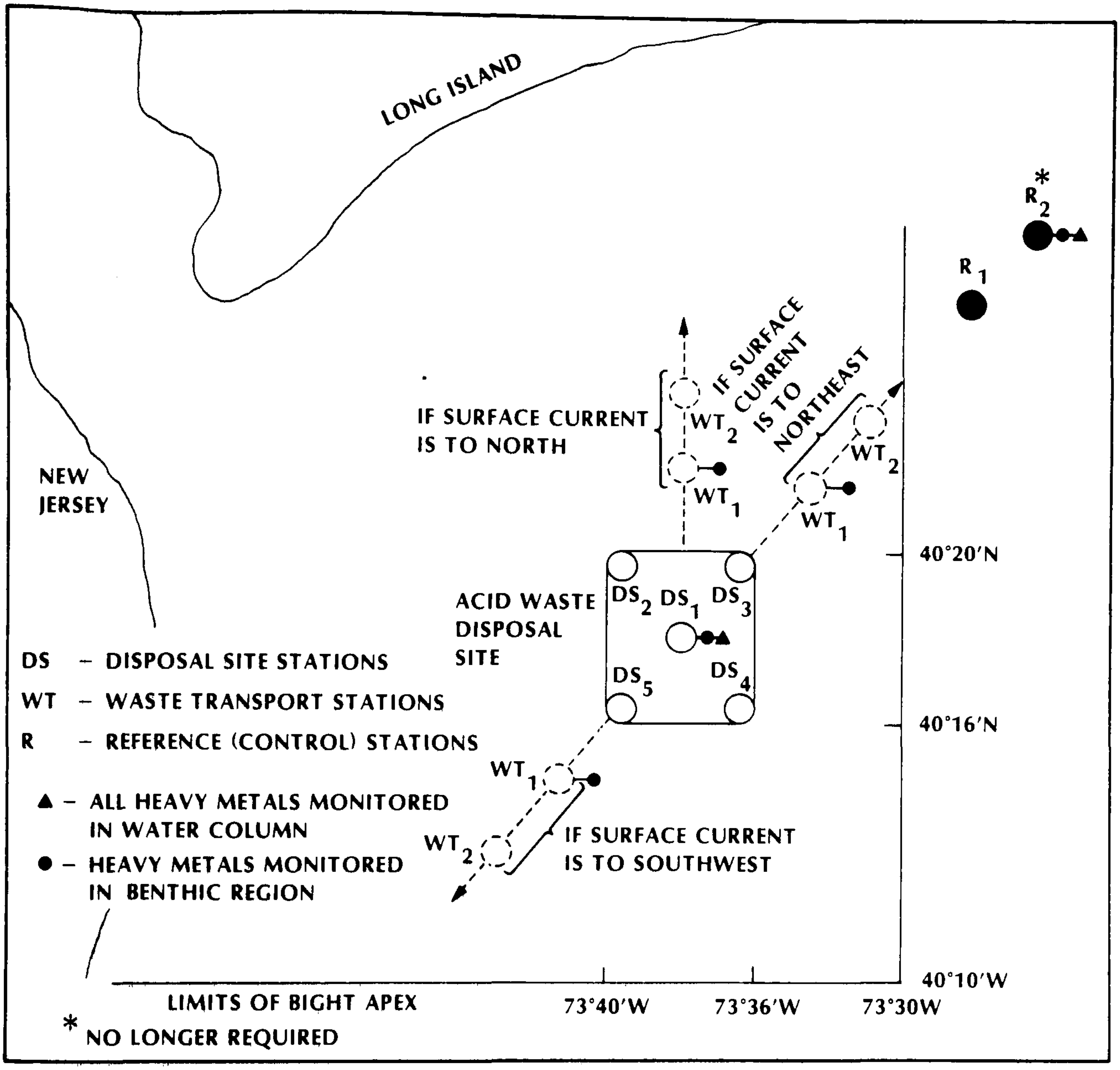


Figure E-1. Monitoring Stations at and Adjacent to the Acid Waste Disposal Site in New York Bight

TABLE E-1. PHYSICAL AND CHEMICAL OCEANOGRAPHIC MONITORING PROGRAM AT AND ADJACENT TO THE ACID WASTE SITE IN THE NEW YORK BIGHT

Water column sampling

- Winter - 3 depths (subsurface, mid, bottom) [no longer required]
- Summer - 4 depths (subsurface, above pycnocline, below pycnocline, bottom)

Parameter	Unit of Measure	Stations	No. of Samples
Temperature	°C	All	Profile
Salinity	°/oo	All	Profile
pH	.	All	2
Dissolved oxygen	ml/liter	All	2
Alkalinity	meq/liter	All	2
Fluoride	mg/liter	All	2
Suspended Particulate Matter	ug/liter	All	2
Chlorophyll a	mg/m^3	All	2
Iron-dissolved	µg/liter	All	2
-particulate	µg/liter	All	2
Nonferric trace metals - arsenic, cadmium, chromium copper, lead, mercury, nickel, titamium, zinc		Center of site and reference	
Dissolved	µg/liter		2
Particulate	µg/liter		2

Benthic Sampling (Surficial Sediment)

Parameter	Unit of Measure	Stations	No. of Samples
Color	Qualitative	3-Site	2
Texture	Description	Center,	2
Trace metals - iron, arsenic cadmium, chromium copper, lead, mercury, nickel, titanium, zinc	mg/kg dry weight	reference, waste transport	2

This sampling program is the minimal design sufficient to detect changes resulting from acid waste disposal. The effects documented at the site are transitory (Appendix B) and have not caused long-term, measurable damage to populations of organisms indigenous to the site or adjacent areas. Chemical changes in the water column caused by disposal are brief, and all values return to ambient levels well within the 4 hour mixing period (ERCO, 1978a, 1978b). Harmful effects to the plankton have been shown but only last for a few minutes. Effects on the bottom have not been documented, although waste contaminants may reach the sediments during the winter, when the water column is well mixed.

The physical and chemical variables presently monitored were chosen based upon the composition of the wastes and the possible effects of waste discharge. The water column sampling is adequate to detect unusual adverse effects of disposal, while the benthic samples can show if waste constituents are accumulating in the sediments. Therefore, no changes in the present monitoring program are recommended.

LONG-TERM MONITORING

Long-term monitoring surveys are the responsibility of the Federal government and are designed to assess progressive changes caused by waste disposal which may be indicated only by subtle changes in selected characteristics over time. NOAA-MESA is involved in developing an overall program for monitoring the conditions in the Bight Apex. One goal of the MESA Project is to "determine the requirements for an efficient monitoring program that will detect environmental change (MESA, 1978b)". The "Ocean Pulse" program being developed by the NMFS-Sandy Hook Laboratory will also provide valuable monitoring data.

Impetus to these formal monitoring programs was given by the passage of the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (PL 95-273), which requires NOAA to develop a 5-year plan for ocean pollution research and monitoring. Long range studies and trend assessment of waste disposal in a complex oceanographic area such as the New York Bight, with its multiple contaminant sources, is feasible only by the combined resources of several agencies under the anticipated NOAA five-year plan.