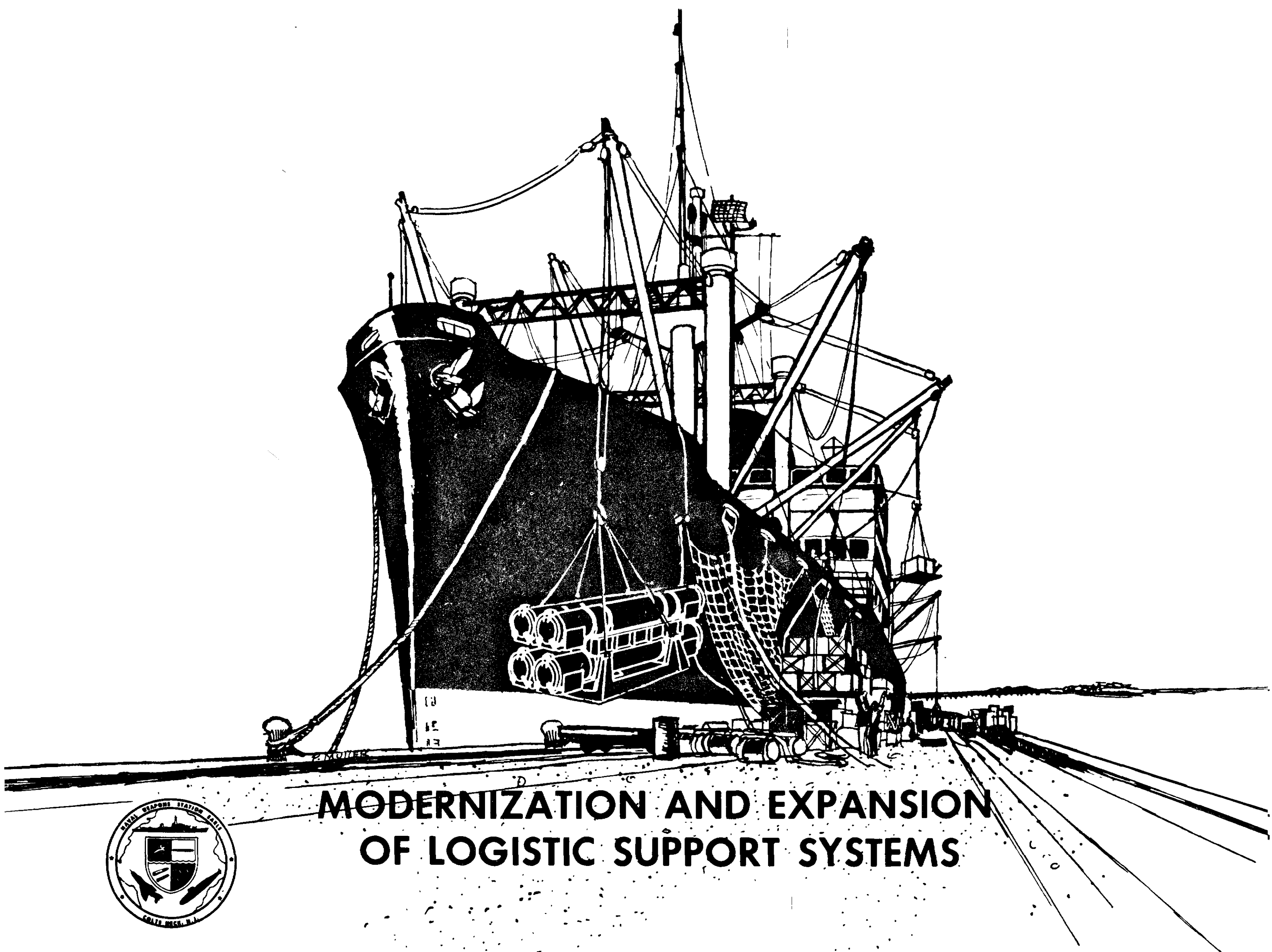
DRAFT

ENVIRONMENTAL IMPACT STATEMENT



MODERNIZATION AND EXPANSION OF LOGISTIC SUPPORT SYSTEMS

NAVAL WEAPONS STATION, EARLE, COLTS NECK, NEW JERSEY

DEPARTMENT OF THE NAVY

DRAFT ENVIRONMENTAL IMPACT STATEMENT

MODERNIZATION AND EXPANSION OF LOGISTIC SUPPORT SYSTEMS, NAVAL WEAPONS STATION, EARLE COLTS NECK, NEW JERSEY

DATED 29 MAY, 1979

"Prepared by Northern Division, Naval Facilities Engineering Command for Commander, Naval Sea Systems Command, in accordance with OPNAVINST 6240.3E in compliance with Section 102 (2)(c) of the National Environmental Policy Act of 1969"

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SUMMARY

A. STATEMENT STATUS

(x) Draft Environmental Impact Statement ( ) Final Environmental Impact Statement

Responsible Office: U.S. Navy, Naval Facilities Engineering Command, Philadelphia, Pennsylvania

B. NAME OF ACTION

Modernization and Expansion of Logistic Support Systems,
Naval Weapons Station Earle, Colts Neck, New Jersey

(AOE Homeport Assignment and Vessel Support Systems)

(x) Administrative Action ( ) Legislative Action

C. DESCRIPTION OF ACTION

The proposed action provides for the homeport relocation of two Auxiliary Oil and Explosive Ships (AOEs) from Naval Station Norfolk, Virginia to Naval Weapons Station (NWS) Earle, Monmouth County, New Jersey. It also provides for the establishment of two additional Vessel Support Systems (VSS) at NWS Earle. These actions require the following modernization and expansion of NWS Earle facilities:

1. Construction of a new pier and trestle for ammunition outloading facilities to support two VSS (during national emergency) and for AOE berthing (during peacetime);

2. Acquiring land for and construction of a ship fuel replenishment system to support AOEs;

3. Dredging approximately 11.3 million cubic yards in Sandy Hook Bay and adjacent approach channels to provide water depth access for fully loaded (oil and ammunition) AOEs;

4. Construction of additional in-transit railroad and truck holding yards to support two VSS;

5. Construction of additional magazines for explosive storage to support AOE requirements; and

6. Providing other shore support facilities for AOE homeporting.

D. ENVIRONMENTAL IMPACTS AND ADVERSE EFFECTS

The proposed action would provide an efficient and integrated AOE homeport facility with a high state of military readiness. It would also provide the required VSS capability for the east coast. The proposed action would accomplish these goals and would also permit the complete utilization (operation ashore) of the Military Ocean Terminal Kings Bay, Georgia (MOTKI) as a base for the large class of Fleet Ballistic Missile Submarines (FBMS). There would be an improvement in explosive and navigational safety, thus reducing the overall risk of accidents and oil spills from AOE operations.

Implementation of the proposed action would result in increased employment and economic activity in the Monmouth County area. Construction of the pier and trestle would create a new habitat for marine organisms, thereby increasing biological productivity. The coastal environment of New Jersey could also benefit from the use of clean dredged material for beach nourishment or for capping of contaminated sediments at the ocean disposal site and from the preservation of the wetlands portion of the land acquisition sites.

Adverse impacts to the terrestrial environment would result from construction of the proposed in-transit holding facilities and magazine storage areas on the Main Station and the ship fuel replenishment system adjacent to the Waterfront Area. Long-term impacts to the terrestrial environment would result from the clearing of 315 acres (280 acres of woodlands and 35 acres of old field and grass) and the loss of the related habitats. There would also be an increase in the risk of an oil spill with the potential to affecting wetlands or water resources. There would be slight increase in air pollution and in water runoff from impervious areas. Short-term construction-related impacts would also occur.

Adverse impacts to the estuarine environment would result from dredging activities and from the construction of the new pier and trestle. Short-term impacts would include removal of marine organisms and habitats and increases in turbidity and release of trace metals, organic compounds and nutrients into the water. Long-term impacts to the estuarine environment would include the increased risk of an oil spill with the potential to produce adverse affects on marine biota and waterfowl.

Adverse impacts would result from disposal of dredged material at the ocean disposal site. These impacts would be short-term and would include impacts on water quality in the immediate disposal area from increases in turbidity and releases of trace metals, organic compounds and nutrients. In addition, burial of benthic organisms, fish eggs and larvae would occur. These impacts are minimized due to the fact that the site has already been impacted from previous disposal operations. Release of metals and organic compounds from sediments may result in long-term accumulations in the food chain.

Adverse impacts to the man-made environment at NWS Earle would result from homeport relocation of the AOEs, acquisition of land for the ship fuel replenishment system and tanker resupply of fuel storage tanks. There would be an increase in the risk of an oil spill with the potential to affect Bay recreational activities and an increase in the risk of fire hazard from the operation of the ship fuel replenishment system. The impacts would also include a slight increase in population (AOE crews and dependents); preemption of 309 acres of site zoned for private industrial development and loss of about $25,000 annually in property taxes. Some of this site contains wetlands which would be largely preserved as a natural buffer zone in the proposed action. Fishing and boating would be prohibited in a small area of Sandy Hook Bay adjacent to the new pier and a slight modification of the outer approach to Compton Creek Channel would be necessary.

E. ALTERNATIVES

The alternatives to the proposed action which were considered, fall into three major categories:

- no action;
- alternative approaches for implementing the proposed actions at NWS Earle; and
- alternative sites for AOE homeporting and for constructing two additional VSS.

F. SIGNIFICANCE OF ENVIRONMENTAL IMPACTS

Most of the adverse impacts associated with the proposed action present local short-term impacts related to construction activities and to dredging and dredge disposal. The clearing of 280 acres of woodland habitat for construction of the in-transit holding and magazine storage facilities on the Main Station is considered a significant long-term impact on the terrestrial environment. The land acquisition for and the construction of the ship fuel replenishment system and the dredging and disposal of dredged materials are also considered significant impacts.

G. FEDERAL, STATE AND LOCAL AGENCIES FROM WHICH COMMENTS HAVE BEEN REQUESTED

FEDERAL AGENCIES

Councils:

Council on Environmental Quality, 722 Jackson Place, NW, Washington, D.C. 20006

Office of Architectural and Environmental Preservation, Advisory Council on Historic Preservation, Suite 510, 1522 "K" Street, NW, Washington, D.C. 20005

Director, Water Resources Council, 2120 "L" Street, NW, 8th Floor, Washington, D.C. 20037

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Coordinator, Environmental Quality Activities, Office of the Secretar;y, Washington, D.C. 20250

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Office of Environmental Coordination, Forest Service, Room 3022, South Bldg., Washington, D.C. 20250

U.S. Department of Commerce

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Director, Office of Ecology & Environmental Conservation, NOAA-Room 5813, Washington, D.C. 20230

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U.S. Department of Defense

Assistant Director of Civil Works, Environmental Programs, Office of the Chief of Engineers, U.S. Army Corps of Engineers, Washington, D.C. 20314

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U.S. Department of Energy

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U.S. Environmental Protection Agency

Director, Office of Federal Activities, U.S. Environmental Protection Agency, Room 537, Waterside Mall Building, Washington, D.C. 20460

Regional Administrator, Region II, Room 908, 26 Federal Plaza, New York, N.Y. 10007.

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U.S. Geological Survey

Office of Environmental Conservation, National Center, Reston, Va. 22092

U.S. Department of Health, Education & Welfare

Director, Office of Environmental Affairs, Room 4740, HEW North, Washington, D.C. 20202

Regional Environmental Officer, Region II, Federal Building, 26 Federal Plaza, New York, N.Y. 10007

U.S. Department of Housing and Urban Development

U.S. Department of Housing and Urban Development, 666 Fifth Avenue, New York, N.Y. 10019

Regional Administrator II, Environmental Clearance Officer, 26 Federal Plaza, New York, N.Y. 10007

U.S. Department of the Interior

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Chief, Office of Environmental Affairs, Bureau of Outdoor Recreation, Washington, D.C. 20240

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Assistant Attorney General, Land & Natural Resources Division, Washington, D.C. 20530

U.S. Department of Transportation

Director, Office of Environmental Quality, Washington, D.C. 20590

Office of Environmental Protection, U.S. Coast Guard, Room 7311, Washington, D.C. 20590

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Office of Marine Environment Systems, U.S. Coast Guard, 400 7th Street, SW, Washington, D.C. 20590

Commander, Third Coast Guard District, Governors Island, New York, N.Y. 10004

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New Jersey:

Honorable Bill Bradley
Honorable Harrison A. Williams, Jr.

New York:

Honorable Jacob K. Javits
Honorable Daniel P. Moynihan

Senate Commerce Committee

Senate Subcommittee on Environmental Pollution

Senate Subcommittee on Oceans and the Atmosphere

United State House of Representatives

New Jersey:

Honorable Jim Courter
Honorable Millicent Fenwick
Honorable James J. Florio
Honorable Edwin B. Forsythe
Honorable Frank J. Guarini
Honorable Harold C. Hollenback
Honorable James J. Howard
Honorable William J. Hughes
Honorable Andrew Maguire
Honorable Joseph C. Minish
Honorable Edward J. Patten
Honorable Matthew J. Rinaldo
Honorable Peter W. Rodino, Jr.
Honorable Robert A. Roe
Honorable Frank Thompson, Jr.

New York

Honorable Joseph P. Addabbo
Honorable Jerome A. Ambro, Jr.
Honorable Mario Biaggi
Honorable Jonathan B. Bingham
Honorable William Carney
Honorable Shirely Chisholm
Honorable Barber B. Conable, Jr.
Honorable Thomas J. Downey
Honorable Geraldine A. Ferraro
Honorable Hamilton Fish, Jr.
Honorable Robert Garcia
Honorable Benjamin A. Gilman
Honorable S. William Green
Honorable James M. Hanley
Honorable Elizabeth Holtzman
Honorable Frank Horton
Honorable Jack F. Kemp
Honorable John J. LaFalce

Honorable Gary A. Lee
Honorable Norman F. Lent
Honorable Stanley N. Lundine
Honorable Robert C. McEwen
Honorable Matthew F. McHugh
Honorable Donald J. Mitchell
Honorable John M. Murphy
Honorable Henry J. Nowak
Honorable Robert L. Ottinger
Honorable Peter A. Peyser
Honorable Charles B. Rangel
Honorable Frederick W. Richmond
Honorable Benjamin S. Rosenthal
Honorable James H. Scheuer
Honorable Stephen J. Solarz
Honorable Gerald B. Solomon
Honorable Samuel Stratton
Honorable Theodore S. Weiss
Honorable Lester L. Wolff
Honorable John W. Wydler
Honorable Leo C. Zefeetti

STATE AGENCIES

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New Jersey State Assembly and Senate, Trenton, N.J. 08625

New Jersey Department of Environmental Protection

Office of Coastal Zone Management, Trenton, N.J. 08625

Wetlands Management Section, Trenton, N.J. 08625

Riparian Lands Management Section, Trenton, N.J. 08625

New Jersey Department of Health, Trenton, N.J. 08625

Department of Environmental Protection, Labor and Industry Bldg., Box 1390, Trenton, N.J. 08625

Division of Fish, Game, and Shellfisheries, P.O. Box 1809, Trenton, N.J. 08625

State Soil Conservation Committee, Department of Agriculture, P.O. Box 1888, Trenton, N.J. 08625

State of New Jersey, Department of Environmental Protection, Chief Office of Environmental Review, Box 1390, Trenton, N.J. 08625

GOVERNOR OF NEW YORK: Honorable Hugh Carey, Governor of New York, State Capital Building, Albany, N.Y. 12224

New York State Assembly and Senate, Capital Building, Albany, N.Y. 12224

New York State Assembly Committee on Environmental Conservation, Albany, N.Y. 12224

Commissioner, New York State Department of Environmental Conservatoin, Two World Trade Center, New York, N.Y. 10047

New York State Department of Environmental Conservation, 50 Wolf Road, Colonie, Albany, N.Y. 12205

New York State Office of Parks and Recreation, Agency Building 1, Empire State Plaza, Albany, N.Y. 12226

New York State Sea Grant Program Office, Albany, N.Y. 12226

New York State Department of Commerce, 112 State Street, Albany, N.Y. 12207

Long Island State Park and Recreation Commission, Babylon, N.Y. 11702

INTERSTATE AGENCIES

Interstate Sanitation Commission, New York, N.Y. 10013

Port Authority of New York and New Jersey, New York, N.Y. 10011

Tri-State Regional Planning Commission, New York, N.Y. 10048

LOCAL AGENCIES

New Jersey

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Borough Administrator, 43 Church Stree, Keansburg, N.J. 07734

Borough Administrator, 18-20 Main Street, Keyport, N.J. 07735

Borough of Union Beach, Municipal Building, Florence Avenue, Union Beach, N.J. 07735

Monmouth County Planning Dept., 1 Lafayette Place, Freehold, N.J. 07728

Administrator, Middletown Township Hall, Kings Highway, Middleton, N.J. 07748

New Jersey State Federation of Sportsmen's Clubs, Box 488, Freehold, N.J. 07728

Association of New Jersey Enviornmental Commissions, Box 157, Mendham, N.J. 07925

Atlantic County Citizens Council on Environment, Inc., (ACCCE), 9100 Amherst Avenue, Margate, N.J. 08402

New Jersey Audubon Society, 790 Ewing Avenue, Franklin Lakes, N.J. 07417

New Jersey Conservation Foundation, 300 Mendham Road, Morristown, N.J. 07960

Ocean County Board of Chosen Freeholders, Toms River, N.J. 08753

Monmouth County Planning Board, Freehold, N.J. 07728

New York

Hempstead Town Department of Conservation and Waterways, Point Lookout, N.Y. 11569

State and Local Clearinghouses

Atlantic City Planning Board, 25 Dolphin Avenue, Northfield, N.J. 08225

Ocean County Planning Board, Court House Square, Toms River, N.J. 08753

Bureau of State and Regional Planning, Dept. of Comm. Affairs, 329 W. State Street, P.O. Box 2768, Trenton, N.J. 08625

Delaware Valley Reg. Plan. Comm., Penn Towers Building, 3rd Floor, 1819 J.F. Kennedy Blvd., Philadelphia, PA 19103

State Clearinghouse, New York State Division of the Budget, State Capital, Albany, N.Y. 12224

Tri-State Regional Planning Commission, 1 World Trade Center, 56 South, New York, N.Y. 10048

Citizens Groups

American Littoral Society, Highlands, N.J. 07732

Colts Neck Environmental Commission, Colts Neck, N.J. 07722

New Jersey Marine Science Consortium, Highlands, N.J. 07732

New Jersey Public Interest Research Group, New York, N.Y. 10001, Trenton, N.J. 08608

South Branch Watershed Association, Clinton, N.J. 08809

Armenian Littoral Society, Sandy Hook, N.J. 07732

New Jersey League of Women Voters, 460 Bloomfield Avenue, Montclair, N.J. 07042

Atlantic Beach Taxpayers Association, Long Beach, N.Y. 11561

Citizens for Clean Environment, Sayville, N.Y. 11782

National Audubon Society, Inc., 950 Third Avenue, New York, N.Y. 12168

Environmental Defense Fund, East Setauket, N.Y. 11733

Friends of the Earth, New York, N.Y. 10001

Long Island Fisherman's Association, Quoque, N.Y. 11959

Malverne Environmental Council, Malverne, N.Y. 11565

Marine Environmental Council of Long Island, Seaford, N.Y. 11783

National Advisory Committee on Oceans and Atmosphere, New York, N.Y. 10001

Natural Resources Defense Council, Inc., 15 West 44th Street, New York, N.Y. 10036

New York League of Women Voters, Suffolk County Council, Smithtown, N.Y. 11733

Regional Marine Resources Council, Hauppague, N.Y. 11787

Scientists Committee for Public Information, New York, N.Y. 10001

Shellfish Institute of North America, Point Lookout, N.Y. 11569

Sierra Club, 800 Second Avenue, New York, N.Y. 10017

New England Natural Resources Center, 506 Statler Office Building, Boston, MA 02116

National Coalition for Marine Conservation, Boston, MA 02109

National Wildlife Federation, 1412 N. 16th, NW, Washington, D.C. 20036

Resources for the Future, 1755 Massachutes Avenue, NW, Washington, D.C. 20036

Academic/Research Institutions

Marine Sciences Center, Rutgers University, New Brunswick, N.J. 08903

Rutgers University, Department of Environmental Sciences, New Brunswick, N.J. 08903

Marine Sciences Research Center, Stony Brook, N.Y. 11790

Marine Sciences Research Group, Brooklyn College - City University of New York, Brooklyn, N.Y. 11201

New York Ocean Science Laboratory, Montauk, N.Y. 11954

Libraries

Atlantic City Free Public Library, Illinois & Pacific Avenues, Atlantic City, N.J. 08401

Rutgers Science/Medicine Library, College Avenue, New Brunswick, N.J. 08901

Suffolk Cooperative Library System, Bellport, Long Island, N.Y. 11713

State University of New York Library, Stony Brook, N.Y. 11790

Trenton Free Public Library, 120 Academy Street, Box 2448, Trenton, N.J. 08607

U.S. EPA Library, Region II, Woodbridge Avenue, Edison, N.J. 08817

New Brunswick Free Public Library, 60 Livingston Avenue, New Brunswick, N.J . 08901

U.S. Department of Commerce, Lionel A. Walford Library, Sandy Hook Fisheries Marine Lab, Highlands, N.J. 07732

Monmouth Beach Library, 18 Willow Avenue, Monmouth Beach, N.J. 07750

Middlesex Public Library, Mountain Avenue, Middlesex, N.J. 08846

Keyport Free Public Library, Broad Street, Keyport, N.J. 07735

Union Beach Memorial Library, 810 Union Avenue, Union Beach, N.J. 07735

Middleton Township Public Library, 55 New Monmouth Road, Middletown, N.J. 07748

Atlantic Highlands Public Library Assn., 100 Forest Avenue, Atlantic Highlands, N.J. 07716

New York Public Library, Fifth Avenue & 42nd Street, New York, N.Y. 10018

New York Historical Society Library, 170 Central Park West, New York, N.Y. 10024

<u>News Media</u>

Atlantic City Press, Toms River, N.J. 08753

CBS News, New York, N.Y. 10001

Daily Observer, Toms River, N.J. 08753

New York Times, New York, N.Y. 10001

Newark Star Ledger, Newark, N.J. 07101

Asbury Park Press, Asbury Park, N.J. 07712

Red Bank Register, Red Bank, N.J. 07701

Middletown Courier, Middletown, N.J. 07748

The Advisor, Middletown, N.J. 07748

Daily Register, Shrewsbury, N.J. 07701

CHAPTER I

I. DESCRIPTION OF THE PROPOSED ACTION

A. INTRODUCTION

A.1 Actions

The United States Department of the Navy proposes to implement two major actions at Naval Weapons Station (NWS) Earle, Colts Neck, Monmouth County, New Jersey (Figure I-1). The first of the major actions is the homeport relocation of two Auxiliary Oil and Explosive Ships (AOEs), from Naval Station (NS) Norfolk, Virginia, to NWS Earle. The AOEs are fast combat support ships. Their mission is to provide, attack-carrier task forces at sea with rapid, simultaneous and one-step underway replenishment of: petroleum products, ammunition, and general stores. The second action is the establishment of two additional Vessel Support Systems (VSS) at NWS Earle. A VSS is a contingency support system employed during a national emergency when large volumes of ammunition must be shipped to overseas military operation areas on a continuous basis. It consists of facilities and storage space necessary to safely handle and load ammunition onto breakbulk freighters.

These actions would require modernization and expansion of the present facilities at NWS Earle and would include the following:

1. CONSTRUCTION OF A NEW PIER AND TRESTLE for ammunition outloading facilities to support two VSS (during national emergency) and for AOE berthing (during peacetime);

2. ACQUIRING LAND FOR AND CONSTRUCTION OF A SHIP FUEL REPLENISHMENT SYSTEM to support AOEs;

3. DREDGING APPROXIMATELY 11.3 MILLION CUBIC YARDS IN SANDY HOOK BAY AND ADJACENT APPROACH CHANNELS to provide water depth access for fully loaded (oil and ammunition) AOEs;

4. CONSTRUCTION OF ADDITIONAL IN-TRANSIT RAILROAD AND TRUCK HOLDING YARDS to support two VSS;

5. CONSTRUCTION OF ADDITIONAL MAGAZINES for explosives storage to support AOE requirements; and

6. PROVIDING OTHER SHORE SUPPORT FACILTIES for AOE homeporting.

A.2 Naval Weapons Station (NWS) Earle

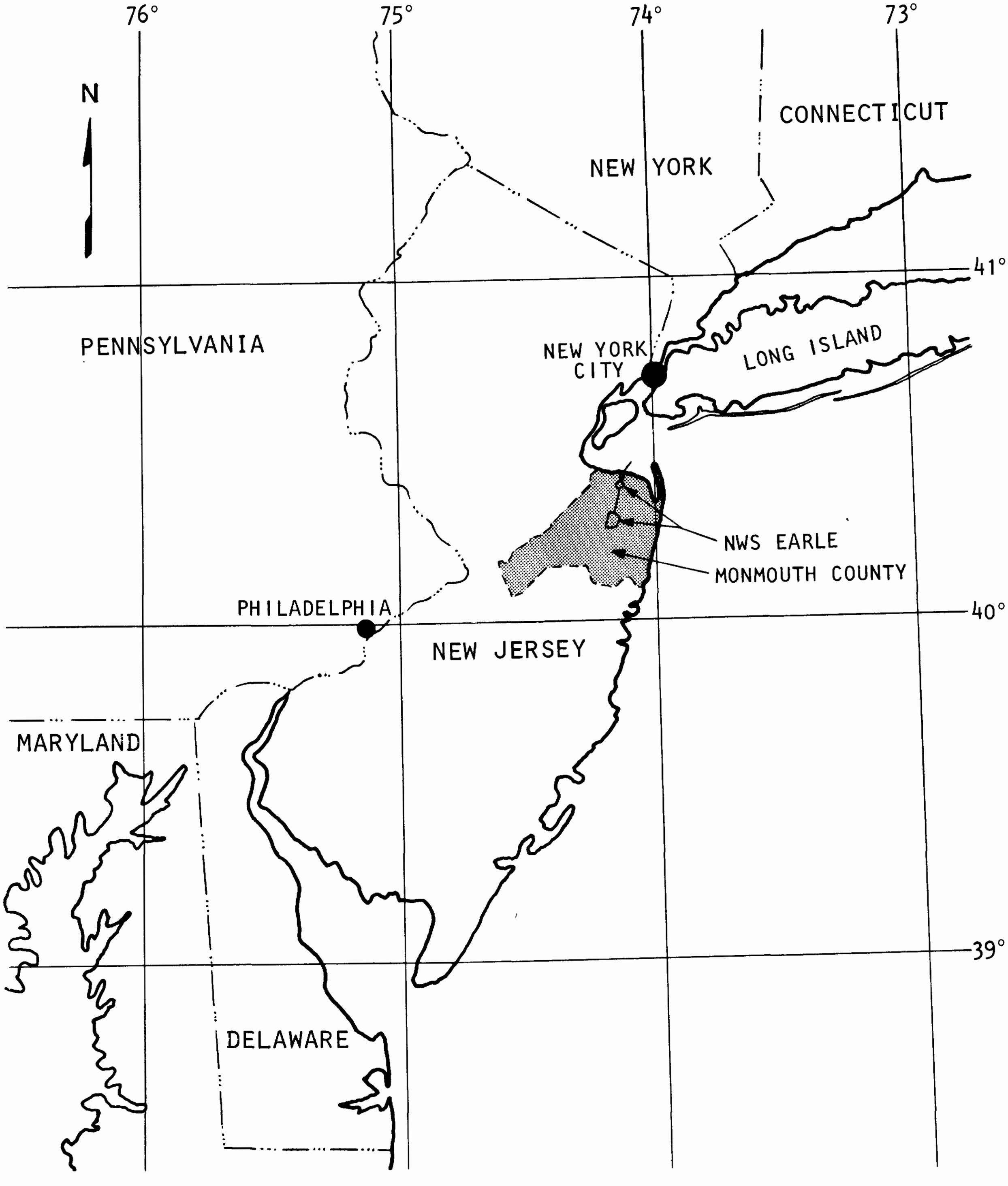
a. History

NWS Earle, originally Naval Ammunition Depot Earle, named after Rear Admiral Earle, Chief of the Bureau of Ordnance during World War I, is one of three east coast Naval Weapons Stations. It was established in 1943 to meet the need for a large ammunition depot in the New York area to supply ships, especially those in convoy, and to avoid delay in ammunition loading.

b. Location and Size

NWS Earle lies approximately 47 miles south of New York City at Colts Neck, in Monmouth County, New Jersey (Figures I-1 and I-2).

NWS Earle consists of 11,141 acres. The Main Station area occupies 10,218 acres. Another 670 acres are occupied in the vicinity of the Waterfront Area adjacent to Sandy Hook Bay at Leonardo (Figure I-3). The two areas of the Station are connected by 253 acres of government owned highway and rail lines.



REGIONAL LOCATION MAP

NWS EARLE

FIGURE I-1

Immediately south of the Waterfront Area is the circular Chapel Hill area. This area contains railroad barricades, where loaded ammunition cars can be safely stored overnight during pier loading operations.

New Jersey State Highway 34, just south of its intersection with Route 537 at Colts Neck is the principal access to the Main Station whereas New Jersey State Highway 36 is the principal access to the Waterfront Area.

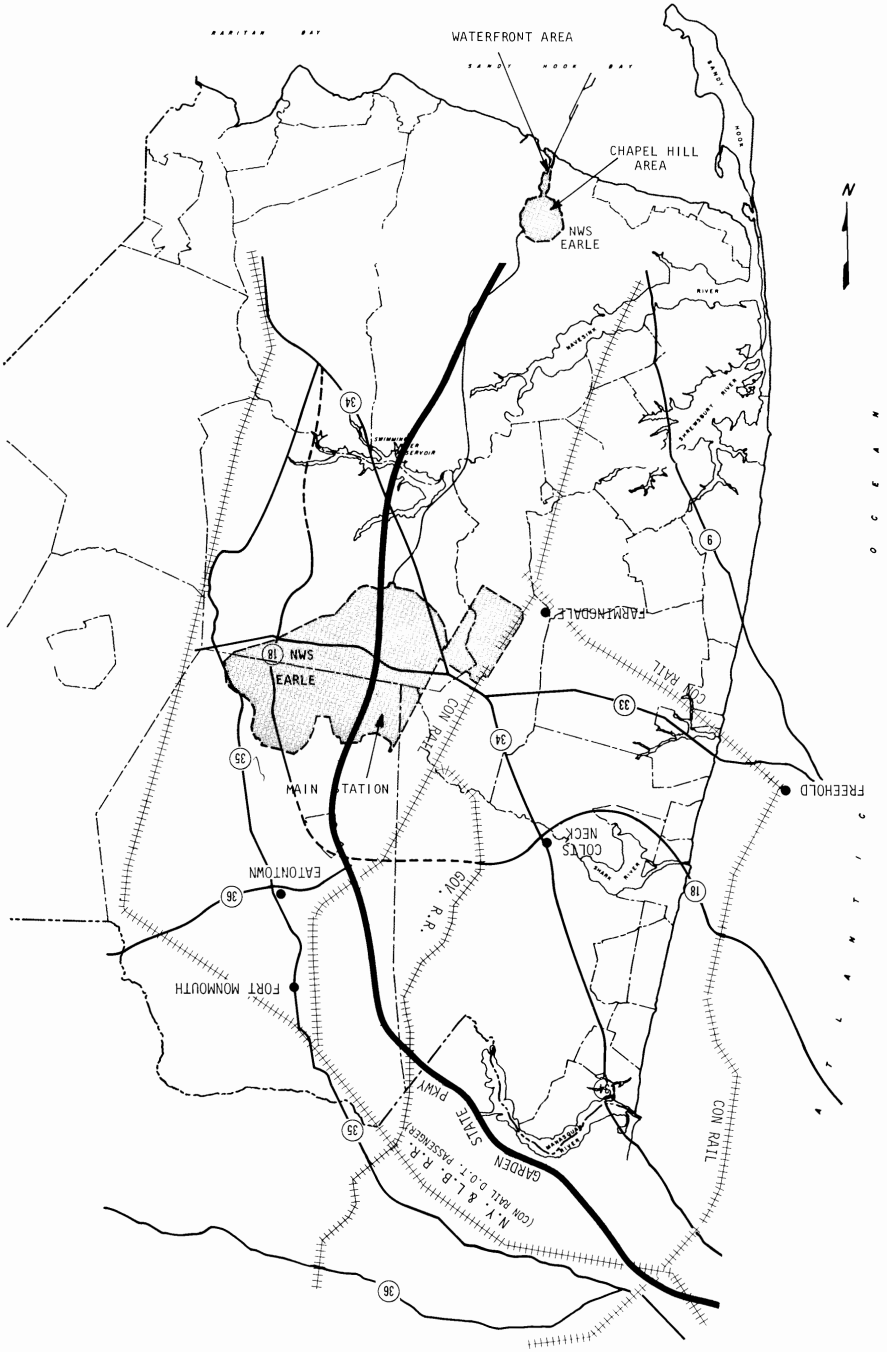
c. Mission

The present mission at Earle includes (1) receiving, renovating, maintaining, storing, and issuing ammunition, explosives, expendable ordnance items and/or weapons and technical ordnance material; (2) providing logistics and administrative support to homeported ships; and (3) performing additional tasks as directed by the Commander of Naval Sea Systems Command (COMNAVSEASYSCOM); (4) providing eastern area Military Traffic Management Command (MTMC) representation on complete - round ammunition shipments.

The Commanding Officer (CO) of NWS Earle reports to the COMNAVSEASYSCOM who exercises command for the Chief of Naval Material.

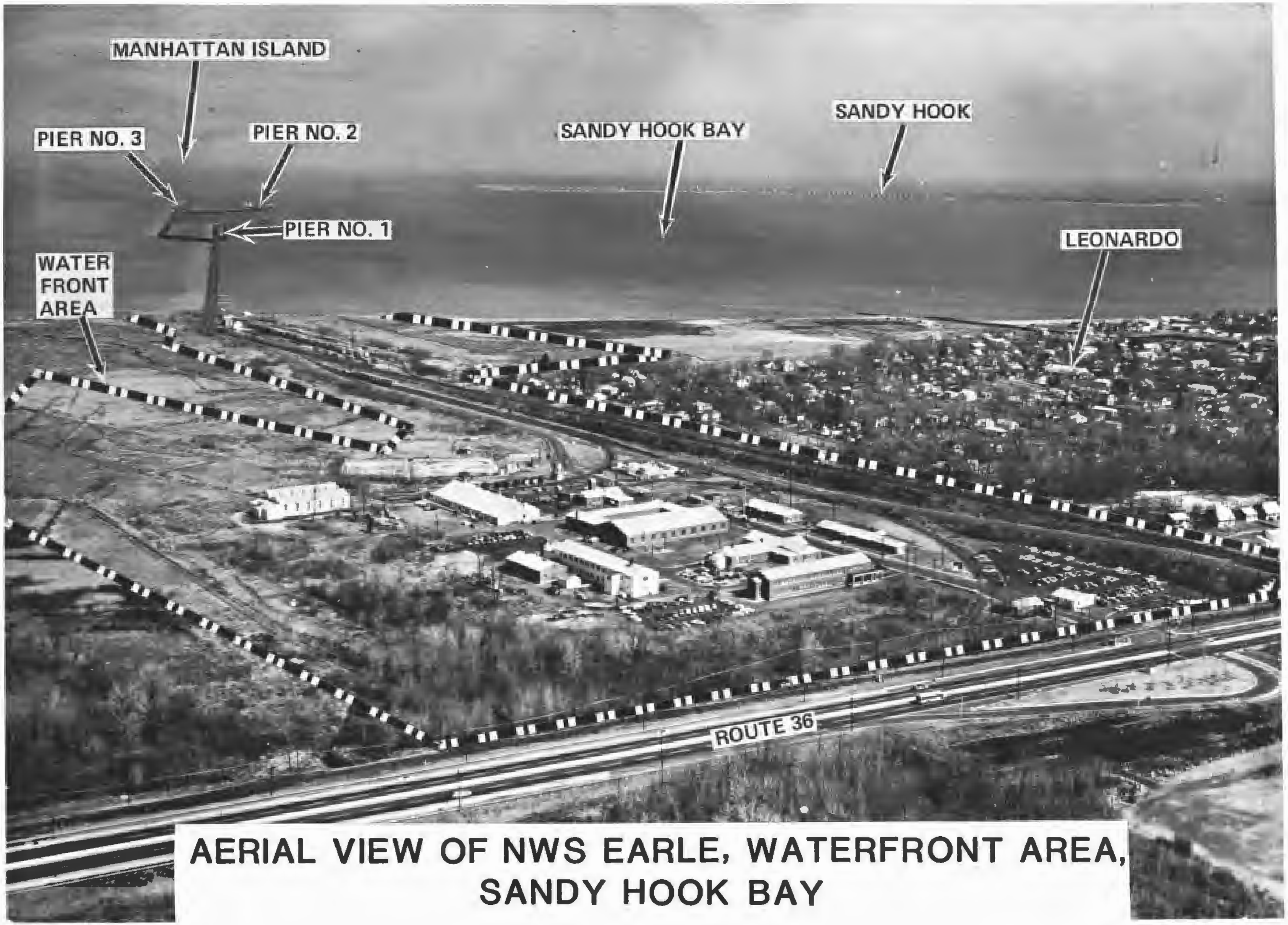
d. Existing Facilities

NWS Earle has three piers at the Waterfront Area (Figure I-4). Pier 1 provides berthing for shallow water small craft (-15 feet MLW). Piers 2 and 3 provide deep water berthing (-35 feet MLW). Pier 2 has two operational berths and Pier 3 has four. The maximum net explosive weight (NEW) allowed on piers 2 and 3 is 10 million pounds. Piers 2 and 3 are not adequately separated to provide the minimum specified explosives safety separation distance for ammunition piers. NWS Earle piers are presently operated on a waiver which allows deviation from the ship and pier separation requirements. Pier 1 supports Piers 2 and 3 and has an assigned limit of 1.0 million pounds NEW. The piers are connected to the shoreline



LOCATION OF NWS EARLE

FIGURE I-2



AERIAL VIEW OF NWS EARLE, WATERFRONT AREA, SANDY HOOK BAY

FIGURE I-3

by an 11,509 foot trestle. The trestle carries two railroad tracks, a truck lane, and pipelines.

With pier improvements, planned for the near future (considered under a separate action), the existing NWS pier complex will increase its VSS handling capability from three to four.

The Waterfront Area also contains a building complex for support facilities located adjacent to the gate off Route 36.

The Main Station consists primarily of explosives and weapons storage facilities including magazines and barricades for loaded trucks and trains as well as holding yards for trucks and trains. The Main Station also contains a general administration building complex and some maintenance and refit facilities.

Until 1974, no ships were homeported at NWS Earle. In 1977, two Auxiliary Explosive (AE) ships, the USS NITRO and the USS SURIBACHI were assigned to homeport at NWS Earle. Effective in July, 1979, another AE, the USS BUTTE, will be homeported at NWS Earle.

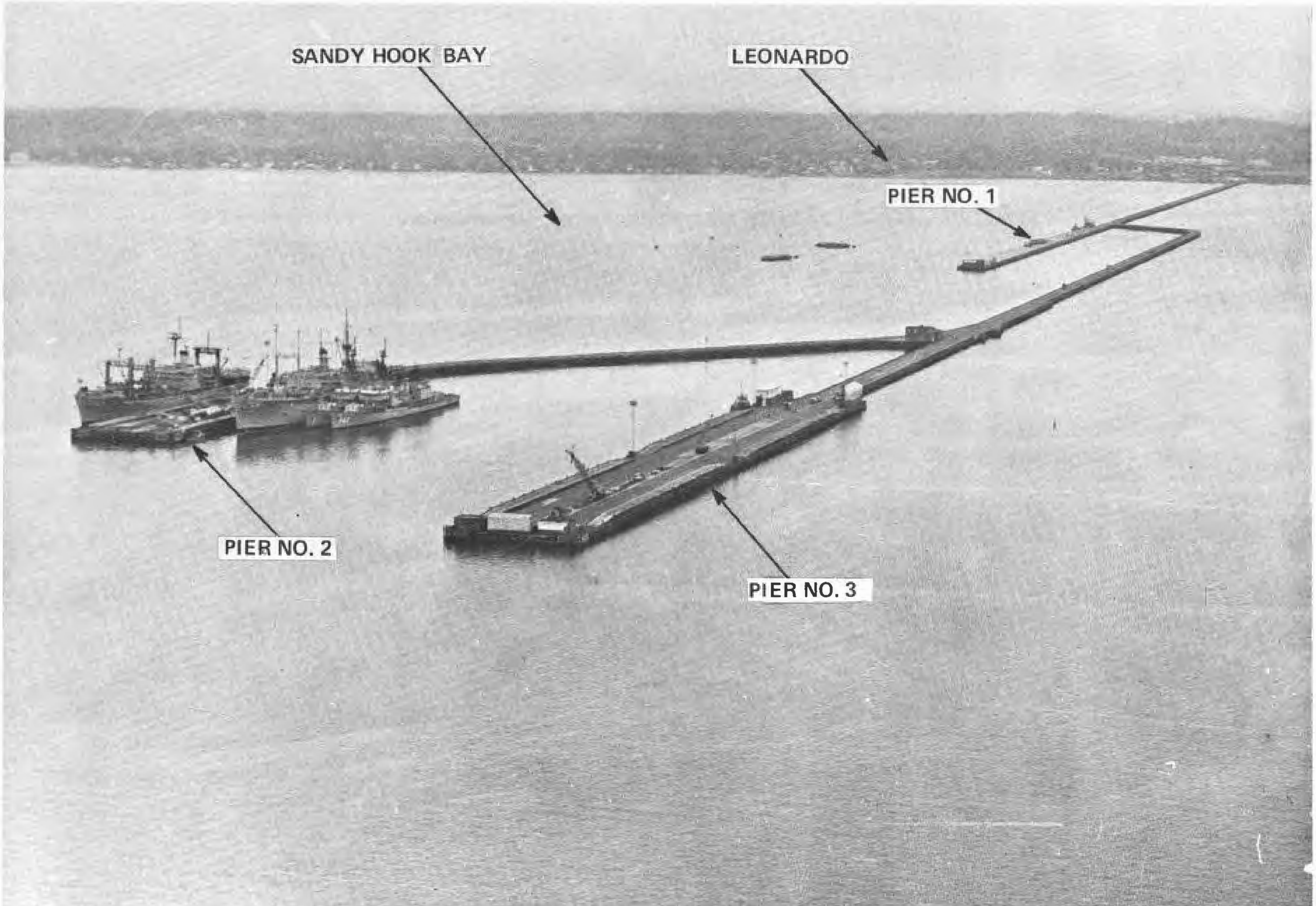
B. HISTORY AND BACKGROUND OF PROPOSED ACTION

B.1 Current AOE Homeporting

The Department of the Navy has built four SACRAMENTO Class AOEs (Figure I-5).

The principal characteristics of an AOE are as follows:

- Length - 794 ft, 8½ inches
- Beam - 107 ft, 4½ inches
- Draft (full load) - 41 ft, 11 inches



AERIAL VIEW OF NWS EARLE PIERS

FIGURE I-4

AOE AT SEA

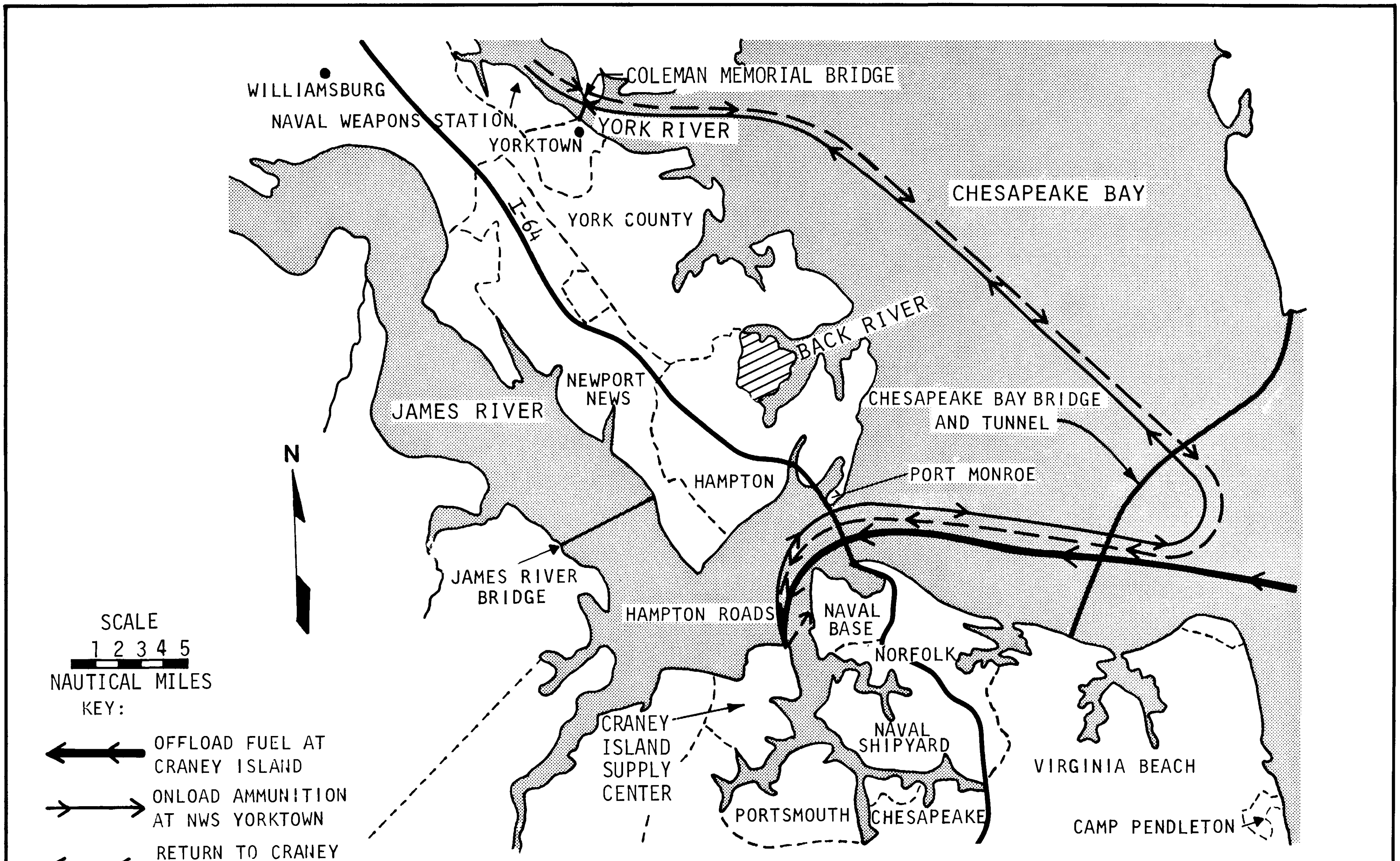
FIGURE I-5

Ammunition Storage	-	1800 tons
Fuel Cargo	-	9,416,474 gallons

The Atlantic and Pacific Fleets are supplied by two AOEs each. The two AOEs supplying the Atlantic Fleet are the USS DETROIT and the USS SEATTLE. As of October 1, 1978, they have reported to the Commander, Service Squadron Two (COMSERVRON TWO). Since September, 1978, COMSERVRON TWO has been headquartered at NWS Earle. COMSERVRON TWO reports to Commander Service Group II (COMSERVGRU TWO) which reports through the Commander Naval Surface Force, Altantic Fleet (COMNAVSURFLANT) to the Commander-in-Chief Atlantic Fleet (CINCLANTFLT).

The DETROIT and SEATTLE are currently homeported at Naval Station Norfolk. Only one AOE is normally in port at any one time; the other is engaged in fleet operations. During a typical two year cycle, each AOE will spend at least six months with the Fleet in the Mediterranean. At other times, the AOE will be homeported and will undergo routine maintenance or major repairs as necessary. It will also deploy for short periods of time to support fleet exercises off the East Coast.

The general operational sequence of the AOE at NS Norfolk is illustrated in Figure I-6. The AOE takes on explosives at NWS Yorktown, Virginia. However, the AOE cannot proceed to NWS Yorktown loaded with fuel, as the NWS Yorktown pier area and channels to Yorktown are currently limited by dredge depths of -36 feet MLW. Therefore, should the AOE return from deployment with a substantial fuel cargo, it must first unload the fuel at the Naval Fuel Depot at Craney Island, Virginia. Because of the channel configurations in Chesapeake Bay, the AOE must cross the Chesapeake Bay Bridge Tunnel twice in proceeding from Craney Island to NWS Yorktown. Once the AOE has taken on its explosives, it then proceeds to Craney Island to take on fuel. When fully loaded with fuel and explosives, the AOE returns to its homeport at Naval Station Norfolk awaiting orders for its next deployment.



EXISTING AOE OPERATIONAL SEQUENCE FOR HOMEPORTING AT NORFOLK NAVAL BASE

FIGURE I-6

In the event of a national emergency, the AOEs should be able to deploy as rapidly as possible, fully loaded with fuel and explosives. Therefore, a proposed homeport should permit the AOEs to dock with a full load of fuel and explosives. The major restrictions at NS Norfolk on this capability are the safety criteria established by the Department of Defense (DOD) Explosive Safety Board. These criteria define minimum permitted distances between concentrations of explosives and the nearest inhabited building or area that is not related to explosive handling or storage. Each AOE carries the equivalent of 1.1 millon pounds Net Explosive Weight (NEW). The safe distance to inhabited buildings for two AOEs berthed at the proposed new pier, under existing DOD criteria, is 6,550 feet. The safe distance to an inhabited building, for one AOE, is 5,385 feet.

The AOEs violate these criteria when homeported at NS Norfolk. A waiver granted by the office of the Chief of Naval Operations (CNO) permits the homeport assignment of the AOEs, in loaded condition, at NS Norfolk until 1980. During fiscal year 1979, the office of CNO is obligated to present to the Assistant Secretary of Defense, a plan for homeporting these two AOEs. In the absence of such a plan, it is expected that the AOEs would have to offload fuel and explosives, and to homeport at NS Norfolk in a "downloaded", and thus, unready, status. Accordingly, the Navy plans to select a new, safe and ready homeport for the AOEs.

NWS Earle is proposed as the preferred AOE homeport for the following reasons:

- the explosive safety criteria can be met without interfering with fleet operations;
- explosives handling facilities are available;
- some usable on-shore support facilities already exist or are under construction for other projects;
- vacant land is available near the NWS Earle piers for construction of a ship fuel replenishment system; and
- NWS Earle is relatively close to open deep water.

B.2 Additional Vessel Support Systems (VSS) Capability

A Vessel Support System (VSS) consists of ammunition storage and handling, and waterfront outloading facilities sufficient to supply breakbulk freighters at a rapid rate during a national emergency. The Joint Chiefs of Staff (JCS) have determined that there is a need for 12 VSS on the east coast to support ammunition supply requirements in the event of a national emergency. Eight VSS exist at this time. With pier improvements at NWS Earle, planned for the near future (considered under separate action), a ninth VSS capability would become available. These systems are distributed as follows (Figure I-7):

- Military Ocean Terminal, Sunny Point (MOTSU), North Carolina - 4 VSS;
- NWS Earle - 4 VSS (including one presently planned); and
- Military Ocean Terminal, Kings Bay (MOTKI), Georgia - 1 VSS.

Thus, at present, there is a deficiency of three VSS in relation to the JCS requirement of 12.

However, VSS capability will be affected when two squadrons of Fleet Ballistic Missile (FBM) Submarines are relocated to MOTKI from Rota, Spain in accordance with a Treaty between Spain and the United States. At the present time MOTKI is being developed as a support base for the relocated squadrons. Development plans call for tender service facilities rather than shore based facilities. An Army/Navy study (May, 1977) determined that a joint use of MOTKI is feasible for two VSS and up to two squadrons of submarines if tender based facilities are used. However, the Navy also has long range plans to utilize MOTKI to base the larger class of submarines in the future, should they be approved. Support of these submarines at MOTKI would require the development of shore based facilities and would not be compatable with VSS utilization at MOTKI. This development, should it occur, would displace the one VSS capability there and bring the total VSS deficiency for the east coast to four. The VSS capability at MOTKI is under the jurisdiction of the U.S. Department of the Army. An Army-Navy memorandum of understanding specifies that the MOTKI VSS capability will not be released until established elsewhere. A joint Army-Navy study determined that the preferred approach to attain the four additional VSS needed to achieve the required 12 VSS on the east coast, should be the addition of two VSS at NWS Earle and two at MOTSU.

C. DETAILED DESCRIPTION OF PROPOSED ACTIONS

C.1 Relocation of AOE Crews

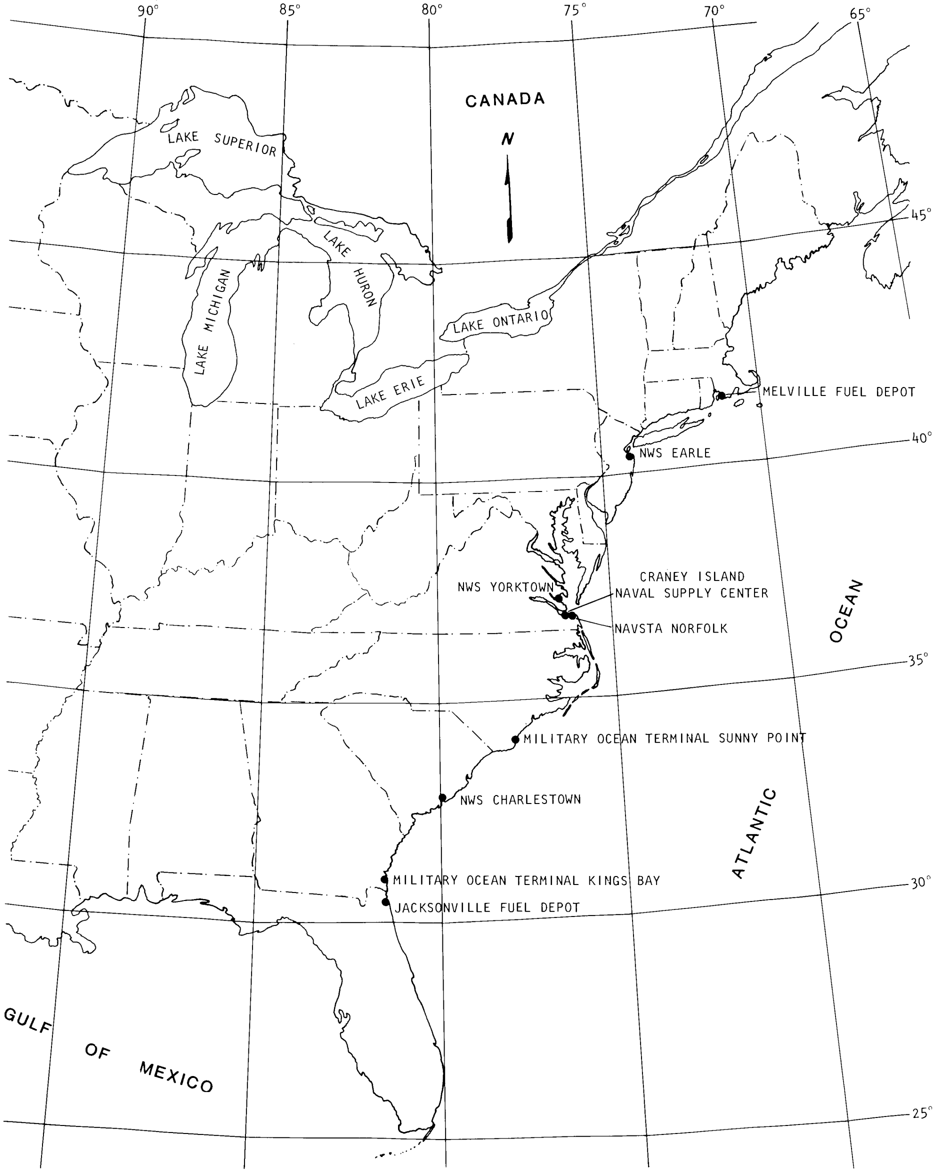
Transferring the AOE homeport requires the relocation of the AOE crews. The two AOE crew complements total 1158 personnel. The overall effect of homeporting the AOEs at NWS Earle would be to raise the complement of personnel assigned to NWS Earle to about 3300. The components of this total are provided in Table I-1. This total is 60 percent of peak World War II staffing.

In addition, approximately 1150 dependents would relocate with the AOE crews. This would bring the military dependents at NWS Earle to about 2,600 (Table I-2).

C.2 Construction of New Pier and Trestle

The ammunition outloading capability for two additional VSS at NWS Earle will require the construction of a new pier and trestle since the existing pier complex cannot handle the volume of traffic required to support more than four systems. In addition, the new pier and trestle would be available for berthing of the two homeported AOEs during peacetime. These joint uses are compatible, since VSS utilization would occur only during a national emergency, at which time the AOEs would be deployed to the fleet. The new pier is configured to permit two VSS operations during a national emergency and the homeporting of two AOEs during peacetime without violating explosive safety criteria.

In order to sustain breakbulk freighter operations, each VSS must be capable of a throughput capacity that will accommodate the berthing, loading and



LOCATION OF RELEVANT MILITARY INSTALLATIONS IN THE EASTERN UNITED STATES

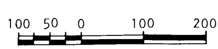


FIGURE I-7

TABLE I-1

PERSONNEL LOADING
NWS EARLE

Existing	Officers	Enlisted	Civilian	Total
Station Assigned	15	157	691	863
COMSERVRON TWO	5	20	0	25
Marines	8	232	0	240
AE 23 NITRO	14	310	0	324
AE 21 SURIBACHI	14	310	0	324
AE 27 BUTTE[a]	15	343	0	358
Subtotal	71	1372	691	2134
Proposed				
AOE 3 SEATTLE[b]	23	551	0	574
AOE 4 DETROIT[b]	23	561	0	584
Subtotal	46	1112	0	1158
TOTAL	117	2484	691	3292

Notes:

[a]To be homeported July, 1979.

[b]To be homeported in 1983-1985.

Source: Naval Facilities Engineering Command (NAVFAC), 1977, Master Plan for NWS Earle.

TABLE I-2

MARRIED/DEPENDENTS LOADING
NWS EARLE

	Married Personnel		Dependents		
	Officer	Enlisted	Officer	Enlisted	Total
Existing					
Station Assigned	12	95	34	228	262
COMSERVRON TWO	4	12	11	29	40
Marines	5	48	14	115	129
3 AEs	35	78	98	907	1005
Subtotal	56	533	157	1279	1436
Proposed					
2 AOEs	37	437	104	1049	1153
Subtotal	37	437	104	1049	1153
Total	93	970	261	2328	2589

Source: Naval Facilities Engineering Command (NAVFAC), 1977,
Master Plan for NWS Earle.

sailing of breakbulk freighters with a capacity of 9,875 short tons every five days. This requires an across-the-pier capability of 1,975 short tons per ship per day. Table I-3 provides some statistics on the VSS operation. Each breakbulk freighter carries the equivalent of 3.2 millon pounds net explosive weight (NEW). The safe explosive distance from the end of the pier to the nearest inhabited building for 2 VSS is 9,330 feet (Figure I-8). The location and configuration of the new pier and trestle are shown on Figure I-8. Construction of a new pier also requires extension of the security zone of restricted navigation. The new security zone is shown on Figure I-8.

The new pier would serve for both vessel fueling and ammunitions handl ing. However, as required by Navy regulations, ammunition handling would be secured prior to refueling operations.

Construction of a new pier would require dredging. Dredging requirements are discussed in Section C.4.

C.3 <u>Ship Fuel Replenishment System</u>

The homeporting of two AOEs at NWS Earle requires fuel storage, pipelines and pumping facilities on shore. These facilities are necessary for the following reasons:

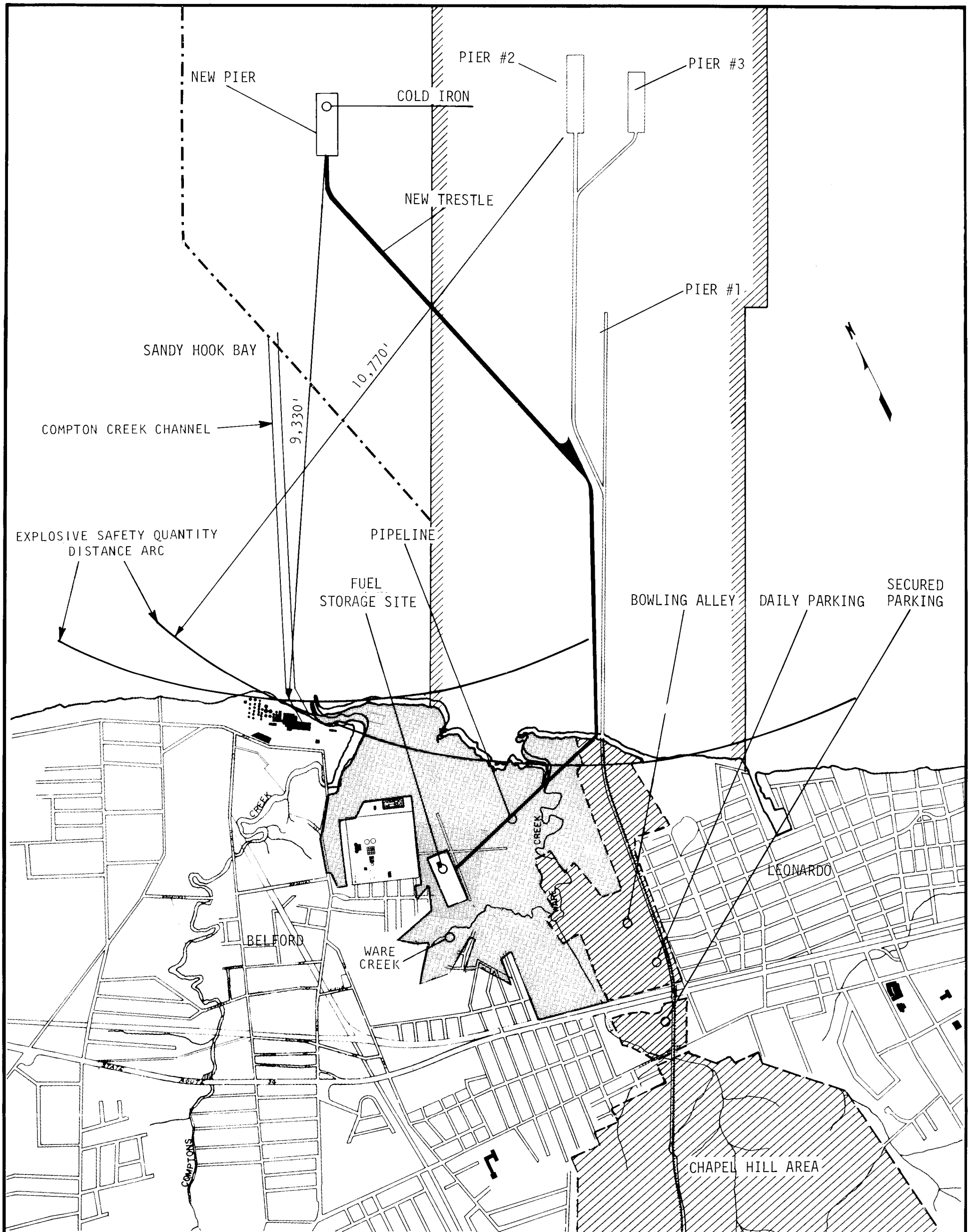
- AOEs must be able to get underway fully loaded within 24 hours to maintain a readiness status.
- Maintenance, including the cleaning, coating and repairing of the AOE cargo tanks, is a common activity during homeporting. It is essential to offload the ship's fuel during these activities.
- Ballast water must be pumped ashore when AOEs enter port in a light condition. This ballast must be removed before the tanks can be refilled with fuel.

TABLE I-3

VESSEL SUPPORT SYSTEM OPERATIONS

	No. of Short Tons			No. of Ships Completed				People On Pier Per
No. of Systems	One Day	Five Days	Twenty Days	5 Days	10 Days	15 Days	20 Days	Day For Loading
1	1,975	9,875	39,000	1.0	2.0	3.0	4.0	220
2	3,950	19,750	79,000	2.0	4.0	6.0	8.0	440

Source: Naval Facilities Engineering Command (NAVFAC), 1977.



LOCATION OF PROPOSED PROJECTS: WATERFRONT & ADJACENT AREAS

KEY:

- LAND ACQUISITION
- EXISTING NAVY PROPERTY
- EXISTING FENCE LINE
- EXISTING SECURITY ZONE
- EXPANDED SECURITY ZONE

1000 0 1000 2000 3000

APPROX. SCALE IN FEET

FIGURE I-8

To comply with water pollution regulations, all tank strippings, contaminated fuel and other waste accumulated on the AOEs must be pumped ashore for storage prior to processing and disposal.

The proposed ship fuel replenishment system includes ten above-ground storage tanks and interconnecting elevated pipelines to carry fuel to the pier (Figure I-8). The storage tanks would be fixed-roof tanks with a combined capacity of 380,000 barrels. The capacity and characteristics of the storage tanks are listed in Table I-4. Vales and containment berms (dikes) are required and would be installed around each tank to contain any fuel spillage and storm water runoff.

The pipeline system would probably consist of three separate pipelines constructed above the ground. Marine diesel fuel (DFM) would be transported in a 16-inch pipeline at 6,000 gallons per minute (gpm); jet fuel (JP-5) in a 10-inch pipeline at 3,000 gpm; and ballast and oily waste in a 10-inch pipeline at 3,000 gpm.

Fuel supplies to the storage tanks would normally be delivered by tanker or barge. However, design of the facilities includes truck unloading stands to provided for the possibility of fuel delivery by tank truck.

Oily waste treatment facilities are required for processing waste products. The purpose of the processing is to separate fuel and the waste water, in conformance with pollution regulations. These facilities would consist of the two settling tanks (Table I-4), a gravity oil-water separator, a chemical fuel system and an air flotation unit. The air flotation unit is required for breaking oil-in-water emulsions.

A pumphouse and control room are required to pump, regulate and monitor the flow of materials in the pipelines. The pumphouse would consist of a 5,000 square foot metal prefabricated building. The control room is a 1,000 square foot concrete masonry attachment to the pumphouse.

TABLE I-4

FUEL CHARACTERISTICS AND STORAGE TANK CAPACITIES

Type	Description	No. of Tanks	Tank Size (bbl)	Total Storage (bbl)
DFM	Marine diesel fuel is used principally on Navy vessels. It is relatively less viscous and has a lower flash point than other fuels used by the Navy in recent years. Because of its low viscosity it can be expected to spread rapidly over any surface (including water) onto which it is spilled.	4	50,000	200,000
JP-5	JP-5 is kerosene-based jet fuel that is primarily used for naval aircraft.	2	50,000	100,000
Ballast	Water will be the ballast used in the storage tanks of the vessel when it is not carrying fuel. Ballast ensures stability during these times but must be removed before the tanks can be refilled with fuel.	1	50,000	50,000
Settling	Settling tanks are used to store and process oil from ballast tanks, tank strippings, bilge water, contaminated fuel and other oily wastes.	2	10,000	20,000
Waste	Waste oil tanks are used to store oil skimmings from the oil-water separator and air flotation unit. The waste oil from this tank will go to a truck fill stand for final disposal.	1	10,000	10,000
	Total			380,000

It is proposed to locate the ship fuel replenishment system on approximately 25 acres of the 309 acres of privately-owned vacant land west of the Water front Area (Figure I-8). The land would be acquired from its current owner, a nearby fish products processing plant. Included in the parcel is an unused airstrip, formerly a landfill site. The site is described as Block 1408, Lot 1, on the Middletown Township tax map. It is bounded on the south by Sandy Hook Bay. Its western boundary is marked by Compton Creek, the Middletown Township Sewerage Authority's treatment plant and private residences. South of the parcel are private residences and Route 36. On the east, the parcel is contiguous with NWS Earle property.

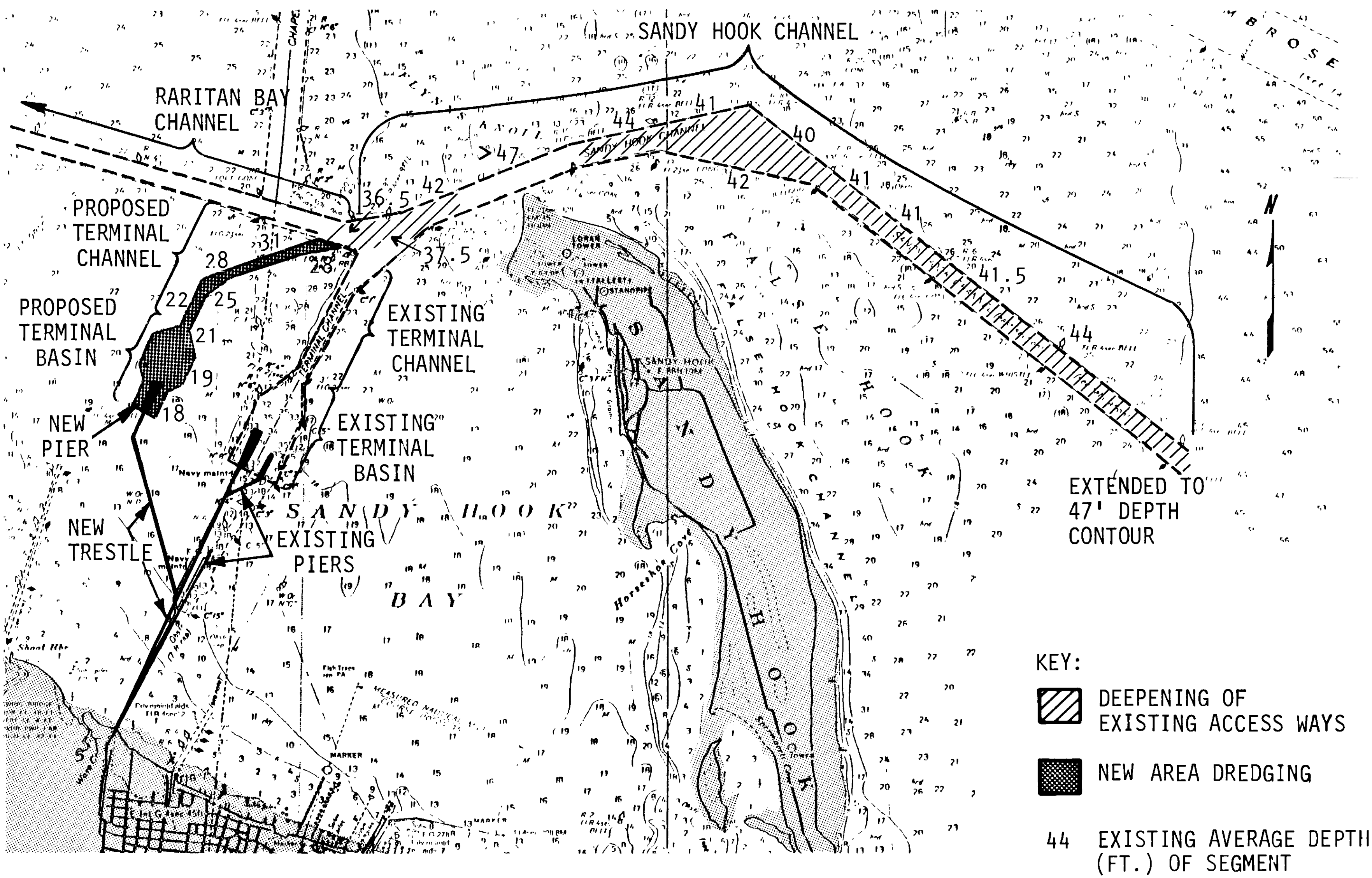
Most of the 309 acres would remain vacant. Preliminary designs locate the storage tanks on about 25 acres west of the north-south runway of the existing airstrip (Figure I-8). The pipeline would connect the storage tanks with the new trestle as shown in Figure I-8.

C.4 Dredging

A fully-loaded AOE draws approximately 42 feet of water and requires 45 feet of water to operate safely. The approach to NWS piers from the ocean is through the Sandy Hook Channel (Figure I-9) which has an authorized project depth of -35 feet MLW. Proposed dredging operations would consist of two actions: (1) deepening of the existing channels including Sandy Hook Channel and the eastern end of the Raritan Bay East Reach Channel and (2) dredging of a new terminal channel and terminal basin for the proposed new pier. Figure I-10 shows details of the proposed terminal channel and basin.

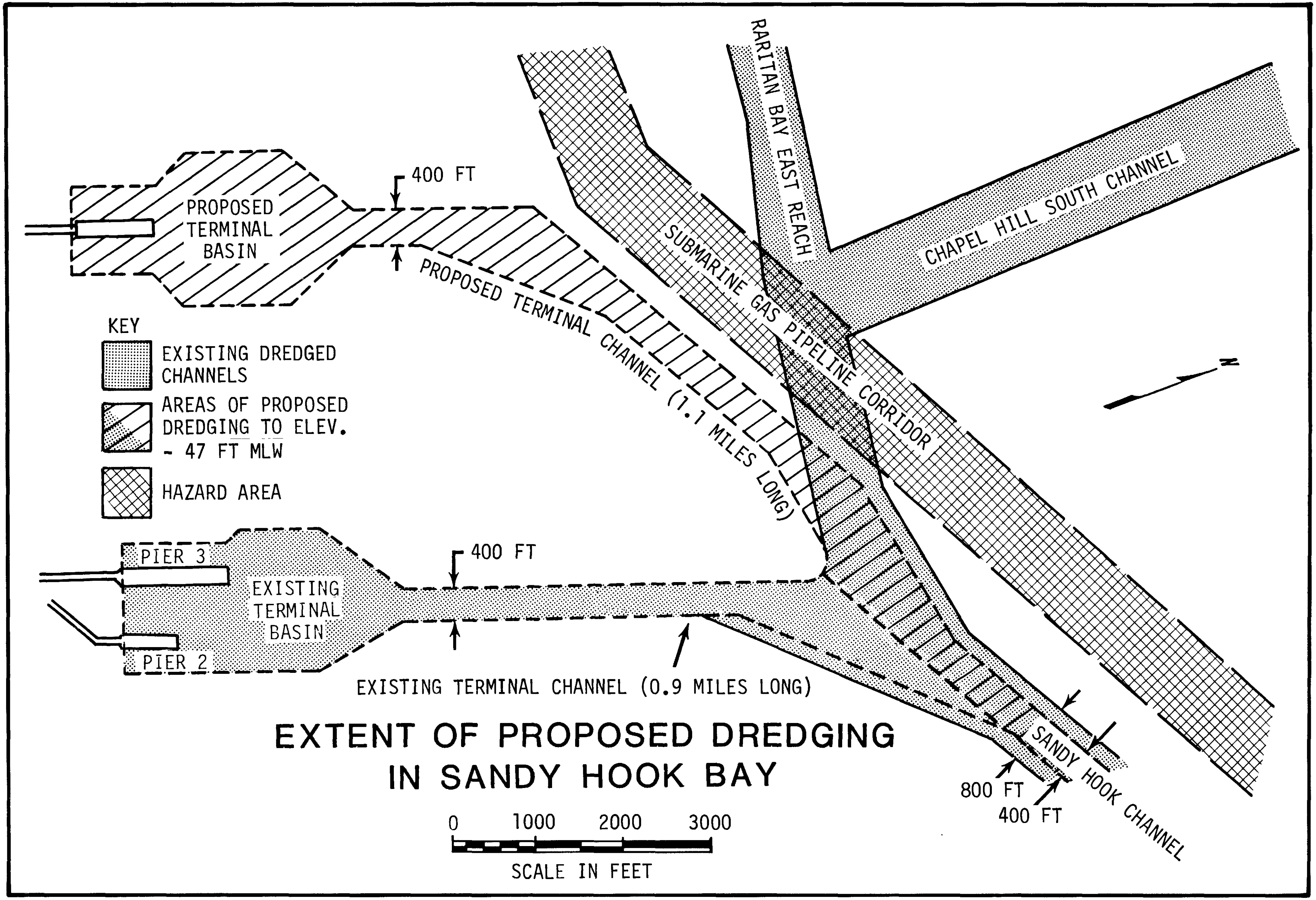
New dredging would involve the removal of approximately 11.3 million cubic yards of material and would affect an area of about 650 acres. A breakdown of dredge volumes for each of the three major segments and material types is presented in Figure I-11.

Approximately 35.5 percent of (4.01 million cu. yds.) of the material to be dredged, is sandy and about 64.5 percent is muddy. The sandy material would



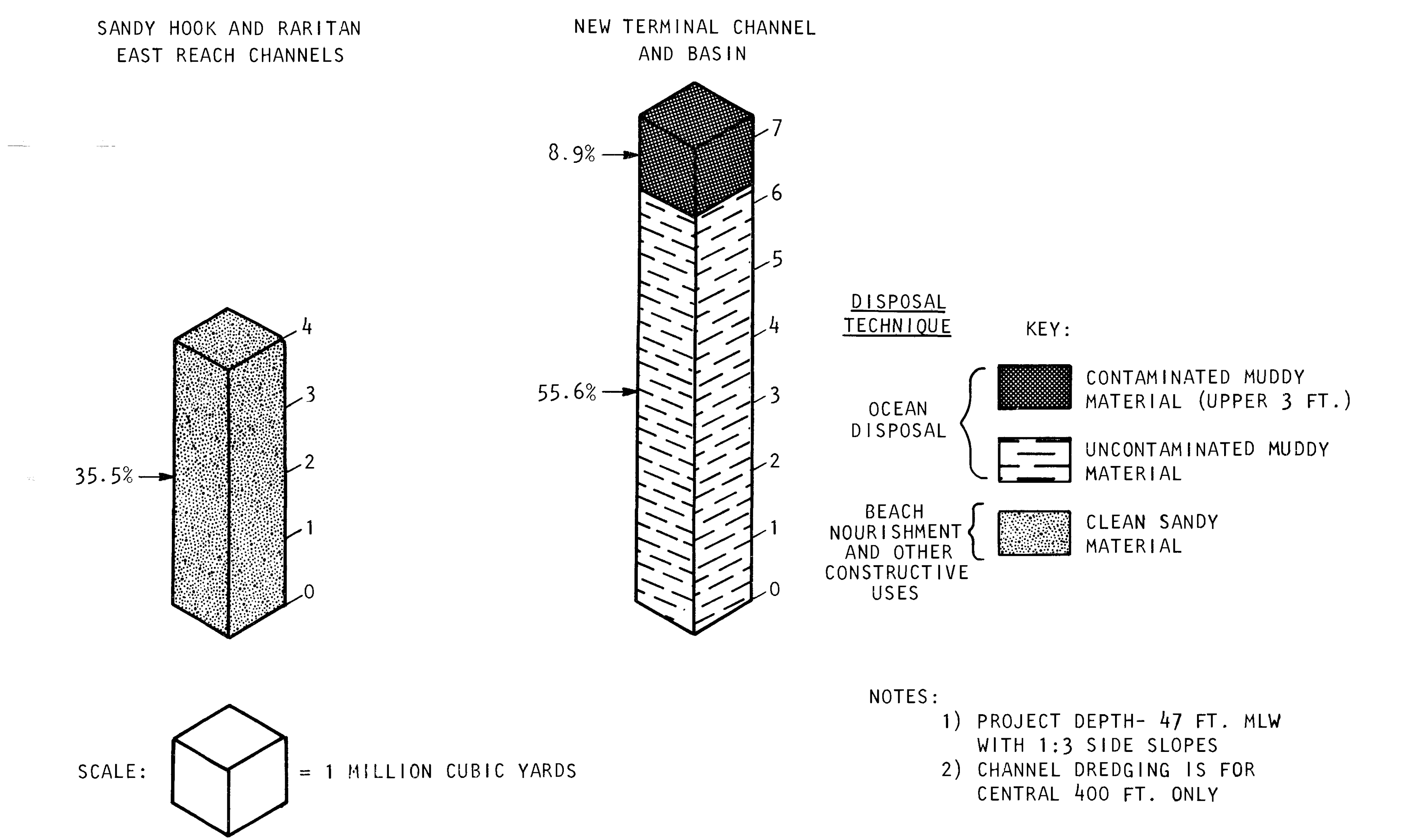
PROJECT DREDGING LOCATION MAP

FIGURE I-9



EXTENT OF PROPOSED DREDGING IN SANDY HOOK BAY

FIGURE I-10



PROJECT DREDGE MATERIALS AND VOLUMES

FIGURE I-11

come from the dredging of Sandy Hook Channel and Raritan Bay East Reach Channel. The new terminal channel and turning basin would involve the dredging of muddy materials. About 1.01 million cu. yds. from the upper 3 ft. of the muddy areas is considered to be contaminated. About 6.28 million cu. yds. of uncontaminated muddy materials would be dredged from the lower (below 3 ft.) portions of the new terminal channel and turning basin.

Considering the nature of sediments, operating conditions and disposal methods, tentative dredging techniques would include but are not limited to, hopper dredging along the Sandy Hook Channel and mechanical or hydraulic techniques in the proposed terminal channel and terminal basin. Dredging operations are expected to proceed 24 hours a day, 6 days a week for a period of 6 months to a year, depending on the number and size of dredges employed and the frequency of adverse weather conditions.

Maintenance dredging would involve periodic removal of lesser amounts of material. Based on the past history of maintenance dredging, an accumulation rate of roughly 600,000 cubic yards per year is anticipated over the proposed project area (Figure I-9). Maintenance dredging cycles have ranged from one to six years, depending on the area. In the vicinity of the terminal channel and basin four- to six-year maintenance cycles are anticipated. Three- to five-year cycles are expected along most of Sandy Hook Channel. More frequent maintenance (possibly annually) will be required along a small portion of Sandy Hook Channel just northeast of the tip of Sandy Hook.

It is proposed that the muddy dredged materials (7.29 million cubic yards) be transported by barge to and dumped at the interim Mud Dump site located approximately 10 miles southeast of the tip of Sandy Hook and about 6 miles directly offshore (Figure I-12).

It is intended that, if feasible, the clean sandy materials (3.2 million cu. yds.) would be utilized for constructive purposes, such as beach nourishment for the Gateway National Recreation Area (at Sandy Hook) and other areas and as construction fill material.

C.5 Other Support Facilites

Several other support facilities are needed for either AOE homeporting or additional VSS capability. These are described in Table I-5 and located on Figures I-8 and I-13. All of these facilities will be located on existing NWS Earle property.

C.6 Schedule

It is expected that the proposed actions will be implemented over a three year period, commencing in 1981. First-year priority will be given to the construction of the new pier and trestle. Dredging operations and the remaining construction, including the fuel replenishment system, will be accomplished over the next two years, 1982 through 1983.

C.7 Costs

The summary of project costs for the proposed actions is presented in Table I-6. Dredging costs are divided into costs for ocean disposal and costs involved in supplying sandy materials to the tip of Sandy Hook. Estimates are projected for 1982 based on an assumed eight percent per year inflation factor for 1976 and 1977 costs based on data from the U.S. Army Corps of Engineers (October 1977) and Dravo/Van Houten, (1977). The projected unit rates for 1982 are: $5.29/cu. yd. for ocean disposal and $3.16/cu. yd. for sand materials to be used in beach nourishment.

TABLE I-5

OTHER SUPPORT FACILITIES

Facility	Location	Description
Ship's Utilities (AOE)	WF	The AOEs require electricity, potable water, fire protection systems, flushing (salt) water, sewage removal and steam in order to maintain a "hotel" status while in port. These utilities permit the ship's system to be shut down for energy conservation, maintenance, repair and replenishment and to permit the ship's crew to take leave. Electricity would be purchased from Jersey Central Power and Light. Potable water would be purchased from the Monmouth Consolidated Water Company and piped along the trestle to the berthing areas. Ship's sewage would be collected, conveyed along the trestle via a force main to aeration tanks at the Waterfront Area then discharged to an interceptor and conveyed to the Middletown Township Sewerage Authority's treatment plant. Steam would be generated by boilers located at the end of the pier.
Oil Spill Containment Facilities (AOE)	WF	The potential exists for an oil spill at the piers from ships or storage tanks. In order to contain such a spill, facilities for the secure storage and rapid deployment of the spill control equipment must be constructed at the new pier. The proposed facilities consist of hoisting cranes (for the launching and recovery of oil spill cleanup equipment and utility boats) and a metal shed on the pier (for storage of the boats and equipment). The facilities would allow emergency response to oil spills and would protect the boats and equipment from the elements when not in use.

Notes:

[a]WF - Waterfront Area, CH - Chapel Hill Area, MS - Main Station. Projects are located on Figure I-8 (WF and CH) and I-13 (MS).

TABLE I-5 (Continued)

OTHER SUPPORT FACILITIES

Facility	Location[a]	Description
Secure and Short-Term Parking (AOE)	CH and WF	Ship's crews require a secured parking area for personal vehicles while crews are at sea. One such facility presently exists in the Chapel Hill Area with space for 100 cars. It is proposed to construct a paved and fenced long-term parking area for an additional 200 cars, adjacent to the existing facility. Also proposed is a 100 car short-term parking lot for daily parking for crew members.
Serv Mart (AOE)	WF	With increased loading in the Waterfront Area a small convenience store is justified. This store would carry miscellaneous food, periodicals, hardware, laundry and sundries. It is proposed to establish this function in an existing building.
Intermediate Maintenance (AOE)	WF	Many ship repairs can be accomplished by the ship's crews using its own onboard facilities and equipment. However, the size and complexity of this onboard capability is necessarily limited. It is proposed, therefore, to establish a shore-based capability for larger and more complex repairs.
Bowling Alley (AOE)	WF	Increased loading would necessitate the expansion of recreational facilities on Station. A new gym has recently been completed. However, this facility would be overtaxed with the arrival of the AOEs. It is therefore proposed to construct an 8-lane bowling alley adjacent to the gym.
AOE Warehouse (AOE)	MS	AOEs and AEs require both cold and dry storage space to receive and store perishable and dry goods for the ship's own use and for their cargo requirements. The warehouse would be located next to building C-21 on the Main Station and comprise 8,000 square feet.

Notes:

[a]WF - Waterfront Area, CH - Chapel Hill Area, MS - Main Station.
Projects are located on Figure I-8 (WF and CH) and I-13 (MS).

TABLE I-5 (Continued)

OTHER SUPPORT FACILITIES

Facility	Location[a]	Description
Smokeless Powder and Projectile Magazines (AOE)	MS	The homeporting of five ammunition ships (three AEs and two AOEs) would overtax the storage capabilities in this class of magazine at NWS Earle. It is therefore, proposed to construct six additional magazines in Magazine Group F.
Naval Exchange (AOE)	MS	NWS Earle is presently served by a small Naval Exchange. This function is presently inadequate. Because of increased loading as a result of AOE homeporting, it is proposed to construct a new 17,000 square foot Naval Exchange facility in the vicinity of the Main Station Family Housing Area. In addition to typical Exchange sales, this facility would also include a Post Office, Family Services Center, Housing Referral Office and Package Store.
In-Transit Holding Facilities (VSS)	MS	Additional railroad siding areas (2) and a truck parking area are required for temporary holding of explosives awaiting loading for two VSS.

Notes:

[a]WF - Waterfront Area, CH - Chapel Hill Area, MS - Main Station. Projects are located on Figure I-8 (WF and CH) and I-13 (MS).

TABLE I-6

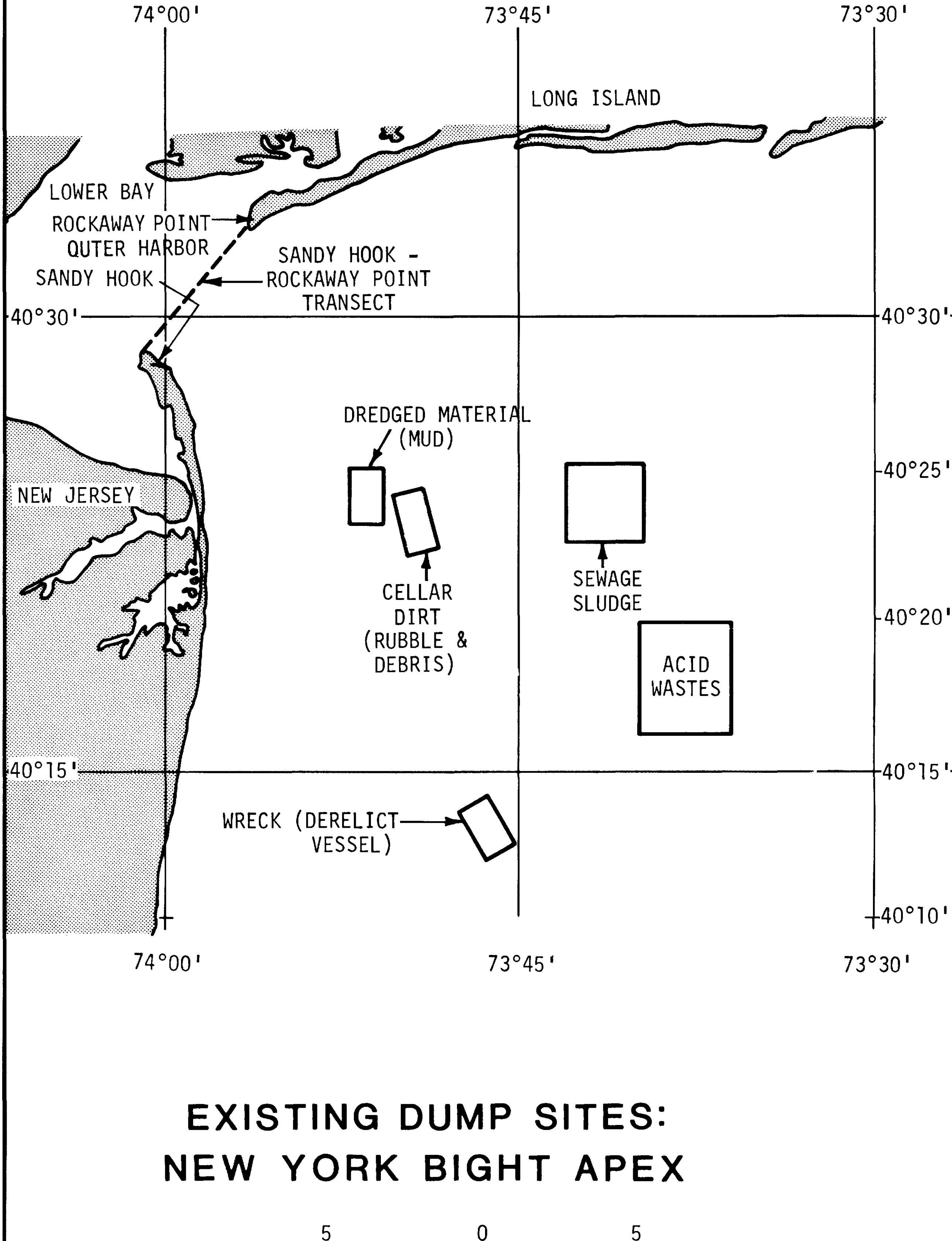
ESTIMATED PROJECT COSTS

PROJECT	COST ($ MILLION)
Pier and trestle	54.46
Dredging (-45 ft. +2)	
1) Ocean disposal	38.56
2) Beach nourishment	12.67
In-transit holding facilities	13.42
Ship's utilities (cold iron)[a]	4.64
Magazines	5.06
AOE Warehouse	0.46
Shore facilities[b]	3.60
Ship fuel replenishment system and land acquisition	18.39
TOTAL	$151.27 million

Notes:

[a]Also includes oil spill containment and battery recharge facilities

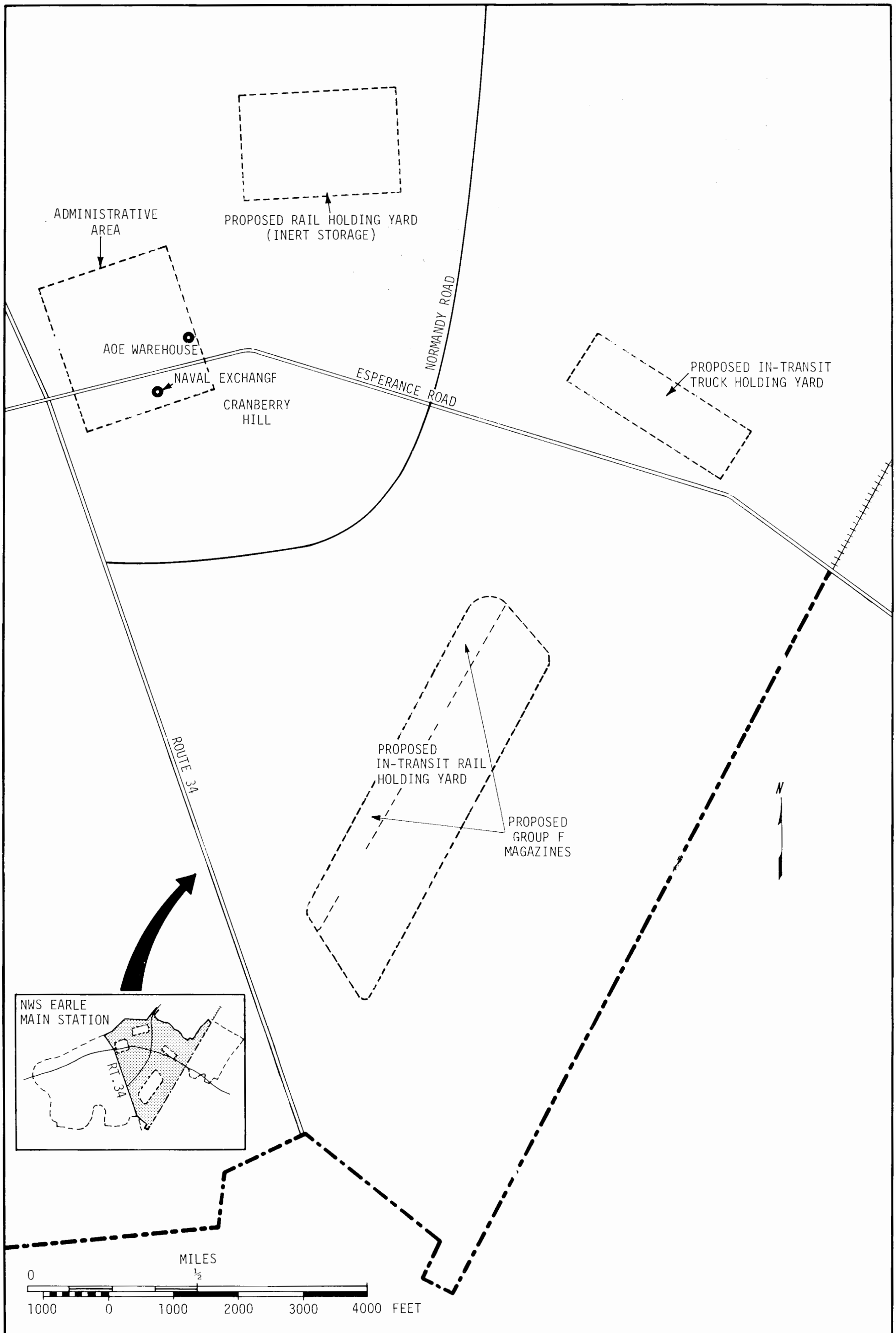
[b]Medical, legal and chaplain offices; servmart, recreation (bowling) and parking facilities and naval exchange.



EXISTING DUMP SITES: NEW YORK BIGHT APEX

SOURCE: USEPA, JULY 1974

FIGURE I-12



LOCATION OF PROPOSED PROJECTS: MAIN STATION

FIGURE I-13

CHAPTER II

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II. DESCRIPTION OF THE EXISTING ENVIRONMENT

A. INTRODUCTION

This chapter presents a description of the environment prior to implementing the proposed actions. This description is presented in order to establish the natural and man-made systems which may be impacted by the proposed actions. The impact analysis is presented in Chapter IV and evaluates the nature of environmental impacts that will result from the implementation of the proposed actions.

Since the proposed actions will potentially affect a wide geographic region, the description of the natural environment has been grouped into three sections, B - Terrestrial Environment, C - Estuarine Environment and D - Ocean Environment - Dredge Material Disposal Site. These subdivisions of the natural environment not only form discrete environmental systems, but also represent the locations where project actions will be implemented. An additional section, E - Man-Made Environment, describes the existing land use and socio-economic aspects of the environment.

The Terrestrial Environment section describes the pertinent physical, chemical and biological components and systems of the air, waters and terrain of project areas within Monmouth County. The section on Estuarine Environment describes the physical, chemical and biological components and systems of the Raritan Estuary, including Sandy Hook Bay and nearshore areas. The section on the Ocean Dredged Material Disposal Site describes the physical, chemical and biological conditions in the ocean environment near the designated disposal site, located about six miles east of Sandy Hook.

B. TERRESTRIAL ENVIRONMENT

B.1 Physiography

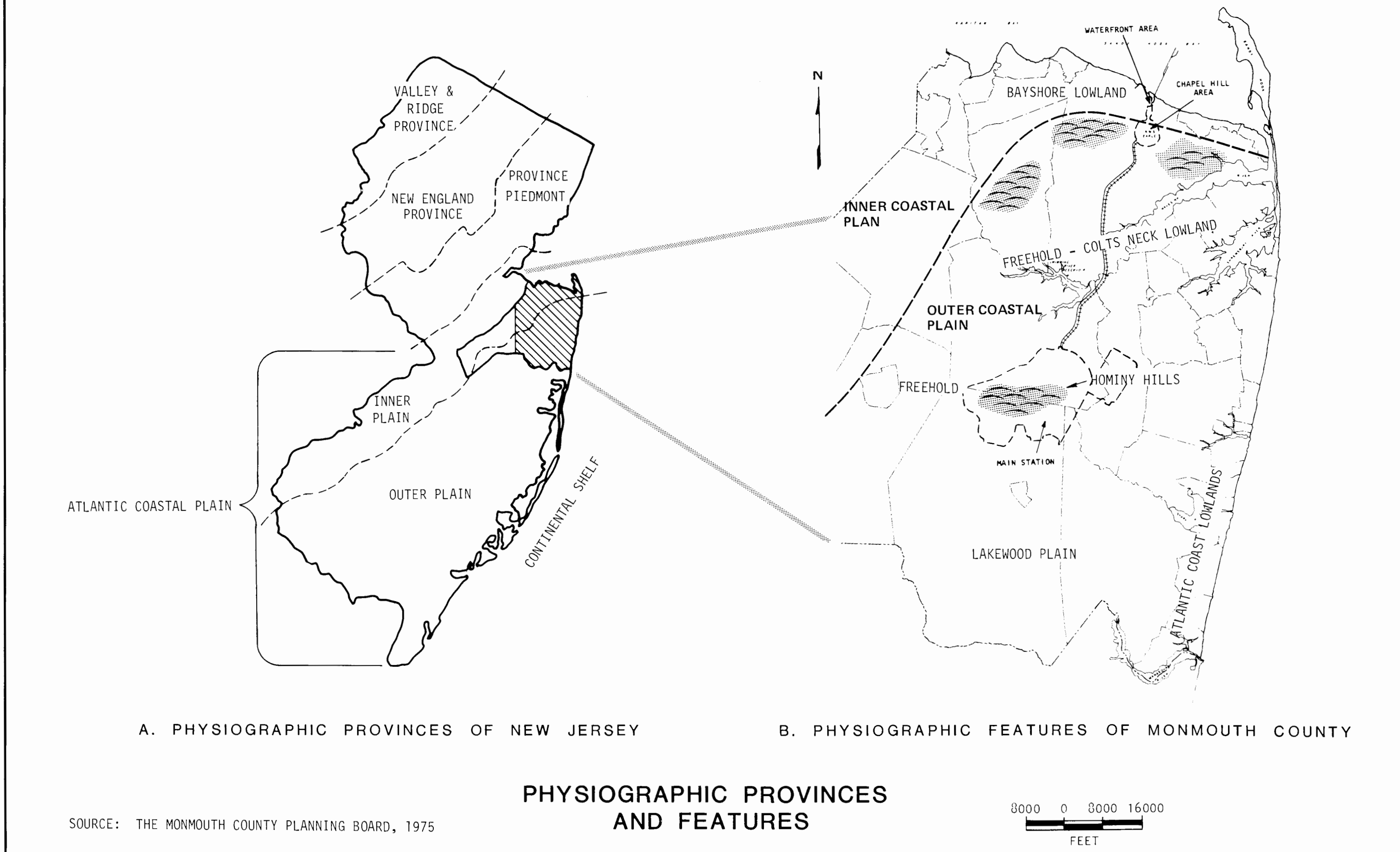
The project area lies within the Inner and Outer subdivisions of the Atlantic Coastal Plain Physiographic Province (Figure II.B-1). The Coastal Plain is a broad, low, gently sloping plain developed from the differential erosion of slightly inclined formations of sand silt, clay and gravel. Only a few areas rise more than 100 feet above sea level.

A series of prominent hills, the Highlands - Mt. Pleasant Hills, form the drainage divide between the Inner and Outer Plains. These hills reflect the exposure of more resistant (sandy) formations. The Inner Plain is characterized by drainage to the west or northwest toward the Delaware River and Raritan River Basins, respectively. The Outer Plain is characterized by drainage systems flowing northeast into Sandy Hook Bay or southeast to the Atlantic Ocean. The details of the drainage basins within the study area are discussed in the Surface Water Hydrology Section of this Chapter (B.4).

The Waterfront Area of NWS Earle lies within the Inner Plain (locally referred to as the Bayshore Lowland). Sluggish streams drain northward into Raritan Estuary and Sandy Hook Bay (Figure II.B-1).

The Chapel Hill area of NWS Earle (about 200 feet elevation), the site of the railroad barricades, is a portion of the Highlands-Mt. Pleasant Hills.

The Main Station lies within the Outer Plain. The Hominy Hills, a prominent line of hills with elevations from about 200 feet to 300 feet, characterize the central portions of the Main Station. These hills form the drainage divide for the Navesink River Basin to the north and the Shark River Basin and Manasquan River Basin to the south (See Surface Water Hydrology Section - B.4).



PHYSIOGRAPHIC PROVINCES AND FEATURES

SOURCE: THE MONMOUTH COUNTY PLANNING BOARD, 1975

FIGURE II.B-1

B.2 Geology

a. General

The study area is underlain by sedimentary formations of clay, silt, sand and gravel. These Coastal Plain formations of Cretaceous and Tertiary age are slightly inclined toward the southeast and are exposed (outcrop) in irregular bands that are oriented northeast-southwest (Figure II.B-2). The older formations are of Cretaceous age and form the outcrop bands to the northwest. Progressively younger formations outcrop toward the southeast. Deposits of Quaternary age are present within the project area, especially in low areas along streams and in coastal areas. These deposits are generally thin and overlie the eroded surface of the inclined Cretaceous and Tertiary Coastal Plain formations.

The Coastal Plain formations form a southeastward thickening wedge of sediments which overlie consolidated basement rocks. This wedge ranges in thickness from about 500 feet in the northwest to about 1200 feet in the southeast. The general configuration of the geologic formations in the study area is illustrated in the Geologic Cross Section (Figure II.B-3). The location of this section is shown in Figure II.B-2.

The nature (lithology) of the formations illustrated in the Geologic Map (Figure II.B-2) is presented in Table II.B-1 together with data on thickness and age. The units in the table are arranged from top to bottom, in order of increasing age.

A number of sand and gravel formations are important sources of ground water and are discussed more fully in the Ground-Water Hydrology Section of this Chapter (B.4).

b. Waterfront Area

The NWS Earle Waterfront Area is characterized by Quaternary deposits. These include bay and tidal marsh sediments as well as glauconite sands and beach sands. At the site of the proposed ship fuel replenishment system, sandy landfill materials overlie the marsh deposits. The Cretaceous Englishtown Forma-

TABLE II.B-1
STRATIGRAPHIC UNITS OF THE NORTHERN ATLANTIC COASTAL PLAIN OF NEW JERSEY(1)

Era	System	Series	Formation		Maximum Thickness (ft)	Lithology
Cenozoic 0 to 55 million yrs. ago	Quaternary	Holocene Recent	Alluvium		50	Sand, silt, and black mud.
			Beach sand and gravel			Sand, quartz, light-colored, medium-grained, pebbly.
		Pleistocene	Cape May Formation		60	Sand, quartz, light-colored, heterogeneous, clayey, pebbly, glauconitic.
			Pensauken Formation[2]			
			Bridgeton Formation			
	Tertiary	Pliocene (?)	Beacon Hill Gravel		60	Gravel, quartz, light-colored, sandy.
		Pliocene (?) and Miocene(?)	Cohansey Sand		30	Sand, quartz, light-colored, medium- to coarse-grained, pebbly; local clay beds.
		Miocene	Kirkwood Formation		74	Sand, quartz, gray to tan, very fine to medium-grained micaceous, and dark-colored distomaceous clay.
		Eocene	Shark River Marl		100	Sand, quartz and galuconite, gray, brown, and green, fine- to coarse-grained, clayey, and green silty and sandy clay.
			Rancocas Group	Manasquan Formation		
				Vincentown Formation	130	Sand, quartz, gray and green, fine- to coarse-grained, glauconitic, and brown clayey, very fossiliferous, glauconite and quartz calcarenite.
				Hornerstown Sand	100	Sand, glauconite, green, medium- to coarse-grained, clayey.
Mesozoic 65-225 million yrs. ago	Cretaceous	Upper Cretaceous	Monmouth Group	Tinton Sand and Red Bank Sand undivided	135	Sand, quartz and glauconite, brown and gray, fine- to coarse-grained, clayey, micaceous.
				Navesink Formation	45	Sand, glauconite and quartz, green, black, and brown, medium- to coarse-grained, clayey.
				Mount Laurel Sand	85	Sand, quartz, brown and gray, fine- to coarse-grained, glauconitic.
			Matawan Group	Wenonah Formation	85	Sand, quartz, gran and brown, very fine to fine-grained, glauconitic, micaceous.
				Marshalltown Formation	50	Sand, quartz and glauconite, gray and black, very fine to medium-grained, very clayey.
				Englishtown Formation	150	Sand, quartz, tan and gray, fine- to medium-grained; local clay beds.
				Woodbury Clay	60+	Clay, gray and black, micaceous.
				Merchantville Formation	60+	Clay, gray and black, micaceous glauconitic, silty; locally very fine-grained quartz and glauconite sand.
			Magothy Formation		175	Sand, quartz, light-gray, fine-grained, and dark-gray lignitic clay.
			Raritan Formation		400	Sand, quartz, light-colored, fine- to coarse-grained, pebbly, arkosic, and red, white, and variegated clay.
Pre-Cambrian 600 million - 4.5 billion yrs. ago		Pre-Cretaceous				Precambrian and early Paleozoic crystalline rocks - metamorphic schist and gneiss; locally Triassic basalt, sandstone, and shale.

Source: (1) Modified after Seaber, 1965, Table 3.
(2) Age of Pensauken Formation now considered late Miocene.

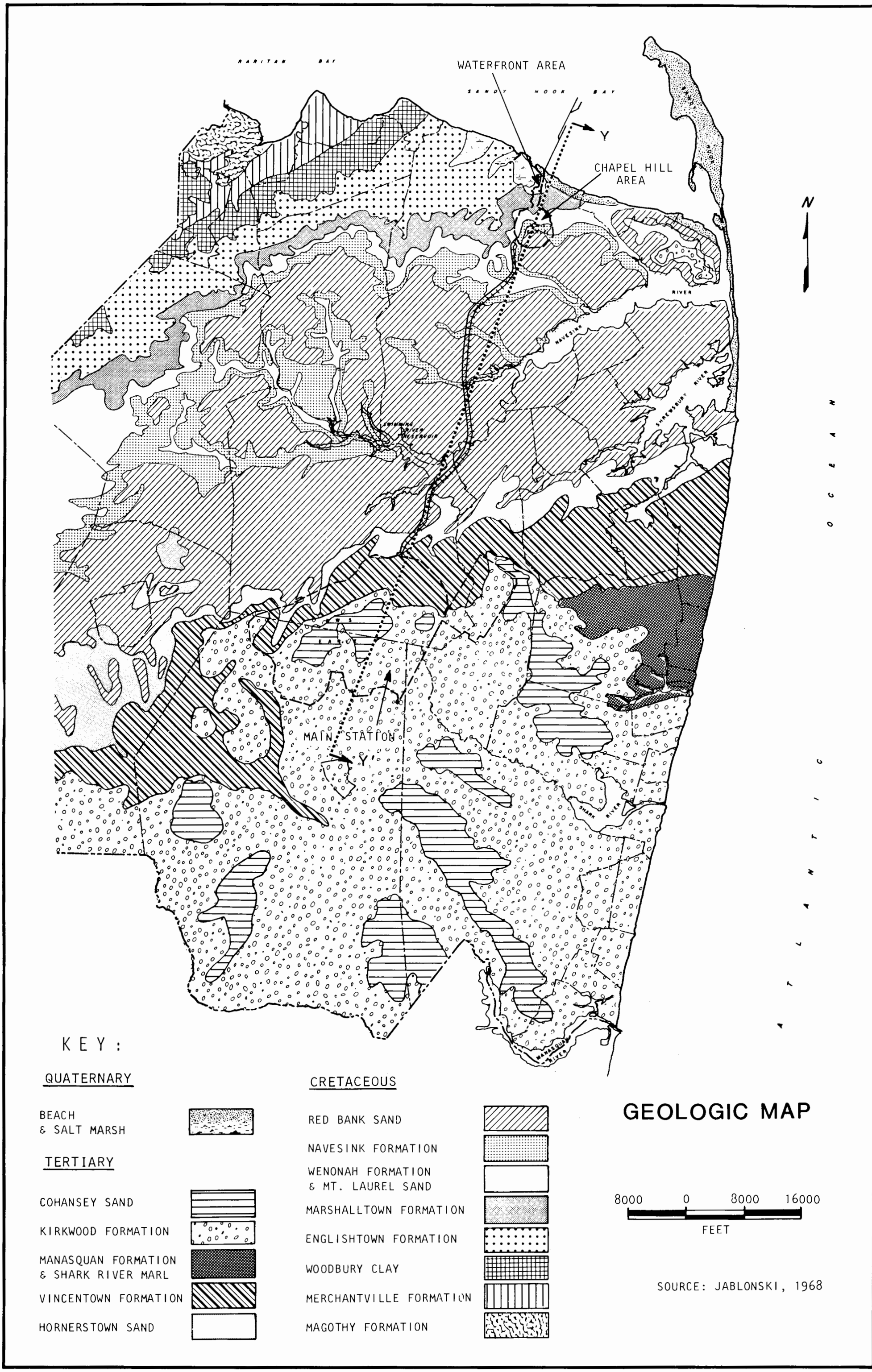
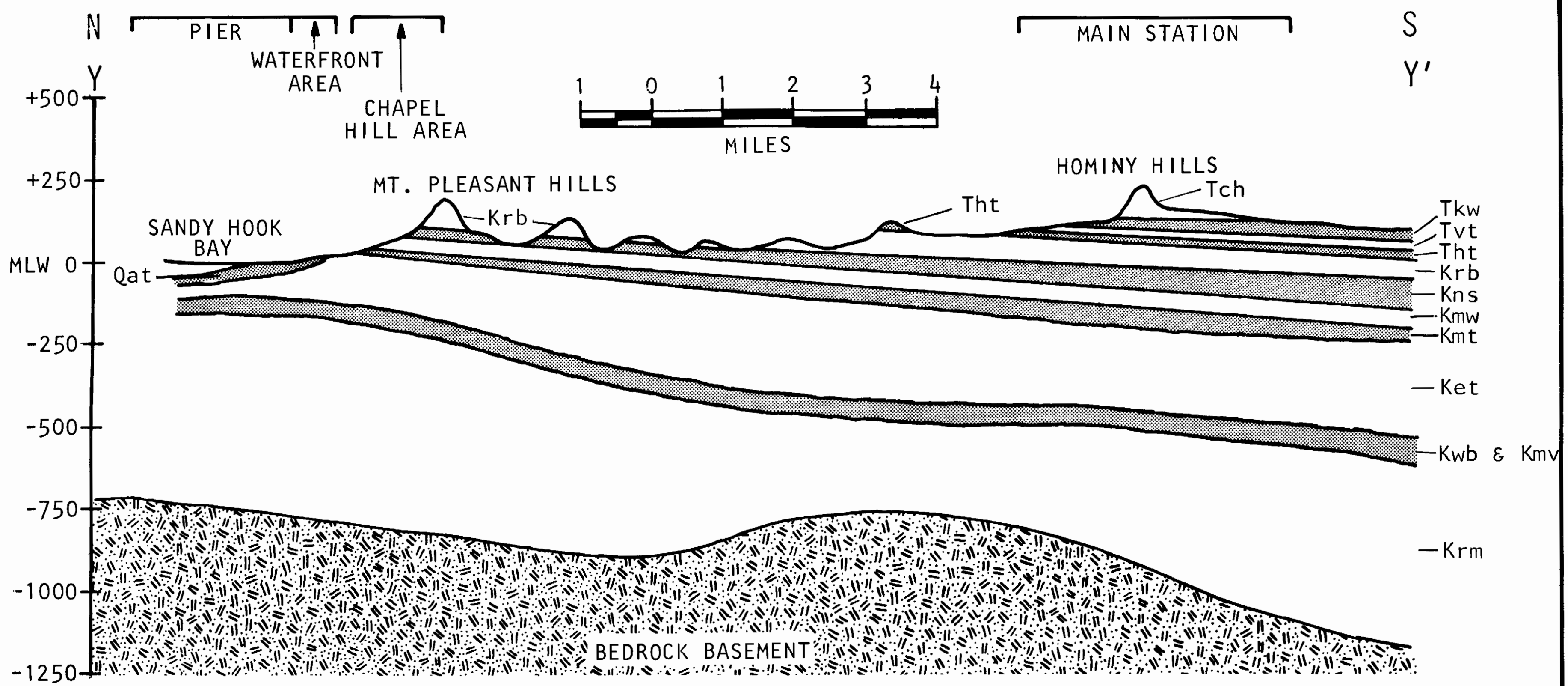

RARITAN BAY
WATERFRONT AREA
SANDY HOOK BAY
Y
CHAPEL HILL
AREA
N
RIVER
NAVESINK
SHREWSBURY RIVER
OCEAN
ATLANTIC
MAIN STATION
Y'
SHARK RIVER
MANASQUAN RIVER
KEY:
QUATERNARY
BEACH
& SALT MARSH
TERTIARY
COHANSEY SAND
KIRKWOOD FORMATION
MANASQUAN FORMATION
& SHARK RIVER MARL
VINCENTOWN FORMATION
HORNERSTOWN SAND
CRETACEOUS
RED BANK SAND
NAVESINK FORMATION
WENONAH FORMATION
& MT. LAUREL SAND
MARSHALLTOWN FORMATION
ENGLISHTOWN FORMATION
WOODBURY CLAY
MERCHANTVILLE FORMATION
MAGOTHY FORMATION
GEOLOGIC MAP
8000 0 8000 16000
FEET
SOURCE: JABLONSKI, 1968

FIGURE II.B-2



GENERALIZED GEOLOGIC CROSS SECTION Y-Y'

LEGEND:

QUATERNARY

Qat - COASTAL DEPOSITS

TERTIARY

Tch - COHANSEY SAND
Tkw - KIRKWOOD FORMATION
Tvt - VINCENTOWN FORMATION
Tht - HORNERSTOWN SAND

CRETACEOUS

Krb - RED BANK SAND
Kns - NAVESINK FORMATION
Kmw - WENONAH FORMATION & MT LAUREL SAND
Kmt - MARSHALLTOWN FORMATION
Ket - ENGLISHTOWN FORMATION
Kwb - WOODBURY CLAY
Kwv - MERCHANTVILLE FORMATION
Krm - RARITAN & MAGOTHY FORMATIONS

NOTE: SEE FIGURE II.B-2 FOR LOCATION OF SECTION.

FIGURE II.B-3

tion underlies the Quaternary deposits at shallow depth. It, along with the Wenonah and Marshalltown Formations, is exposed in the elevated terrain adjacent to the Waterfront Area on the east.

c. Chapel Hill Area

The Chapel Hill area of NWS Earle is underlain by Cretaceous formations including, from oldest to youngest, the Wenonah Formation (to the northwest), the Mount Laurel Sand, the Navesink Formation and the Red Bank Sand (to the southeast).

d. Main Station

At the Main Station area of NWS Earle, younger Tertiary units are exposed. The northwestern boundary area is underlain by the Vincentown Formation. The underlying Hornerstown Formation is exposed in streams in the northwest corner of the Main Station. The Kirkwood Formation overlies the Vincentown Formation and is exposed over most of the Main Station, expecially the southern portions. The overlying Cohansey Formation outcrops as part of the Hominy Hills which occupy the central portions of the Main Station.

B.3 Soils

a. General

Soils in the vicinity of the NWS Earle facilities are numerous and extremely variable. The USDA Soil Conservation Service (SCS) recognizes 43 series of soil represented by 114 subtypes within Monmouth County. More than half of these occur within the boundaries of NWS Earle (see Table II.B-2).

The different soil series are determined primarily by these factors: the geologic sediment of "parent material" from which the soil is derived, the location of the soil on the slope of the hill, and the level of the water table. In general, the

TABLE II.B-2
SELECTED SOIL PROPERTIES - NWS EARLE

Soil Series	Location[1]	Wetness (Natural Drainage)[2]	Permeability[3]	Seasonally High Water Table (ft)[4]	Stream/Tidal Flood Hazard[5]	Hydrologic Group[6]	Erodibility Factor[7]	Organic Content (%)	Soil Reaction (pH)[8]	Comments
Colemantown	MS	Poorly drained	Slow	0-1	Occasional (stream)	DD	0.43	2-3	3.5-5	
Collington	MS, CH	Well drained	Moderate to moderately slow	5+	None (stream)	B	0.28	0.5-3	4.5-5	
Keansburg	MS, CH	Very poorly drained	Moderate	At surface	None to common (stream)	D	NA	2-5	4.5-5	
Freehold	MS	Well drained	Moderate	5+	None	B	0.20-0.28	0.5-3	4.5-5	
Colts Neck	CH	Well drained	Moderate to moderately rapid	6	None	B	0.28	0.5-2	3.6-5	
Howell	MS	Well to moderately well drained	Slow	1½-5	None	D	0.43	2-4	4.5-5	Extremely acid (pH 1-3) when exposed to oxidation
Evesboro	MS, WF	Excessively drained	Rapid to moderate	5+	None	A	0.17	0-1	3.5-5	
Klej	MS, WF	Moderately well to well drained	Slow to rapid	1½-4	None	B	0.17	0-1	4-5	
Sassafras	MS, CH	Well drained	Moderate to moderately slow	3-5	None	B	0.28	0.5-2	4.5-5	
Lakewood	MS	Excessively drained	Rapid	5+	None	A	0.17	0-1	3.5-5	
Lakehurst	MS	Moderately well to somewhat poorly drained	Rapid	1½-4	None	B	0.17	0-1	3.5-5	
Atsion (Leon)	MS	Poorly drained	Rapid	0-1	Seldom (stream)	D	0.17	3-8	3.5-4.5	
Berryland (St. Johns)	MS	Very poorly drained	Moderately rapid	At surface	Seldom or occasionally (stream and tidal)	D	0.17	3-8	3.5-4.3	
Keyport	MS, WF	Moderately well drained	Slow	1½-2½	None	D	0.43	2-4	4-5	
Elkton	MS, WF	Poorly drained	Slow	0-1	None to slight (stream)	D	0.43	2-4	4-5	Severe frost heave
Matawan	MS	Moderately well drained	Slow	1½-3	None	C	0.28-0.32	0.5-2	4-5	
Alluvial land (Manalapan)	MS	Poorly drained	Moderate	0-1	Frequent (stream)	D	NA	2-4	4.5-5	

TABLE II.B-2 (Continued)
SELECTED SOIL PROPERTIES - NWS EARLE

Soil Series	Location[1]	Wetness (Natural Drainage)[2]	Permeability[3]	Seasonally High Water Table (ft)[4]	Stream/Tidal Flood Hazard[5]	Hydrologic Group[6]	Erodibility Factor[7]	Organic Content (%)	Soil Reaction (pH)[8]	Comments
Alluvial land (Johnson)	MS	Very poorly drained	Rapid	0-3	Frequent (stream)	D	NA	Variable	Variable	
Deep muck	MS	Very poorly drained	Rapid	At surface	Very frequent (stream)	D	NA	20-80	4.5-5.5	Severely acid, subject to shrinkage when drained and dried
Coastal Beach	WF	Excessively drained	Rapid	1-10	Very frequent (tidal)	NA	NA	0.5	6.6-7.3	Tidal/storm flooding hazard
Tidal Marsh	WF	Very poorly drained	Rapid	At surface	Vey frequent (tidal)	D	NA	5-20	6.6-7.3	
Fill land	WF	Excessively drained	Rapid	Variable	Variable	A	0.18	Low-variable	4-5	
Sanitary land Fill	WF	Variable	Variable	Variable	None	Variable	Variable	Variable	Variable	Subject to formation of gases and leachate, variable settling limits

Notes:

[1]Location: MS = Main Station Area, WF = Waterfront Area, CH = Chapel Hill Area.

[2]Wetness (natural drainage classes or water table height and duration) - This is an indication of the amount of the year that a soil is saturated or contains excess water. In some cases the soil is saturated by a water table that rises and falls seasonally; in others, water is perched over slowly permeable layers (clay or fragipans). Six natural drainage classes (before man's improvements efforts) are normally used; excessively drained; well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. Natural drainage classes are: excessive - no excess water in soil in any season; well drained - excess water for only short periods after abnormally heavy rainfall; moderately well drained - seasonally high water at $1\frac{1}{2}$ to 4 feet from surface from January to April; somewhat poorly drained - seasonally high water at $\frac{1}{2}$ to $1\frac{1}{2}$ feet from surface from December to May; poorly drained - seasonally high water at 0 to 1 foot from surface from November to June; very poorly drained - seasonally high water at surface from October to June. Each class successively is wet for longer periods. There is not an absolute relation of wetness to permeability because wetness is merely an expression of whether the water can get away.

[3]Permeability - Permeability refers to the rate of vertical movement of water through a wet soil.

[4]Depth to seasonal high water is the normal range of minimum depth, in feet, to the water table (real or perched).

[5]Flood Hazard - This refers to the overflow of rivers, streams, tributaries, and tidal waters but is not intended to include shallow ponding associated with normal rainfall runoff. The hazard is given in terms of normal occurrence - none, seldom (less than 1 year in 5), occasional (1 overflow in 3 or 4 years), frequently (annually), and very frequent (several times a year).

[6]Hydrologic Soil Group are ratings of soils to indicate amount of runoff following prolonged wetting. A indicates the least runoff and D the most. Factors considered in rating were natural drainage or water table, permeability rate, depth to fragipan (dense slowly permeable layer) or bedrock. Conversely soils rated A can absorb the greatest rainfall and generally at the most rapid rates.

[7]Erodibility (K) factor are relative erosion factors indicating sheet erosion that might be expected from bare soil. Ratings are .17, .20, .24, .28, .32, .37, .43, and .49. Lowest erosion hazard is .17; highest is .49. Some soils that are nearly level are not rated.

[8]Soil reaction - presented as the natural range of pH for the soil.

SOURCE: Adapted from "Soil Properties and Soil Survey Interpretation Sheets for New Jersey" 1972-1976, Soil Conservation Service, USDA in cooperation with Rutgers University, College of Agriculture and Environmental Science.

soils are distributed in northeast-southwest trending belts related to the local physiographic feature and underlying geologic formations.

Soils of particular interest at NWS Earle are the acid soils and the poorly-drained soils. The soil acidity is attributed to the pyrite and or lignite derived from the parent materials. Through exposure to air and water, the pyrite/lignite-rich soils oxidize, producing sulfuric acid, which has corrosive qualities that can adversely affect fish and plant life. Black acid soils have been detected by the SCS within several feet of the surface at over 60 locations in Monmouth County. The acid soils seem to be common in, but not confined to, exposure areas of the Englishtown, Marshalltown, Kirkwood, Mount Laurel and Wenonah Formations, and the Red Bank Sands, Navesink Formation, Hornerstown Sand and Woodbury Clay (see Geology Section, B.2, this Chapter). All of these units contain varying amounts of pyrite and lignite.

Poorly-drained soils are associated with stream and river flood plains and low-lying wetland areas, including freshwater swamps and salt water marshes. Soils in these areas are typically unconsolidated, organic-rich sands, silts and clays which are susceptible to both tidal or stream flooding and settlement under loading.

b. Main Station

On the Main Station the soils are predominantly deep sand with lesser areas of silt loam, sandy loam, loamy sand and muck. The distribution of soils in the vicinity of proposed construction is presented in Figure II.B-4. A summary of selected soil properties is presented in Table II.B-2. In Figure II.B-4 it can be seen that the vicinity of the proposed projects at the Main Station is covered primarily by poorly drained soils and is dissected by numerous streams.

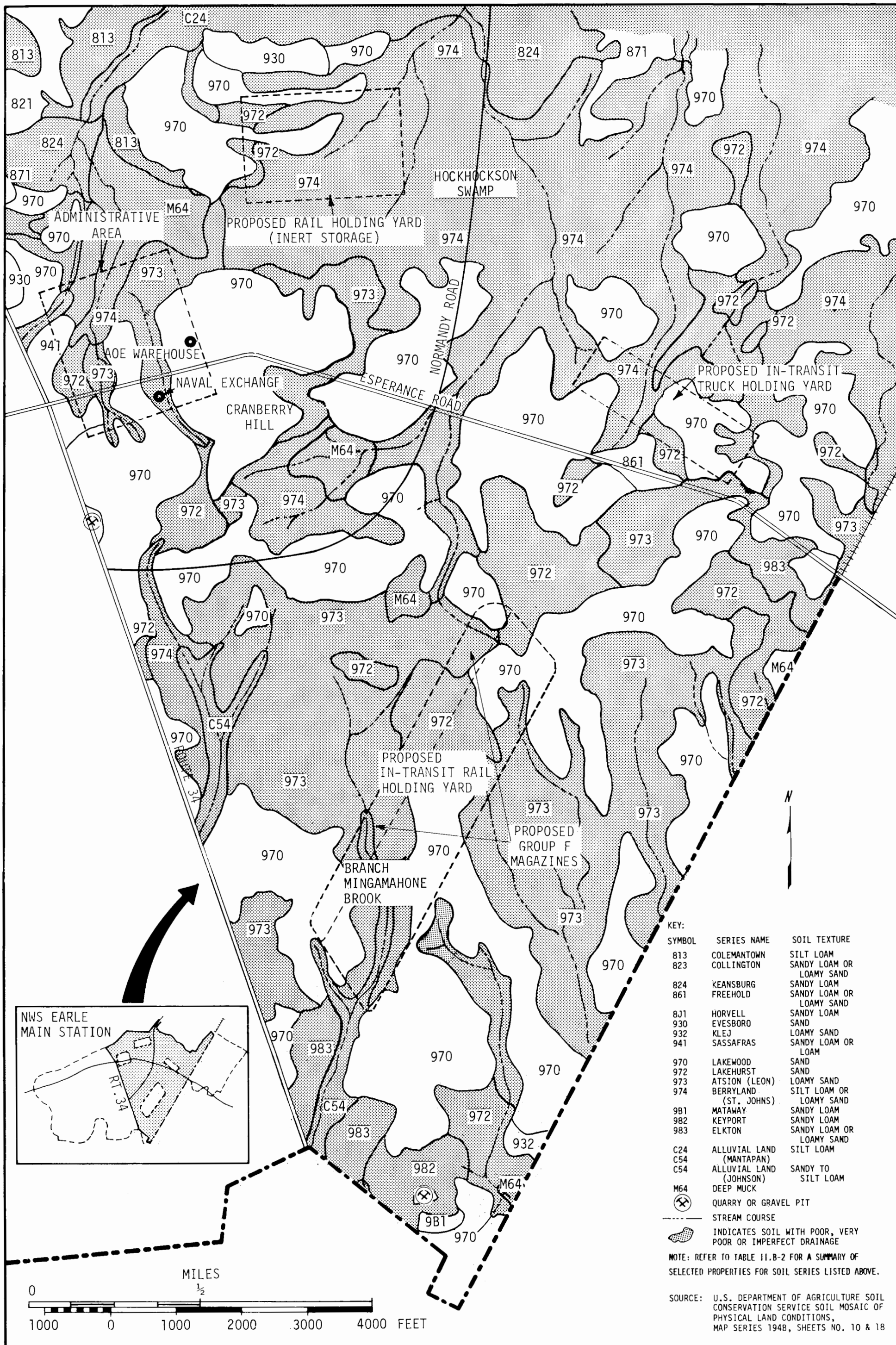
Historically, disturbances of Main Station soils by construction activity has resulted in severe erosion problems. In areas in which rapid infiltration occurs, water moves laterally through soil strata and seeps from hillsides and cuts. This seepage phenomenon tends to cause extensive erosion and slope failure. Since the sand in most of the soil strata is well rounded and has low cohesive values when wet, it flows and erodes severely when exposed in cuts.

Erosion is also enhanced by steep slope gradients which cause rapid runoff. Figure II.B-5 indicates the distribution of steep slopes. None of the proposed construction projects occur in these steep slope areas.

Black, highly acid soils have been exposed by construction at various depths on the Main Station (Figure II.B-5). The acidity appears to be associated with the Kirkwood lignitic clays underlying these areas (Geology Section, B.2, this Chapter). In general, the acidity of these soils, once exposed, makes it difficult or impossible to establish vegetation on them. Lack of vegetation tends to accelerate the erosion process. Erosion preventive measures including seeding, bank stabilization and revegetation have been conducted in some areas with limited success (NAVFAC, 1975). However, the proposed construction areas on the Main Station are not characterized by such acid soils associated with the Kirkwood Formation (Figures II.B-2 and II.B-5).

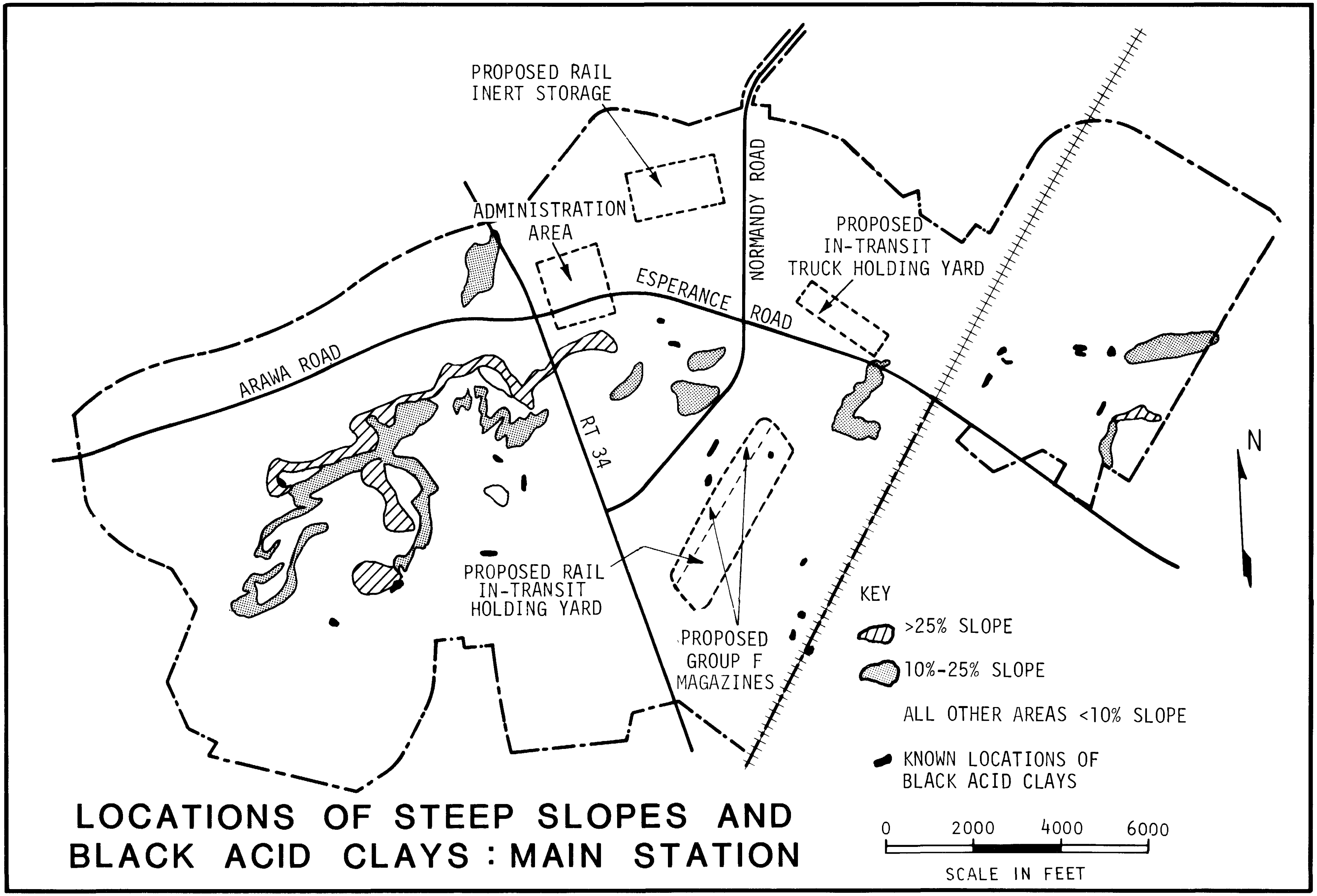
c. Waterfront Area and Proposed Site for Ship Fuel Replenishment System

Historic maps of the Waterfront Area (Archaeological Studies, Appendix H) indicate that the building complex area consists of original high ground while the trestle area near the shore and the site of the proposed ship fuel replenishment system to the west was formerly a tidal marsh. Sanitary landfill and sandy fill material has been added to these areas as shown by Figure II.B-6. The area of the land acquisition east of the north-south runway is developed on a presently unused sanitary landfill, whereas, the area west of this runway is developed on fill soil. The proposed site of the storage facilities of the ship fuel replenishment system is within the soils of the sand fill area which overlie the buried tidal marsh deposits. The tidal marsh soils consist of soft organic-rich silt, sand and clay. Beach sand



SOILS MAP: MAIN STATION

FIGURE II.B-4



LOCATIONS OF STEEP SLOPES AND BLACK ACID CLAYS : MAIN STATION

FIGURE II.B-5

occurs in patches along the bay shore and silt loam and loamy sand are present in areas south and east of the waterfront pier area.

Select soil properties are summarized in Table II.B-2. Sandy areas are typically well-drained while tidal marshes are poorly drained and are flooded by daily tides and occasionally by storm tides (see Hydrography Section, C.3). The boundaries of the raised landfill areas are subject to minor erosion. Coastal erosion of the beaches is discussed in Section C.7, this Chapter. Soils in the Waterfront Area have not been associated with the acidity problem encountered on the Main Station. Sanitary landfill areas may be subject to formation of gases and leachate. Differential settlement in fill areas may also pose problems in development.

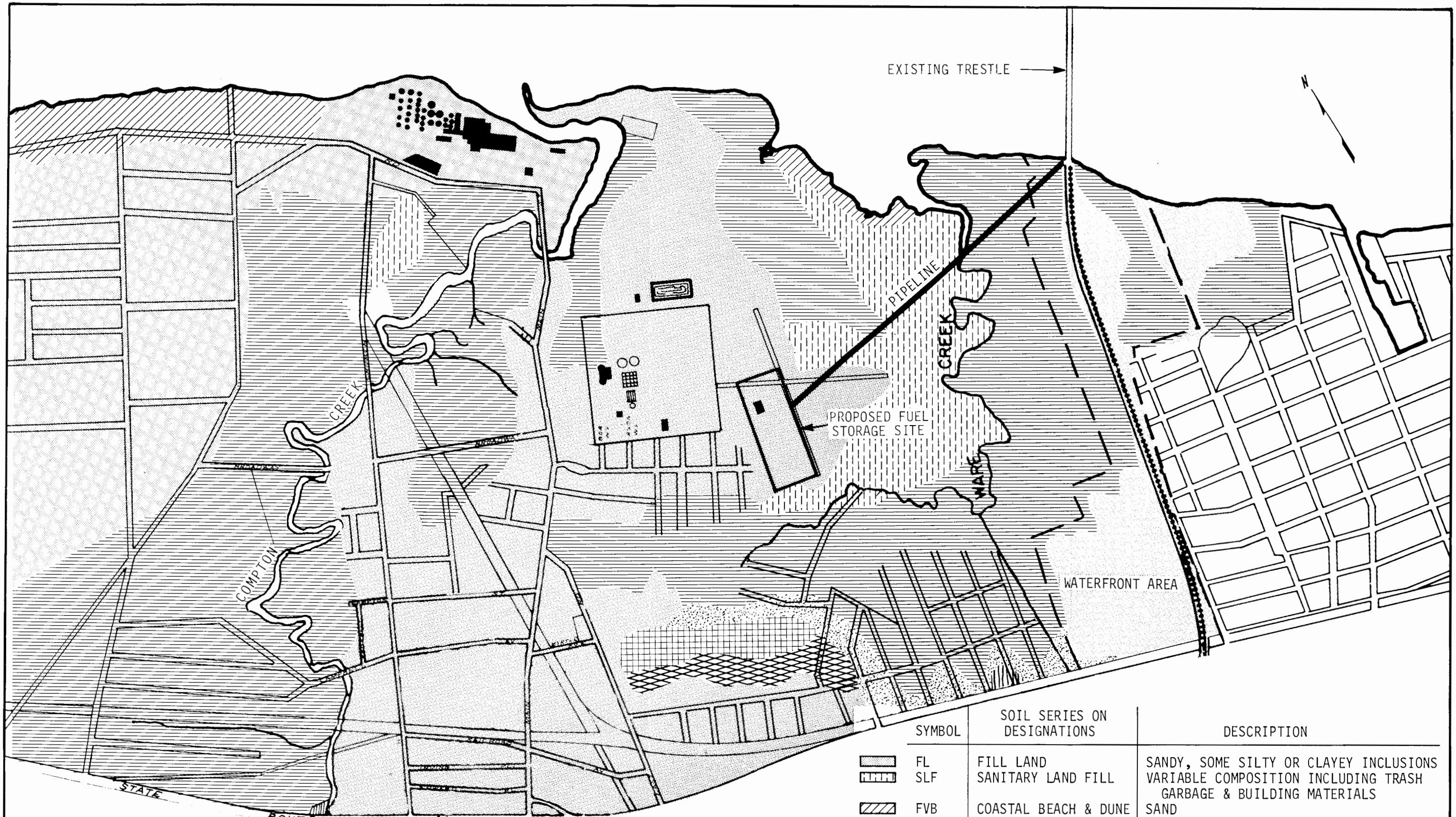
d. Chapel Hill Area

The Chapel Hill area is covered by fertile, well-drained sand, sandy loam and loamy sand of the Collington, Sassafras and Colts Neck series (Lee and Tine, 1927).

Due to the nature of the local soils, landforms and the general absence of streams, erosion and flooding have not been a problem. Although no black acid soils have been uncovered in the Chapel Hill Area, certain local geologic formations present in the Chapel Hill Area have been associated with this condition elsewhere in Monmouth County.

B.4 Surface-Water Hydrology

The manner in which water is distributed in the atmosphere, the streams and in the ground can be expressed in terms of an overall water budget which can be written as:



SOURCE: SOILS ADAPTED FROM PRELIMINARY MAP BY SOIL CONSERVATION SERVICE, FREEHOLD DISTRICT, 1977.

SOILS MAP: WATERFRONT AND ADJACENT AREAS

1000 500 0 1000 FEET

SCALE

SYMBOL	SOIL SERIES ON DESIGNATIONS	DESCRIPTION
FL	FILL LAND	SANDY, SOME SILTY OR CLAYEY INCLUSIONS
SLF	SANITARY LAND FILL	VARIABLE COMPOSITION INCLUDING TRASH GARBAGE & BUILDING MATERIALS
FVB	COASTAL BEACH & DUNE	SAND
SS	TIDAL MARSH	ORGANIC SILT
KMB	KLEJ	LOAMY SAND, CLAYEY SUBSTRATUM
KEB	KEYPORT	LOAM, SILT, LOAM, SANDY LOAM
EN	ELKTON	LOAM, SILT LOAM, SANDY LOAM
EVB	EVESBORO	SAND

$$I = E + O + S,$$

where I is the total inflow (precipitation), E is the total evaporation loss (includes interception and evapotranspiration), O is the total runoff (includes direct overland runoff and ground-water discharge base flow) and S is the change in reservoir storage.

Construction projects have the potential to alter the amount of water that can seep into the ground and thus may cause increased runoff or flooding. Thus, it is important to determine the nature and variations in the existing hydraulic regime in order to assess the impacts of such projects.

a. Main Station

The average annual precipitation for this area is 46 inches and the annual runoff totals about 22.5 inches (USGS, 1976). Since lakes and ponds occupy approximately one percent of the study area, the change in reservoir content is estimated to be about 2.4 inches. The water budget equation therefore yields an estimated 21.1 inches per year for the total evaporation loss.

The southern portion of the study area lies within the fringes of the Pine Barrens region of New Jersey. Hydrologic characteristics of this region include an evaporative loss of 22.5 inches per year and a ground-water discharge which constitutes 89 percent of the total annual runoff. This high ground-water contribution provides most of the area streams with a relatively steady water flow during periods of low rainfall (NJDEP, 1970).

The 100-year rainfall for a 24-hour duration storm is 7.3 inches (NOAA, 1961). Table II.B-3 shows the 24-hour rainfall for other selected recurrence intervals.

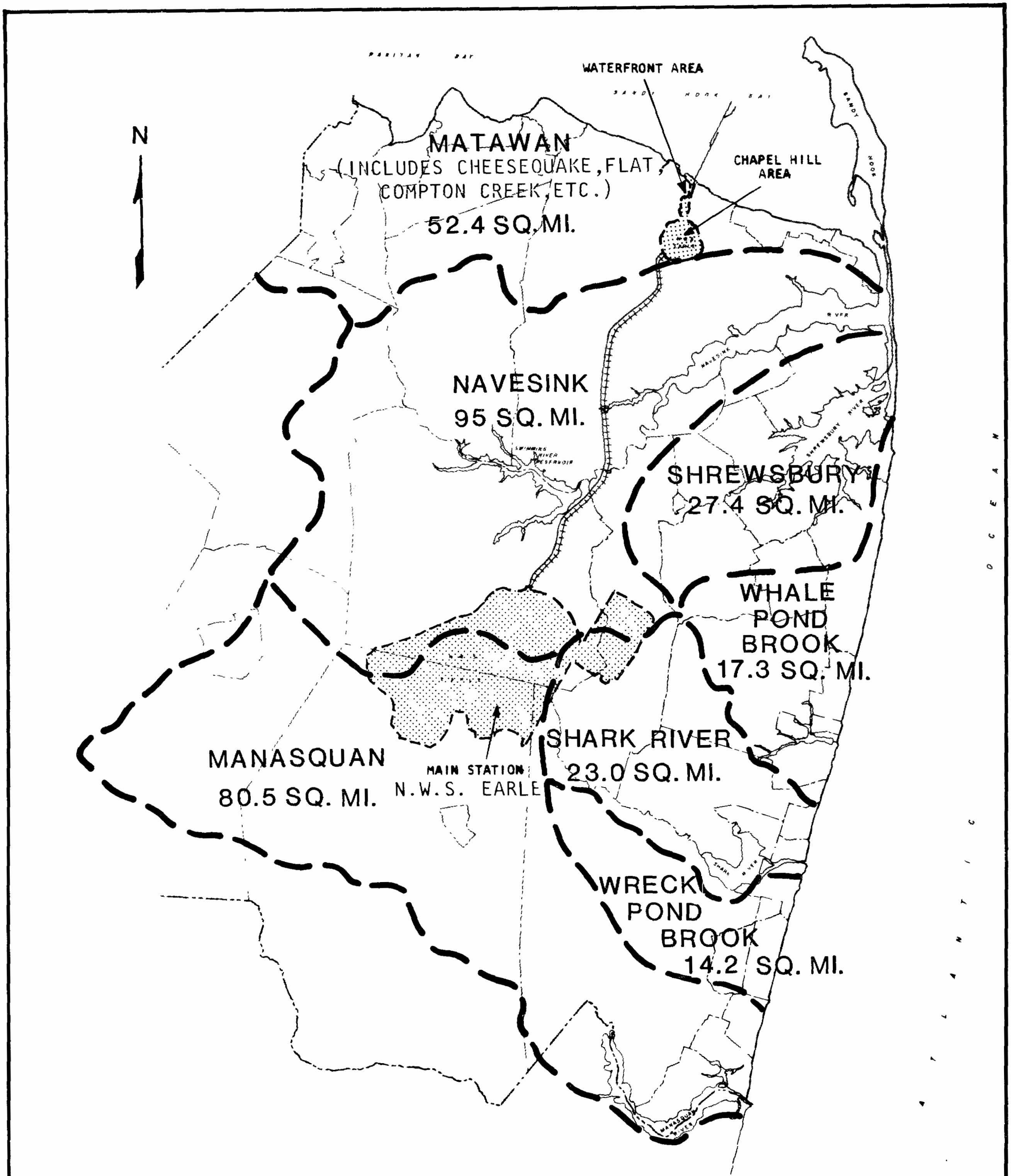
The major water bodies within the Main Station are headwater tributaries to the Manasquan, Shark and Navesink Rivers (Figure II.B-8). The high (280 foot elevation) terrain of the Hominy Hills forms a central drainage divide for

TABLE II.B-3

24-HOUR RAINFALL (INCHES)

	Recurrance Intervals (years)						
Duration (hrs)	1	2	5	10	25	50	100
0.5	0.95	1.15	1.50	1.70	2.00	2.20	2.50
1.0	1.25	1.45	1.90	2.20	2.55	2.80	3.20
2.0	1.50	1.80	2.30	2.75	3.20	3.50	3.90
3.0	1.65	2.00	2.60	3.00	3.50	3.90	4.30
6.0	2.00	2.40	3.10	3.60	4.20	4.80	5.20
12.0	2.40	2.90	3.70	4.40	5.10	5.50	6.30
24.0	2.70	3.30	4.40	5.10	5.90	6.50	7.30

Source: U.S. Weather Bureau



MAJOR DRAINAGE BASINS

SOURCE: N.J. DEPT.
DIVISION OF WATER RESOURCES
BUREAU OF GEOLOGY & TOPOGRAPHY

FIGURE II.B-7

TABLE II.B-4

HYDROLOGIC CHARACTERISTICS OF STREAMS NEAR NWS EARLE, MAIN STATION

Basins			
Basin Area Sq. Miles	80.5	23.0	95.0
Flow Direction	SE	SE	NE
Receiving Water Body	Atlantic Ocean	Atlantic Ocean	Sandy Hook Bay
Representative Average Runoff cfs (inches)	74.2 (23.22)[a] at Squankum for Mingamahone Brook	—	79.4 (22.23)[b] at Swimming River for Hockhockson Brook
Tributaries Near Main Station NWS Earle	**Branch Mingamahone Brook**	**Unnamed Headwater Tributaries of Shark River**	**Hockhockson Brook**
Length in Main Station (miles)	0.95	0.83	2.1
Gradient (%)	0.5	0.5	0.5

[a]45 year period (1931-1976)

[b]54 year period (1922-1976)

Source: USGS

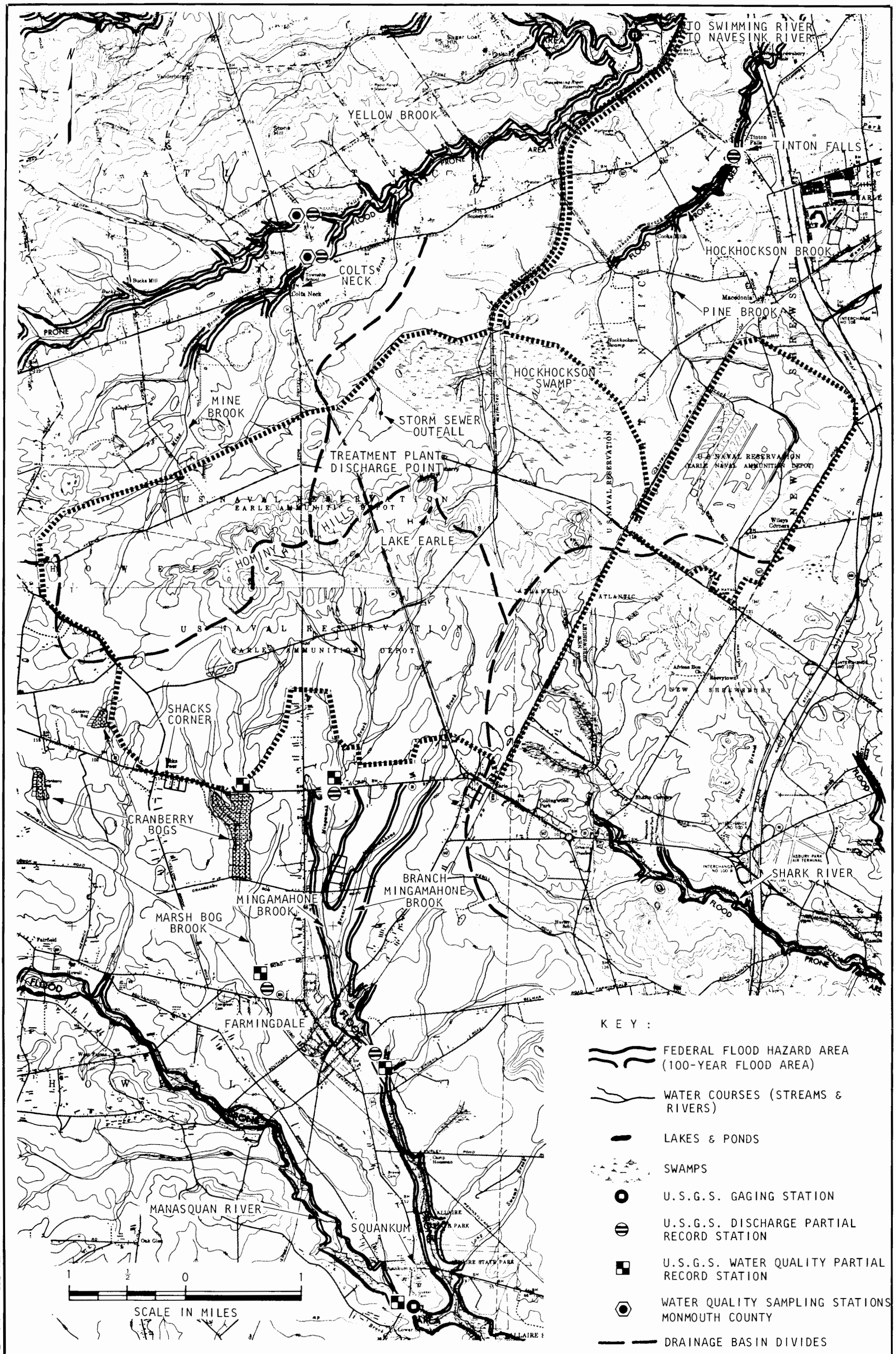


FIGURE II.B-8

HYDROLOGIC FEATURES : MAIN STATION

Manasquan and Shark River Basins on the south and the Navesink River Basin to the north (Figure II.B-7).

The hydrologic and drainage characteristics of these drainage basins and particular tributary streams near proposed project areas are presented in Table II.B-4. These tributary streams, Branch Mingamahone Brook (Manasquan River Basin), headwater tributaries to the Shark River Basin, and Hockhockson Brook (Navesink River Basin) traverse short distances within the Main Station and are characterized by low gradients (Table II.B-4 and Figure II.B-8).

Although flow data is not available for these watercourses or others on the Main Station, this data is available for other segments of the drainage basins (Table II.B-4).

Average flow data recorded at U.S. Geological Survey (USGS) gaging stations on Swimming River near Red Bank and on the Manasquan River near Squankum (Figure II.B-8) reveal long-term average flows of 79.4 cubic feet per second (cfs) and 74.2 cfs, respectively. These flows correspond to runoff values of 22.23 inches per year for Swimming River and 23.22 inches per year for the Manasquan, comparable to that for the area (22.5 inches per year). Considerable variation occurs in the yearly distribution of runoff as a result of seasonal variations in rainfall.

In general, high runoff occurs in the months of late Fall to early Spring and low runoff characterizes the Summer to early Fall months. For example, in the year 1975-1976, monthly flow averaged 84 cfs, ranging from 564 cfs in January to 0.4 cfs in June, July, August and September (USGS, 1976).

Since the Main Station is located at the headwater portions of the three drainage basins, flow in these smaller streams should be lower than that recorded on Swimming River at Red Bank and on the Manasquan River at Squankum. Partial flow measurement data taken in the April to September period since 1967 at

TABLE II.B-5

MAXIMUM PREVIOUSLY KNOWN DISCHARGE

U.S.G.S Station	Location	Drainage Area (Sq. Mi.)	Year	Discharge (CFS)	River Basin
01407500	Swimming River near Red Bank, N.J.	48.5	1919	11800	Navesink Basin
01408000	Manasquan River at Squankum, N.J.	43.4	1938	2940	Manasquan Basin
01408015	Mingamahone Brook at Farmingdale, N.J.	6.2	1969	2620	Manasquan

Source: U.S.G.S. Water Resources Division, SP-37 selected sites closer to the Main Station (on Pine Brook at Tinton Falls, Yellow Brook at Colts Neck, Mine Brook at Colts Neck, Mingamahone Brook at Squankum and Marsh Bog Brook at Yellow Brook Road) (Figure II.B-8) shows a lower average base flow (less than 3 cfs).

The USGS Flood Prone Elevation Maps for the 100-year flood are presented in Figure II.B-8 and provide a preliminary assessment of the flood hazard areas. They are based on relationships among drainage areas, percentage of lakes and swamps and water elevation above the top of the bank. Detailed flood insurance studies are presently being conducted by the N.J. Department of Environmental Protection - Water Resources Division for portions of this area. The results of this study will not be available for public release until early 1979. Although the 100-year flood is not mapped within the Station boundary, it apparently does extend into limited portions of the headwater tributaries.

No historical flood data is available except for stations downstream of the station. The highest previously known discharges recorded for Swimming River, Manasquan River and Mingamahone River are tabulated in Table II.B-5.

Storm water within the Main Station is collected and discharged at various points along Hockhockson Brook. The location of a storm drain discharge point is shown in Figure II.B-8. Storm-drain full-flow capacities range from 2 to 50 cfs. A tabulation of the storm drain capacities is provided in Table II.B-6.

b. Waterfront and Chapel Hill Areas and Proposed Site for Ship Fuel Replenishment System

This region is located within the Matawan River Basin. The area has a general slope of four percent with elevations ranging from 200 feet above sea level in the Chapel Hill area to 40 feet at the Waterfront Area and to about 15 feet on the proposed site for the ship fuel replenishment system. Drainage for the area is provided by Ware Creek and Compton Creek which drain north into Sandy Hook Bay

TABLE II.B-6

CAPACITY OF STORM DRAINS, NWS EARLE

Location of Storm Drains/Culverts Into Nearby Ditches	Pipe Diameter (in)	Total Discharge Under Full Flow (cfs)	Final Receiving Water Body
Waterfront Area			
(WF)	36	50	Ware Creek
(WF)	36	55	Ware Creek
(WF)	18 12	8.5	Ware Creek
Main Station			
(MS)	18	10	Hockhockson Brook
(MS)	24	20	Hockhockson Brook
(MS)	18 24 24 12	Total -50	Hockhockson Brook
(MS)	36	26	Hockhockson Brook
(MS)	24 24	Total 37	Hockhockson Brook
(MS)	18 36	Total	Hockhockson Brook
(MS)	24	13	Hockhockson Brook
(MS)	24[a]	12	Hockhockson Brook
(MS)	24	7.5	Hockhockson Brook
(MS)	18[a]	8.5	Hockhockson Brook
(MS)	24[a]	7.5	Hockhockson Brook
(MS)	8	2	Hockhockson Brook
(MS)	18	4	Hockhockson Brook
(MS)	8	2	Hockhockson Brook

[a]Gross estimate only

Source: NAVFAC, 1977

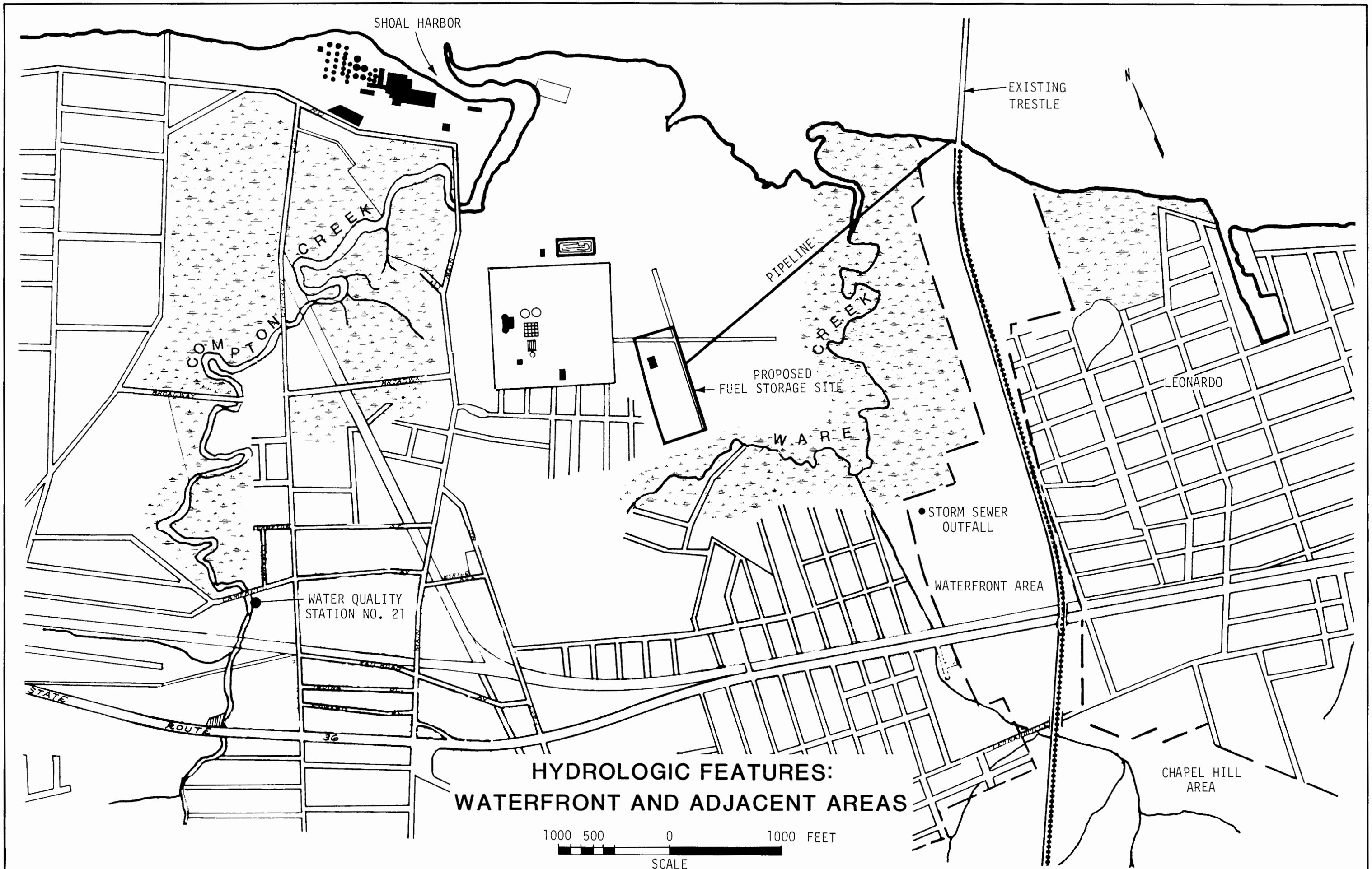

SHOAL HARBOR
EXISTING TRESTLE
N
COMPTON CREEK
PIPELINE
WARE CREEK
PROPOSED FUEL STORAGE SITE
LEONARDO
STORM SEWER OUTFALL
WATERFRONT AREA
WATER QUALITY STATION NO. 21
STATE ROUTE 36
HYDROLOGIC FEATURES: WATERFRONT AND ADJACENT AREAS
1000 500 0 1000 FEET
SCALE
CHAPEL HILL AREA

FIGURE II.B-9

(Figure II.B-9). A tributary of Ware Creek originates south of Leonardville Road and drains northward through the marshy area into the Bay. The Creek has a general gradient of 0.2 percent. Compton Creek drains part of the area west of the proposed site for the ship fuel replenishment system. No flow data are presently available for Ware Creek or Compton Creek.

Since the headwaters of Compton Creek are located several miles upstream, downstream flooding generally occurs due to substantial urban and rural runoff. Both river and tidal flooding occur in this region, especially during storms. The "Intermediate Regional Tidal Flood", (100-year flood) will inundate areas below 11.3 feet elevation (Figure II.C-4). The site of the proposed fuel storage facilities is characterized by elevations at about 15 feet and is above the 100-year flood level. For additional details on tidal flooding see the Estaurine Hydrography Section, C.3, this Chapter.

Most of the storm water in the Waterfront Area is collected in a storm drainage system. The water is discharged into a marshy area along Ware Creek. The full flow capacity of the storm drain is approximately 50 cfs. The location and capacity of the storm drain outfall is provided in Figure II.B-9 and Table II.B-6.

B.5 Surface-Water Quality

Water quality data for streams draining portions of the Main Station and Waterfront Areas are presented in this section. Water quality data available for portions of the Navesink River and Manasquan River Basins is presented in order to characterize the quality of water draining the Main Station.

a. Main Station

1. Navesink River Basin - Water Quality data is quite limited. Monitoring programs are conducted at the effluent discharge point into Hockhockson Brook for the secondary sewerage treatment facility on the Main Station and provide some data. Selected water quality parameters for this station are presented in Table II.B-7 along with State and Federal Standards.

TABLE II.B-7

COMPARISON OF WATER QUALITY FROM EFFLUENT FROM MAIN STATION TREATMENT PLANT WITH STATE AND FEDERAL STANDARDS

Parameters	Sampling Date or Period	Plant Inflow	Plant Outflow	Percent Removal	30-Day Averages	N.J. State Standards	Federal Standards
Biochemical Oxygen Demand BOD (mg/l)	Oct. 21, 1975	61	5	91.8		90% Removal	95% Removal
	1975 Jan-Dec				6.15		30 mg/l (30 day avg)
	1976 Jan-Dec				3.53	—	45 mg/l
	1977 Jan-Sept				4.52		(7 day avg)
Suspended Solids (mg/l)	Oct. 21, 1975	52	6	88.4		—	85% Removal
	1975 Jan-Dec				10.40		30 mg/l (30 day avg)
	1976 Jan-Dec				5.07	—	45 mg/l (7 day avg)
	1977 Jan-Sept				7.85		
Fecal Coliform (no/100 ml)	Oct. 21, 1975	—	< 20	—	—	—	200/100 ml (30 day avg) 400/100 ml (7 day avg)
Ammonia-Nitrogen (mg/l)	Oct. 21 1975	15	9	—		—	—
Nitrate-Nitrogen (mg/l)	Oct. 21, 1975	—	2.5	—		—	—
Phosphorus (mg/l)	Oct. 21, 1975	9	8.5	—		—	—
Turbidity (JTU)	Oct. 21, 1975	27	11	—		—	—
Discharge (g/day)	Period				24-hr avg		
	1975 Jan-Dec				74,133		
	1976 Jan-Dec				76,557		
	1977 Jan-Sept				78,956		

Source: N.J. Department of Environmental Protection.

Average inflow into the receiving water body is approximately 76,000 gallons per day (gpd). Biological Oxygen Demand (BOD) ranged from 2.2 milligrams per liter (mg/1) to 12.7 mg/1 for the period January, 1975 through September, 1977. Suspended solids ranged from 1.75 mg/1 to 19.7 mg/1 and no settleable solids were observed. In general, the effluent discharge met Federal and State requirements.

The entire length of Hockhockson Brook has been classified by the New Jersey Department of Environmental Protection (NJDEP) as Trout Maintenance Water. Trout survival is not probable when pH values are less than five. As discussed in the Soil Section, B.3 of this Chapter, Hockhockson Brook drains the northern area of the Main Station which is underlain by the Vincentown Formation. Acid lignitic clay beds found within the Main Station are only associated with the soils developed on the Kirkwood Formation to the south. These facts suggest that Hockhockson Brook may not be characterized by the low pH values which characterize other streams draining the acid soil associated with the Kirkwood Formation.

In May and August 1975, detailed water samplings were carried out at Pine Brook at Tinton Falls and Yellow Brook at Colts Neck. Results are presented in Table II.B-8, together with water quality data for other streams near NWS Earle (USGS, 1976). All chemical parameters appear to be above standards except for the fairly high concentration of fecal coliform, fecal streptococci and total iron. Total iron for both stations are 6,000 ug/1 and 2,100 ug/1 respectively. The high number of bacteria indicate a source of domestic sewage or agricultural runoff; the iron concentration indicates a source of industrial waste. Since these two stations are close to the Towns of Tinton Falls and Colts Neck, it is not possible to identify the contribution from the Station.

2. Manasquan River Basin - Tests conducted by the USGS in 1973 in tributaries located south of the Main Station are also summarized in Table II.B-8. All streams in the area of the Main Station are classified as FW-2 waters by NJDEP approved for potable supplies and for primary recreation uses (Table II.B-8).

TABLE II.B-8

WATER QUALITY OF STREAMS NEAR NWS EARLE

Basin	MANASQUAN RIVER					NAVESINK RIVER		
Stream	Mingamahone Brook[i]			Marsh Bog Brook		Yellow Brook	Pine Brook[i]	N.J. DEP STANDARDS[f,g,h]
Location / Parameters (Units)	Cranberry[a] Bog Road	Hurley[a] Pond Road	Near[b] Earle Center USGS (01408009)	Near Shacks Corner USGS (01407988)	At Farmingdale[c] USGS (01407992)	At Colts Neck USGS (01407400)	At Trinton Falls	
Dissolved Oxygen (mg/l)	7.8	8.6	8.6	4.2	6.2	9.9[d] 8.4[e]	9.6[d] 7.4[e]	Trout Maintenance[f] (5.0 (min) Non-trout Maintenance (4.0 (min)
Ammonia-Nitrogen (mg/l)	0.021	< 0.01	0.05	0.22	0.73			Varies with pH and temperature
Organic Nitrogen (mg/l)	4.95	4.94						None
Nitrate-Nitrogen (mg/l)	0.12	0.17	0.25	0.02	0.54			10[g]
Nitrite-Nitrogen (mg/l)	0.5	4.7						1.0 mg/l[h]
Total Kjeldahl-Nitrogen (mg/l)			0.14	0.37	0.92			None
Phosphate (mg/l)	0.04	0.05		0				0.1[h]
Total Phosphorus (mg/l)			0.1	0.03	0.46			None for streams
Sulphate (mg/l)	38	39						250[g]
Alkalinity (mg/l)	32	46						20 as $CaCo_3$[h]
Chloride (mg/l)	14	16						250[g]
Conductivity (micromhos)			1.23	71	135			None
Floride (mg/l)	< 0.5	< 0.5						1.5[g]
Cyanide (mg/l)	0.03	< 0.01						0.2[g]
Dissolved Solids (mg/l)	85	85						500[f]
Fecal Coliform (No/100 ml) (MPN) - Mean Probable Number	220	183				130[d] 1,100[e]	5,400[d] 70[e]	200[f] (max) 70 for shellfish waters
Fecal Streptococci (MPN)						130[d] 350[e]	72,400[d] 350[e]	None
Total Iron (mg/l)						2.1[d]	6.6[d]	None
pH	6.6	7.1	7.1	4.3	6.2			6.5 - 8.5[f]

Notes:

Sampling Period

NJDEP, 1977 - [a]Summer, 1977
USGS, 1973 - [b]Oct. 9-11, 1973
USGS, 1973 - [c]Oct. 9-11, 1973 and Mar. 1, 1974
USGS, 11976 - [d]May, 1976
USGS, 1976 - [e]Aug., 1976
- [f]N.J. Ambient Stream Standard FW-2 Waters
- [g]N.J. Potable Water Standard
- [h]E.P.A. Recommended Criterion
- [i]Trout Maintenance Streams

The headwater tributary of Marsh Bog Brook at Shacks Corner is characterized by low pH (4.3). This low pH is probably caused by exposure to runoff of the acidic soil of the Kirkwood Formation. Values of pH return to normal levels downstream at Farmingdale. Dissolved oxygen concentration is slightly above the 4 mg/1 criterion for FW-2 waters, indicating the presence of organic pollution. Water quality improves downstream at Farmingdale with the exception of a slight increase in mean values of total phosphorous (0.03 mg/1 at Shacks Corner, to 0.46 mg/1 at Farmingdale) suggesting the influence of increased urban runoff.

The data indicate that water quality in Mingamahone Brook near the Main Station is fairly good with dissolved oxygen concentrations above the standard (Table II.B-8). Total nitrate, total Kjeldahl-nitrogen and ammonia-nitrogen were less than 1 mg/1. Total phosphorous values were in the range of 0.03 - 0.77 mg/1, indicating a small contribution from urban runoff.

Additional sampling of Mingamahone Brook was conducted in the summer of 1977 (Monmouth County 208 Studies) at Cranberry Bog Road and Hurley Pond Road (Table II.B-8 and Figure II.B-8). The Cranberry Road Station occurs about 3/4 of a mile south of the Station border and the Hurley Road station is about one mile south of Farmingdale. Dissolved oxygen levels are well above the standard 4 mg/1. Fecal coliform is slightly above standard at Cranberry Road but improves downstream. Organic nitrogen values are high at both stations and exceed Monmouth County standards.

b. Waterfront Area

Both Compton and Ware Creeks are classified at TW-1 class water bodies in the New Jersey Department of Environmental Protection (NJDEP) classification. Criteria and guidelines for TW-1 water bodies is provided in Table II.B-9.

TABLE II.B-9

CRITERIA FOR NEW JERSEY STATE WATER QUALITY STANDARDS

Class TW-1

Item	Specifications
Best usage of water	Suitable for public potable water supply after such treatment as required by law or regulation; shellfish harvesting where permitted; suitable for maintenance, migration and propagation of natural or established biota; primary contact recreation; industrial and agricultural water supply
Floating, suspended, colloidal and settleable solids; oils, grease color and turbidity	None in concentrations affecting use; 25 JTU (Jackson Turbidity Unit) (maximum 30 day average), 130 JTU (maximum at any time unless due to natural causes)
Fecal coliforms (geometric mean)	Not to exceed 200/100 ml
pH	6.5 - 8.5
Dissolved oxygen	5.0 mg/l (minimum 24-hour average) 4.0 mg/l (minimum at any time)
Toxic substances	Not to exceed one-twentieth of the TL_{50} value at 96 hours
Toxi metals	In no case shall be substances listed below exceed the specified limits:

Arsenic	0.05	mg/l
Barium	1.00	mg/l
Cadmium	0.01	mg/l
Chromium (hexavalent)	0.05	mg/l
Lead	0.05	mg/l
Mercury	0.005	mg/l
Selenium	0.01	mg/l
Silver	0.05	mg/l

Source: New Jersey Surface Water Quality Standards, amended July 9, 1975. Environment Reporter, Bureau of National Affairs, Inc., Washington, D.C.

Water quality data is sparce for this area. Limited data from Compton Creek at Belford (USEPA STORET Data, September, 1969), is not sufficient to characterize the water quality (Station 21 in Figure II.B-9).

A storm sewer outfall discharges into Ware Creek from the Waterfront Area. Discharge from this storm sewer is believed to contribute to the level of pollutants in Ware Creek.

B.6 Ground-Water Hydrology

Ground-water occurs within the pore spaces of the grains composing the unconsolidated geologic formations underlying the area. The groundwater results from precipitation which recharges the geologic formations at their outcrop areas. All of the formations contain water to varying degrees. The formations that readily yield water to wells are termed aquifers. Water exists in one of two states in the aquifers: artesian (confined) or phreatic (water table). Artesian formations are overlain and underlain by confining beds or aquicludes that usually have a high clay content and lower permeability than the aquifer. All the artesian formations are phreatic in their outcrop areas. Water bearing properties of the geologic formations in Monmouth County are listed in Table II.B-10. For a more detailed description of the formations see the Geology Section B.2 of this Chapter. Wells in the poor water-yielding formations produce on the order of 5 to 10 gallons per minute (gpm). Wells in the better aquifers yield in the range of 25 to 1,400 gpm. Most of the ground-water in Monmouth County is derived from artesian aquifers.

The most important aquifers in the area are the Raritan and Magothy Formations, the Englishtown Formation, the Wenonah Formation and Mount Laurel Sand, the Red Bank Sand, the Vincentown Formation, and the Kirkwood Formation. The Raritan and Magothy Formations are considered a single unit which is the principal aquifer for the area. Wells in this aquifer yield 100 to 1,400 gpm.

TABLE II.B-10

WATER-BEARING PROPERTIES OF GEOLOGIC FORMATIONS

ERA	SYSTEM	SERIES	SUBDIVISION	WATER BEARING PROPERTIES	Thickness Penetrated (feet)
Cenozoic	Quaternary	Recent	Alluvium and beach sand and gravel	A relatively poor aquifer. No drilled wells reported in this material.	0-30
		Pleistocene	Cape May, Pensauken, and Bridgeton Formations (undifferentiated)	Yields up to 6 gpm (gallons per minute) to domestic wells.	0-60
	Tertiary	Miocene (?) and Pliocene (?)	Cohansey Sand (series is debatable)	No wells reported in this formation.	0-30
		Miocene	Kirkwood Formation	Yields range from 15-1,200 gpm from wells, water usually contains iron, sulfide, and is acid.	60-100
		Eocene	Manasquan Formation and Shark River Marl	A poor aquifer; yields up to 12 gpm to domestic wells.	25-100
		Paleocene	Vincentown Formation	Numerous domestic wells tap this sand; yields range 10-50 gpm to domestic wells.	10-130
			Hornerstown Sand	A poor aquifer; yields up to 5 gpm to domestic wells.	30-100
Mesozoic	Cretaceous	Upper Cretaceous	Red Bank Sand (includes the Tinton Formation at the top)	Yields range from 3-30 gpm to domestic wells.	30-135
			Navesink Formation	Important to domestic consumers. Wells yield 10 gpm or less.	10-45
			Mount Laurel Sand Wenonah Formation	A single aquifer. Average yield 10 gpm. Maximum yield reported was 335 gpm.	15-85
			Marshalltown Formation	Not considered water-bearing in the county.	30-50
			Englishtown Formation	Average yield 25 gpm. Maximum yield reported 640 gpm. Average yield to large-capacity wells 410 gpm.	35-150
			Woodbury Clay Merchantville Formation	Both formations act as a single aquiclude. Not water-bearing.	50 50-60+
			Magothy Formation	Sands are discontinuous, and thickness variable. Maximum yield reported 250 gpm.	25-175
			Raritan Formation	Contains most important aquifers. Yields range 100-1,400 gpm to large-diameter wells.	140-400+
Precambrian	Late Pre-cambrian(?)		Wissahickon Formation	No wells in this formation.	—

Source: Adapted from Minard & Owens, 1960, p. 7.

When water is pumped from an aquifer, part of it comes from storage and part is derived by transmission from the zone of recharge. The ultimate long-term yield of the aquifer is limited to its long-term average recharge rate. The recharge rate is, in turn, largely controlled by the rainfall intensity and duration, soil infiltration capacity, aquifer permeability, and available storage in the aquifer. When the water levels in the recharge portion of an aquifer are high, the aquifer has less available storage. Part of the recharge will be rejected in the form of runoff and stream base flow, and is not available to wells. However, when aquifer ground-water levels are low, more storage is available and more precipitation enters aquifer storage and ground-water levels recover. Approximately 25 to 50 percent of precipitation recharges the aquifers in Monmouth County, while the remainder is lost by evapotranspiration, or becomes storm runoff. For aquicludes, the recharge is only on the order of five percent of precipitation with the remainder being either evaporated or runoff. Generally, the runoff is low from the aquifer outcrops and high from the aquiclude outcrops.

B.7 Ground-Water Quality

a. General

The ground-water quality in the various Coastal Plain aquifers of Monmouth County is generally good. The total dissolved solids and other important water quality parameters all fall within acceptable federal and state potable water standards. These standards are given in Table II.B-11 along with the chemical quality of Monmouth County ground-water for various major aquifers in and around the project area. The most notable exception to the generally good water quality of the area, is the excessive iron content known to occur locally in certain aquifers (Raritan and Magothy Formations, Englishtown Formation and the Vincentown Formation). The recommended upper limit for iron in drinking water is 0.3 milligrams per liter. The two major aquifers in the country (Raritan-Magothy and Englishtown Formations) have yielded consistent iron levels greater than the 0.3 milligrams per liter limit. Figure II.B-10 illustrates the Monmouth County well locations for the water quality data presented in Table II.B-11.

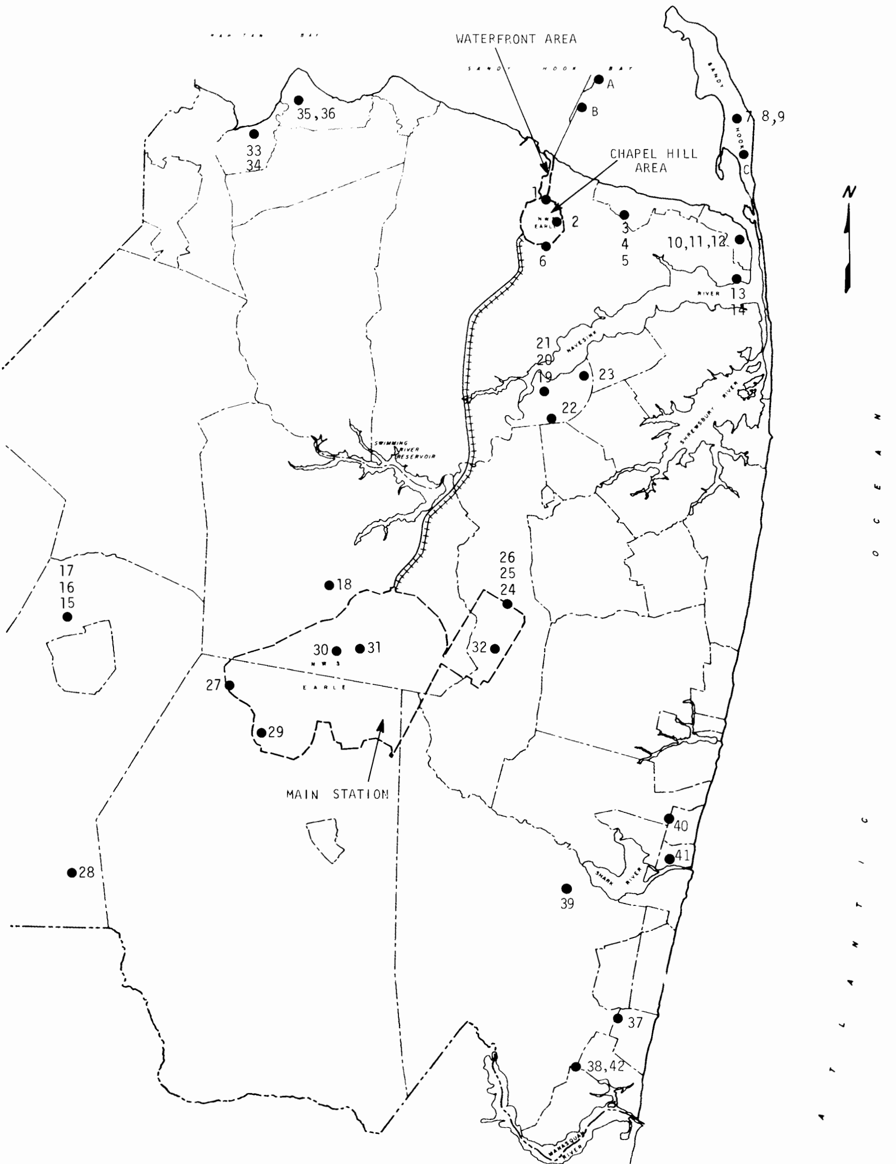
TABLE II.B-11

WATER QUALITY OF GROUND-WATER IN AQUIFERS OF MONMOUTH COUNTY
Parameters in (mg/l Unless Noted) (Range of Values Occurring)

Aquifer Formations	pH	Nitrate	Sulfate	Chloride	Specific Conductance (micromhos)	Total Dissolved Solids	Hardness	Total Iron
Raritan- Magothy	3.8-7.4	0.0	—	0.6-60.0 mostly ≤ 3.0	64.0-290.0	34.0-117.0	13.0-103.0	>6.0
Englishtown	7.0-8.4	0.05-.13	4.0-8.0	1.4-11.0	69.0-244.0	56.0-160.0	≤90.0	≤ 3.0
Wenonah & Mount Laurel Sands	6.5-8.1	0.04[b]	11.0[b]	0.2-6.0	160.0-290.0	112.0-145.0	56.0-110.0	≤ 0.3 (one sample +10.0)
Red Bank Sands	6.9[b]	0.05[b]	4.0[b]	7.4-16.0		12.0[b]		
Kirkwood	4.8-6.6	0.12[b]	17.0[b]	9.6-17.0	52.0-189.0	18.0[b]		
Range for all Formations[a]	3.8-8.1	0.0-1.0	0.0-38.0	0.0-164.0			4.0-260.0	0.0-33.0
U.S. Public Health Service Potable Water Standards	None	10.0	250.0	250.0	None	500.0	None	0.3
N.J. Potable Water Standards	None	10.0	250.0	250.0	None	500.0	None	None

Notes: [a]After Jablonski (1970)
[b]Only one value given, blanks indicate no values are available.

Sources: N.J. State of, Dept. of Conservation & Economic Development, 1968. "Ground Water Resources of Monmouth Co., N.J.
N.J., State of, Dept. of Conservation & Economic Development, 1963. "Chloride Concentrations of Water from wells in the Atlantic Coastal Plain of N.J."
U.S. Environmental Protection Agency, 1976, Quality Criteria For Water



KEY

LOCATION - AQUIFER

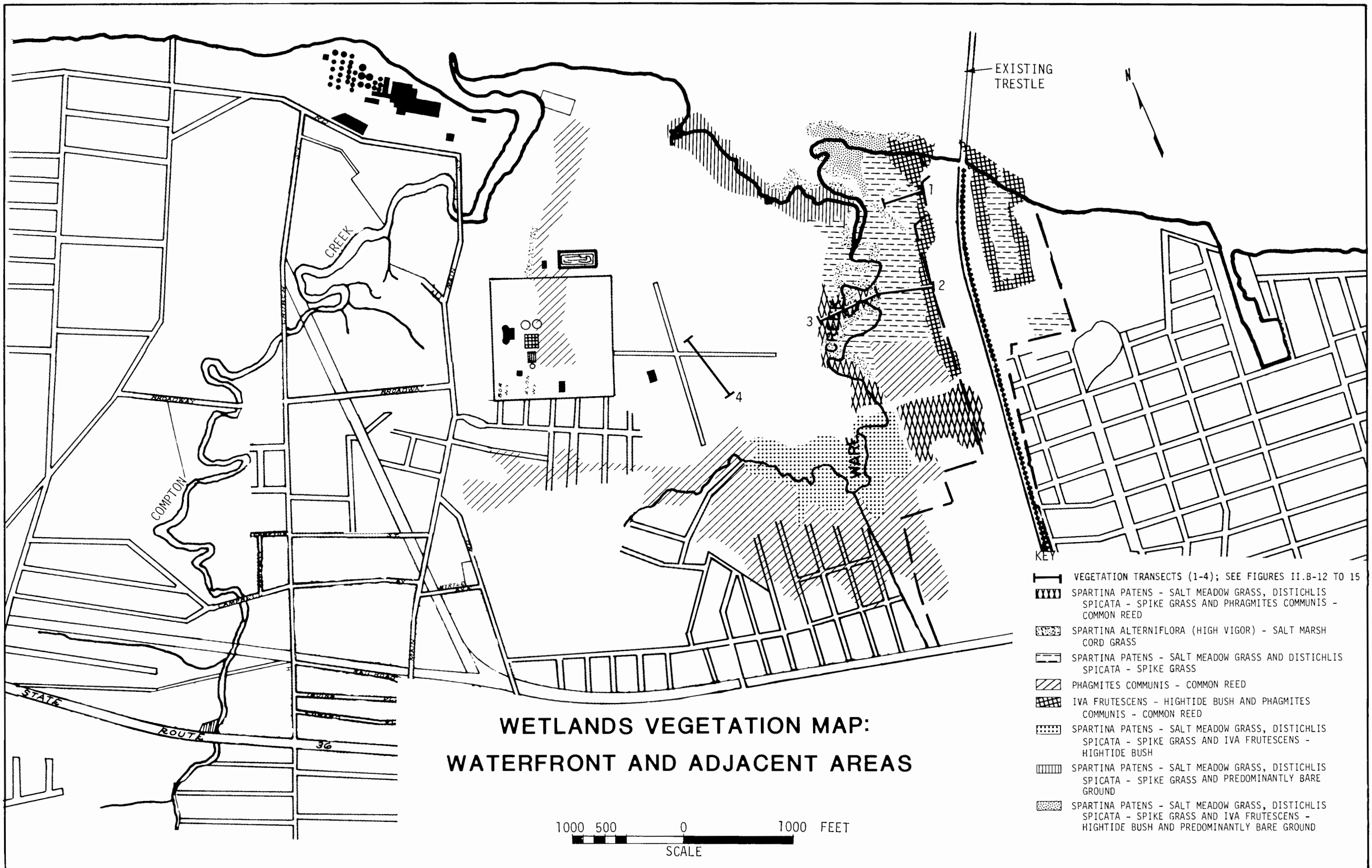
1 N.W.S. EARLE ENGLISHTOWN
2 N.W.S. EARLE ENGLISHTOWN
3 ATLANTIC HIGHLANDS - MAGOTHY AND RARITAN
4 ATLANTIC HIGHLANDS - ENGLISHTOWN
5 ATLANTIC HIGHLANDS - MAGOTHY AND RARITAN
6 N.W.S. EARLE ENGLISHTOWN
7 FORT HANCOCK - MAGOTHY AND RARITAN
8 FORT HANCOCK - MAGOTHY AND RARITAN
9 FORT HANCOCK - MAGOTHY AND RARITAN
10 HIGHLANDS - MAGOTHY AND RARITAN
11 HIGHLANDS - MAGOTHY AND RARITAN
12 HIGHLANDS - HORNERSTOWN
13 HIGHLANDS AIR FORCE BASE - ENGLISHTOWN
14 HIGHLANDS AIR FORCE BASE - ENGLISHTOWN
15 FREEHOLD - ENGLISHTOWN
16 FREEHOLD - MAGOTHY AND RARITAN
17 FREEHOLD - MAGOTHY AND RARITAN
18 COLTS NECK - ENGLISHTOWN
19 RED BANK - ENGLISHTOWN
20 RED BANK - MAGOTHY AND RARITAN
21 RED BANK - MAGOTHY AND RARITAN
22 RED BANK - ENGLISHTOWN
23 RED BANK - ENGLISHTOWN
24 N.W.S. EARLE - RED BANK
25 N.W.S. EARLE - RED BANK
26 N.W.S. EARLE - RED BANK
27 N.W.S. EARLE - RED BANK
28 N.W.S. EARLE - RED BANK
29 N.W.S. EARLE - RED BANK
30 N.W.S. EARLE - MAGOTHY AND RARITAN
31 N.W.S. EARLE - MAGOTHY AND RARITAN
32 N.W.S. EARLE - RED BANK
33 KEYPORT - MAGOTHY AND RARITAN
34 KEYPORT - OLD BRIDGE
35 UNION BEACH BORO - MAGOTHY AND RARITAN
36 UNION BEACH BORO - OLD BRIDGE
37 SEA GIRT - KIRKWOOD
38 MANASQUAN - KIRKWOOD
39 CAMP EVANS - MOUNT LAUREL & WENONAH
40 OCEAN GROVE - MOUNT LAUREL & WENONAH
41 AVON BY THE SEA - MOUNT LAUREL & WENONAH
42 MANASQUAN - KIRKWOOD
A N.W.S. EARLE PIER 2 - ENGLISHTOWN
B N.W.S. EARLE PIER 1 - ENGLISHTOWN
C SANDY HOOK RECREATION AREA - ENGLISHTOWN

WELL LOCATION

8000 0 8000 16000

FEET

FIGURE II.B-10



WETLANDS VEGETATION MAP: WATERFRONT AND ADJACENT AREAS

FIGURE II.B-11

b. Salt Water Intrusion

The Raritan and Magothy Formations aquifer is exhibiting some problems with salt water intrusion. Wells in the Raritan and Magothy Formations aquifer have shown increased chloride content at a few sites in Monmouth County: Fort Hancock, Keyport and Union Beach (chloride content to 125 parts per million (ppm) for the first time in 1975 (Figure II.B-10). The remaining aquifer formations have a potential for salt water intrusion because of possible hydraulic connection with salt water bodies.

A potential for salt water intrusion into the Englishtown aquifer exists in the coastal areas where the aquifer may be in hydraulic connection with the estuarine waters. In coastal wells, low chloride concentrations in the Englishtown Formation indicate no salt water intrusion as of 1964.

In order to determine baseline water quality in the Englishtown Aquifer in the areas potentially affected by the proposed dredging operation, three observation wells were installed and water quality data collected in July, 1978. Two wells are located in Sandy Hook Bay (at the end of Pier 1 and Pier 2; A & B of Figure II.B-10, respectively) and one well, on Sandy Hook (C of Figure II.B-10). Water quality of the Englishtown Aquifer from these wells is presented in Table II.B-12. The results, especially the high chloride levels, indicate that the Englishtown Aquifer in the project area is intruded to a high degree by salt water from Sandy Hook Bay.

A moratorium on further development of the Englishtown Aquifer is in effect and should help to control any potential problem with salt water intrusion. The Supply Council of the New Jersey Division of Water Resources has limited development through its diversion permit review process.

TABLE II.B-12

WATER QUALITY OF ENGLISHTOWN AQUIFER IN THE SANDY HOOK BAY AREA

	A[a]	B[a]	C[a]	Seawater
Total Dissolved Solids	23-27,000	23-27,000	23-27,000	34,478
pH	5.5	4.8	4.9	
Calcium	37	41	58	400
Magnesium	82	86	51	1,272
Sodium	5,803	6,821	6,433	10,556
Potassium	35	34	26	380
Sulfate	1,718	1,685	1,650	2,659
Bicarbonate Alkalinity	56	49	42	140
Chloride	16,177	16,310	16,037	18,980
Iron	89	109	107	0.007

Note:

[a]Average of three replicates

A - Pier 1

B - Pier 2

C - Sandy Hook Recreational Area

Source: Feedwater Assoc., August 1978.

B.8 Terrestrial Ecology

a. Regional

The regional distribution of forest types is closely related to the inner and outer subdivisions of the Coastal Plain Physiographic Province (see Physiography, Section B.1, this Chapter). The outer Coastal Plain to the south is characterized by Oak-Pine forests, while the inner Coastal Plain is generally forested by the Oak-Chestnut type (Braun, 1950). In addition, wetlands are present locally.

The Oak-Chestnut forest is dominated by various species of oak. The most common oaks of the overstory are usually white, black, red, chestnut, and scarlet. A shrub cover of heath plants such as laurel, blueberry, huckleberry and swamp azalea are typical of these forests (Robich and Buell, 1973).

The Pine-Oak forest can be categorized in two ways: pine-dominated or oak-dominated. The pine-dominated forest is present in areas of sandy, less fertile soil, and in New Jersey is commonly referred to as the Pine Barrens. The most abundant tree is the pitch pine. Other common trees include shortleaf pine, black oak, white oak, post oak, scarlet oak and blackjack oak. The shrub layer is composed predominantly of heaths and may include black huckleberry, lowbush blueberry, sheet laurel, fetterbush and mountain laurel.

Oak-dominated Pine-Oak forests are generally considered a fringe area of the Pine-Oak forest (McCormick, 1970) and a transition between the Oak-Chestnut forest and pine-dominated Pine-Oak forests. Trees in this forest include black oak, scarlet oak, white oak, chestnut oak, post oak, pitch pine, and shortleaf pine.

Common shrubs include black huckleberry, dangleberry and lowbush blueberry.

Wetlands form some of the biologically richest and most valuable ecosystems. Five wetland types are present in Monmouth County, their occurrence being a function of topography, hydraulic conditions and soils. These types are: salt-water marshes, freshwater marshes, bogs, swamps, and floodplains. The ecological functions of the wetlands are related not only to the terrestrial ecosystem but are also intimately related to the estuarine system discussed in Section II.C. Important functions served by the wetlands include:

- Providing large quantities of plant life that are a source of organic matter for shellfish and other aquatic life.
- Providing habitat for furbearing mammals, fish and waterfowl, including delicate and irreplaceable specimens.
- Providing nursery areas for wildlife and aquatic species.
- Providing pollution control by serving as biological and chemical oxidation basins and aiding in natural purification of water.
- Providing erosion control by serving as sedimentation areas and filter basins.
- Providing flood and storm control.
- Providing unique recreational areas, outdoor educational and scientific laboratories.

b. Waterfront Area and Proposed Site of Ship Fuel Replenishment System

The Waterfront area and the proposed site of the ship fuel replenishment system is located at the margin of the boundary between the terrestrial and the estuarine ecosystem. This area is characterized by wetlands and filled developed upland.

1. Vegetation Distribution - Two major vegetative communities are present at the site of the proposed ship fuel replenishment system. Salt marsh surrounds the proposed storage tanks on three sides, at a minimum distance of 600 feet. The actual site of the storage tanks, however, is comprised of old fields and disturbed areas. The proposed pipeline would run from the eastern edge

of the storage tanks to the pier and would traverse: 1) fill areas presently in early stage old field, 2) common reed and 3) salt marsh along Ware Creek.

In addition to the fuel replenishment system, two secured parking areas are proposed for the Waterfront Area. The parking area north of Route 36 would be situated within the existing building complex, on land presently in grass. The parking area south of Route 36 is on land which is half bare and half in close-cropped grass (a baseball field).

Plants observed and recorded during a site survey of the Waterfront Area and of the proposed site for the ship fuel replenishment system are presented in Appendix A.

2. Salt Marsh Vegetation - Salt marsh communities are located in those areas which are periodically flooded by brackish water. Bands consisting of single species of wetland vegetation occur inland of the water's edge.

Smooth cord grass is found closest to the water's edge in those areas regularly flooded by the tides. Shoreward of this zone is an area of salt meadow, supporting salt grass and salt bog. Landward of this zone, high tide bush and sea-myrtle are found. Common reed is locally abundant along the upper marsh edge, expecially where there has been soil disturbance.

The State of New Jersey has mapped the vegetation within the State's coastal wetlands. In an effort to verify and update this mapping on the site of the proposed ship fuel replenishment system, a field survey was conducted. Three transects were established and the Braun-Blanquet coverage abundance scale was used to estimate the vegetative cover within sample square-meter plots placed at 50-foot intervals. Figure II.B-11 shows the locations of these transects. Figures II.B-12, II.B-13 and II.B-14 depict the results of the survey, which generally agree with the New Jersey Wetlands maps. The few exceptions occurred at a scale smaller than that mapped by the State.

This is outside the period of maximum standing crop.

In addition to confirming the occurrence of the wetlands species, productivity measurements were taken (in late October) in each vegetation band along the three marsh transects. Living plants were harvested at ground level within $\frac{1}{2}$ meter by $\frac{1}{2}$ meter plots, and the wet weight was determined in the field. Samples were returned to the laboratory and dried to constant weight at 105° C. This procedure estimates net community productivity.

Table II.B-13 presents the results of this survey and compares this area with other salt marshes in the region. The data indicates that the marsh near the site of the proposed ship fuel replenishment system is a relatively productive area, comparable to other marshes in the metropolitan area.

3. Upland Vegetation - The proposed fuel storage tanks would be located on filled land adjacent to a sanitary landfill and until recently was used as an airstrip. Five cover types are present: cleared land, old field, shrub, young woodlands, and common reed. Figure II.B-11 shows the location of the Braun-Blanquet transect through the upland area. Figure II.B-15 presents the results of the transect. Figure II.B-16 shows the general distribution of vegetation communities at the site. The old field community is restricted to filled land that has recently been cleared. Goldenrods, aster and various grasses are most prominent. The presence of debris and garbage within the filled land will reduce the rate of successional development within this area.

Young woodlands and shrub communities are also present on the filled land, adjacent to the airstrip. The woodlands are comprised of cottonwood and black locust, averaging one to three inches in diameter. Additional plants of abundance include Japanese honeysuckle, poke, climbing false buckwheat and bittersweet. The shrub community is dominated by bayberry, which forms dense impenetrable thickets. Both the woodland and the shrub communities have been cleared and thinned along the air strip as a safety precaution. Cleared land includes the air strip and hangar, and the cleared visual zone around the air strip.

TABLE II.B-13

MARSH BIOMASS ESTIMATES FOR PROJECT AREA AND ADJACENT AREAS

Species	Project Area[1] Middletown, N.J.	Conaskonk Point[2] N.J.	Hempstead,[3] Long Island, N.Y.	Raritan River[4] (near Crab Island), N.J.
Smooth cord grass (*Sparitan alterniflora*)	912	932 (ditched marshes) 1,495 (un-ditched marshes)	891	1,128
Salt Meadow *Distichtis spicata* *Spartina patens*	595	514	633	NA
Common reed (*Phragmitas communis*)	1,422	NA	NA	NA

Note: Biomass is given in grams per square meter, all biomass are mean values.

Source:
[1] Dames & Moore, this study
[2] Environmental Concern, Inc., 1973
[3] Udell, *et al*., 1969
[4] Dames & Moore, 1977

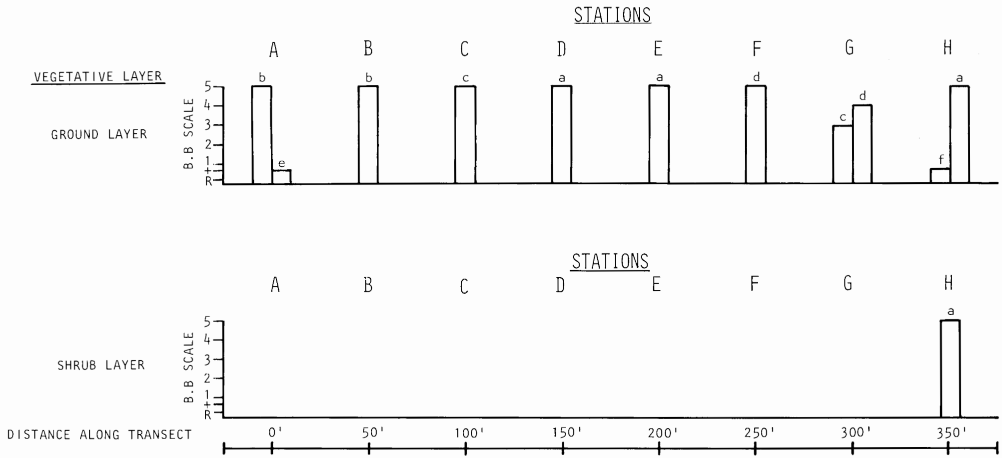
TABLE II.B-14

WILDLIFE SPECIES OF POTENTIAL OCCURRENCE AT WATERFRONT AREA AND PROPOSED SITE OF SHIP FUEL REPLENISHMENT SYSTEM

BIRDS	AQUATIC SPECIES
Semipalmated Plover[a]	Ribbed Mussel[a]
Killdeer[a]	Soft Clam[a]
Spotted Sandpiper[a]	Anemone[a]
Lesser Yellow Leg[a]	Barnacle[a]
Gulls[a]	Common Mud Snail[a]
Mallard[a]	Fiddler Crab[a]
Canvasback[a]	Square Back Crab[a]
Greater Scoop[a]	TERRESTRIAL SPECIES
Bufflehead[a]	Reptiles & Amphibians
Great Heron[a]	Northern Diamondback Terrapin[a]
Little Heron[a]	American Toad[b]
Blue Heron[a]	Rat Snake[b]
Green Heron[a]	Black Racer[b]
Black-Crowned Night Heron[a]	Mammals
Clapper Rail[a]	Muskrat[a]
Long-billed Marsh Wren[a]	Raccoon[a,b]
Redwinged Blackbird[a,b]	Meadow Vole[a,b]
Marsh Hawk[a]	Meadow Jumping Mouse[a]
Fish Crow[a]	House Mouse[a,b]
Catbird[b]	Shorttail Shrew[a,b]
Brown Trasher[b]	Whitefooted Mouse[a,b]
Myrtle Warbler[b]	Norway Rat[b]
Savannah Sparrow[b]	Eastern Cottontail[b]
White-Throated Sparrow[b]	Oppossum[b]
	Skunk[b]

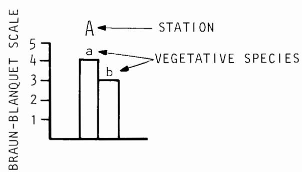
Notes: [a]Species normally associated with marsh or water-related habitats.
[b]Species normally associated with upland habitats.

Source: Environmental Concern, Inc. 1975; Dames & Moore, 1976; N.J. Division of Fish, Game and Shellfisheries, 1973; Sandy Hook Marine Laboratory, 1971; Shure, 1970.



VEGETATION TRANSECT NO. 1 - SALT MARSH

EXPLANATION:



BRAUN-BLANQUET SCALE KEY:

5 = COVERAGE >75%

4 = COVERAGE 50-75%

3 = COVERAGE 25-50%

2 = COVERAGE 5-25%

1 = NUMEROUS, BUT LESS THAN 5% COVERAGE, OR SCATTERED AND UP TO 5% COVERAGE

+ = A FEW WITH SMALL COVERAGE

R = RARE OR SOLITARY WITH SMALL COVERAGE

SPECIES KEY:

GROUND LAYER

a) SALT GRASS

b) COMMON REED

c) SALT WATER CORD GRASS

d) SALT HAY

e) ORACH

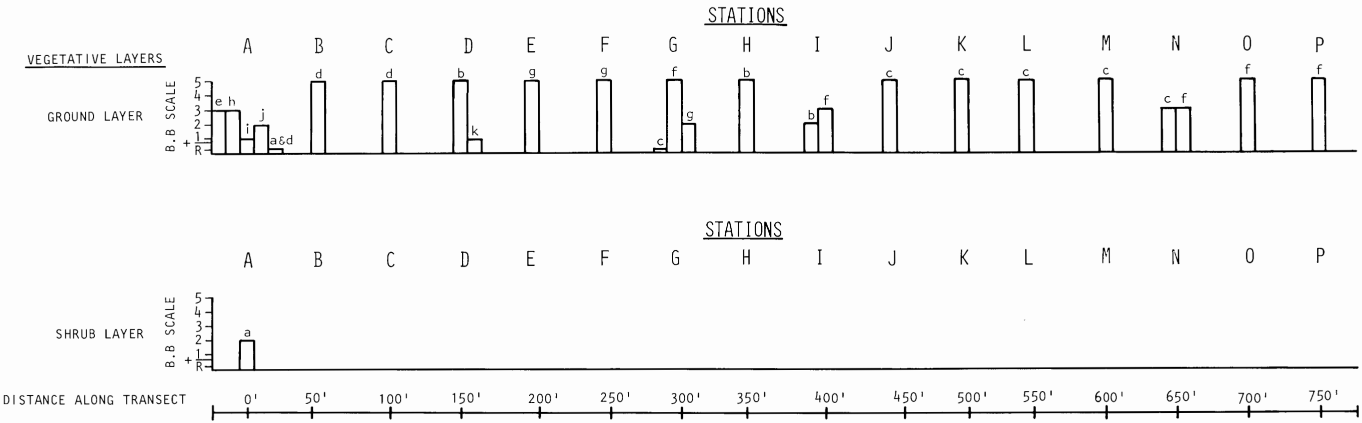
f) MARSH ELDER

SHRUB LAYER

a) MARSH ELDER

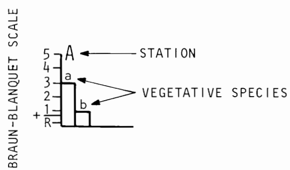
NOTE: SEE FIGURE II.B-11 FOR LOCATION OF TRANSECT

FIGURE II.B-12



VEGETATION TRANSECT NO. 2 - SALT MARSH

EXPLANATION:



BRAUN-BLANQUET SCALE KEY:

5 = COVERAGE >75%

4 = COVERAGE 50-75%

3 = COVERAGE 25-50%

2 = COVERAGE 5-25%

1 = NUMEROUS, BUT LESS THAN 5% COVERAGE, OR SCATTERED AND UP TO 5% COVERAGE

+ = A FEW WITH SMALL COVERAGE

R = RARE OR SOLITARY WITH SMALL COVERAGE

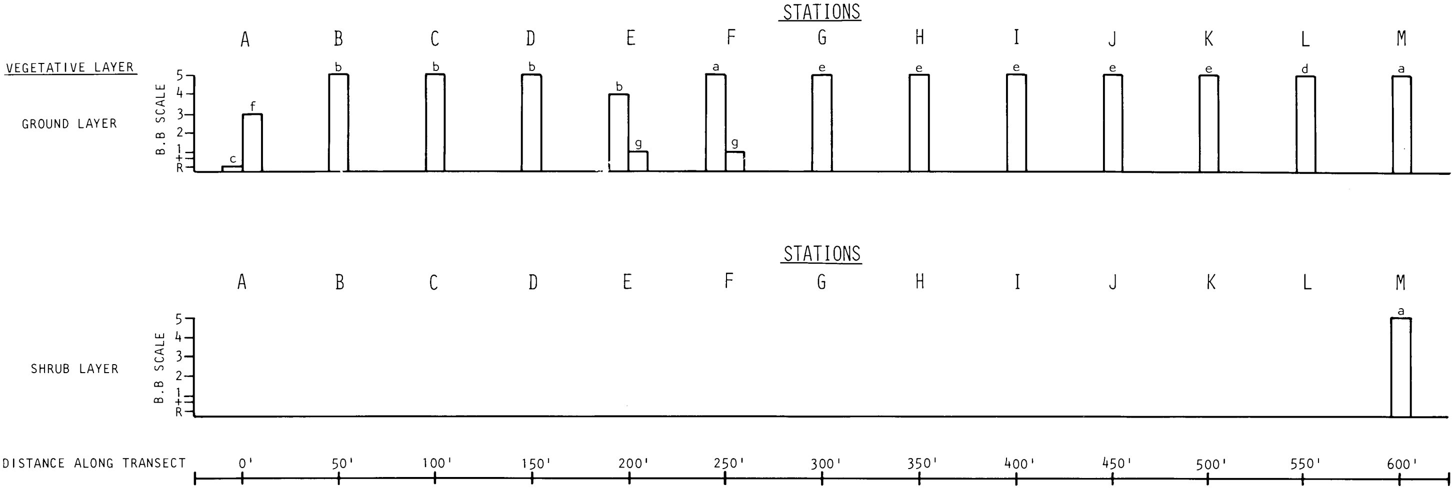
SPECIES KEY:

GROUND LAYER
a) CLIMBING FALSE BUCKWHEAT
b) SALT GRASS
c) SALT GRASS - SALT HAY
d) COMMON REED
e) WINGED RIB - SUMAC
f) SALT WATER CORD GRASS
g) SALT HAY
h) ORACH
i) BLACKBERRY
j) GOLDENROD
k) MARSH ELDER

SHRUB LAYER
a) BLACK LOCUST

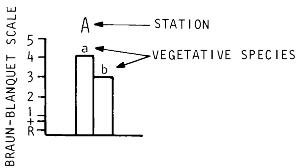
NOTE: SEE FIGURE II.B-11 FOR LOCATION OF TRANSECT.

FIGURE II.B-13



VEGETATION TRANSECT NO. 3 - SALT MARSH

EXPLANATION:



NOTE: SEE FIGURE II.B-11 FOR LOCATION OF TRANSECT

BRAUN-BLANQUET SCALE KEY:

5 = COVERAGE >75%

4 = COVERAGE 50-75%

3 = COVERAGE 25-50%

2 = COVERAGE 5-25%

1 = NUMEROUS, BUT LESS THAN 5% COVERAGE, OR SCATTERED AND UP TO 5% COVERAGE

+ = A FEW WITH SMALL COVERAGE

R = RARE OR SOLITARY WITH SMALL COVERAGE

SPECIES KEY:

GROUND LAYER

a) SALT GRASS

b) COMMON REED

c) WINGED RIB- SUMAC

d) SALT WATER CORD GRASS

e) SALT HAY

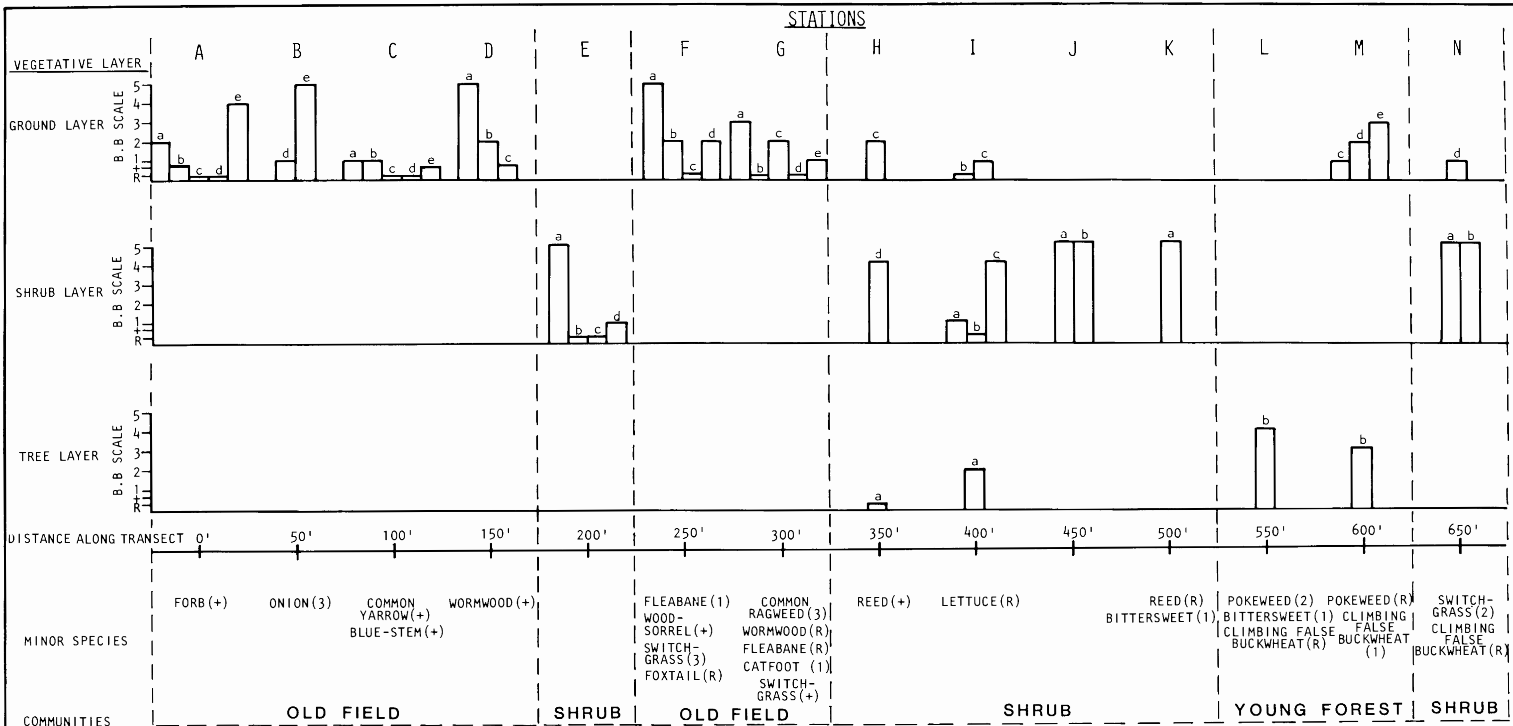
f) BLUE STEM

g) MARSH ELDER

SHRUB LAYER

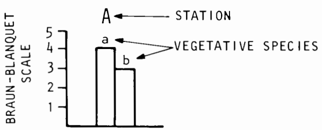
a) MARSH ELDER

FIGURE II.B-14



VEGETATION TRANSECT NO. 4 - OLD FIELD

EXPLANATION:



NOTE: SEE FIGURE II.B-11 FOR LOCATION OF TRANSECT

BRAUN-BLANQUET SCALE KEY:

5 = COVERAGE >75%
4 = COVERAGE 50-75%
3 = COVERAGE 25-50%
2 = COVERAGE 5-25%
1 = NUMEROUS, BUT LESS THAN 5% COVERAGE, OR SCATTERED AND UP TO 5% COVERAGE
+ = A FEW WITH SMALL COVERAGE
R - RARE OR SOLITARY WITH SMALL COVERAGE

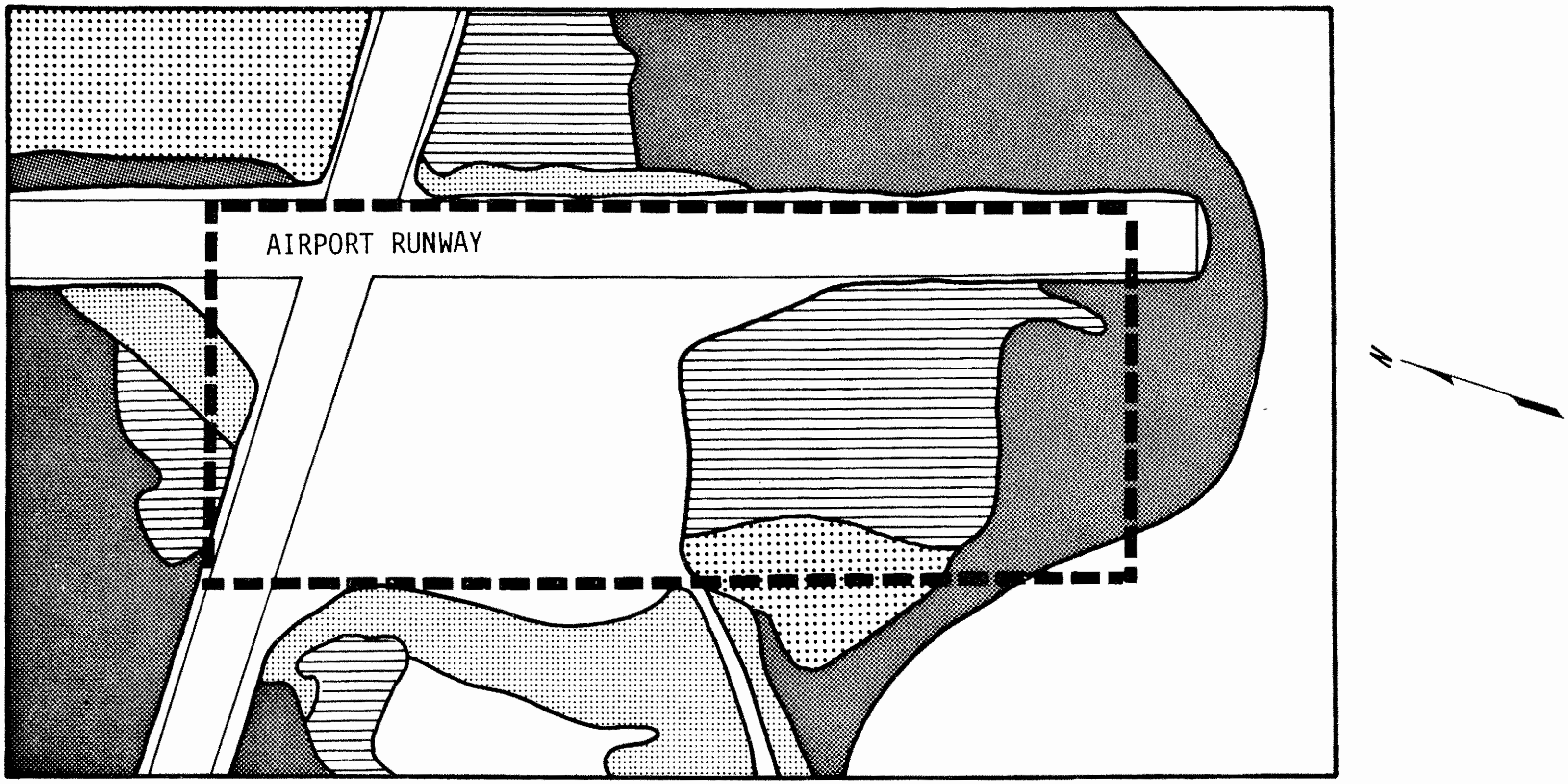
SPECIES KEY:

GROUND LAYER
a) ASTER
b) FORB
c) GRASS
d) GRASS-LEAVED GOLDENROD
e) SWEET GOLDENROD

SHRUB LAYER
a) JAPANESE HONEYSUCKLE
b) BAYBERRY
c) WING-RIB SUMAC
d) STAGHORN SUMAC

TREE LAYER
a) COTTONWOOD
b) BLACK LOCUST

FIGURE II.B-15



GENERALIZED VEGETATION COVER MAP AT SHIP FUEL REPLENISHMENT SITE

0 100 200
FEET

NOTE: COVERAGES DETERMINED FROM GROUND SURVEYS.

KEY:
- OLD FIELD
- SHRUB
- WOODLANDS
- COMMON REED
- CLEARED LAND
- FUEL REPLENISHMENT SITE BOUNDARY

FIGURE II.B-16

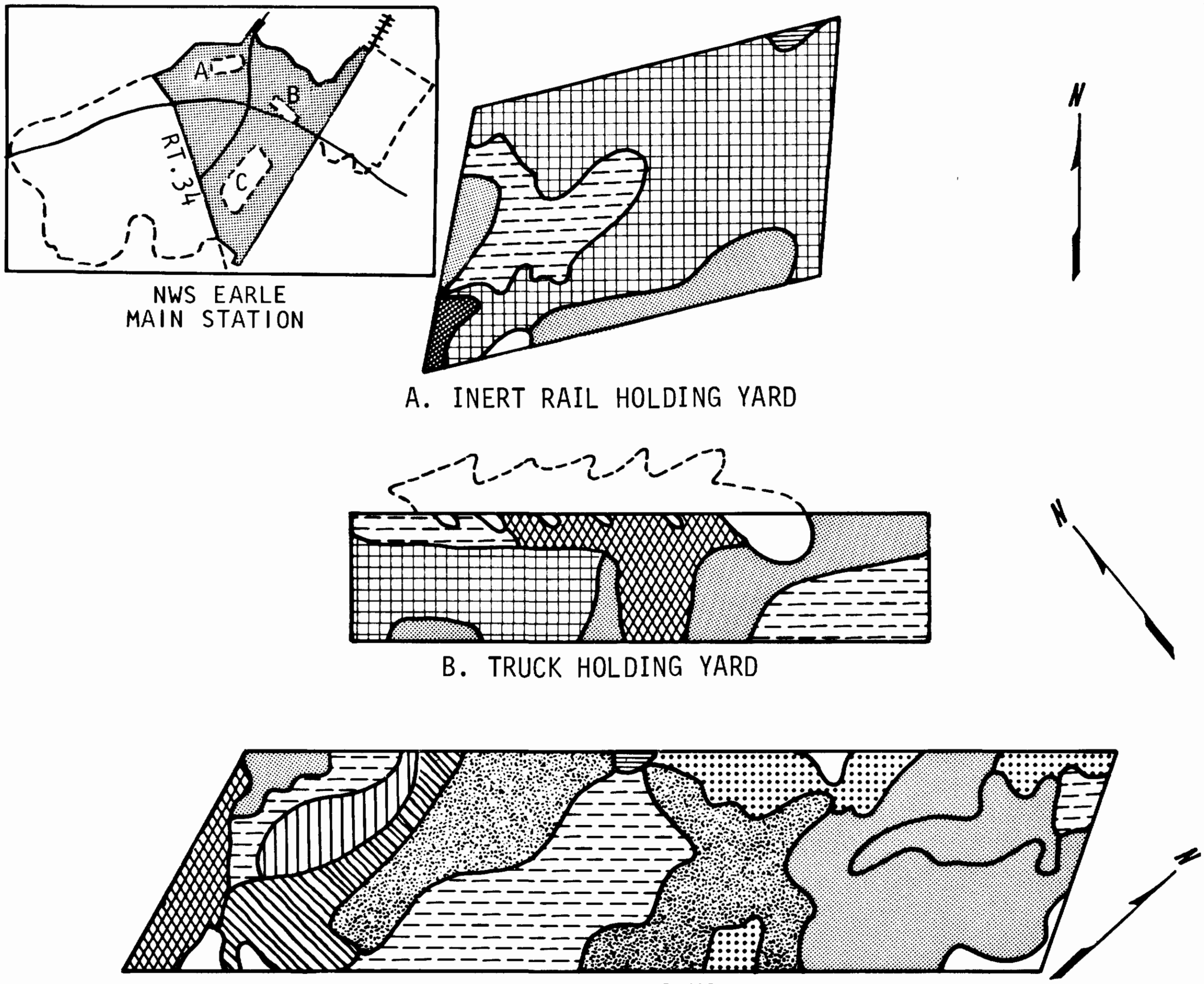
The lower elevations of the site are dominated by common reed, Phragmites communis. This plant is a transitional species between the upland and marsh ecosystems. Common reed is tolerant of disturbance and may totally dominate disturbed marshlands.

4. Wildlife - As described above, the Waterfront Area contains diverse ecological habitats, i.e. terrestrial, aquatic, intertidal and marsh. Table II.B-14 lists the wildlife species which can be expected to inhabit these environments.

c. Main Station

1. General Vegetation - With the exception of building areas, magazines, rail lines and roadways, much of the Main Station is forested. Eight forest associations have been identified on the Station and are presented in Table II.B-15.

The three components of the proposed in-transit holding facilities are located in areas which are presently in woodlands. These components are the proposed rail holding yard, the proposed truck holding yard, and the proposed inert rail holding yard. The rail holding yard, located adjacent to Magazine Group F, is covered by white pine and red maple saplings, grass and open land, and pine, pine-hardwood and oak poletimber. A low, wet area of red maple saplings crosses the area. This is the point at which Branch Mingamahone Brook originates (Figure II.B-8). The proposed truck holding area, some 4000 feet northeast of Group F, is comprised of mixed hardwood sawtimber, and oak-pine poletimber and hardwood-pine poletimber (Figure II.B-17). The proposed inert rail storage area, approximately 8000 feet north of Group F, is primarily covered by mixed oak poletimber pine hardwood poletimber and oak-pine poletimber (Figure II.B-17). The presence of mixed hardwoods at the inert rail and truck handling areas indicates a moist forest floor.



FOREST COVER TYPES

IN-TRANSIT HOLDING FACILITIES: MAIN STATION

0 1000

SCALE 1 INCH = 1320 FT.

KEY:

- ATLANTIC WHITE CEDAR
- PINE - HARDWOOD PALETIMBER
- MIXED OAK POLETIMBER
- MIXED HARDWOOD SAWTIMBER
- OAK - PINE POLETIMBER
- SEEDLING SAPLING
- PINE-OAK POLETIMBER
- HARDWOOD-PINE POLETIMBER
- PINE POLE TIMBER
- NON-FORESTED LAND

NOTE: SEE FIGURE I-13 FOR LOCATION OF HOLDING AREAS A, B & C.

SOURCE: GENTILE (1977)

TABLE II.B-15

FOREST TYPES AT NWS EARLE MAIN STATION

FOREST TYPES	ACRES	Percent[a]
Mixed Oak	1,445	17.5
Poletimber[b]	1,183	
Sawtimber[b]	262	
Oak - Pine (Poletimber)	1,321	16.1
Mixed Hardwood	1,857	22.6
Poletimber	938	
Sawtimber	919	
Hardwood - Pine (Poletimber)	492	6.0
Pine - Oak (Poletimber)	676	8.2
Pine - Hardwood (Poletimber)	886	10.7
Pine (Poletimber)	378	4.6
Atlantic White Cedar (Poletimber)	17	0.2
Seedling - Sapling Types[b]	1,144	13.9
Total Managed Forest	8,216	99.8
Total Unmanaged Forest	824	
Total Forest	9,040	
Cleared or Developed	2,134	
Total	11,174	

Notes:

[a]Percent of managed forest

[b]Saplings: Seedlings - less than 4 inches diameter at breast height (dbh)
Poletimber - 4 inches - 11 inches dbh
Sawtimber - greater than 11 inches dbh

Source: Gentille, 1977.

The proposed magazines, are to be located between the rail lines of the proposed Rail Holding area. The sites of new construction for the naval exchange, and the AOE warehouse are located on the improved grounds of the developed administration center of the Main Station. Ground cover consists of grass, shrubs and scattered trees which were preserved when the area was developed.

A survey was made on June 6 and 7, 1978 of these three in-transit holding areas. The objectives of the survey were the identification of endangered species and the general characterization of the various types of vegetative coverage. All vegetation and wildlife observed during the survey were recorded and are presented in Appendices B-1 and B-2.

2. Rail Holding Yard Vegetation - Forests of the Rail Holding area are younger than those of the other proposed holding yards. Upland forest associations (mixed oak, oak-pine, pine-oak) possess trees representative of dry, well-drained soils. Common trees include pitch pine and various oaks, such as white, blackjack, chestnut, scarlet, black and northern red. A dense blueberry dominated shrub layer, and a sparse or nonexistent herbaceous ground cover are characteristic of these forests. Immature stands of pure pine have been planted on eroded areas of these well-drained uplands.

Woodlands possessing characteristics of both the dry uplands and the more moist lowlands represent a transitional forest. These woodlands on the proposed rail holding yard comprise the pine-hardwood and the hardwood-pine forest associations. Within these forests, hardwoods such as red maple and black gum are found in association with pitch pine. A relatively diverse ground and shrub cover with many species typical of lowland forests was present.

The final forest type is characterized by a moist forest floor and is totally dominated by hardwoods (seedling-sapling). This forest is found along the margin of a tributary of Mingamahone Brook. Common trees of this immature woodland include red maple, black gum and birch. Shrubs commonly encountered during the survey were sweet pepper-bush, sweetbay magnolia, rhododendron and blueberry. Herbaceous ground cover was rather diverse and included skunk cabbage, sedges and various ferns. Sphagnum moss indicates much of this area is wet throughout the year.

3. Truck Holding Yard Vegetation - The forests of the dry uplands (mixed oak and oak-pine) and those of the transition (hardwood-pine) between wet and dry conditions are comparable to those present on the proposed rail holding yard. Pitch pine and white, black and northern red oak were the most common trees of the upland forests. Red maple, black gum and pitch pine were common in the transitional forests.

The lowland forests of this area represent rather mature hardwood forests. The overstory is primarily red maple with beech, pitch pine and black gum of occasional occurrence. The forest possesses a well developed understory and shrub layer. Common species of the understory include black gum, red maple and American holly. Some of the more abundant shrubs are sweet pepper-bush, mountain laurel and blueberry. Very little herbacious ground cover was present.

4. Inert Rail Holding Yard Vegetation - The majority of Inert Rail Holding Yard area is comprised of mature hardwood forest stands. The overstory and understory are dominated by red maple and occasional black gum and beech. Shrubs common to the forest included greenbrier, sweet bay magnolia, blueberry, American holly and sweet pepper-bush. Common herbaceous plants encountered included skunk cabbage, sedges, partridge berry and cinnamon and royal ferns.

Remaining forest associations include Atlantic white cedar, mixed oak and oak-pine. The latter two forest associations are relatively young in age and of limited extent. Species composition is similar to upland forest types on previously discussed in-transit holding yards.

The forest dominated by Atlantic white cedar represents a latter stage of bog succession. The forest is of limited area, however, it does represent a unique wetland association. The understory is dominated by red maple and black gum. Common shrubs include sweet pepper-bush, mountain laurel and rhodondendron. Some of the common herbaceous plants of the forest floor were netted chain fern, skunk cabbage, sedges, and cinnamon fern.

5. Evaluation of Vegetation - Evaluation of the proposed in-transit holding yards indicates vegetative coverage on all three areas which possess relatively high ecological value. The greatest ecological loss can be expected on inert rail holding yard. Approximately 55 percent of the proposed holding yard is comprised of continuous mature hardwood forest bisected by a stream. Additionally, a small cedar forest representing the later stages of bog succession is present. The greatest ecological loss on the truck holding yard also involves the removal of mature hardwood forest which comprises approximately 30 percent of the holding yard. The habitat of greatest value on the proposed rail holding yard is the immature hardwood forest and the tributary of Mingamahone Brook. This forest possesses characteristics of a low floodplain and also provides habitat appropriate for the bog turtle.

6. Birds - The general uniformity of vegetation on Main Station limits the variety of nest sites, nest material, perches and other physical features which affect bird distribution. Populations are generally composed of a few species with numerous individuals. Rufoussided Towhee, Pine Warblers and Tufted Titmice may be common in upland forests, while species such as Parula Warbler, American Redstart, Yellow Throat, Cardinal and Catbird are abundant in swamp forests. Great Blue Herons, Egrets, Kingfishers, and migratory waterfowl would be found along streams and ponds. Birds common to this area are listed in Appendix C-1.

7. Mammals - Mammals that can be expected to occur within the Pine Barrens, the fringe forests of the Main Station, include masked shrew, eastern mole, eastern cottontail, gray squirrel, red squirrel, southern flying squirrel, white-footed mouse, pine vole, meadow jumping mouse, red and gray fox, raccoon, striped skunk and white-tailed deer. Mammals common to this area are listed in Appendix C-2.

8. Game Animals - Game animals hunted on the Station include white-tailed deer, eastern cotton tail, Bobwhite, Ruffed Grouse and fox (American Publishers, 1977.) Beaver has been recorded in flooded forests at the extreme eastern portion of the Station (NWS Earle, Forestry Plan; Gentille, 1977).

9. Aquatic Fauna - Portions of the headwaters of Mingamahone Brook and Hockhockson Brook originate in the area of the proposed in-transit holding area. These streams have been designated by the New Jersey Department of Environmental Protection as Trout Maintenance Waters. Waters so designated either support trout throughout the year, or have the potential to do so. Reptiles and amphibians of potential occurrence are presented in Appendices C-3 and C-4, respectively.

d. Endangered or Threatened Species

The State of New Jersey (New Jersey State Register, April 10, 1975) and the Federal Government (Federal Register, June 16, 1976; Federal Register, October 27, 1976) have identified several plant and animal species within New Jersey as being endangered or threatened. Only species designated as endangered received complete protection under state or federal law. Although there are no existing records of these plants or animals on the Station, the potential of their occurrence does exist.

Field surveys failed to reveal the presence of any species designated as endangered or threatened (Appendices B-1 and B-2). Concern over potential occurrence of endangered species primarily involves two species: small whorled pogonia and bog turtle. The pogonia has previously been found in Monmouth County (Fairbrothers, 1978) and required habitat of acid soil on dry uplands in present on all three proposed in-transit holding yards.

The bog turtle is known to occur four miles south of the main base at Allaire State Park (Frier, 1978). Since the rail holding yard lies within the same drainage basin the potential for occurrence at this site was of concern. Preferred habitat of a sedge and grass stream bank, and a soft muddy bottom were present along much of this stream. An exhaustive survey of the stream (June 6 and 7, 1978) for reptiles and amphibians was made to determine presence or absence of this endangered turtle. Only common species were encountered during the survey and included common snapping turtle, spotted turtle and green frog.

Species for which habitat is available on the Station, or for which sightings have been made in the region, are presented in Table II.B-16.

B.9 Air Quality

a. Climatic Setting

Despite its proximity to the ocean, this region's climate is dominated by the influence of continental air masses. This is due to the dominant westerly flow across the mid-latitudes produced by the earth's rotation.

The seasonal circulation patterns change from prevailing southerly air flow in the summer to northerly winds in the winter. The summer conditions are influenced by the semipermanent Bermuda High pressure center which generates a very warm and frequently humid flow of air from the Gulf of Mexico. Winters are characterized by cold continental air masses associated with central U.S. high

TABLE II.B-16

ENDANGERED AND THREATENED SPEICIES OF POTENTIAL OCCURRENCE AT NWS EARLE

ENDANGERED SPECIES	COMMENTS
Plants (Rare and Endangered)	
Knieskern's Beak-Rush[b]	Bogs containing iron
Small Whorled Pogonia[b]	Acid soil of dry woodlands
Hirst's Panic Grass[b]	Swamps
Amphibians	
Eastern Tiger Salamander[a]	Unstocked farm ponds
Reptiles	
Bog Turtle[a]	Sphagnum bogs, swamps, clear meadow streams - mud bottoms
Birds	
Bald Eagle[c]	Transient
Cooper's Hawk[a]	Breeds in alluvial woodlands
Osprey[a]	Nests in Sandy Hook - may feed in area
Peregrine Falcon[a,b]	Transient
THREATENED SPECIES	
Reptiles	
Eastern Earth Snake[a]	Abandoned fields, back road near deciduous forest
Timber Rattlesnake[a]	Second growth hardwoods best
Birds	
Barred Owl[a]	Breeds lowlands - winters in conifers
Black Rail[a]	Rare coastal visitant - no breeding records in area

Sources:

[a] N.J. State Register, April 10, 1976
[b] Federal Register, June 16, 1976
[c] Federal Register, October 27, 1976

TABLE II.B-16 (Continued)

ENDANGERED AND THREATENED SPEICIES
OF POTENTIAL OCCURRENCE AT NWS EARLE

THREATENED SPECIES	COMMENTS
Birds (Continued)	
Bobolink[a]	Common fall migrant (abundant along coast) local breeder grassy fields, ditched salt marsh
Grasshopper Sparrow[a]	Rar migrant (outer coast) - local breeder (dry fields), no report
Henslow Sparrow[a]	Very local breeder - dry fields and damp meadows - no report
Ipswich Sparrow[a,b]	Rare migrant - no breeding reported in area
King Rail[a]	Seen in salt marshes in winter
Least Bittern[a]	Possible in marsh, but unlikely - prefers cattails
Marsh Hawk[a]	Breed in marshes but rare - fairly common fall migrant and winter visitant
Merlin[a]	Common migrant along coast
Piping Plover[a]	Migrant - unlikely breeder
Red-Headed Woodpecker[a]	Rare migrant - no breeding reported in area
Red-Shouldered Hawk[a]	Breeds in lowlands - rare on coastal plain
Roseate Tern[a]	Uncommon - rare migrant
Sharp-Skinned Hawk[a]	Breeds in conifers but rare - common migrant
Short-billed Marsh Wren[a]	Very local breeder - S. alterniflora but no report
Short-Eared Owl[a]	Winter resident - very likely in marsh

Sources:

[a]N.J. State Register, April 10, 1976
[b]Federal Register, June 16, 1976
[c]Federal Register, October 27, 1976

TABLE II.B-16 (Continued)

ENDANGERED AND THREATENED SPEICIES
OF POTENTIAL OCCURRENCE AT NWS EARLE

THREATENED SPECIES	COMMENTS
Birds (Continued)	
Upland Sandpiper[a]	Uncommon - rare migrant
Vesper Sparrow[a]	Uncommon to common migrant - unlikely breeder - need agricultural area
Yellow-Crowned Night Heron[a]	Possibly breeds in Monmouth County
Mammals	
Keen's Myotis[a]	Caves, buildings, hollow trees, storm sewers
Small-footed Myotis[a]	Caves, crevices in rocks, buildings, forested areas
Southern Bog Lemming[a]	Low damp bogs and meadows

Sources:

[a]N.J. State Register, April 10, 1976
[b]Federal Register, June 16, 1976
[c]Federal Register, October 27, 1976

pressure centers and by fast-moving storm systems which track across the area, sometimes depositing heavy amounts of rain or snow. The spring and summer months are characteristically transitional periods which provide gradual climatic changes.

Land-sea breezes further modify the circulations, particularly near the coastline where the temperature and air density gradients are likely to be most pronounced. A more detailed discussion of additional features of the project region climatology is presented in Appendix D.

b Stagnation and Atmospheric Stability

The meteorological conditions that are most conductive to a high air pollution potential are light winds and a stable atmospheric boundary layer. The frequent passage (three to four days) of frontal systems help reduce the length of both warm and cold spells and is a major factor in keeping periods of prolonged air stagnation at a minimum.

The normal westerly movement of large-scale circulation features is occasionally interrupted for several days. During these periods of air stagnation, gradual increases in pollutant concentrations may result.

The frequency and duration of the region's air pollution episodes has been estimated based on the upper air observations taken at Kennedy International Airport, the nearest radiosonde station to the site area. Table II.B-17 provides episode duration, number of episodes, number of episode days, and the associated mixing depth, wind speed and season of greatest episode frequency for the period 1960 to 1964. This data indicates that the autumn seasons were characterized by the most significant episodes of air pollution.

The low level mixing capabilities of the regional atmosphere is also important in characterizing the dispersion character of the area. This quality may

TABLE II.B-17

TOTAL AIR POLLUTION EPISODES[a] AT
J.F. KENNEDY AIRPORT 1960-1964

Duration[b] (Consecutive Days)	Mixing Height (meters)	Wind Speed (m/sec)	Season of Greatest Frequency	Number[c] of Episodes	Episode[d] Days
2	500	2	—	0	0
2	500	4	Winter	1	3
2	500	6	Winter	1	3
2	1,000	2	—	0	0
2	1,000	4	—	9	20
2	1,000	6	Winter	19	43
2	1,500	2	—	0	0
2	1,500	4	Autumn	18	39
2	1,500	6	Autumn	44	113
2	2,000	2	Autumn	0	0
2	2,000	4	Autumn	33	83
2	2,000	6	Autumn	71	220
5	500	4	—	0	0
5	500	6	—	0	0
5	1,000	4	—	0	0
5	1,000	6	—	0	0
5	1,500	4	—	0	0
5	1,500	6	Autumn	2	9
5	2,000	4	Autumn	1	9
5	2,000	6	Autumn	5	40

[a]Consecutive days with mixing heights and wind speeds less than those indicated in columns 2 and 3.

[b]Minimum number of consecutive days of indicated meterological conditions.

[c]Number of separate air pollution periods lasting at least the indicated duration of consecutive days.

[d]Total number of air pollution days for indicated meteorological conditions.

Source: Holzworth, 1972.

be found in the structure of the atmosphere's stability, that is, its vertical temperature profile. Table II.B.18 provides the monthly and annual frequencies of atmospheric stability based on the stability criteria of Turner (1969) and New York City data. On an annual basis, neutral stability (D) occurs most frequently (47%), unstable conditions (A, B and C, where A is the most unstable) occur the least often (17%), and stable conditions (E, and F, where F is the most stable) occur at about 36 percent of the time. The stable condition is associated with atmospheric stagnation and pollution potential and is most predominant in the autumn months, although it is fairly common throughout the year.

c. Pollutant Standards and Ambient Levels

The U.S. Environmental Protection Agency and the N.J. Department of Environmental Protection have established ambient air quality standards for six pollutants: photochemical oxidants, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulates and hydrocarbons. The standards are considered to be the threshold levels which, if exceeded, can affect the health and the welfare of humans (Table II.B-19).

To attain and maintain these standards, the Federal government requires states to adopt an Air Quality Maintenance Plan (AQMP). The AQMP is more comprehensive than previous air quality control plans, in that long-range land use and transportation control plans are required to be evaluated along with automo-bile and industrial source emission controls.

In developing an AQMP, a determination must be made as to whether an area has attained or is exceeding the air quality standards. The existing designations for Monmouth County with respect to various pollutants is listed in Table II.B-20 together with the designations which have been recently proposed by the State of New Jersey.

TABLE II.B-18

ATMOSPHERIC STABILITY FREQUENCY (%)
(TURNER METHOD)
NEW YORK CITY DATA (1949-1957)
STABILITY CLASS

	Unstable			Neutral Stability	Stable	
Month	A	B	C	D	E	F
January	0.00	1.37	5.09	60.18	11.16	22.20
February	0.11	1.99	6.27	56.03	12.49	23.12
March	0.27	2.88	6.57	61.60	9.90	18.78
April	0.71	4.26	9.18	55.99	10.02	19.85
May	2.15	7.20	14.24	46.76	9.34	20.32
June	3.35	10.02	17.46	35.88	8.89	24.39
July	2.45	12.92	19.24	28.03	8.86	28.50
August	2.35	10.11	14.88	32.81	9.53	30.33
September	0.79	6.92	12.30	38.78	9.94	31.28
October	0.43	4.87	10.35	42.71	10.27	31.36
November	0.00	2.10	6.64	48.24	13.11	29.92
December	0.00	0.90	5.14	53.76	13.84	26.35
Annual	1.06	5.51	10.67	46.64	10.58	25.54

Souce: U.S. Department of Commerce, TDF-14, New York City, NOAA, Asheville, North Carolina, 1976.

TABLE II.B-19

NEW JERSEY AND FEDERAL AMBIENT AIR QUALITY STANDARDS (1977)

		N.J. Standards[a]		Federal Standards		
Pollutant	Averaging Time	Primary	Secondary	Primary	Secondary	Basis for Primary Standards
Photochemical Oxidants	1 hour	0.08 ppm	0.08 ppm	0.12 ppm	Same as Primary Std.	Prevention of eye irritation and possible impairment of lung function in persons with chronic pulmonary disease.
Carbon Monoxide	12 hours	—	—	—	Same as Primary St.	Prevention or interference with oxygen transport by blood.
	8 hour	9.0 ppm	9.0 ppm	9.0 ppm		
	1 hour	40.0 ppm	40.0 ppm	35.0 ppm		
Nitrogen Dioxide	Annual Average	0.05 ppm	0.05 ppm	0.05 ppm	Same as Primary Std.	Possible health effects could occur at slightly higher dosage. Produces atmospheric discoloration.
	1 hour	—	—	—		
Sulfur Dioxide	Annual Average	0.03 ppm	0.02 ppm	0.03 ppm	---	Prevention of increase in chronic respiratory disease on long-term exposure.
	24 hours	0.14 ppm	0.1 ppm	0.14 ppm	---	
	3 hours	—	0.5 ppm	—	0.5 ppm	
	1 hour	—	—	—	---	
Suspended Particulate Matter	Annual Geometric Mean	75 $\mu g/m^3$	60 $\mu g/m^3$	75 $\mu g/m^3$	60 $\mu g/m^3$	Long continued exposure may be associated with chronic respiratory disease. Exposure to a combination of suspended particles and sulfur dioxide may produce acute illness.
	24 Hour Average	260.0 $\mu g/m^3$	150.0 $\mu g/m^3$	260 $\mu g/m^3$	150 $\mu g/m^3$	
Hydrocarbons (Corrected for Methane)	Annual Average for 3 hours 6:00 am to 9:00 am	0.24 ppm	0.24 ppm	0.24 ppm	Same as Primary Std.	

[a]Concentrations given may not be exceeded more than once over the given averaging time

ppm = parts per million

$\mu g/m^3$ = micrograms per cubic meter

TABLE II.B-20

EXISTING AIR QUALITY DESIGNATIONS FOR MONMOUTH COUNTY, NEW JERSEY, PURSUANT TO SECTION 107 OF THE FEDERAL CLEAN AIR ACT AS AMENDED AUGUST 7, 1977

Parameter	Existing	Proposed
Particulate Matter	Attainment	Attainment
Sulfur Dioxide	Attainment	Attainment
Photochemical Oxidants	Non-attainment	Non-attainment
Carbon Monoxide[a]	Unclassified	Attainment (Monmouth County except City of Asbury Park and Boro of Freehold)
Nitrogen Dioxide[a]	Unclassified	Attainment

Notes:

[a]Although not designated, the County is considered to be in compliance for this pollutant.

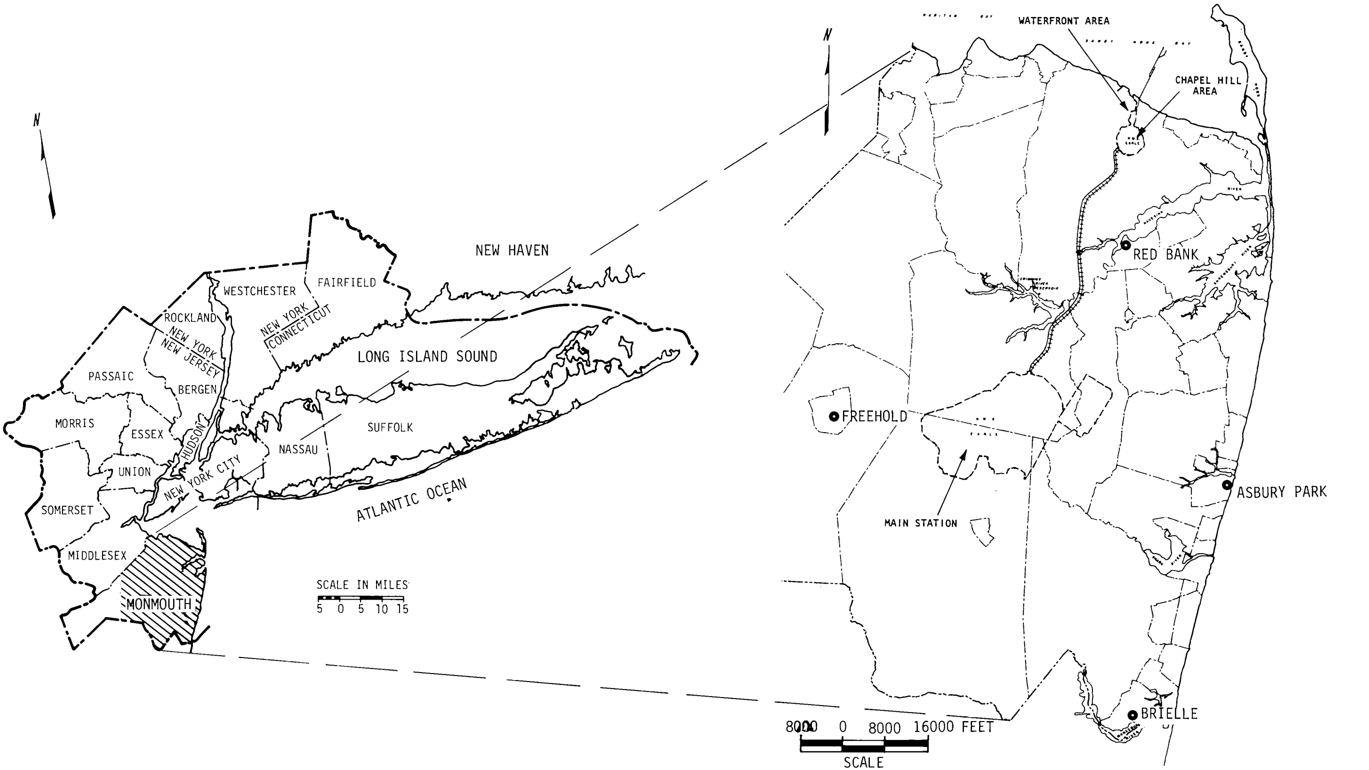
Source: NJDEP (1978)

The term "non-attainment area" for an air pollutant means that an area is shown by monitored data or by air quality dispersion modeling to exceed the ambient air quality standard. The term does not suggest that new sources are to be prohibited. An attainment area is one in which data indicates that the ambient air quality standards are not being exceeded. The Interpretative Ruling for Implementation of the Requirements of 40 CFR 51.18 (41 FR 55528) provides, in general, that a major new source may locate in an area with air quality worse than permitted by an ambient air quality standard only if stringent conditions are met. These conditions are designed to insure that new source emissions will be controlled to the greatest possible degree; that at least equivalent offsetting emission reductions will be obtained from existing sources; and that progress will be made toward achieving the required standards. The term "major new source" refers to a development for which the allowable emission rate is equal to or greater than the following:

Pollutant	Emission Rate (Tons per Year)
Particulate	100
Sulfur Oxides	100
Nitrogen Oxides	100
Non-Methane Hydrocarbons	100
Carbon Monoxide	1000

The Earle facility is located in an attainment area for particulates, sulfur dioxide, carbon monoxide and nitrogen oxides. It is in a non-attainment area for photochemical oxidants.

These designations are based upon analysis of data collected from sampling stations. The sampling stations nearest to NWS Earle are located at Asbury Park, Red Bank, Brielle and Freehold (Figure II.B-18). Data from these stations are available from 1974 to 1976 for sulfur dioxide, particulates and carbon



A. NEW JERSEY - NEW YORK - CONNECTICUT
INTERSTATE AIR QUALITY CONTROL REGION (AQCR)

B. LOCATION OF AIR QUALITY MONITORING STATIONS
MONMOUTH COUNTY

AIR QUALITY CONTROL REGION AND MONITORING STATIONS

FIGURE II.B-18

monoxide (Table II.B-21). Sulfur dioxide and particulate levels are below those permitted by standards. The business centers of Asbury Park and Freehold exceed the 8-hour standards for carbon monoxide. Carbon monoxide levels are extremely sensitive to local activity and close proximity (within 2000-3000 feet) to traffic congestion. The high levels recorded at Asbury Park and Freehold are not expected to occur in the project area as traffic volumes are substantially lower near NWS Earle (Figure II.E-6).

Although nitrogen dioxide levels were not observed, it is expected that the site's levels should comply with standards because of the minimal amount of industrial sources of this pollutant in the immediate area.

The Clean Air Act authorizes EPA to prevent significant air quality deterioration in areas that are cleaner than air quality standards. All areas are assigned to one of three classes. Class I designates areas where significant development is not desirable. Class II designates areas in which moderate development is permitted. Class III designates areas where intensive growth is permitted. The proposed site falls within an area currently designated as Class II (Code of Federal Regulations, 1977). The maximum allowable increase in pollutant concentrations over existing levels is set forth in Table II.B-22.

B.10 Noise

a. Introduction

This section contains a description and the results of the program conducted to obtain existing ambient sound quality data near the proposed facilities. To describe sound quality, an ambient sound survey was conducted at six locations, shown on Figure II.B-19. These locations, were selected to reflect the present sound climates at nearby noise-sensitive areas. A description of survey methodology and nomenclature is presented in Appendix E-1.

TABLE II.B-21

AMBIENT AIR QUALITY FOR OFFSITE STATIONS
1973-1976

PARAMETER MEASURED		SULFUR DIOXIDE (SO_2)			TOTAL SUSPENDED PARTICULATES (TSP)				CARBON MONOXIDE (CO)		
Measruing Site	Year	Highest[a] 3 hour Average (ppm)	Highest[a] 24 hour Average (ppm)	Annual Average (ppm)	Number Samples	Annual Geometric Mean $\mu g/m^3$	Highest[b] 24 hour Average $\mu g/m^3$	Secondary[b] Standard # Times > 150 g/m^3	Highest 1 hour Average (ppm)	Highest 8 hour Average (ppm)	Primary & Secondary Standards[c,e] # Times 8-hour Standard Exceeded
Asbury Park	1976[d]	.107	.035	.009	57	51.6	156	1	20.3	12.3	16
	1975	.154	.078	.010	59	50.3	123	0	30.9	10.6	9
	1974	.069	.044	.007	58	50.6	138	0	24.5	15.3	12
Freehold	1976[d]	.112	.046	.008					23.7	13.4	170
	1975	.143	.070	.013	—	—	—	-	19.1	12.6	156
	1974	.165	.085	.017					32.3	14.8	326
Red Bank	1976[d]				55	39.0	119	0			
	1975	—	—	—	59	38.7	95	0	—	—	—
	1974				60	43.8	120	0			
Brielle	1976[d]				60	35.6	126	0			
	1975	—	—	—	59	33.8	91	0	—	—	—
	1974				58	36.6	125	0			

Notes:

[a]Neither the primary or the secondary standard for SO_2 were exceeded in a 3 hour and 24 hour period.

[b]The primary standard for TSP (>160 $\mu g/m^3$) was not exceeded at any community site.

[c]Neither the primary nor the secondary 1 hour standard for CO were exceeded at any community site.

[d]Based on preliminary 1976 data - June not available.

[e]Based on moving 8 hour averages with potential for 24 hours above the standard each day.
Blanks indicate that no data for that site was generated; ppm - parts per million; $\mu g/m^3$ - micrograms per cubic meter of air
Highest average over a given period indicates the maximum average amount for that period on a particular day and year.

Source: NJDEP, 1977.

TABLE II.B-22

THE FEDERAL SIGNIFICANT DETERIORATION STANDARDS

	Particulate Matter		in $\mu g/m^3$	Sulfur Dioxide	
	Annual	24 hr.	Annual	24 hr.	3 hr.
Class I	5	10	2	5	25
Class II	19	37	20	91	512
Class III	37	75	40	182	700

Source: Air and Water Pollution Report, 1977.

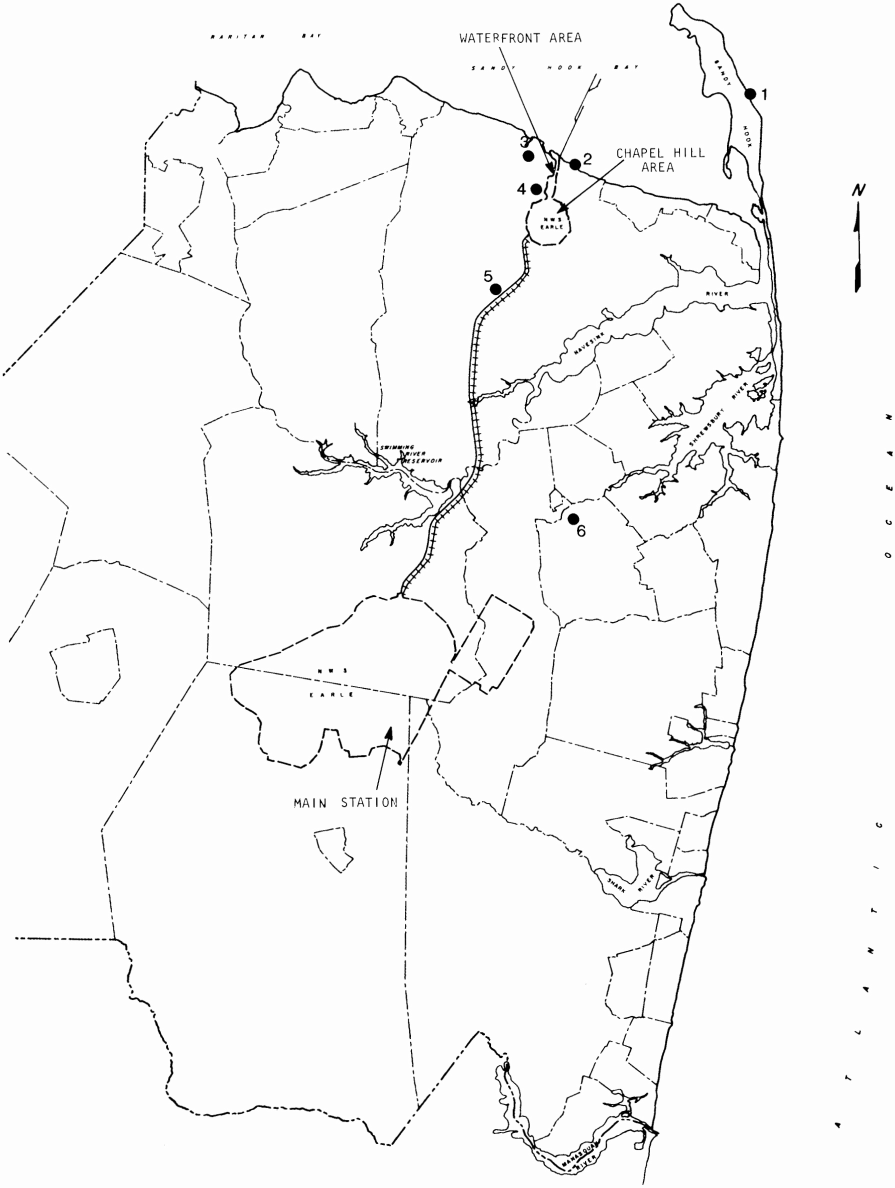
b. Survey Results

A summary of ambient sound survey results for the data collected at the six monitoring locations described below is presented in Table II.B-23. This table contains the statistical A-weighted sound levels L_{90}, L_{50}, L_{10} and average sound level, L_{eq}, for each measurement period, and L_d, L_n and L_{dn} at each measurement location. These data represent the background ambient sound levels of the existing environment near the proposed facilities. They were acquired during periods of characteristic activities at the site, and thus do not contain intrusive sounds.

The background ambient day-night sound levels at the measurement locations are compared with background ambient day-night sound levels of other land uses and communities (Figure II.B-20). Ambient sound levels as measured near homes in the area are typical of suburban small town and quiet suburban land uses. Except for Sandy Hook, the day-night sound levels ranged from 49.3 to 56.5. Traffic on rail lines and thoroughfares and overflying aircraft influence the sound quality.

The sound quality at Location 1 is representative of the recreational land use areas on Sandy Hook, approximately 2-1/2 miles east of the present and proposed waterfront facilities. This area, adjacent to Fort Hancock, is exposed to frequent periods of high winds, making wind noise a dominant noise source. Other noise sources in this area are traffic on Ocean Avenue, recretional activities, and frequent aircraft overflights.

Locations 2, 3 and 4 are noise sensitive land uses near the proposed waterfront facilities. These locations are representative of small residential communities near the area. Major noise sources at these locations are traffic along local roads, car and truck traffic on Route 36, residential activities, train noise, and frequent aircraft overflights.



AMBIENT SOUND SURVEY MEASUREMENT LOCATIONS

8000 0 8000 16000 FEET

SCALE

FIGURE II.B-19

TABLE II.B-23

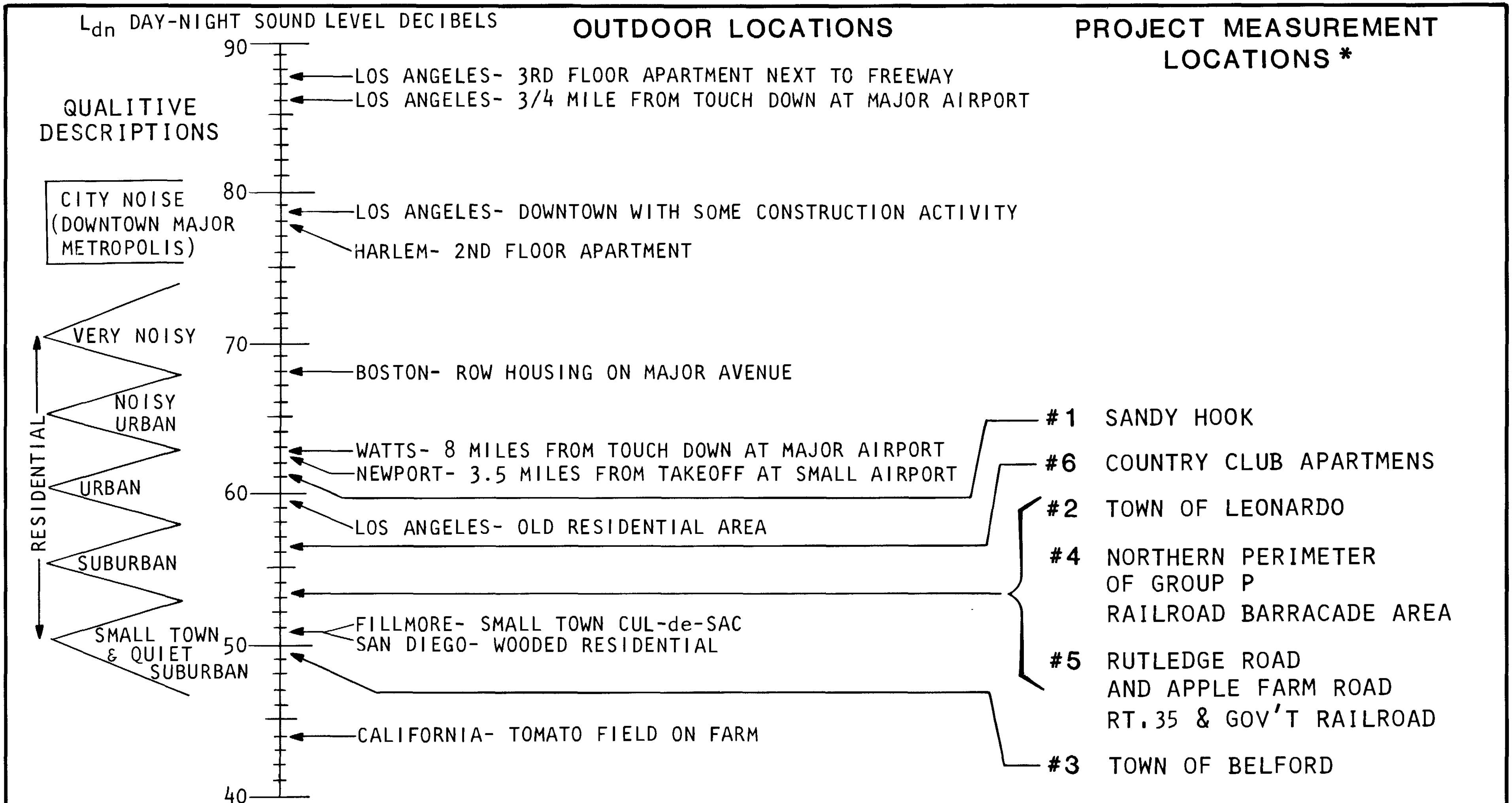
SUMMARY OF AMBIENT SOUND LEVELS (DECIBELS)

Location	Description		Morning (0700 - 1500)	Afternoon (1500 - 1800)	Evening (1800 - 2200)	Nighttime (2200 - 0700)
		Date, hour	11/15/77, 1325	11/15/77, 1620	11/15/77, 1850	11/15/77, 2225
1	Northern Boundary of Gateway National Park, Sandy Hook	L_{90}	43.0	50.0	47.0	48.0
		L_{50}	47.0	55.0	51.0	50.0
		L_{10}	55.0	50.0	61.0	58.0
		L_{eq}	53.3	57.4	55.7	54.7
		L_d				55.1
		L_n				54.7
		L_{dn}				61.2
		Date, hour	11/10/77, 1430	11/15/77, 1705	11/15/77, 1950	11/15/77, 2315
2	Residence on Cedar Avenue and Ray Avenue, Town of Leonardo	L_{90}	42.0	43.0	42.0	42.0
		L_{50}	44.0	45.0	44.0	43.0
		L_{10}	47.0	51.0	54.0	47.0
		L_{eq}	48.5	47.6	49.4	46.5
		L_d				48.6
		L_n				46.5
		L_{dn}				53.3
		Date, hour	11/9/77, 1035	11/9/77, 1715	11/9/77, 2120	11/10/77, 0050
3	Residence on Center Avenue, Town of Belford	L_{90}	40.0	41.0	41.0	36.0
		L_{50}	42.0	43.0	43.0	38.0
		L_{10}	53.0	50.0	52.0	40.0
		L_{eq}	50.7	48.7	48.8	38.2
		L_d				49.9
		L_n				38.2
		L_{dn}				49.3

TABLE II.B-23 (Continued)

SUMMARY OF AMBIENT SOUND LEVELS (DECIBELS)

Location	Description		Morning (0700 - 1500)	Afternoon (1500 - 1800)	Evening (1800 - 2200)	Nighttime (2200 - 0700)
	Date, hour		11/9/77, 1320	11/9/77, 1630	11/9/77, 2040	11/9/77, 0015
4	Residence on	L_{90}	43.0	44.0	39.0	37.0
	Fox Avenue and	L_{50}	48.0	50.0	44.0	40.0
	Chester Parkway,	L_{10}	57.0	56.0	52.0	46.0
	near northern	L_{eq}	54.0	53.6	49.1	42.5
	perimeter of	L_d				53.0
	group P Railroad	L_n				42.5
	Barricade Area	L_{dn}				52.8
	Date, hour		11/9/77, 1125	11/15/77, 1525	11/9/77, 1800	11/9/77, 2230
5	Residence on	L_{90}	45.0	43.0	38.0	35.0
	Rutledge Drive and	L_{50}	47.0	49.0	45.0	37.0
	Apple Farm Road,	L_{10}	55.0	61.0	58.0	42.0
	near Route 35 and	L_{eq}	51.7	57.3	53.3	43.5
	along U.S. Govern-	L_d				53.9
	ment Railroad	L_n				43.5
		L_{dn}				53.7
	Date, hour		11/9/77, 1210	11/9/77, 1500	11/9/77, 1850	11/9/77, 2320
6	County Clerk	L_{90}	45.0	45.0	41.0	37.0
	Departments, near	L_{50}	50.0	49.0	48.0	43.0
	Camp Charles Wood	L_{10}	59.0	57.0	56.0	52.0
	and Fort Monmouth	L_{eq}	55.1	53.5	52.0	48.8
		L_d				54.1
		L_n				48.8
		L_{dn}				56.5



BACKGROUND AMBIENT DAY-NIGHT SOUND LEVEL AT PROJECT AREA: COMPARISON TO OTHER AREAS

SOURCE: USEPA, MARCH 1974

*NOTE: SEE FIGURE II.B-19 FOR LOCATION OF STATIONS

FIGURE II.B-20

The sound quality of Location 5 is representative of more recently developed residential areas adjacent to the Government Railroad, in the Middletown area. Sound levels at this location are dominated by residential activities and local traffic. Occasional cars and trains along the U.S. Government road and railroad also contribute to sound levels at this location.

The ambient sound level at Location 6 is typical of the densely populated apartment and residential dwellings adjacent to Ft. Monmouth and Camp Charles Wood in Eatontown. Sound levels in this area are predominantly due to heavy vehicular traffic along major routes and local roads, residential activities, and frequent aircraft overflights.

C. ESTUARINE ENVIRONMENT

C.1 Introduction/General Setting

Construction and dredging for the proposed expansion of the NWS Earle pier and channel improvements would take place on or adjacent to the Sandy Hook Bay and in the Sandy Hook Channel approach to New York Harbor.

Sandy Hook Bay is a subdivision of the Raritan Estuary, which also includes the Raritan Bay and Lower Bay (Figure II.C-1). The Raritan Estuary is a roughly triangular body of water with a surface area of approximately 72 square miles. It is located at the apex of the New York Bight, which is formed by the Atlantic Ocean coasts of Long Island and New Jersey. The estuary is bounded on the north by Staten Island, New York, on the south by the shoreline of Monmouth County, New Jersey and on the east by the Atlantic Ocean and Sandy Hook. Sandy Hook is a five-mile long active sand spit. At the present time, the estuary is connected with the Atlantic Ocean through a 5.5 mile wide opening between the tip of Sandy Hook and Rockaway Point, Long Island (the Sandy Hook-Rockaway Point Transect, Figure II.C-1).

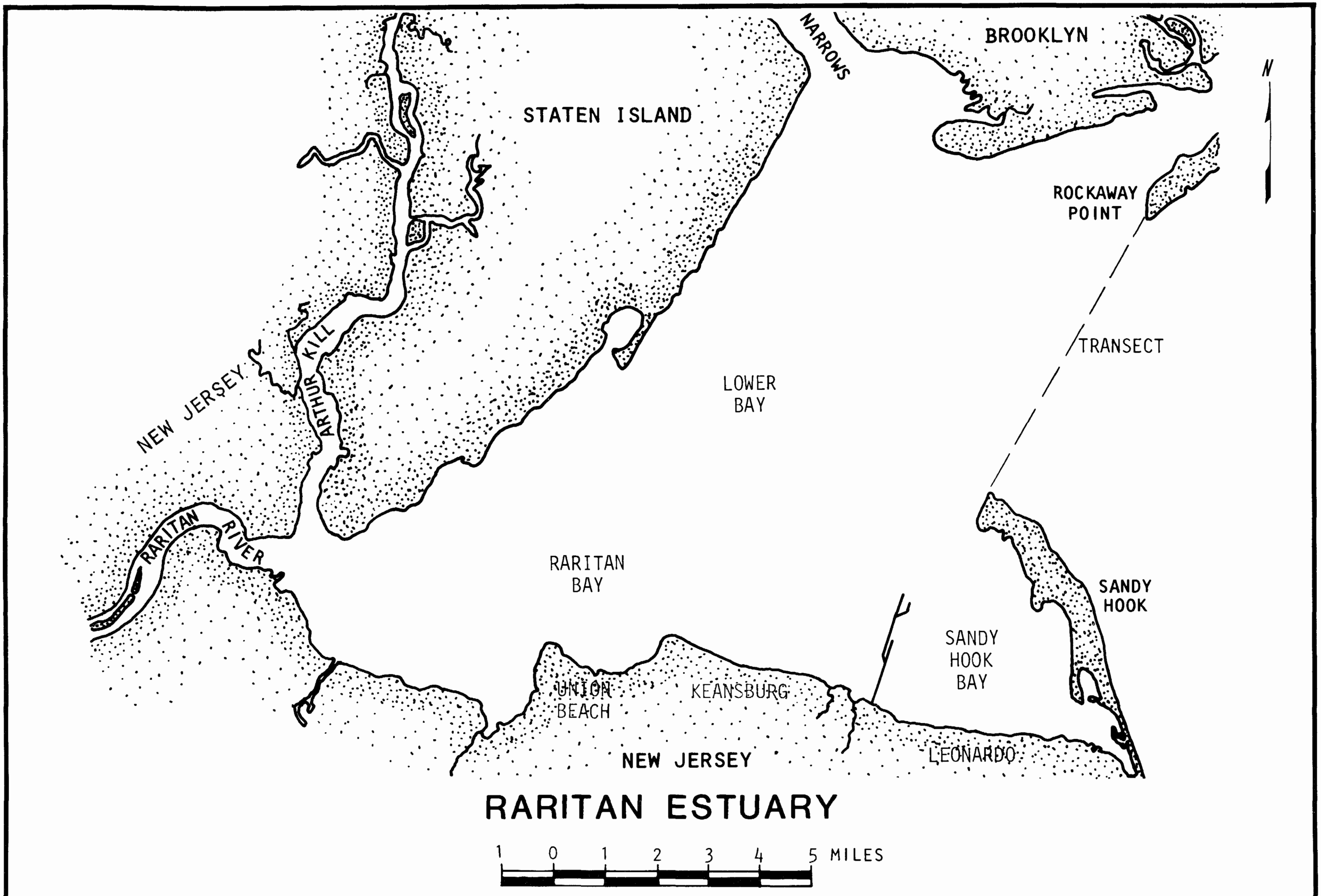

STATEN ISLAND
BROOKLYN
NARROWS
N
ROCKAWAY POINT
TRANSECT
NEW JERSEY
ARTHUR KILL
LOWER BAY
RARITAN RIVER
RARITAN BAY
SANDY HOOK
SANDY HOOK BAY
UNION BEACH
KEANSBURG
NEW JERSEY
LEONARDO
RARITAN ESTUARY
1 0 1 2 3 4 5 MILES

FIGURE II.C-1

The Raritan River and Arthur Kill form the western extreme of the Raritan Bay and the Navesink/Shrewsbury River system enters into Sandy Hook Bay from the southeast. The Hudson River flows south through the Narrows into the Lower Bay at the northeast corner of the estuary. The main flow of the Hudson, however, is east of the estuary into the Atlantic Ocean. Several short creeks flow through fringing salt marshes into the estuary along the southern shore.

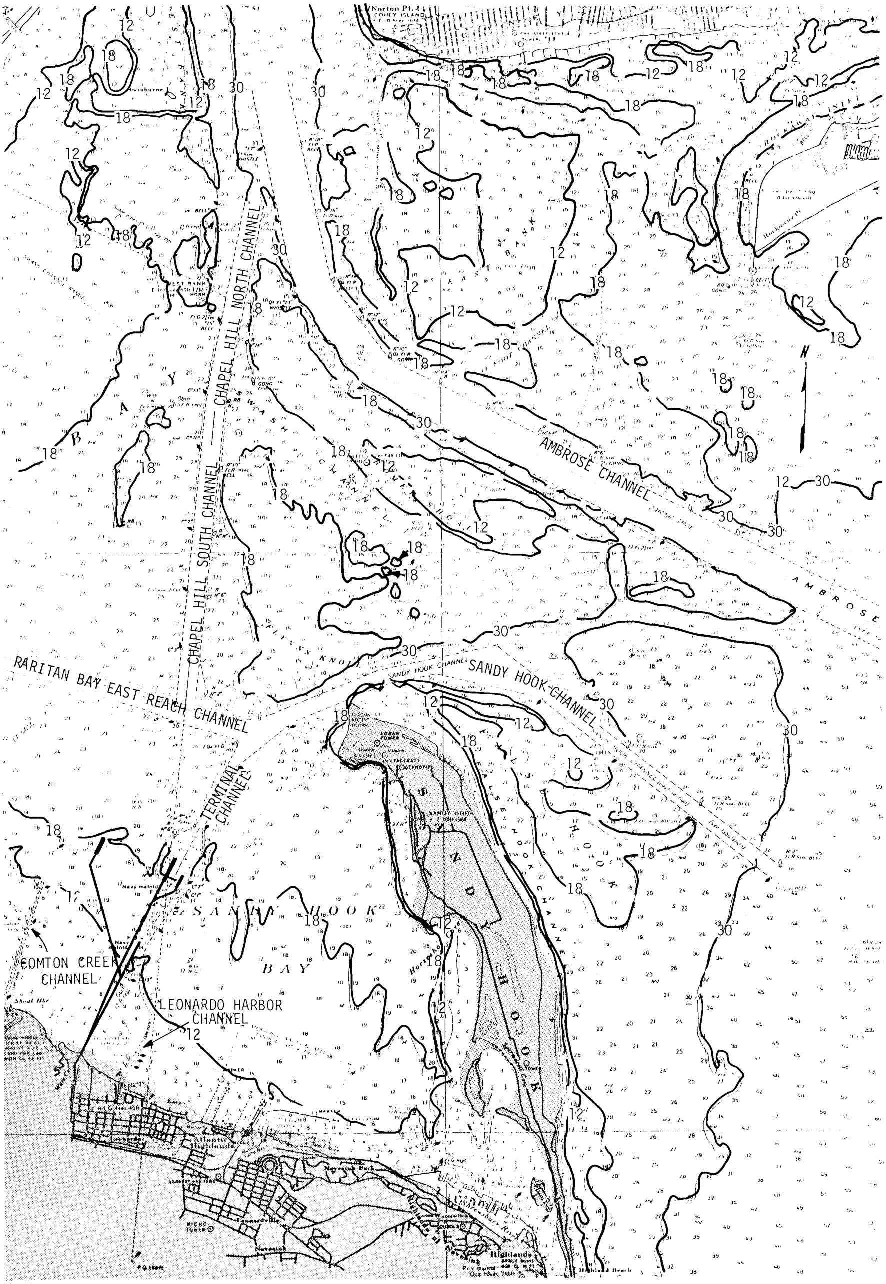
The following sections will concentrate primarily on the eastern portion of the Raritan Estuary in which the project area is located and the adjacent channel approach areas east of Sandy Hook.

C.2 Bathymetry

The bathymetry of the eastern portion of the Raritan Estuary and the adjacent offshore area is shown in Figure II.C-2. The estuary is a shallow embayment with water depth generally less than 30 feet. Bottom slopes or gradients are generally less than 1:200 and in places are as flat at 1:2000 (Alpine, 1969).

Depth contours generally parallel the shorelines of the estuary and adjacent Atlantic Ocean. This pattern is interrupted by the Sandy Hook spit and a series of shoals extending into and across the mouth of the Estuary. The shoals rise above the bottom to within 10 feet of the surface. The Sandy Hook spit and associated coastal processes will be discussed in greater detail in the Coastal Processes section (C.7d) of this chapter.

Depths exceeding 50 feet occur immediately off the northern tip of the Sandy Hook spit and appear to be the result of scouring by high velocity tidal currents. Depths of about 70 feet were measured locally along Sandy Hook Channel in the same northern tip area during field studies in October, 1977.



BATHYMETRY: PROJECT AREA

1 ½ 0 1

NAUTICAL MILES

KEY:

—18— DEPTH IN FEET
—30— DEPTH IN FEET
—12— DEPTH IN FEET

DATUM MLW

NOTE:
SEE TABLE II.C-1 FOR CHANNEL SPECIFICATIONS

FIGURE II.C-2

The area of the existing and proposed NWS Earle piers in Sandy Hook Bay range in depth from about 30 feet in the north to six feet or less, approximately 0.5 miles offshore. The 12- and 18-foot depth contours cross the pier area parallel to the shore at distances of about one and two miles offshore, respectively.

Sandy Hook Channel and Sandy Hook Channel East Sector are major incoming shipping channels, providing access from the 40 foot depth contour offshore to the Lower Bay and Sandy Hook Bay. It connects with Raritan Bay Channel to the west, Chapel Hill Channel to the north and Terminal Channel to the south. Offshore access to the NWS Earle piers is through Sandy Hook Channel to Terminal Channel. Several minor channels have been dredged to provide access to small boat harbors. In the immediate vicinity of the NWS Earle pier area, Compton Creek Channel provides access to Belford via Compton Creek and Leonardo Harbor Channel provides access to the State Marina at Leonardo. These channels are located about one mile to the northwest and 0.5 miles to the southeast, respectively, of the NWS Earle piers. The major shipping channels and minor dredged channels located within the proposed project area are listed with their project dimensions in Table II.C-1.

C.3 Hydrography

a. Tides

1. Astronomical Tides - Tides throughout the Raritan River Estuary and adjacent coastal waters are semidiurnal, having two high waters and two low waters per tidal day. The sequence of tides is from higher high water (HHW) to lower low water (LLW). However, the diurnal inequality is not pronounced. The mean range of tide within the estuary varies from 4.9 feet at Keansburg, to 4.6 feet at Sandy Hook (Table II.C-2, Figure II.C-1). The mean range along the outer coast is 4.4 feet. The ranges of spring tides, which are by definition greater than average, follow a similar trend at these locations with

TABLE II.C-1

DREDGED CHANNELS

Major Shipping Channels	Project Dimensions		
	Length (Naut. Mi.)	Width (Ft.)	Depth (Ft. MLW)
Ambrose Channel	9.2	2,000	45
Sandy Hook Channel (East)	2.9	800	35
Sandy Hook Channel	4.0	800	35
Chapel Hill South Channel	2.7	1,000	30
Chapel Hill North Channel	1.8	1,000	30
Terminal Channel	0.8	400	35
Raritan Bay East Reach	4.0	600	35

Shoal Channel is a natural passage between Romer Shoal and Flynns Knoll. Depths vary between 18 and 30 feet.

Minor Channels			
Compton Creek Channel	1.1	150	12
Leonardo Harbor Channel	0.4	150	8

Atlantic Highlands Breakwater Harbor has been dredged to 8 feet.

Note: For locations, see Figure II.C-2.

Source: NOAA Chart #12327 - New York Harbor.

TABLE II.C-2

TIDAL CHARACTERISTICS OF SANDY HOOK BAY

Station	Position: Latitude ° ' N	Position: Longitude ° ' W	Ranges: Mean Ft.	Ranges: Spring Ft.	Ranges: Neap Ft.	Mean Tide Level Ft. (MLW)
Keansburg[1]	40 27	74 09	4.9	5.9		2.4
Port Monmouth[1]	40 26	74 05	4.8	5.8		2.4
Atlantic Highlands[1]	40 25	74 02	4.7	5.7		2.3
Sandy Hook[1]	40 28	74 01	4.6	5.6		2.3
Sandy Hook[2]	40 27	74 00	4.7	5.6	3.5	
Sea Bright[1]	40 22	73 58	4.4	5.3		2.2

Sources:

[1]National Ocean Survey, 1977

[2]Marmer, 1935

values of 5.9 feet, 5.6 feet and 5.3 feet for Keansburg, Sandy Hook and the New Jersey coast, respectively (Table II.C-2).

The tide station at Sandy Hook serves as a reference location for the daily tide prediction prepared by the National Ocean Survey (NOS) (NOAA, 1977a). Tidal characteristics for Sandy Hook and for additional subordinate stations on the Sandy Hook Bay shore and New Jersey coast are provided in Table II.C-2.

2. Storm Tides - Hurricanes and other severe wind storms can cause major deviations from the normal tide levels. The difference between an observed high water level and the predicted normal water level is known as storm surge. Storm surge occurrences in the vicinity of Sandy Hook have been studied in detail (Pore and Barrientos, 1975; USACOE, 1972). Discussions of the major storms that have affected the area and estimates of storm surge recurrence are presented in these studies.

Table II.C-3 summarizes the recent storm surge history for five hurricanes and northeastern storms that caused the highest tidal flood levels. Of these storms, Hurricane "Donna" (Sept. 1960) produced the highest recorded tide level, which was 8.6 feet above mean sea level (MSL) at Sandy Hook.

Figure II.C-3 shows the high tide frequency relationships for the Sandy Hook Bay area. These curves are based upon the evaluation of available data for approximately 250 storms. This figure also includes two projected flood levels that are commonly used in flood protection planning. These are the Intermediate Regional Tidal Flood and the Standard Project Tidal Flood.

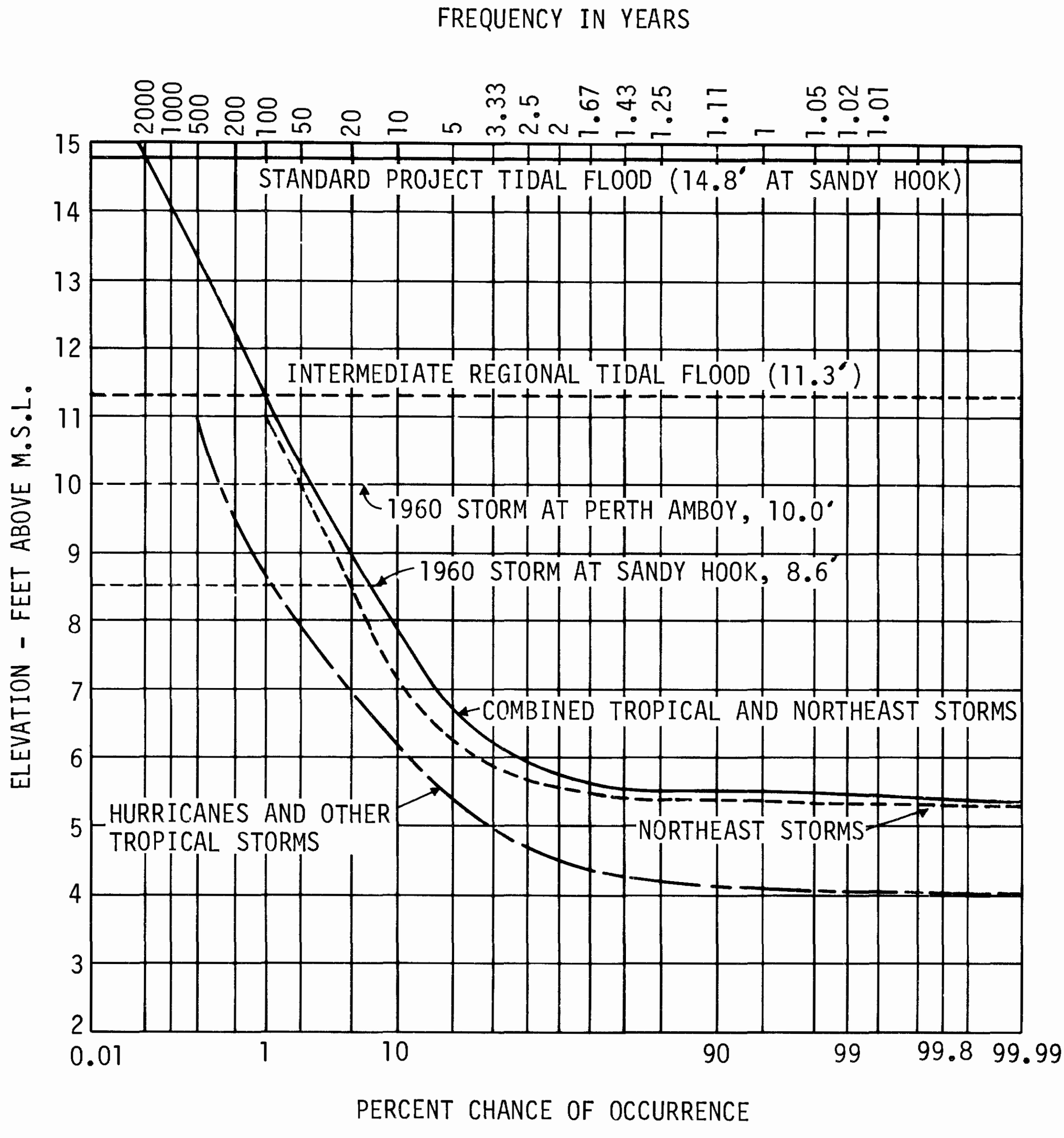
The Intermediate Regional Tidal Flood is defined as a tide having an average frequency of occurrence of one in 100 years. Such tide levels, however, may occur in any year. Results of a study by the Corps of Engineers indicate that the Intermediate Regional Tidal Flood applicable to the Sandy Hook Bay Area

TABLE II.C-3

STORM TIDES IN THE SANDY HOOK AREA

Storm	Date	Maximum Tidal Elevation (Ft. MSL) Sandy Hook Outer Coast
Hurricane "Donna"	12 Sept 1960	8.6
Northeaster	6-7 Nov 1953	7.9
Northeaster	6-8 Mar 1962	7.8
Hurricane	14-15 Sept 1944	7.4
Northeaster	25 Nov 1950	7.2

Source: USACOE, July 1972.



EXTREME HIGH TIDE FREQUENCY RARITAN ESTUARY

SOURCE: U.S. ARMY CORPS OF ENGINEERS, 1972

FIGURE II.C-3

reaches an elevation of 11.3 feet mean sea level (MSL). Areas inundated by the Intermediate Regional Tidal Flood are shown on Figure II.C-4.

The Standard Project Tidal Flood is defined as the tide that may be expected from the most severe combination of meteorological and hydrological conditions (excluding extremely rare combinations) considered reasonably characteristic of the area. The tide level associated with the Standard Project Tidal Flood in the Sandy Hook Bay Area is 15.6 feet MSL. This tide level represents the estimated upper limits of the expected tidal flooding that may occur in the area.

C.4 Currents and Circulation Patterns

In the entrance area of the Raritan Estuary, the velocity of the current at full strength averages between 1.5 and 2.0 knots. Within the Bay itself, the current is weaker, being less than one knot at strength. Currents at the entrance to the Sandy Hook Channel are rotary in nature with magnitudes of less than one knot. In general, as a result of fresh water discharge from the estuary, ebb currents are somewhat stronger than flood currents (Marmer, 1935).

a. Netflow

Net current flow in the estuary is schematically presented in Figure II.C-5 (Jefferies, 1962). Flow along the New Jersey Coast of the estuary is dominated by the saline water entering through the estuary mouth. This flow moves west toward the southern end of Staten Island and arrives in the area of extensive eddies where it mixes with water from the Raritan River and the Arthur Kill. A southward thrust of flooding water nearly bisects the slug of water that is discharged from the Raritan River during the previous ebb tide. This flow feature has been called a "milking action" (Jefferies, 1962; Ayers, et al, 1949). This "milking action" accelerates the seaward movement of freshened water along the south shore of the estuary. Some of this water enters the clockwise gyre that lies west of the NWS Earle pier.

The currents within Sandy Hook Bay to the east of the pier are generally weak (NOAA, 1977b), except for the area near the mouth of the Shrewsbury River in the southern extremity of the Bay, where currents reach 2.5 knots at strength. The ebb flow from the river has an exceptionally long duration of about nine hours. The flood currents flow for only 3.5 hours (Marmer, 1935). The ebb flow moves along the shore of Sandy Hook and joins the net eastward flow that sweeps the Terminal Channel. Both flows exit the estuary around the northern tip of Sandy Hook (Figure II.C-5).

In the immediate vicinity of the entrance to the Raritan Estuary, the oceanographic regime is dominated by the discharge from the Raritan and Hudson Rivers. The surface layers carry the brackish estuarine waters seaward. The flow turns southward paralleling the New Jersey shoreline.

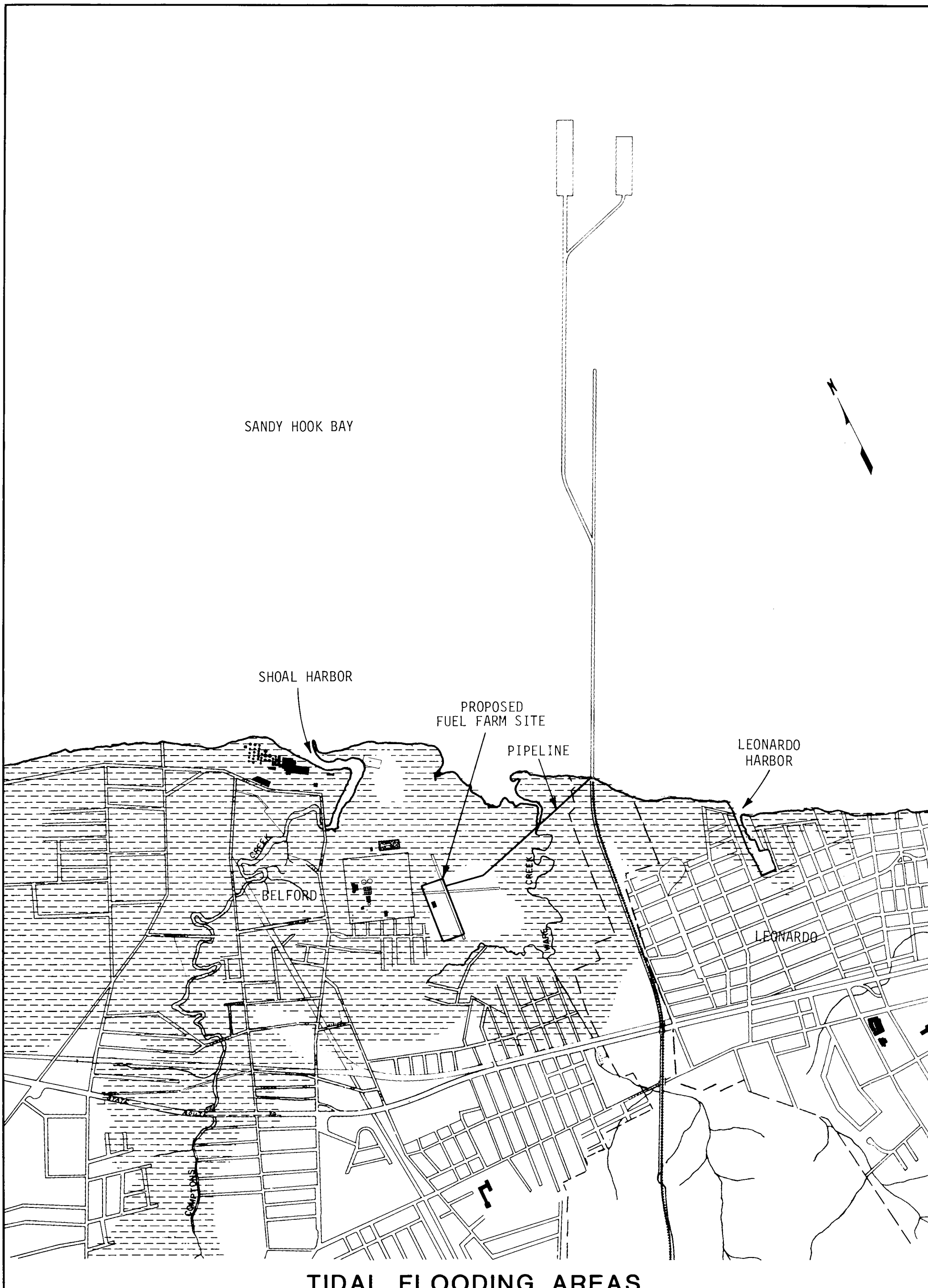
The characteristics of the estuary discharge plume vary seasonally with river runoff. The plume does not exhibit a clearly defined path under low runoff conditions (Bowman and Wurderlich, 1977).

A return flow of water into the estuary occurs in the lower depths of the estuary entrance. This two-layer flow appears only as a slight imbalance of the ebb and flood tidal currents in the bottom and surface layers.

Figure II.C-6 is a profile from Sandy Hook to Rockaway which shows the average current velocities over a tidal cycle (Kao, 1975). This profile illustrates the two-layer flow imbalance with bottom return flows present within the Sandy Hook and Ambrose Channels.

b. Sandy Hook Vicinity

The general flow patterns discussed above result from the averaging of the currents over time. This section discusses the time variation of currents in the vicinity of Sandy Hook.



TIDAL FLOODING AREAS

(100-YEAR TIDAL FLOOD)

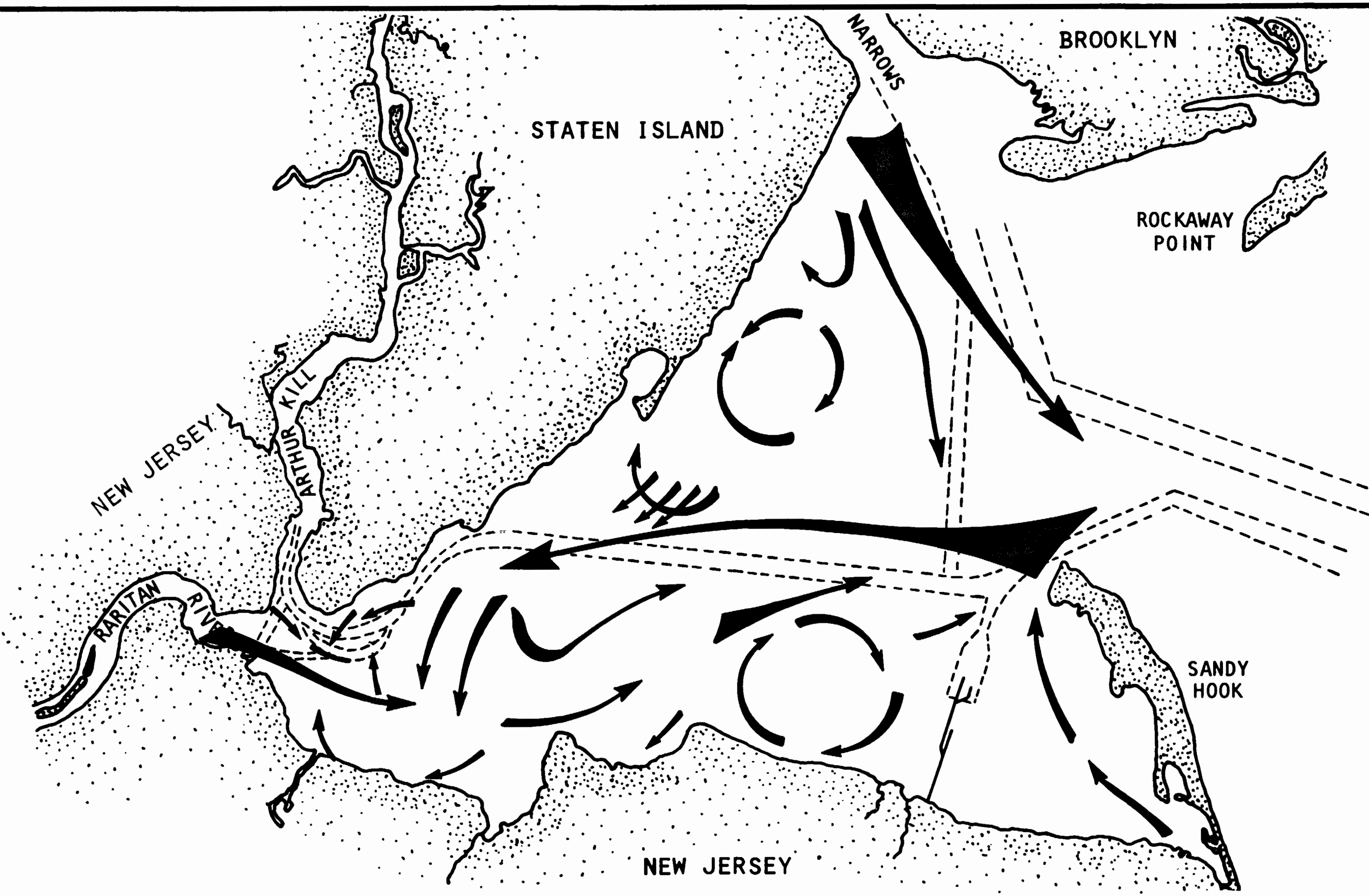
SOURCE: DEPT. OF ARMY, N.Y. DISTRICT, CORPS OF ENGINEERS, "TIDAL FLOOD PLAIN INFORMATION: SANDY HOOK & RARITON BAY," JULY 1972.

KEY: AREA BETWEEN MEAN SEA LEVEL & INTERMEDIATE REGIONAL TIDAL FLOOD STAGE OF 11.3 FEET ABOVE MEAN SEA LEVEL.

1000 0 1000 2000 3000

APPROX. SCALE IN FEET

FIGURE II.C-4



CIRCULATION : RARITAN ESTUARY

1 0 1 2 3 4 5
MILES

SOURCE: JEFFERIES, 1962

KEY:
SHIPPING CHANNELS

FIGURE II.C-5

Figures II.C-7 through II.C-10 show the spatial variation of currents at low, high and intermediate tide levels. The currents are those that would be encountered on days when the tide is at its mean range. Strong winds and freshets, however, bring about nontidal currents which may considerably modify the current magnitudes and directions shown in the figures.

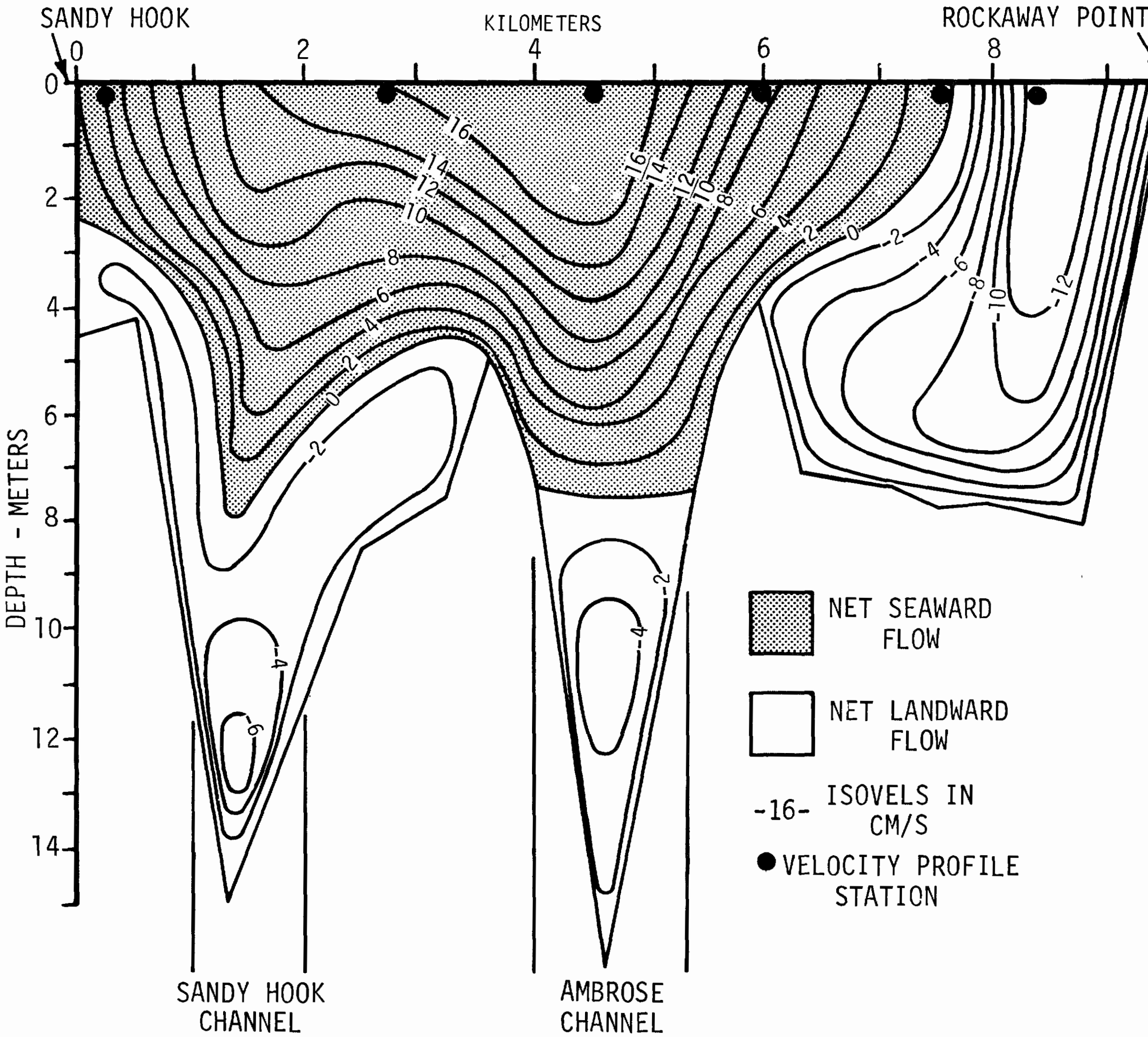
The major flow features identified on these figures are: 1) the east-west flow moving across the Terminal Channel; 2) the predominant ebb flow along the Sandy Hook shore; 3) the high currents at the tip of Sandy Hook; 4) the southward flow of estuary discharge around the tip of Sandy Hook; and, 5) the rotary nature of the tidal currents at the entrance to the Sandy Hook Channel.

Figure II.C-11 shows the rotary current plot for the channel entrance. Minimum currents are about 0.2 knots; maximum currents are 0.6 knots. The greater strength of the southeasterly maximum current results in a net drift of 0.02 knots in that direction.

c. NWS Earle Pier Area

Currents in vicinity of the pier are generally weak as in the case throughout most of Sandy Hook Bay. Current measurements predating the pier have been reported by Marmer (1935). The directions and magnitudes of the currents are shown in Figure II.C-12. Recent results have also been obtained. Current meters were moored at mid-depth during the period from 22 October to 2 November 1977. The locations of these current meter stations in also shown on Figure II.C-12.

The areas to the north and west of the pier are swept by currents with strengths along an approximate east-west line. The progressive vector plot for current meter Station 2 to the northwest of the existing pier is shown in Figure II.C-13. This shows the currents to be of a rotary nature with the axis of maximum

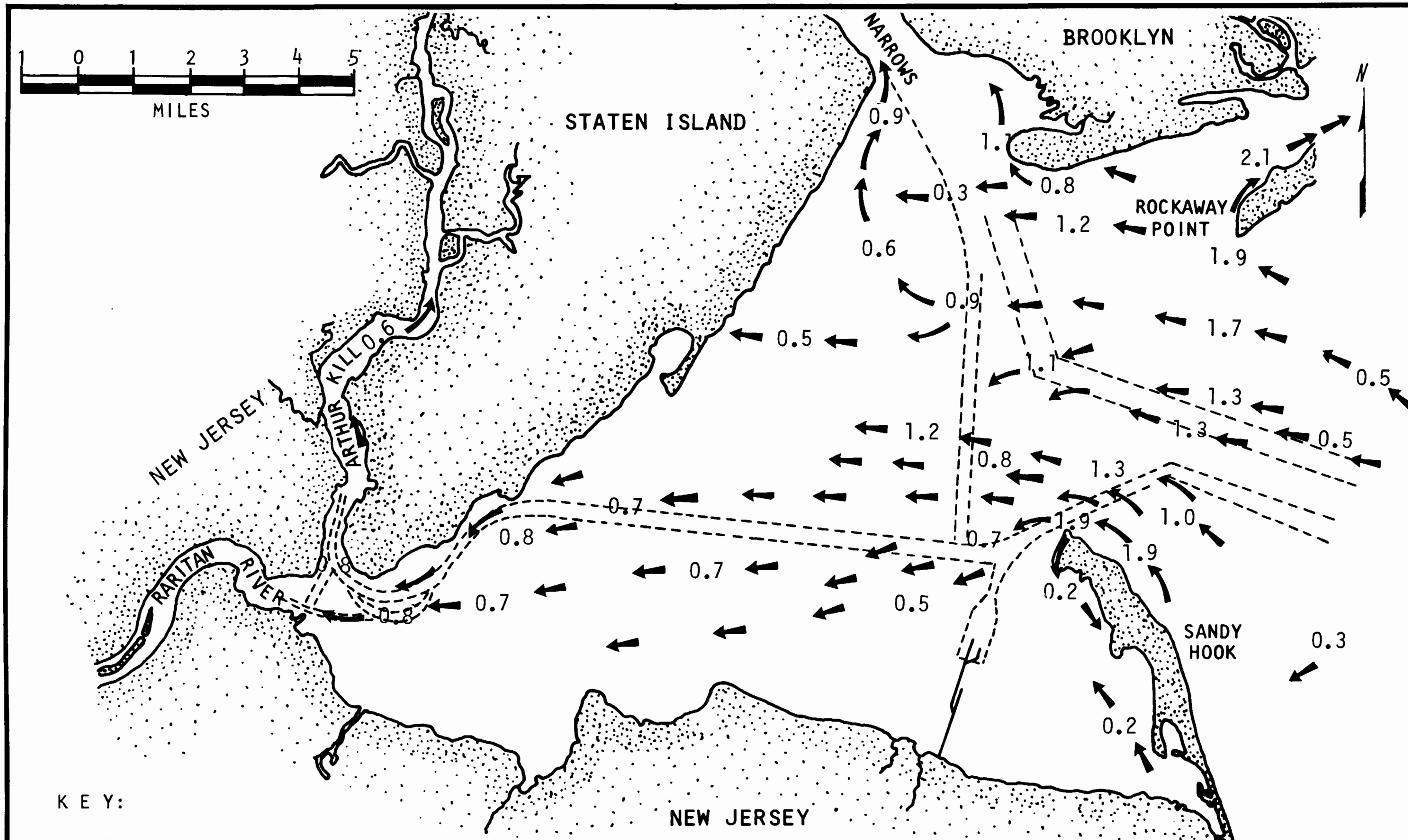


NET NON-TIDAL FLOW ACROSS THE SANDY HOOK-ROCKAWAY POINT TRANSECT

NOTE: SEE FIGURE II.C-1 FOR LOCATION

SOURCE: KAO, 1975

FIGURE II.C-6



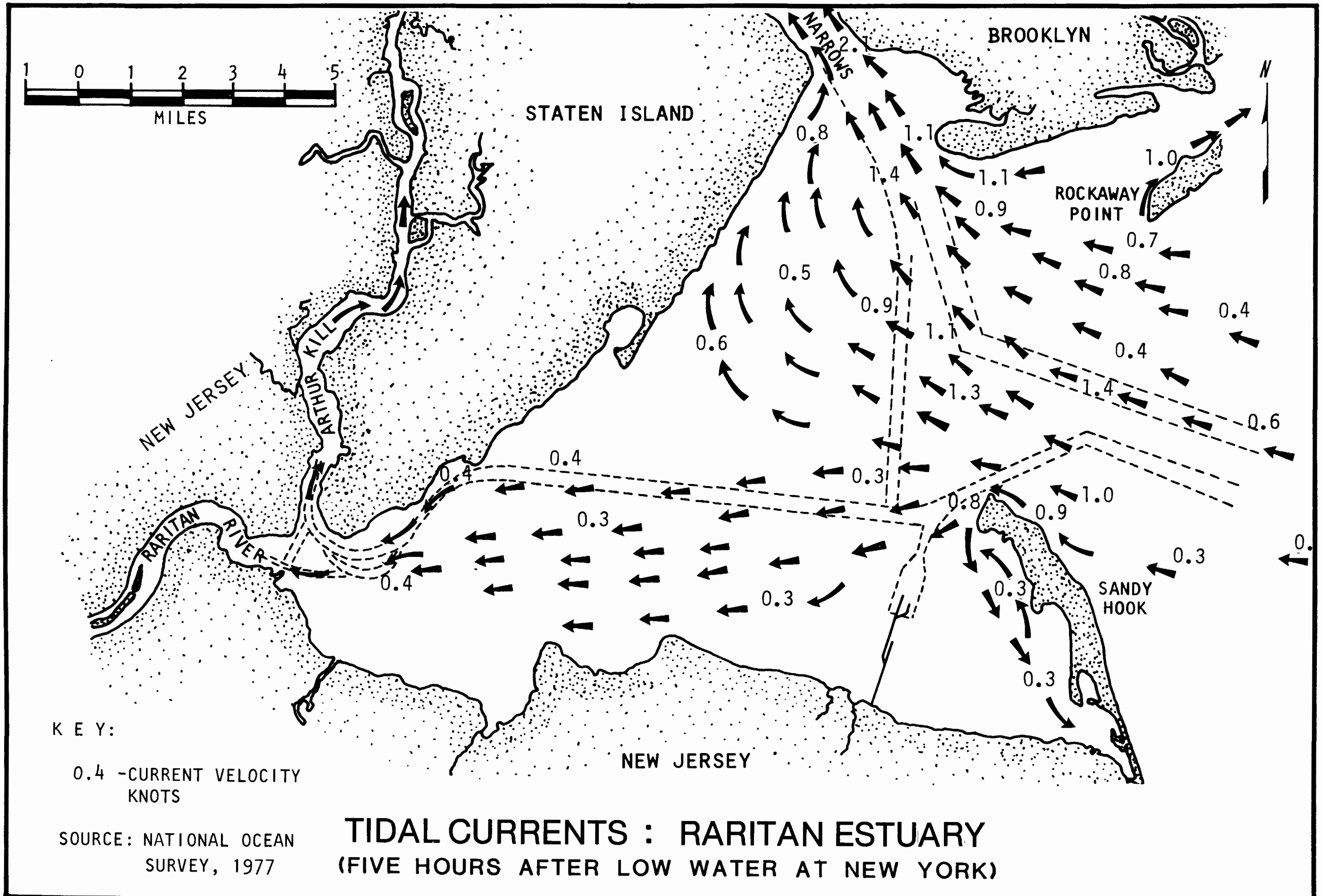
KEY:

0.4 -CURRENT VELOCITY KNOTS

SOURCE: NATIONAL OCEAN SURVEY, 1977

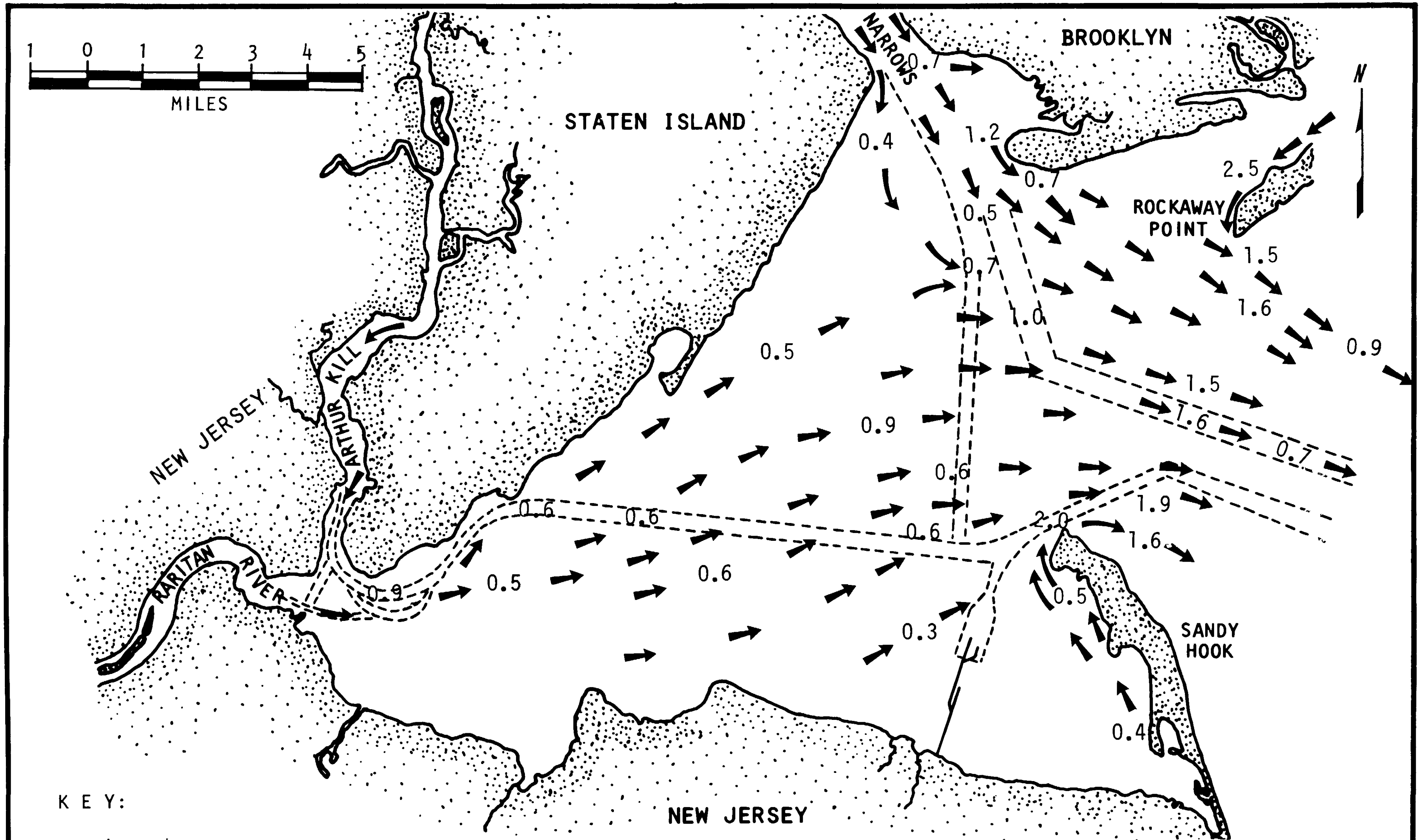
TIDAL CURRENTS : RARITAN ESTUARY
(TWO HOURS AFTER LOW WATER AT NEW YORK)

FIGURE II.C-7



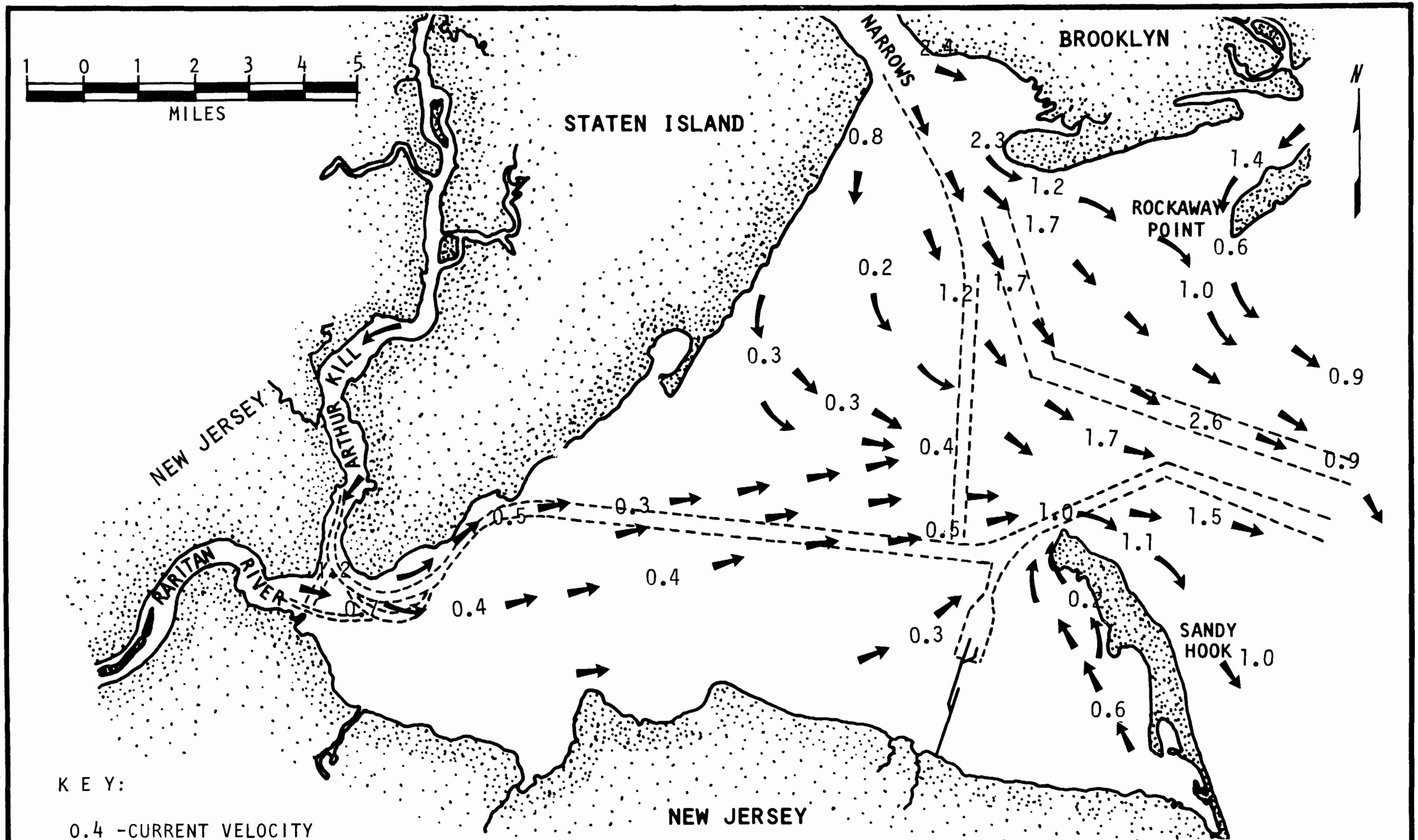
TIDAL CURRENTS : RARITAN ESTUARY
(FIVE HOURS AFTER LOW WATER AT NEW YORK)

FIGURE II.C-8



TIDAL CURRENTS : RARITAN ESTUARY
(TWO HOURS AFTER HIGH WATER AT NEW YORK)

FIGURE II.C-9



KEY:

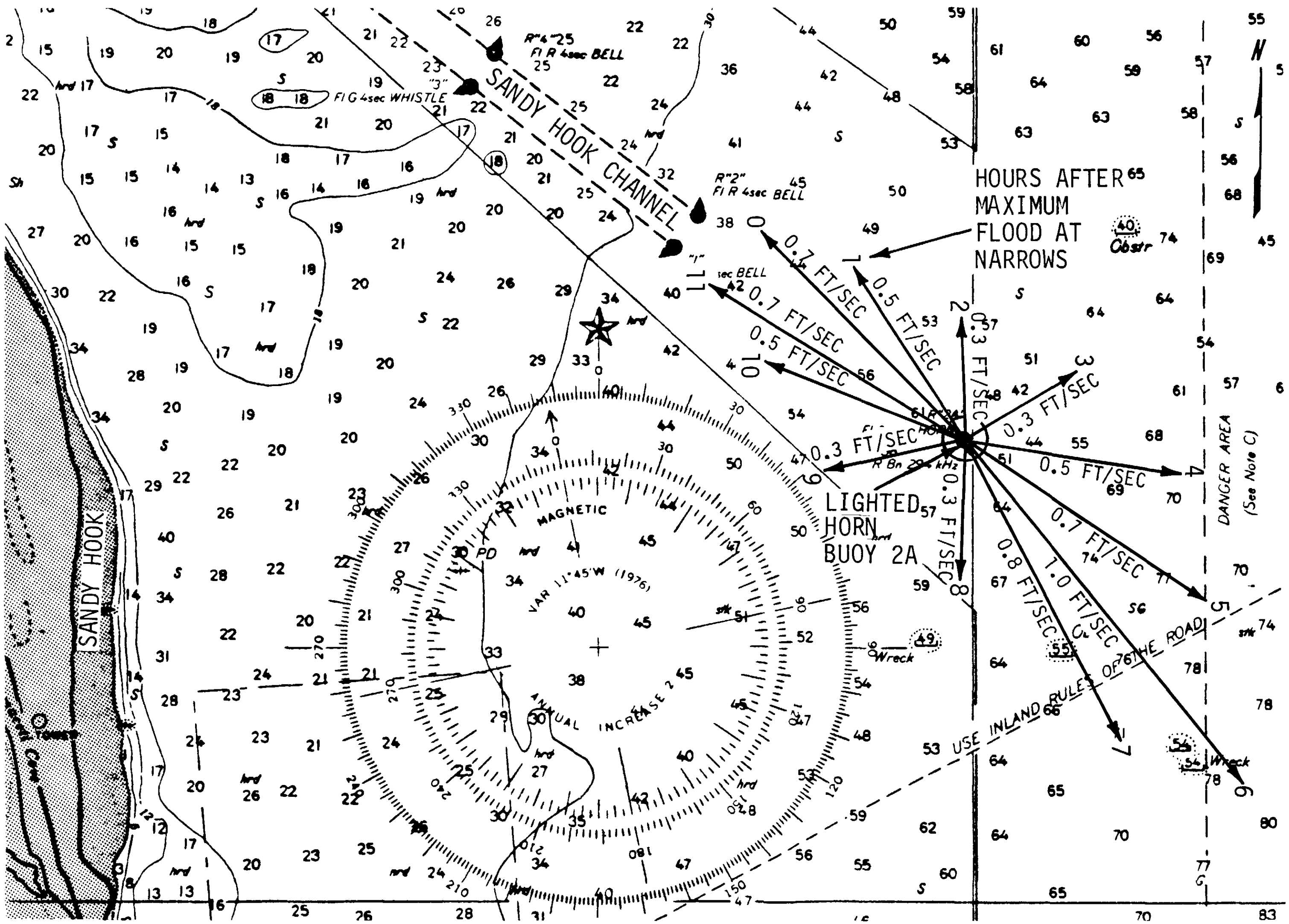
0.4 -CURRENT VELOCITY KNOTS

SOURCE: NATIONAL OCEAN SURVEY, 1977

TIDAL CURRENTS : RARITAN ESTUARY

(FIVE HOURS AFTER HIGH WATER AT NEW YORK)

FIGURE II.C-10



ROTARY CURRENT PLOT

CHART SCALE

0 ½ 1

NAUTICAL MILES

SOURCE: U.S. DEPT OF COMMERCE "TIDAL CURRENT TABLES: ATLANTIC COAST OF NORTH AMERICA", NOAA, 1977.

FIGURE II.C-11

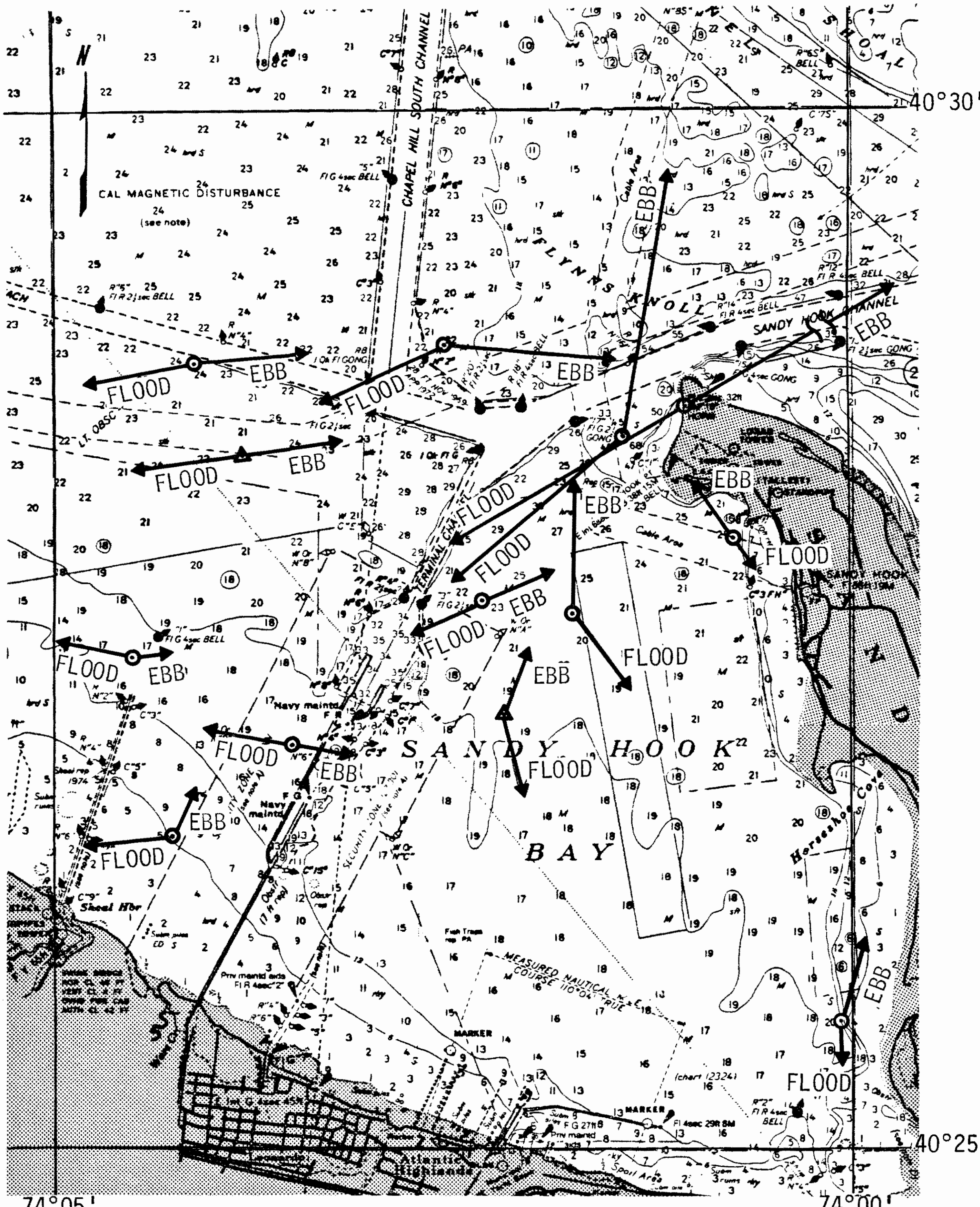
current strength in the east-west direction. The figure also indicates a net drift to the east-northeast averaging about 0.08 feet per second for the period of record.

Current meter Station 1 is located immediately east of the end of the existing pier. As Figure II.C-12 shows, the recorded north-northeast ebb and the south-southeast flood flow is consistent with the earlier report current measurements. The progressive vector plot for Station 1 is shown on Figure II.C-14. This figure shows a steady net drift to the southeast of about 0.26 feet per second. These results suggest that counter-clockwise gyre may exist in the northern part of Sandy Hook Bay. Flow moves to the southeast, possibly joining the predominant ebb flow along the Sandy Hook shore in a movement to the north.

C.5 Waves

The Raritan Estuary is affected both by ocean waves entering through the opening between Sandy Hook and Rockaway Point, as well as by waves generated within the estuary. Wave height data based on actual observations within the estuary are limited. Alpine (1969) has summarized most of the existing data for the area as follows:

> "...Experienced seafearing personnel have estimated that swells as high as 15 feet occur between Sandy Hook and Rockaway Point after severe ocean storms. Within the estuary these waves and swells will be modified in both height and direction by the effects due to refraction and shoaling. A study indicated that although waves 14 feet in height from the east-northeast direction would be generated in the ocean by 40-mile per hour winds, the waves would probably not exceed 6 feet in the area off Point Comfort in Keansburg.
>
> In 1945, the firm of Frederic R. Harris, consulting engineers, made a study of wave heights in the vicinity of the U.S. Navy pier at Leonardo. They concluded that 15-foot swells entering between Sandy Hook and Rockaway Point would be reduced to a maximum of 6 feet in the area off the Navy pier because of refraction.
>
> No wave gaging stations have been established in Raritan Estuary. However, a study of deep-water wave heights, frequency of occurrence, and direction of approach, based upon hindcasting technique and use of synoptic weather



FLOOD AND EBB CURRENTS

SANDY HOOK BAY

SOURCE: MARMER, 1935
DAMES & MOORE FIELD SURVEY, 1977
(SEE APPENDIX F)

KEY:
MARMER DATA STATIONS
D&M DATA STATIONS

SCALE
0 1
FT/SEC

0 1.0
NAUTICAL MILE

FIGURE II.C-12

charts for the three-year period 1948-1950, were made by the Beach Erosion Board for the Atlantic Coast, and published at Technical Memorandum No. 55. Graphs of wave heights for the entrance to New York Harbor (Lat. $40^{\circ}15'$N, Long. $73^{\circ}45'$W) made in conjunction with this study revealed that 28 percent of the time computed waves were 4 feet or greater in height, 9.5 percent 8 feet or greater, 2.0 percent 14 feet or greater, and only 1.0 percent of the time 18 feet or greater. The largest waves computed for this period were between 25 and 30 feet in height, but waves of this magnitude would be expected for a period of only 52 hours or during 0.2 percent of the period of observation. Refraction data for the New York Bight indicates that 50 percent of the wave energy comes from the east-northeast, 25 percent from the east, and nearly all the remainder from the quadrant between east and south.

No refraction data are available for Raritan Estuary, since the effect of Ambrose Channel and other channels in Lower New York Bay on wave refraction is unknown".

C.6 Water Quality

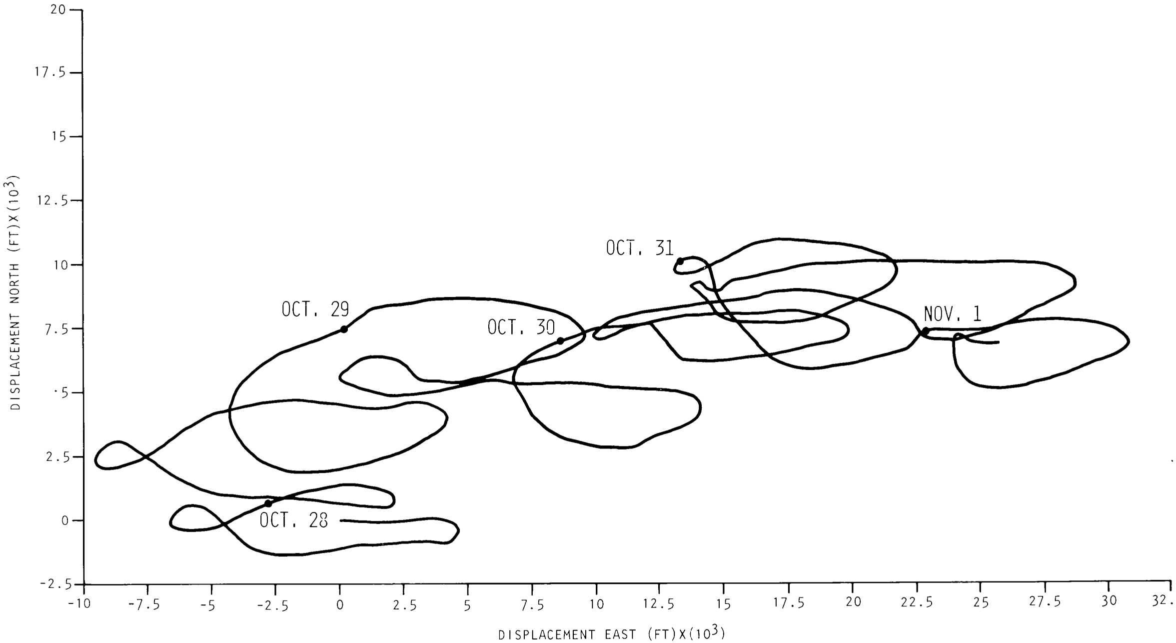
a. Temperature and Salinity

Due to the well mixed nature of the Raritan Estuary, temperature and salinity are nearly the same from the bottom to the top at any one location (vertically homogeneous estuary) (Bumpus, et al., 1973). Salinity and temperature regimes follow river inflow. Salinity variations reflect the seasonal variation of fresh water inflow, most of which (95 percent) is contributed by the Hudson River and its tributaries. During high river discharge in the spring, salinity values are low (11 parts per thousand (^{o}/oo) and highest during the summer (24^{o}/oo).

Water temperatures may vary from 0^{o}C to 26^{o}C. The highs occur in July; the lows in January or February.

b. Water Pollution Sources

The Raritan Estuary lies adjacent to the New York-New Jersey Metropolital Region and its water quality has been degraded as a result of an overload from various pollutant sources. The major sources of pollution for the



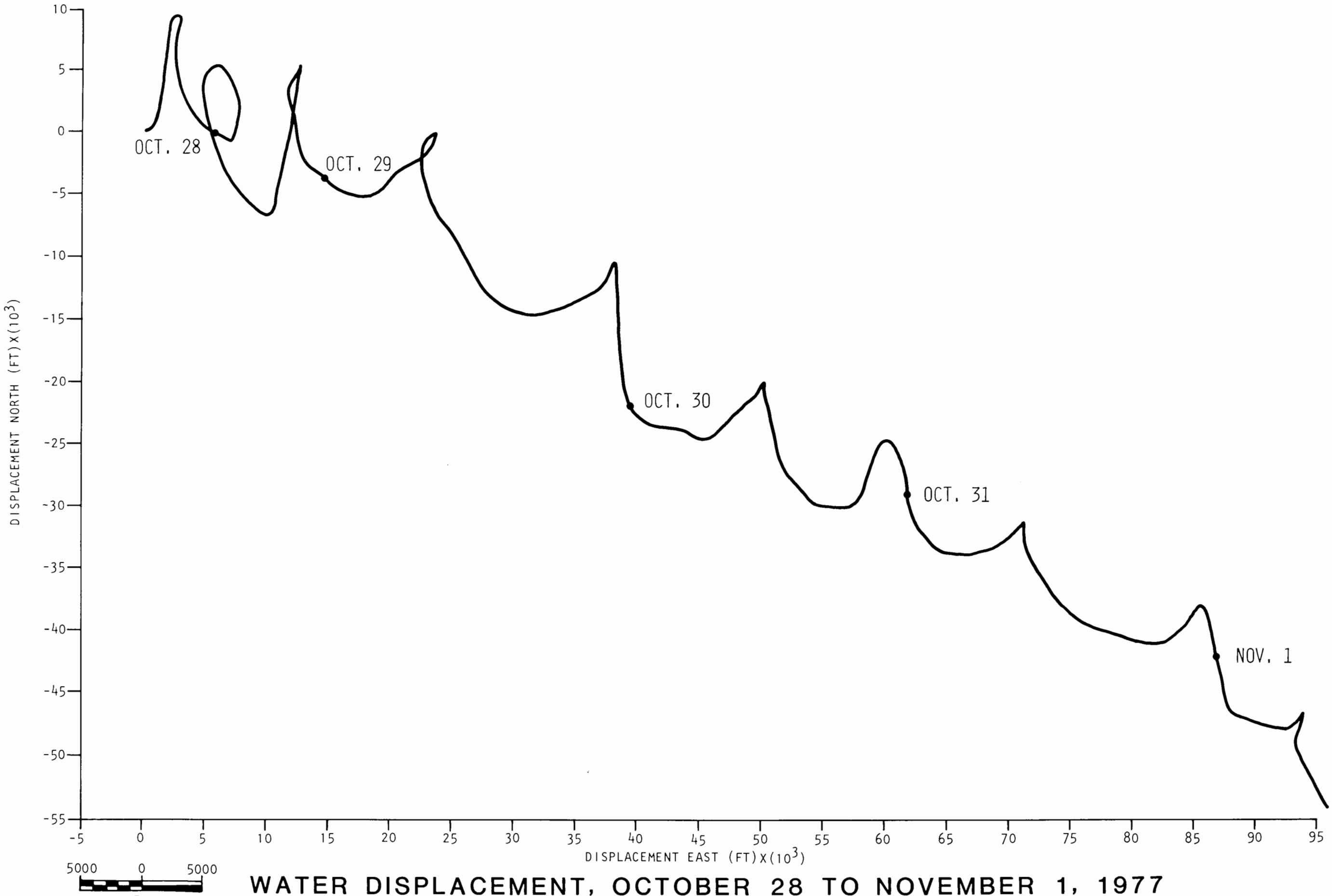
WATER DISPLACEMENT, OCTOBER 28 TO NOVEMBER 1, 1977

STATION 2

5000 0 5000

FEET

NOTE: SEE FIGURE II.C-12 FOR LOCATION



WATER DISPLACEMENT, OCTOBER 28 TO NOVEMBER 1, 1977
STATION 1

NOTE: SEE FIGURE II.C-12 FOR LOCATION

FIGURE II.C-14

Raritan Estuary are from wastewater discharges and from gaged and urban runoff. Contributions from atmospheric fallout are an additional minor source of pollution. The wastewater inputs are related to the high nutrient and bacteriological levels in the estuary. The locations of wastewater discharge into the estuary are shown in Figure II.C-15 and the types of discharge and flow are tabulated in Table II.C-4.

The relative contribution from wastewater, gaged runoff and urban runoff sources for various pollution loads for the outflowing waters of lower New York Harbor (across the Sandy Hook - Rockaway Transect - Figure II.C-1) is presented in Table II.C-5 (Mueller et al, 1976). Most major pollutants contributed across this zone originate predominantly from wastewater discharges. The Hudson River is the principle source (60 to 90 percent) of the gaged runoff pollutant load.

The water quality of the Raritan Estuary reflects the contribution from these pollution sources, especially wastewater discharges. Water quality data from USEPA STORET (Table II.C-6), from wastewater effluent measurements (Table II.C-7) and from other independent studies forms the basis for the following discussion of water quality parameters. The locations of STORET stations are shown in Figure II.C-15.

c. Coliforms

Analysis of STORET data (Table II.C-6) and the results of earlier bacteriological studies by the Federal Water Pollution Control Administration (FWPCA) indicate that coliform contamination can be linked to wastewater sources close to shore, especially at the western portions of the estuary near the junction of the Raritan River and Arthur Kill (Walker, 1967). Coliform counts are lowest near the center of the estuary.

TABLE II.C-4

WASTEWATER DISCHARGE SOURCES FOR RARITAN ESTUARY

MUNICIPAL DISCHARGES

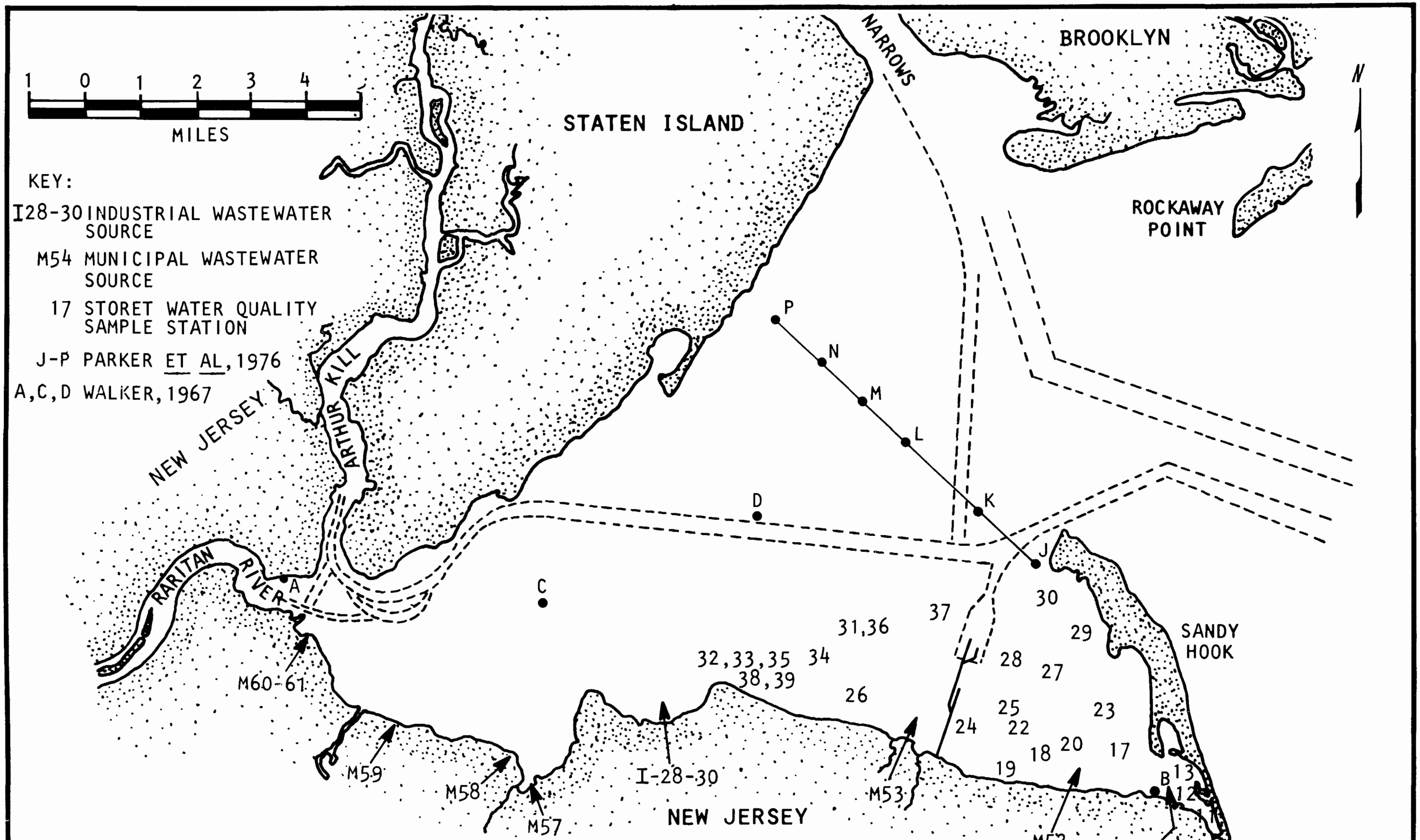
Location Number	Compliance with 1977 Secondary/Best Practicable Requirements	Dishcarger	Municipality	Receiving Stream	NPDES Permit Number	Existing Treatment Process	Flow Des. Cap.	(mgd) Avg.	1975 Max.
M-50	NA	Oakwood Beach	Oakwood Beach, Staten Island	N.Y. Harbor	NA	Secondary	NA	19.2	NA
M-51	No	Boro. of Highlands	Highlands	Shrewsbury River	0026204	Primary	1.2	.55	NA
M-52	No	Boro. of Atlantic Highlands	Atlantic Highlands	Sandy Hook Bay	0025402	Primary	.6	.61	NA
M-53	NA	Middletown Twp. S.A. Discharge #2	Middletown Twp.	Compton Creek	NA	Secondary	6.5	4.86	5.15
M-57	No	Boro. of Matawan	Matawan Boro	Matawan Creek	0022527	Secondary	.8	.78	NA
M-58	NA	Clifwood Beach STP	Matawan Twp.	Whale Creek	0022535	Secondary	NA	0.6	NA
M-59	No	Lawrence Harbor STP	Old Bridge	Raritan Bay	0022471	Primary	1.4	1.0	1.5
M-60	No	City of South Amboy	South Amboy	Raritan Bay	0020541	Primary	1.0	.82	
M-61	No	Middlesex County Sewage Authority	Sayreville	Raritan Bay	0020141	Primary	54.0	85.0	93.0
M-62	No	Melrose Twp.	Sayreville	Raritan Bay	0022833	Primary	.15	.05	.07

INDUSTRIAL DISCHARGES

Location Number	Compliance with 1977 Secondary/Best Practicable Requirements	Dishcarger	Municipality	Receiving Stream	NPDES Permit Number	Existing Treatment Process	Flow Des. Cap.	(mgd) Avg.	1975 Max.
I-28	NA	Lavin Charles of the Ritz	Holmdel	Raritan Bay	NA	NA	NA	.1	NA
I-29	NA	I.F.F. Inc.	Union Beach	Raritan Bay	NA	NA	NA	0.21	NA
I-30	NA	Owens-Illinois, Inc.	Holmdel	Raritan Bay	0001775	NA	NA	0.28	NA
I-31	NA	Exxon Corp.	Atlantic Highlands	Sandy Hook Bay	0000868	NA	NA	NA	NA

Note: All station locations are marked on Figure II.C-15.

Source: Mueller et al., 1976; NJDEP, 1978, Office of Sewerage Construction Permits.



WATER QUALITY STATIONS AND WASTEWATER DISCHARGES: RARITAN ESTUARY

SOURCE: US EPA, STORET WATER QUALITY DATA. PARKER ET AL, 1976, MUELLER ET AL, 1976

FIGURE II.C-15

TABLE II.C-5

CONTAMINANT LOADS ACROSS THE
SANDY HOOK-ROCKAWAY POINT TRANSECT

Parameter	Mass Load, Metric Tons/Day	Percentage Contribution		
			Runoff	
	Total	Waste-Water	Gaged[a]	Urban
FLOW, (cubic ft./sec.)	30,000	14	80	6
SS Suspended Solids	7,300	12	48	40
ALK Alkalinity	4,900	35	60	5
BOD_5 Biochemical Oxygen Demand (5 day)	1,400	71	16	13
COD Chemical Oxygen Demand	4,900	57	25	18
TOC Total Organic Carbon	1,500	48	26	26
Oil & Grease	460	42	14	44
NH_3-N Ammonia Nitrogen	141	80	13	7
Organic Nitrogen	130	63	29	8
Total Kjeldahl Nitrogen	271	72	21	7
Nitrite & Nitrate	68	10	89	1
TOTAL - Nitrogen	339	60	34	6
ORTHO - Phosphate	46	72	18	10
TOTAL - Phosphorous	62	72	18	10
Cd Cadmium	0.36	40	27	33
Cr Chromium	2.2	42	23	35
Cu Copper	6.2	44	20	36
Fe Iron	35	37	26	37
Hg Mercury	0.26	76	16	6
Pb Lead	5.8	46	13	41
Zn Zinc	17	19	38	43
Fecal Coliform[b] - Winter	5.6×10^7	87	0.01	13
Summer	4.9×10^7	85	0.01	15
Total Coliform[b] - Winter	21×10^7	91	0.06	9
- Summer	11×10^7	84	0.1	16

[a]Including Hudson River nongaged area.

[b]Coliform load (=) 10^{10} org/day.

Source: Mueller, et al., 1976; Data obtained 1970-1974.

TABLE II.C-6
U.S.E.A.P. STORET WATER QUALITY DATA FOR RARITAN ESTUARY (1962-1973)

Station Number	Temperature C°	pH	Total Coliforms no/100 ml	Fecal Coliforms no/100 ml	Fecal Strep no/100 ml	Turbidity JTU's	Dissolved Oxygen mg/l	Ammonia Nitrogen mg/l	Nitrate Nitrogen mg/l	Total Organic Content mg/l	Chloride mg/l	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury	Total Residue	Biochemical Oxygen Demand mg/l	Organic Nitrogen mg/l	Ortho-Phosphate mg/l	Sample Period
10	29.2	7.5	19	3	6	7.1		0.28	0.28	6.4	14,400												66-68
11	13.3	7.4	87	26	45																		67
13	13.9	7.0	556	143	1209																		62-67
17		7.3		22		17.6	7.7	2.93	0.41	9.9	14,400	0.67	10	58	3.3	49	40	.21	2,009				July 71
20	14.3	7.1	143	39	57																		67; 62-65
22	14.4	7.0	545	150	905																		62-67
23	14.4	7.9	84	1	11		10.3		0.01		13,750									4.5	.16	0.47	63-64
25	22.2	7.4		22		18.3	9.4	2.64	0.40	9.3	13,866	0.75	10	135	3.5	46	45	.30				0.13	Jul 12-26 1971
26	14.2	6.8	402	228	1183																		Jun-Sept 62 & 67
27	11.8	7.8	130	56	54		8.4																Aug 62-64
28	13.4	6.8	720	184	322																		June-Aug 62, 67
29	13.6	7.7	121	33	35	7.2	10.1	0.18	0.13	4.8	13,613	110.00	120	50	270.0			.50	14,435	3.4		0.40	62-72
30		7.4		6		17.5	8.8	3.30	0.37	9.6	14,214	0.65	10	58	2.5	48	45	.29					July 71
31	8.5	7.6	91	17	97		9.2				12,850												62-64
32	13.9	6.8	787	145	247																		62-67
34	22.9	7.3		9		18.6	9.2	3.19	0.47	9.0	13,933	1.75	10	67	7.0	43	52	.22					July 71
35	13.7	6.8	781	278	653																		62-63 62-67
36	21.6	7.0		20		17.0	8.4	2.55	0.44	9.7	14,833	1.00	10	66	2.7	46	55	.24					July 71
37	8.7	7.9	91	100	182		8.9				13,100												Nov 62 Aug 64

Notes: All stations are marked on Figure II.C-15. Blanks mean no data was available.

Source: U.S.E.P.A. STORET Water Quality Printouts.

TABLE II.C-7

AVAILABLE WATER QUALITY DATA FOR TREATMENT PLANT EFFLUENT INTO SANDY HOOK BAY (1971-74)

(Lbs/Day Unless Otherwise Specified)

Station Number	Avg. Daily Flow (MGD)	Treat-ment Type	Suspended Solids	Bio-chemical Oxygen Demand 5 Day	Total Organic Carbon	Oil & Grease	Ammonia Nitrogen	Total Nitrogen	Ortho Phosphate	Chloride	In micrograms per liter Cd	Cr	Cu	Pb	Zn	Feco Coli no/ 100 ml	Total Coli no/ 100 ml
Highlands M 51[a]	.55	Primary		987	786	46.7	156		33.9	895	0.13	0.36	1.2	1.25	0.63		
Atlantic Highlands M 52[a]	0.61	Primary	171	214				20.4								8.8	20
Middletown Twp. S.A.	4.86	Primary	1590	1720													
Leonardo 24[b]	0.15	Unknown but treated	14.7 mg/l	3.75 mg/l	6 mg/l		2.15 mg/l			44.5 mg/l	13.3	23.0	13.3	0.1	80.0	163.79	
Atlantic Highlands 18[b]	0.47	Unknown but treated	59 mg/l	109 mg/l	84 mg/l	14.7 mg/l	9.2 mg/l			217 mg/l	13.7	25	58.8	137	86	24.8	
Leonardo 19[b]	.15	Unknown but treated	NA	138 mg/l	NA	NA	NA	NA	NA	67.9 mg/l	NA	NA	NA	NA	NA	NA	NA
Highlands 12[b]	.56	Unknown but treated	NA	189.6 mg/l	127.1 mg/l	16.7 mg/l	17.51 mg/l	NA	NA	163.5 mg/l	14.2	28.5	108.5	142.8	104.3	NA	NA

Note: All stations are marked on Figure II.C-15

Sources:

[a]Mueller et al., 1976.

[b]STORET data EPA (1962-1966).

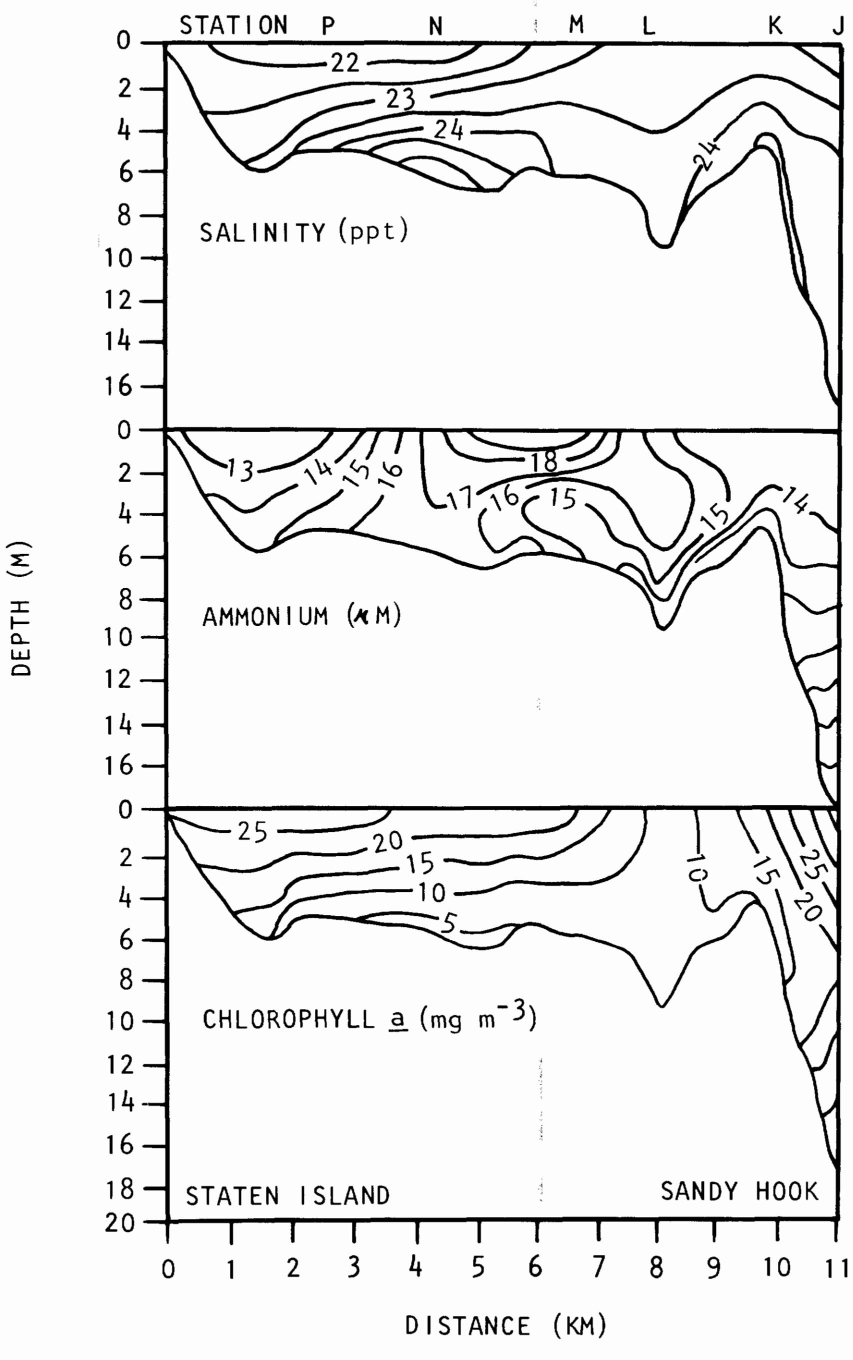
d. Nutrients

Marine phytoplankton, like land plants, require certain chemical elements (nutrients) in addition to carbon dioxide and water in order to photosynthesize and grow. Nitrogen and phosphorus, are the most important nutrients and their availability control phytoplankton growth. During intense growth periods, these nutrients may be completely depleted in the water column. Regeneration of these nutrients takes place as dead organisms sink to the bottom and decay.

Analysis of the seasonal variation in relative abundance of nitrogen and phosphorous (N/P ratio) by a number of investigations (Jefferies, 1962; Walker, 1962; Alexander and Alexander, 1977) indicates that nitrogen is the limiting factor in phytoplankton growth since it is more completely stripped from the water column than phosphorous.

The estuary is rich in natural nutrient enrichment from stream runoff and regeneration. In addition, wastewater discharge provides significant nutrient loading to the estuary. This abundant nutrient supply, especially nitrogen, results in abundant plankton growth which has the potential to deplete dissolved oxygen content, especially during late spring and early summer. Walker (1962) reports that nitrate levels are higher at the western end of the bay, reflecting the influence of the sources of wastewater discharge.

Recent studies by Parker, et al, (1976) of chlorophyll a and ammonium in Raritan Bay and Sandy Hook Bay illustrate the relationship between nutrient levels as measured by ammonia and phytoplankton biomass as measured by chlorophyll a, the primary photosynthetic pigment of all plants. High concentrations of ammonium (60-70 micrograms) and chlorophyll a (50 mg/m^3) were found at the center of Raritan Bay (Figure II.C-16). This is related to the circulation in the Bay system. A sluggish circulation (counter-clockwise gyre) exists which allows time for a buildup of ammonium and chlorophyl a (Jeffries, 1962). Areas in Raritan Bay having the longest flushing times correspond to those regions where ammonium and chlorophyll a concentration were highest.



AMMONIUM AND CHLOROPHYLL a: RARITAN ESTUARY

(JUNE 1974 AND 1975)

SOURCE: PARKER ET AL, 1976
SEE FIGURE II.C-15 FOR LOCATION OF PROFILE

FIGURE II.C-16

In addition, Sandy Hook Bay was found to have the highest chlorophyll a (45-90 mg/m^3) and low ammonium concentration (5-8 micrograms). The high chlorophyll a concentrations indicated that Sandy Hook Bay may be one of the major sources of chlorophyll a contribution to the Atlantic Ocean. Maximum concentrations of chlorophyll a indicates transport of chlorophyll a-rich water around Sandy Hook during periods of strong ebb flow.

e. Dissolved Oxygen

The amount of dissolved oxygen in water depends on the rate of natural aeration or transfer from the atmosphere, photosynthesis, removal by oxygen demanding material, water salinity and temperature. Variation of dissolved oxygen in the estuary is primarily seasonal, with secondary effects caused by tidal and diurnal cycles.

Average dissolved oxygen concentrations had been found (FWPCA, 1967) to range from 6 mg/1 at the mouth of the Arthur Kill to values of 9 mg/1 in the center of the bay along a band reaching from Princess Bay, Staten Island, to Sandy Hook Bay. East and north of this band average dissolved oxygen levels decreased to 6 mg/1. The highest average dissolved oxygen level (10 mg/1) was found in Sandy Hook Bay. Minimum dissolved oxygen values recorded were approxi mately 2 mg/1 at all stations except at mouth of Arthur Kill where levels as low as 1.4 mg/1 were observed.

In the winter and autumn, an average of 9 to 10 mg/1 and 5 to 7 mg/1 were observed respectively throughout the estuary (Federal Water Pollution Control Administration, FWPCA, 1967). In the summer, a pronounced gradient occurs with dissolved oxygen values ranging from 10 mg/1 at the center of the bay to 4 mg/1 in the vicinity of Raritan River, the Narrows and Arthur Kill. Special studies at two stations in Raritan Bay (FWPCA, 1967) showed that photosynthetic production of oxygen was essentially limited to the top 11 feet. An average of 46 percent of the oxygen produced by photosyntheses was consumed by respiration, with the remainder being available to the waters of the bay.

STORET Data (USEPA, 1962-1973) for selected sampling sites offshore in Sandy Hook Bay showed that average dissolved oxygen was 9 mg/1, ranging from 7.7 mg/1 (Station 20 in Figure II.C-15) to 10.07 mg/1 and 10.26 mg/1 (Station 29 and Station 28 in Figure II.C-15). Although dissolved oxygen data is not available for treatment plant effluent along the shore of Sandy Hook Bay, it is expected that wastewater and industrial dishcarge would consume large concentrations of dissolved oxygen.

f. Biological Oxygen Demand (BOD)

The total mass load of BOD across the Sandy Hook-Rockaway Transect is estimated at 1400 metric tons per day (Mueller et al, 1976, see Table II.C-5). Most of this load (71 percent) is contributed by wastewater discharge.

Data for the period 1971-1974, show that existing treatment plants in Highlands, Atlantic Highlands, and Middletown discharged a total load of 2921 lbs/day of BOD into Sandy Hook Bay (Table II.C-7). Average BOD values ranged from 3 to 4.5 mg/1 in the eastern end of Sandy Hook Bay (Walker, 1967;STORET Data, U.S. EPA 1962-63, 1962-67). The highest observed BOD value, 11 mg/1, (Walker, 1967) occurred at the center of Raritan Bay (Station C in Figure II.C-15). During the surveillance operation, a maximum of 12 mg/1 (Walker, 1967) was found at the center of the bay system (station D in Figure II.C-15).

g. Chemical Oxygen Demand (COD)

A total mass load of 4900 metric tons/day of chemical oxygen demand is estimated to be discharging across the Sandy Hook-Rockaway Point Transect. Wastewater sources contribute 57 percent and runoff contributed 43 percent of this load (Table II.C-5). The average value of 120 mg/1 observed at the mouth of Arthur Kill represents the only data available for Sandy Hook Bay. However, industrial and waste discharge (denoted by M51, M52, M53 and I28-I30 in Figure II.C-15) are expected to have a great influence on COD.

h. Heavy Metals

The relative metal loadings to the Raritan Estuary can be extrapolated from data compiled by Mueller et al., (1976). Metal loadings into this region are principally affected by the Hudson and Raritan River drainage systems. Metal loading rates into these bays are presented in Table II.C-5. The rates range from 0.26 metric tons per day for mercury to 35 metric tons per day for iron.

In addition, wastewater contributed much more mercury (76 percent) and slightly more lead (46 percent), chromium (42 percent), cadmium (40 percent), and copper (40 percent) than the other runoff sources. In contrast, highest zinc loadings were evenly distributed between urban runoff (43 percent) and river runoff (38 percent). The urban runoff loadings of cadmium, chromium, copper and lead were also generally high, but lower than those for wastewater. No data were available for atmospheric loadings, but it is expected that these would be significant for zinc and lead. Metal loadings from groundwater discharge were considered negligible (Mueller et al, 1976).

The concentration of dissolved metals in the waters of Sandy Hook and Raritan Bays varies spatially and temporally. The levels are generally high (Table II.C-6) and comparable to those for the New York Bight (see Section D.4 of this chapter). These high metal levels are prinicpally due to proximity to coastal pollution sources, e.g. municipal and industrial wastewater discharge, urban runoff, river runoff and atmospheric loadings. The concentrations of cadmium, chromium, and lead in the wastewater discharge were approximately 10, 2 and 30 times greater, respectively, than the ambient concentrations of the receiving waters. The concentrations of copper, mercury and zinc, on the other hand, were generally comparable.

i. Oil and Grease

Existence of oil and grease in water can interfere with the normal transfer of oxygen from the atmosphere into water. Deposition of oil in the bottom sediments can affect aquatic food supply. It is estimated that 460 metric tons are discharging through the Sandy Hook-Rockaway Point Transect each day, of which 42 percent of the contribution is from wastewater and 44 percent is from urban runoff (Table II.C-5)(Mueller et al, 1976). In Raritan Bay, the main sources of oil and grease are treated and untreated industrial and municipal wastes, dockside fueling spillage and petroleum transfer activities. A survey conducted between 1971-1974 showed a high effluent discharge of oil and grease from Keansburg into Sandy Hook Bay (203 lbs per day).

j. Turbidity/Suspended Sediments

Turbidity is mainly due to suspended particles from river, agriculture runoff, boating and dredging activities. STORET Data (USEPA, 1971) showed that turbidity was in the range of 17 Jackson Turbidity Units (JTU) at most sampling sites in Sandy Hook Bay (Stations 17, 25, 30, 34, 36, in Figure II.C-15). In general, higher turbidity occurs in bottom waters. Lower turbidities (around 7 JTU) were found adjacent to Sandy Hook, northwest of Horseshoe Cove (Station 29 in Figure II.C-15). A total of 7300 metric tons per day of suspended solids had been estimated to be discharging through the Sandy Hook-Rockaway Point Transect zone (Table II.C-5)(Mueller et al, 1976). Runoff is the major source of suspended solids, 90 percent of which is contributed by the Hudson River. The weighted average concentration from gaged runoff was estimated to be 57 mg/1 for the Transect zone.

In addition to storm runoff, treatment plant effluent is another source of suspended solids contribution. During periods of 1962-1966, suspended solids in effluent from treatment plants discharging into Sandy Hook Bay (STORET Data, USEPA) were well below the standard (average values of suspended solids were 60 mg/1). On a recent survey (1971-1974) by NOAA, it was found that Middletown-

Belford and Atlantic Highlands treatment plants were discharging significant levels of suspended solids of 1590 lbs/day and 171 lbs/day, respectively, into Sandy Hook Bay.

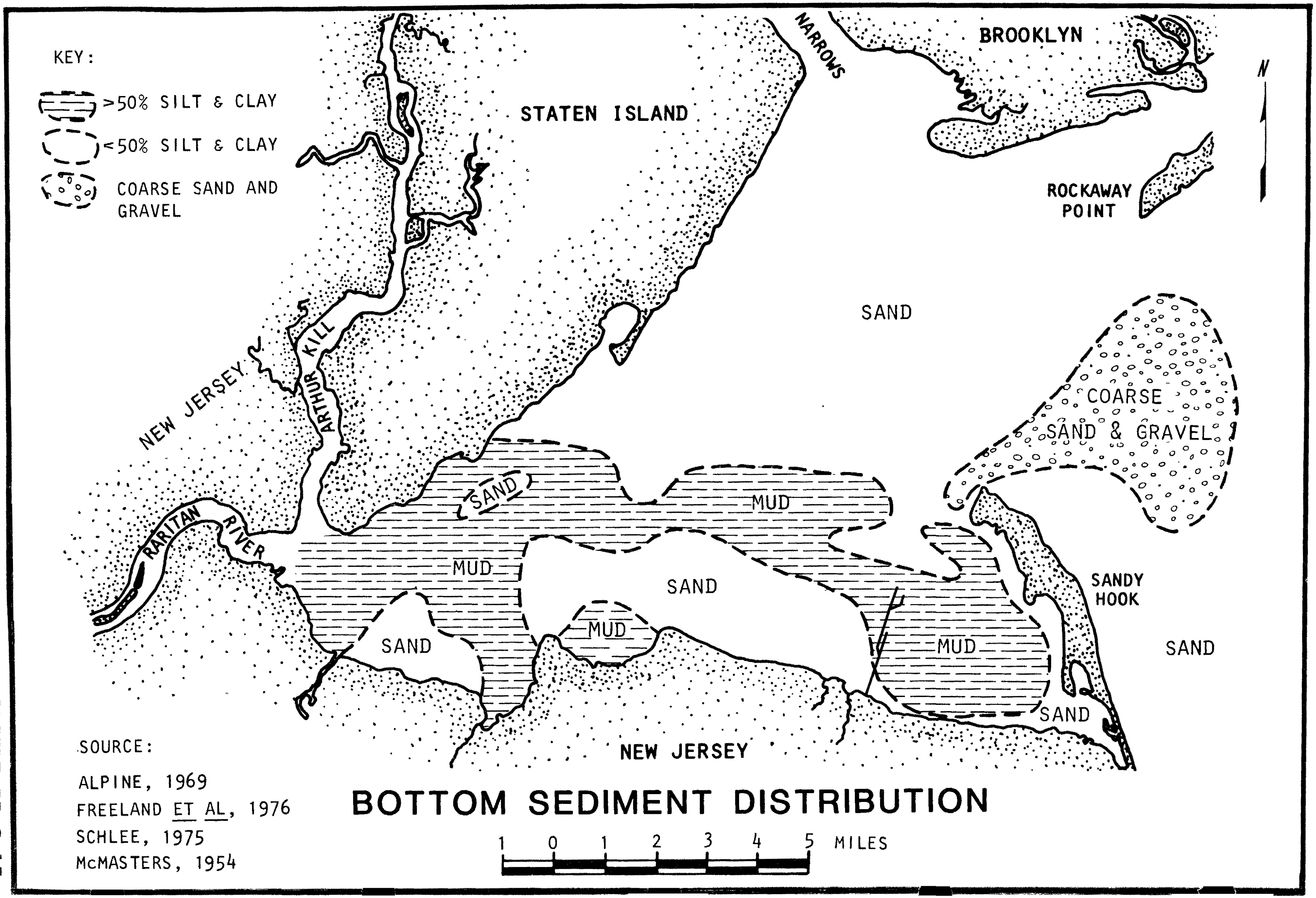
C.7 Sediments and Sediment Transport

a. Surficial Sediment Distribution

Most of the Raritan Estuary and adjacent ocean floor are covered by sand and to a lesser extent by mud (silt and clay)(Figure II. C-17). The sandy areas are typically composed of yellow-brown, well-sorted sand in the fine to medium size range. Coarse sand and gravel characterize a portion of Sandy Hook Channel and an area northeast of Sandy Hook. The transitions from one type of sediment to another are quite abrupt within the estuary (Alpine, 1969, Figure II.C-17).

Within the lower portion of the Raritan Estuary in the vicinity of existing and proposed NWS Earle pier facilities, a continuous bank of mud extends east-west into Sandy Hook Bay. The average grain size of this sediment falls within the fine to medium silt range. Many samples show significant fractions of clay-sized particles as well as varying amounts of very fine to medium sand. In the vicinity of the proposed and existing terminal channels, the band of mud is interrup ted by a zone of sandier material with average grain size in the very fine to fine sand range (Figure II.C-17). This local variation appears to be related to the sedimentary processes which have built the Sandy Hook spit. Those processes are further discussed in Sections C.7c and C.7d of this chapter.

The strip of sand adjacent to the shore in the vicinity of the pier facility was probably derived from erosion and subsequent littoral transport of the local shoreline materials including some beach fill materials placed there to retard erosion.



SOURCE:

ALPINE, 1969

FREELAND ET AL, 1976

SCHLEE, 1975

McMASTERS, 1954

BOTTOM SEDIMENT DISTRIBUTION

FIGURE II.C-17

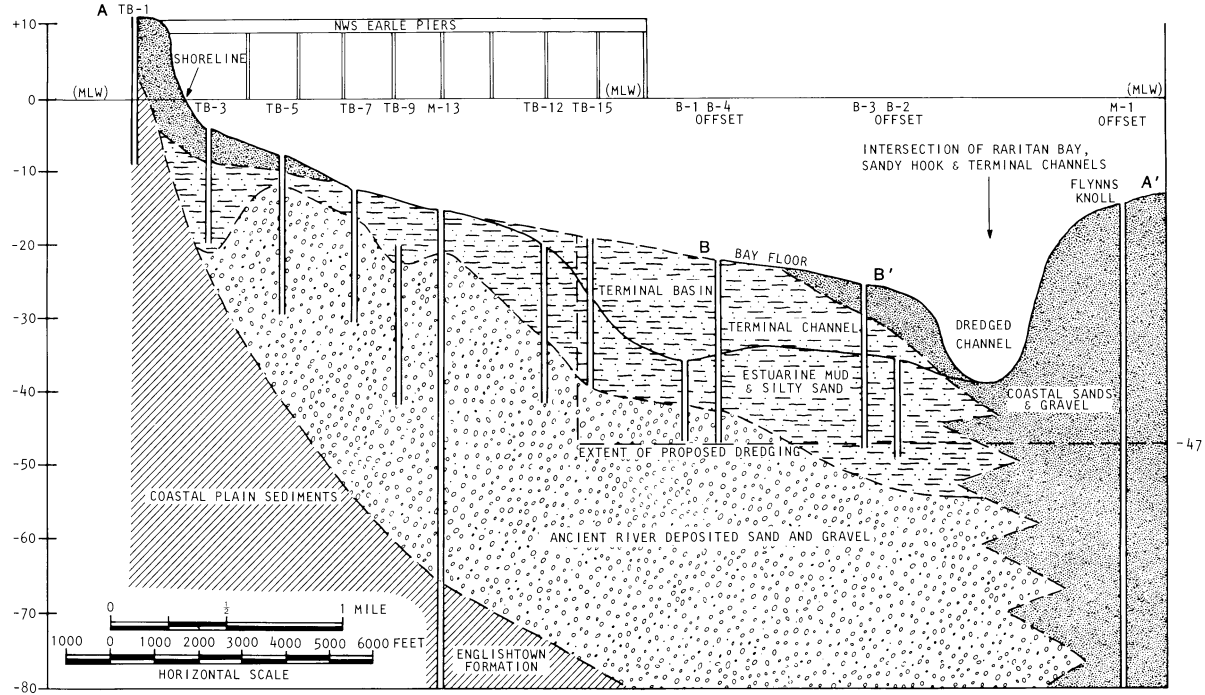
Bulk density of Raritan Estuary sediments varies proportionally with sediment grain size, sharing values of less than 0.51 kilograms per liter for muddy sediments and values from 1.00 to 1.25 kilograms per liter for sandy sediments (Nagel, 1967).

The distribution of bottom sediment types in the Raritan Estuary and on portions of the adjacent Atlantic offshore area as presented in Figure II.C-17, is based on the grain size analysis of grab samples and cores collected by various investigators and agencies during the period 1953 to 1977. As part of this study, grab samples were collected along the proposed and existing channels and basins. The locations of these sampling stations, the results of grain size analyses of these samples and cumulative grain size plots are presented in Appendix F.

b. Subsurface Sediments

This discussion concentrates primarily on the subsurface sediments in the vicinity of proposed dredging where data is adequate to define subsurface conditions. Subsurface sediments of Sandy Hook Bay consist of an upper silt and clay (mud) layer containing varying amounts of fine sand (Figure II.C-18). The silt and clay layer overlies a wedge of river-deposited sand and gravel which lies directly on the deeply eroded surface of the coastal plain strata. (See Geology, section B.2 of this chapter). Relief on the buried coastal plain strata has been attributed to deep subaerial erosion and downcutting by the ancestral Raritan River which flowed in this area during Pleistocene periods of lower sea level (Williams and Duane, 1974).

Figure II.C-18 presents a composite cross section of the subsurface sediment in the vicinity of the existing NWS Earle pier. Section A-A' (see Figure II.C-19 for location) runs the length of the pier and extends out into the existing turning basin and terminal channel. Section B-B' has been constructed from the two borings in the area of the proposed turning basin and terminal channel, west of section A-A'.



COMPOSITE SUBSURFACE SECTION: SANDY HOOK BAY

LEGEND:

- TERTIARY AND CRETACEOUS COASTAL PLAIN SEDIMENTS
- QUATERNARY ANCIENT RIVER DEPOSITS OF SAND AND GRAVEL
- QUATERNARY DEPOSITS OF MUD AND SILTY SAND
- QUATERNARY COASTAL DEPOSITS OF SAND AND GRAVEL

|| BORINGS AND CORES

TB-1 - TB-15-TEST BORINGS TAKEN FROM NAVFAC DRAWING NO. 2022289 EARLE, NEW JERSEY BY TAYLOR-WISEMAN & TAYLOR, 3/76

M-1, M-13-AUGER HOLES BY MINARD 1969

B-1 - B4-DAMES & MOORE BORINGS - SEE APPENDIX F FOR DETAILED BORING LOGS

NOTE: THE LOCATION OF BORINGS AND AUGER HOLES AND THE ALIGNMENT OF SECTIONS A-A' AND B-B' ARE SHOWN ON FIGURE II.C-19.

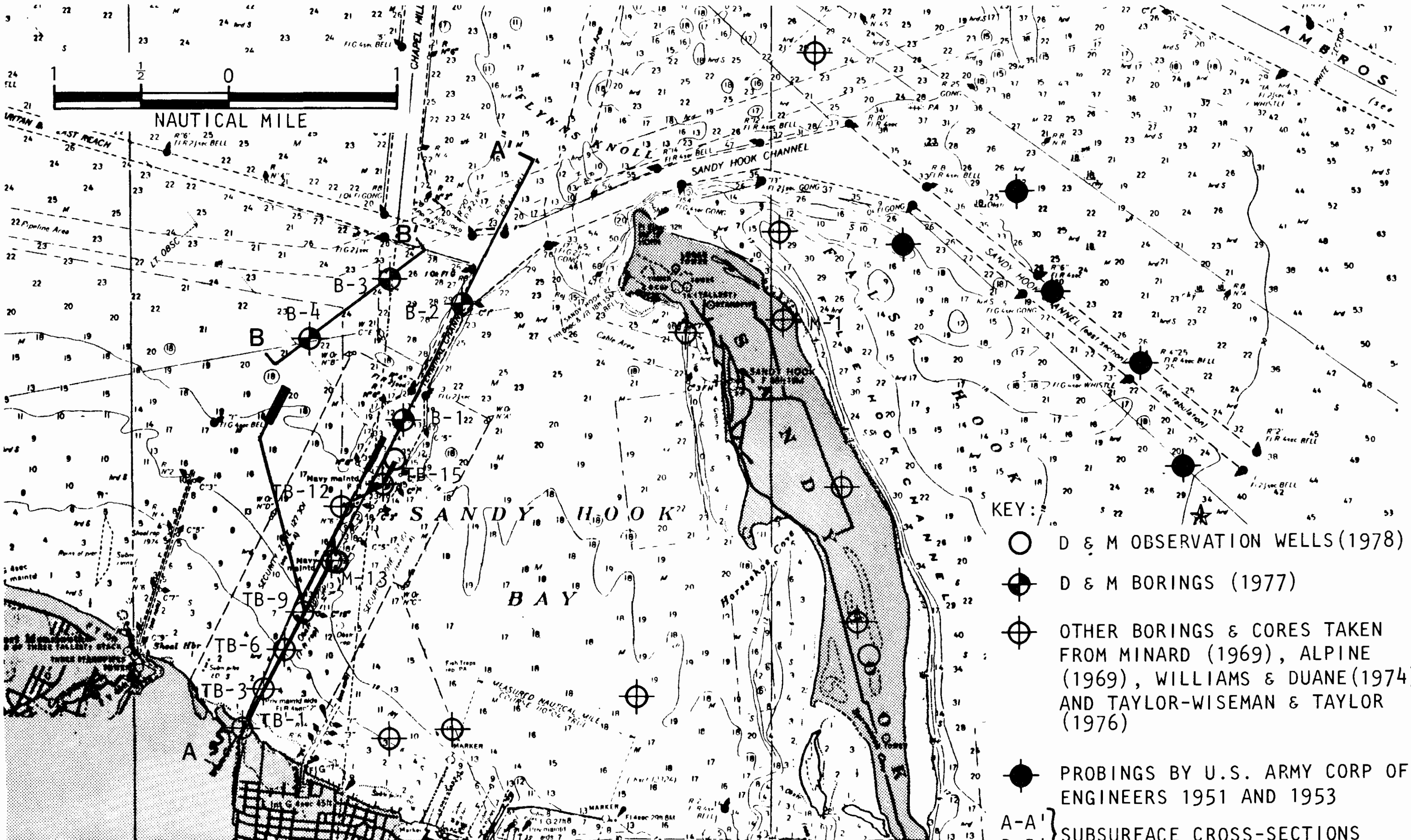
SOURCE: BATHYMETRIC PROFILES TAKEN FROM NOAA NAUTICAL CHART #12327, 1977 NEW YORK HARBOR

FIGURE II.C-18

Along the inner reach of the existing Sandy Hook Channel, the mud-dominated subsurface section changes abruptly to a thick sequence of clean, fine to medium sand with traces of gravel, silt and shells. The sandy material prevails along the entire length of the existing channel east of Sandy Hook and appears to extend to a depth of at least -47 feet MLW. The exact nature of the abrupt subsurface transition from mud to sand is uncertain but it is probably related to the scour and fill process associated with the growth of the Sandy Hook spit into the estuary.

Proposed dredging within Sandy Hook Bay would involve mostly soft muds. Dredging the bottom 5 to 10 feet in the area of the turning basins would encounter dense river-deposited sands and gravels which overlie the coastal plain strata. The remainder of the dredging, along the existing Sandy Hook Channel would involve loose to medium dense sands containing pockets of fine gravel. Mud would comprise roughly 64 percent of the total proposed volume of dredging.

Information on the nature and distribution of subsurface sediments in the Raritan Estuary and adjacent Atlantic offshore area has been compiled from scattered shallow cores, probings, borings and continuous seismic reflection profiles. Existing data were supplemented with four borings to a minimum depth of -47 feet below mean low water (MLW) within the existing and proposed turning basins and terminal channels for the NWS Earle piers. The location of the four borings is shown on Figure II.C-19 along with the locations of selected cores and borings examined for this investigation. Detailed boring logs, a description of field procedures, and the results of grain size analysis of boring samples are provided in Appendix F.



LOCATION PLAN

SELECTED BORINGS, CORES AND PROBINGS

NOTE: A COMPOSITE OF CROSS SECTIONS A-A' AND B-B' IS PRESENTED IN FIGURE II.C-18

FIGURE II.C-19

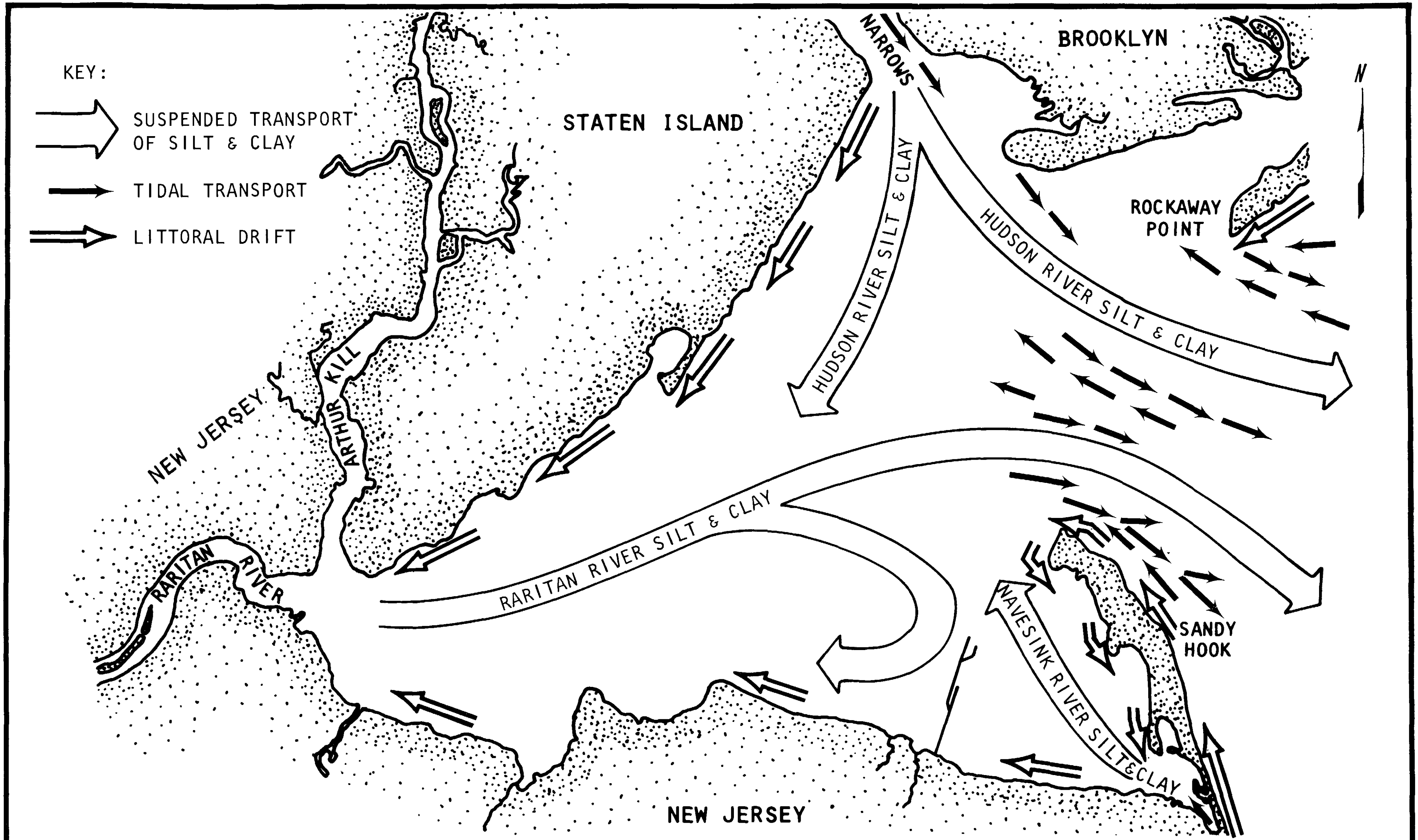
c. Estuarine Sediment Transport, Deposition and Erosion

Sedimentary processes in the Raritan Estuary and adjacent Atlantic offshore area fall into two basic categories. Coarse sediment (mainly sand) is entrained and transported only under intense bottom flow conditions. This includes continuous, shore-parallel littoral transport of sand along beaches as well as transport by intense tidal flows at the mouths of the estuary. On the sea floor, transport of sand occurs in intense bursts when intermitent storms accelerate near-bottom currents above a threshhold level. (Swift et al., 1975).

Suspended fine sediment (mud) is also entrained by storms and other peak flow events including high river and tidal flows. Since settling velocities of mud particles are low, they tend to remain in suspension for long periods of time and may be transported a considerable distance after entrainment.

Recent sediments within the Raritan Estuary appear to be a combination of reworked glacial outwash and fluvial deposits of sand and gravel, and silt and clay derived from local rivers and creeks. Offshore sediments consist primarily of mixtures of sand and gravel derived from reworking of the Pleistocene and older sediments eroded from the shore face and inner sea floor surface. Sedimentary processes indicate that the estuary tends to serve as a sediment sink. Most of this sediment is deposited upstream in the rivers, creeks and tidal marshes.

The movement and distribution of sediments within the Raritan Estuary and adjacent offshore areas are dependent upon the hydraulic characteristics and the forces of wind, waves, currents and tides which supply the necessary energy to the system. The movement of sediments into, out of, and through the estuary is shown graphically in Figure II.C-20. It was determined on the basis of bathymetry, size distribution and percent silt and clay in the sediments, and evidence of littoral drift. The patterns of sediment movement appear to coincide to a large degree with dominant circulation patterns and littoral processes.



SEDIMENT TRANSPORT: RARITAN ESTUARY

SOURCE: ALPINE GEOPHYSICAL, 1969; SWIFT ET AL, 1976

FIGURE II.C-20

Comparison of bathymetric surveys over the 120 to 130 year period for which there are records indicates that very little natural change has occurred in the bottom configuration. Some shifting of the depth contours has occurred but the movement has been random with both onshore and offshore movement occurring in the same area during different periods of time. Permanent changes in depth appear to be minor for the area as a whole (Alpine, 1969). Varying amounts of erosion and accretion have occurred during the last 120 years along the shoreline of the estuary, ocean and Sandy Hook spit. The history and driving mechanisms associated with these changes are discussed in detail in the Coastal Processes section (C.7d) of this chapter.

Man-induced changes are obvious in the localized deepening resulting from the dredging of navigation channels and commercial dredging of sand for use in construction or as beach fill. The effects due to dredging appear to be restricted to the immediate area of operations (Alpine, 1969). These deeper portions of the estuary act as sediment traps for recent sediment, making maintenance dredging necessary.

The bathymetry data away from the dredge channels suggest that during the period for which survey data are available, the total volume of sediment that is permanently accumulating in these areas is fairly small. This conclusion is supported to some degree by the fact that no significant variations in grain size have been identified for repetitive sediment samples taken at the same sample stations during the period for which sampling has occurred (almost 20 years). This implies that either much of the modern sediment from local rivers is being trapped in the rivers and connecting coastal wetlands or it is bypassing the estuary completely.

d. Coastal Processes

Coastal processes are and have been the major mechanism shaping the local shorelines through erosion, deposition and transport of sediments. More specifically, littoral drift coupled with small cumulative sea level fluctuations has resulted in the continuous erosion of shorelines and the formation of barrier islands and spits.

Littoral drift is the wave- and current-generated shore-parallel transport of beach materials in the littoral zone (the zone extending from the high water level to some shallow depth offshore). The rate and direction of littoral drift are controlled by the supply of material, the magnitude of incoming waves and by the angle between the beach and the incoming wave.

Sea level fluctuations have resulted in broad lateral movements of the shoreline. The tide guage at Sandy Hook indicates a 5.6-inch rise in sea level between 1940 and 1970. If that 30-year rate continues, sea level will rise one foot in only 108 years. Based on the average shore slope, such a rise in sea level would cause the shoreline to migrate landward more than 360 feet (Yasso and Hartman, 1975). Similar sea level changes over the last 20,000 years have resulted in the westward migration of the local shorelines many miles from their position along the edge of the continental shelf when sea level was an estimated 430 feet below its present level.

The Sandy Hook spit and its broad shallow platform were built out into the Raritan Estuary by the wave-driven northerly littoral drift of beach sand derived from the nearshore sea floor and beaches up to 25 miles south. False Hook Shoal, extending southeast from the tip of Sandy Hook, appears to be a seaward extension of the spit platform, formed by ebb tidal currents carrying sand seaward.

Historically, the Hook has alternately been attached to and separated from the mainland at the Navesink Highland. Most recently, since 1850 it has been connected to the barrier beach ending at Monmouth Beach four miles south of the Highland. The north end of the spit is reported to have advanced one mile in 200 years and 1/2 mile since 1865 (Alpine, 1969). During that time a recurve formed on the northern tip of the Hook with a westerly migration of over 3,400 feet.

Concurrently, various periods of erosion and deposition along the ocean and bay shores have kept the Hook in a constant state of flux. Dredging and periodic maintenance of Sandy Hook Channel across the terminus of Sandy Hook has effectively precluded its further northward development. It has also reduced sand supply to the False Hook Shoal and bayside spit beaches. Since the channel acts as a sink for sediment transported along oceanside beaches, it is in constant need of maintenance dredging.

On the bay side of Sandy Hook, the limiting variables of wind speed, duration, and fetch favor wave generation from the northwest resulting in littoral transport of sediments from north to south. The influence of these northwest winds is evident in the orientation of bayside beaches and in micro-spit development to the south of those beaches. Tidal and longshore currents also have a role in the shaping of the beaches. The materials in drift along bayside beaches have been derived through transport around the end of the spit from the ocean beaches. Recent erosional trends appear to be a result of reduced drift supply and increased incident wave energy. (Norstrom et al., 1975).

Littoral transport along the southern shores of Raritan Bay and Sandy Hook Bay is from east to west but is far less intense than along the beaches of Sandy Hook. The history of erosion there appears to be related to the formation and attachment of the Sandy Hook spit in the early 1800s (Alpine, 1969). The greatest erosion occurred during the early to mid 1800s, varying with location but amounting to as much as 650 feet in places. Localized areas of accretion occurred where there was less exposure to wave attack. Erosion continues to pose a minor threat to Loft Beach and the landfill area on the bay shore just west of the NWS Earle Waterfront Area (Personal Communication, Monmouth County Planning Board, 1977).

The source of sediments in littoral drift along the southern bay shore is fluvial sand from the Navesink and Shrewsbury River and eroded beach and coastal plain sediments from exposure along the Highlands to the east.

Comparison of historical shorelines reveals that recent erosional trends have resulted in a reduction in the width of beaches, a loss of beach area for recreational use, and a loss of private property. Coastal storms and man's encroachment onto beaches have amplified the erosion attributed to littoral processes. The construction of protective structures and employment of artificial fill during the 1900s has stabilized the shorelines to some degree.

By constructing numerous jetties, groins, piers, seawalls and bulkheads, man has effectively reduced the extent of shore exposure to wave and current attack which, in turn, has affected the movement of sediment along the shores. Protective structures such as jetties and groins temporarily block littoral drift but do not stop beach erosion entirely. Typically, erosion is slowed on updrift beaches and accelerated on downdrift beaches. On the other hand, placement of sediment for artifical beach nourishment temporarily stabilizes shorelines without significantly affecting downdrift beaches.

e. Bottom Sediments as a Potential Resources

Sand and gravel has been and still is the most important mineral resource in the United States (Schlee, et. al., 1975). Extensive deposits of sand and gravel have been identified by numerous investigators in the Raritan Estuary and adjacent Atlantic offshore areas. An augered hole at the end of the NWS Earle Pier #1 gives evidence that the subsurface sediments below Sandy Hook Bay could be an important source of sand and gravel (Minard, 1969). The distribution of surface sediments, supplemented by cores, borings and seismic data by the U.S. Army Corps of Engineers and Alpine Geophysical Associates, indicate that much of the eastern portion of the Raritan Estuary is underlain by deposits of sand and gravel. According to Williams and Duane (1974), large volumes, in excess of 960 million cubic yards, of clean sand and gravel suitable for beach fill are widely distributed over the areas north and east of Sandy Hook. All of this material is available for retrieval using present dredging techniques.

At the present time, most of the sand and gravel used in the New York metropolitan area is mined at inland sites. In recent years, however, for a variety of ecological and economic reasons, it has become increasingly difficult to obtain suitable material for inland sources. Because of the relatively low cost of recovery of marine aggregates, dredging of this resource has become a viable alternative to inland mining (Schlee et al., 1970). The major expense in production of the aggregates is that of transportation to a marketing point or use area. It seems inevitable, then, that as the economics presently favoring inland sources shift, utilization of readily accessible offshore sand and gravel will become more advantageous and more widespread.

Within the Raritan Estuary, aggregate resources have already been exploited to a considerable degree. Sand is being mined commercially in the Lower Bay area and has been for many years. An average of 5.5 million cubic yards per year of sand was dredged from Lower Bay between 1966 and 1974. Lesser quantities of sediment have been removed from Sandy Hook Bay at the entrance to the Shrewsbury River (Alpine, 1969). Most of the sand was used to fill and subgrade materials in construction projects and as beach replenishment in New York and New Jersey. In most cases, material dredged for use as beach fill have been obtained immediately offshore of the placement area. Ocean mining of sand and gravel is not yet economically advantageous.

C.8 Sediment Quality

The sediments of Sandy Hook Bay generally reflect the increased levels of pollutant loading that characterize this region (Section C.6 of this chapter). Higher pollutant levels are found in the finer-grained muddy sediments. As discussed above in Section C.7 of this chapter, muddy sediments characterize the areas near the existing terminal channel and turning basin and the proposed channel and turning basin for the new pier.

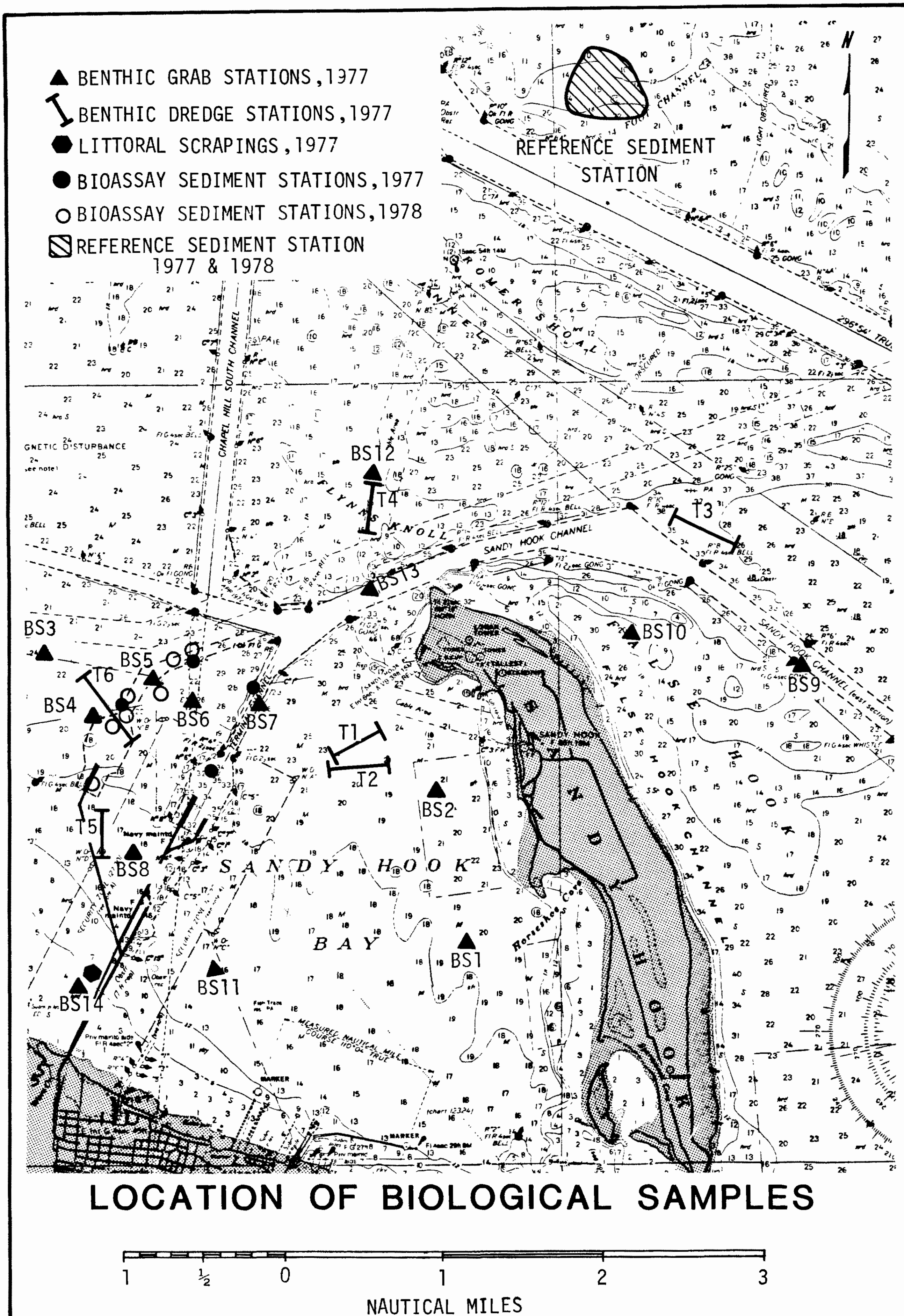
Typically, the surficial muds of the estuary are enriched in organic matter. Total carbon concentrations in the estuarine muds range from two to five percent while the sands range from less than 0.5 to 2.5 percent (Nagel, 1967; Gross et al., 1971).

Surficial samples from the areas of the existing and proposed terminal channels and basins (Figure II.C-21) have been tested for bacteria densities. The results are presented in Table II.C-8, together with comparisons with total and fecal coliform from other areas.

The data indicate bacterial contamination of these muddy sediments. The area of the proposed channel and turning basin shows much higher concentrations than the existing channel. Fecal coliform counts are generally lower than for sediments from the Hudson River (Table II.C-8). Total coliform counts are high compared to the Hudson River sediments.

The concentration of heavy metals in surficial sediments of Raritan Estuary are very high (Table II.C-9), and comparable to those of the waste disposal sites of the Bight Apex (Section D.6 of this chapter). These high levels are principally due to proximity to the coastal pollution sources.

While surficial sediments, especially muddy sediments of the estuary, reflect accumulation of industrial pollutants, subsurface sediments are unpolluted. Bulk chemical analysis of composite samples from the project depth (-45 + 2 ft. MLW) at the existing terminal channel and basin (9 to 11 feet below sediment surface) and at the proposed terminal channel and basin (20 to 22 feet below the sediment surface) indicate that these subsurface materials are unpolluted (Table II.C-10).



LOCATION OF BIOLOGICAL SAMPLES

FIGURE II.C-21

TABLE II.C-8

COLIFORM COUNTS FROM SURFICIAL SAMPLES IN THE EXISTING AND PROPOSED TERMINAL CHANNEL

Location	Total Coliform Count MPN[a]	Fecal Coliform Count MPN	Fecal Strepto-coccus MPN	Salmonella	Staphylo-coccus
Composite 1[b] (Terminal Channel)	9,300	90	24,000	Negative	8/gram
Composite 2[b] (New Channel)	430,000	430	240,000	Negative	16/gram
Hudson River[c]	2,052	1,233			
Hudson River[c]	4,109	3,827			
Hudson River[c]	1,952	341			
Hudson River[c]	5,843	8,169			

Note:
[a]Mean Probable Number

Source:
[b]This study, see Appendix F
[c]Liberty State Park (T.I., 1976)

TABLE II.C-9

HEAVY METAL CONCENTRATIONS IN SEDIMENTS FROM THE GENERAL PROJECT AREA

Location	Metal Concentration (ppm)					
	Cadmium Cd	Chromium Cr	Copper Cu	Lead Pb	Mercury Hg	Zinc Zn
Sandy Hook Bay (av. of 2 samples)[b]	NA	NA	NA	338	0.69	391
Sandy Hook Bay @ Lenoardo	NA	NA	NA	151	0.167	206
Shoal Harbor & Comptons Creek, N.J. (av. of 2 samples)[b]	NA	NA	NA	195	1	310
Raritan Bay Cutoff Channel (av. of 2 samples)[c]	3.79	25.1	266.6	201.8	1.89	239.1
Raritan Bay, N.Y. & N.J. (av. of 2 samples)[b]	NA	NA	NA	89	0.215	136
Lower Bay (av. of 2 samples)[d]	2.12	152	179	119	0.87	233
Sandy Hook Bay @ Earle[e]	2.4	NA	NA	NA	2.4	NA
Sandy Hook Bay muddy areas[f] within 1 n. mi. of project area (av. of 6 samples)	4.5	156	267	198	NA	340

[a]NA = Not Available

Sources:

[b]Mueller et al., 1976
[c]USACOE, 1976
[d]City of New York, 1973
[e]USACOE, 1977a
[f]Greig and McGrath, 1977

TABLE II.C-10

SEDIMENT QUALITY, PIER AREA, SANDY HOOK BAY

Parameter	Composite 1 (Existing Channel)[a,b]	Composite 2 (New Channel)[a,b]	Sandy Hook Bay[c,d]	Sandy Hook Bay[c,d]	Sandy Hook at Leonardo[c,d]	Shoal Harbor and Compton Creek[c,d]	Shoal Harbor and Compton Creek[c,d]	Entrance Channel Shrewsbury River[c,e]
Total Organic Carbon mg/kg	6,817	6,100						
Volatile Solids mg/gm	31.0	26.4	13.29	13.35	6.99	9.91	13.21	1.20
Oil & Grease mg/gm	10.6	20.7	28.8	27.3	18.8	0.030	0.44	0.020
Total Phosphate mg/kg	5.15	5.65						
Ortho-Phosphate mg/kg	3.44	40.8						
Phenols mg/kg	.273	.361						
Nitrate mg/kg	.266	.632						
Nitrite mg/kg	.156	.634						
Ammonia mg/kg	.278	.03						
Organic Nitrogen mg/kg	.047	.152	0.492	0.460	0.264	0.28	0.35	0.06
COD mg/kg	39,203	28,968	15,270	14,500	7,910	11,450	17,440	200
DDT micrograms/kg	0.1	0.1						
PCB micrograms/kg	0.1	0.1						
Sulfide mg/gm	.001	.001						
Cyanide mg/kg	.0025	.0019						
Flouride mg/kg	.157	.197						

Notes:

[a] average of 3 replicate samples
[b] at -47 feet MLW
[c] % dry weight

Sources:

[d] Mueller et al., 1976
[e] USACOE, 1976b

C.9 Estuarine Ecology

a. General

Estuarine organisms are exposed to abrupt changes in temperature, salinity, chemical and oxygen concentrations over seasonal, daily and tidal cycles. The predominantly estuarine species belong to groups that are tolerant of wide ranges of variability in these parameters.

The Raritan Estuary can be considered a typical well-mixed, pollution-stressed estuary characterized by a high level of productivity which can support a diverse biota (Weiss and Wilkes, 1974). The estuary is a nutrient trap in which benthos retain and recycle nutrients and organic aggregates and detritus are formed. Since pollutants can also become trapped (Odum, 1971), primary productivity is also related to pollution levels and is very high in the Raritan Bay area (Sandy Hook Marine Laboratory Staff, 1971; Patten, 1961a; FWPAC, 1967) and moderate in Sandy Hook Bay area to the east (Kawamura, 1966). Productivity in the estuary results from the photosynthetic activities of macrophytes (see marsh grasses in Section B.8) and phytoplankton. A relatively stable benthic community is present in the polluted Raritan Estuary; however, species diversity is reduced in comparison with healthy systems in other areas. Dean (1975) lists 127 taxa in the Raritan Estuary whereas Parker (1969) reports 385 species of benthic invertebrates near Woods Hole, Massachusetts.

b. Phytoplankton

Phytoplankton are a major food source in estuaries and provide a substantial food base for numerous filter-feeding organisms (zooplankton and shellfish) and for plankton-feeding fish (menhaden, bay anchovy). Several independent investigators have studied phytoplankton populations in the Raritan Estuary complex over the past two decades (Jeffries, 1959; Patten, 1961a, 1961b, 1962; Yamazi, 1966; Kawamura, 1966; Prager and Mahoney, unpublished data/McCarthy, 1965; Croker, 1965; Sandy Hook Marine Laboratory Staff, 1971).

Of the 104 species in this particular phytoplankton community, 18 are freshwater, 9 brackish and the remaining are saltwater forms (Kawamura, 1966). Appendix G-1 includes a list of area phytoplankton. Diatoms, euglenoids and dinoflagellates are the dominant forms (Kawamura, 1966).

Patten (1962) found the three most significant phytoplankters of Raritan Bay in the spring to late summer to be the diatoms Skeletonema costatum, Thalassiosim gravida and Chaetoceros decipiens. In the late summer the most abundant are chlorophycean Nannochloris atomus, and the dinoflagellates Prorocentrum micans, Perianinium trachoideum, P. breve and P. divaricatum.

The dominant winter flora are diatomaceous, the most important being Nitzschia seriata, Leptocylindrus danicus, Rhizosolenia setigera, R. alata, Asterionella japonica, Thalassionema nitzschioides and Guinardia flaccida (Smayda, 1973). Primary production in Raritan Bay is very high (Sandy Hook Marine Laboratory Staff, 1971; Patten, 1961a; FWPCA, 1967). Based on gross productivity (oxygen released in photosynthesis), summer plankton communities average between 3 and 13 times that measured in neighboring bays and estuaries suffering from less pollution (Jeffries, 1959; Patten, 1962). The occurrence of Nannochloris is a good indicator of the polluted conditions of Raritan Bay. During mid to late summer, dinoflagellate blooms occur which are a nuisance to bathers and may result in reduced catches by local anglers. These blooms are produced by the influence of excessive nutrients and usually last a few days. Extended blooms may result in local fish kills. Blooms of the dinoflagellates Massartia rotundata, Prorocentrum sp. and Glenodinium sp. do occur in the Raritan Estuary system. These frequent outbreaks reflect a highly eutrophic condition.

c. Zooplankton

Zooplankton are subdivided into three forms: (1) holoplankton which spend their entire life cycles in the water column, (2) meroplankton which spend only a portion of their life cycles as plankton, and (3) tychoplankton which are accidentally swept off the bottom.

The major factors limiting the production and dispersal of estuarine zooplankton are temperature and salinity. Peak numbers of zooplankton produced annually are usually observed in late spring to early summer, following the characteristic winter-spring phytoplankton bloom. In shallow estuarine waters where mixing with offshore waters is restricted, dramatic reductions in the standing crop coincide with high summer temperatures. In the winter, the largest concentration occur in the lower part of the bay.

The seasonal variation of common zooplankton species of Raritan Bay is presented in Table II.C-11. The dominant zooplankton are the two copepods Acartia and Euritemora. The population of these holoplankton are comparable to nearby, unpolluted estuaries, indicating that they have a remarkable ability to withstand high pollution levels (Jefferies and Johnson, 1963).

The meroplankton, which consist of larval stages of benthic invertebrates and fish, show atypical distributions which could be associated with inimical conditions arising from pollution or indirectly from ectocrines produced during the phytoplankton's exceptional growth in this over-fertilized estuary (low dissolved oxygen, high BOD, and nutrient eutrophication), (Jeffries, 1964).

Compared to Raritan Bay, Sandy Hook Bay zooplankton show greater diversity and a greater degree of dominance, reflecting the influence of less pollution stress. Approximately 60 species (Appendix G-2) are reported in the Sandy Hook Bay area (Yamazi, 1966). Estuarine forms are the most common. Three of the most common species are the copepods Acartia tonsa, Pseudodiaptomus coronatus and the rotifer Synchaeta littoralisuch (U.S. Army Corps of Engineers, New York District, 1976b).

TABLE II.C-11

ZOOPLANKTON SPECIES COMMON TO RARITAN BAY

Season: Fall and Winter	Season: Spring and Summer	Season: All Year
Acartia clausi (winter)	*Mya arenaria* larvae	*Acartia tonsa*
Centropages typicus (fall)	*Acartia clausi*	*Centropages hamatus*
Euritemora affinis (winter)	*Centropages typicus*	*Paracalanus crassirostris*
Euritemora americana (winter)	*Euritemora affinis*	*Oithona similis*
Pseudocalanus minutus (winter)	*Euritemora americana*	
Temora longicornis (winter)	*Pseudocalanus minutus* (spring)	
Cancer sp larvae	*Temora longicornis*	
	Carcinus maenas larvae (spring)	
	Crangon septemspinosus larvae	
	Neopanope texana sayi larvae (summer)	
	Pagurus longicarpus larvae (summer)	
	Balanus sp larvae	
	Pelecypoda larvae & eggs	
	Polychaeta larvae	
	Rotifera	

Source: The Research Institute of the Gulf of Maine and Public Affairs Research Center, 1974, *A Socioeconomic and Environmental Inventory of the North Atlantic Region, Volume 1, Book 3*, Bureau of Land Management.

Numbers of Acartia tonsa are reported in a range of 10,000 and 30,000 per cubic meter for May and June in Sandy Hook Bay (Yamazi, 1966).

Fish eggs and larval forms of benthic invertebrates, such as polychaete larvae, gastropod veligers, and shrimp larvae are distributed widely in the region and are an important part of the plankton community. Balanus larvae and larvae of mysid shrimp and the polychaete Polydora are other important forms. Twenty species from 16 families of fish eggs and larvae are found in the area. Seven species comprise 98 percent of the larval fish which include Anguilla rostrata, Clupea harengus harengus, Ammodytes americanus, Pseudopleuronectes americanus, Anchoa mitchilli, Syngnaithus fuscus and Menidia menidia (Croker, 1965). Larvae are abundant from March through July. The most abundant fish eggs collected were the sea robin and Atlantic menhaden. Such results suggest a possible nursery area.

d. Benthic Invertebrates

The waters of the area support an assemblage of both mature and immature forms of benthic macroinvertebrates (polychaete worms, nematodes, mollusks and arthropods)(USACOE, 1976b). However, little information is available for Sandy Hook Bay and Channel areas.

Results from benthic sampling at 193 stations from 1957-1960 identified 127 taxa (Appendix G-3) of which polychaetes, mollusks and crustaceans made up 86 percent (Dean, 1975). Most prevalent were Mya arenaria, Nereis succinea, Polydora ligni, Ampelisca sp. and Nassarius obsoletus. Thirty-one species were listed from 8 sampling stations in the Raritan Estuary (Sandy Hook Marine Laboratory, 1971). These results indicate that species densities in this area are lower than other estuarine environments and coastal waters of the Atlantic Ocean. In an estuarine complex near Woods Hole, Massachusetts, Parker (1969) reports finding 385 species of benthic invertebrates.

TABLE II.C-12

BENTHIC SURVEY RESULTS SANDY HOOK BAY, FALL, 1977

Species	Sample Station[a]														
	BS1	BS2	BS3	BS4	BS5	BS6	BS7	BS8	BS9	BS10	BS11	BS12	BS13	BS14	Total
Nassarius trivittatus				1											1
Turbonilla sp.												1			1
Mercenaria mercenaria		1		1								1	1		4
Mulinia lateralis	77*	45*		3					1		2			8	136
Mya arenaria														1	1
Tellina agilis	2					2	5	3							12
Glycera capitata												1			1
Nephtys incisa	1					3					1				5
Nephtys picta			1		1										2
Pectenaria gouldii			1										1		2
Spio filicornis	11											15		1	27
Spiophanes bombyx												3			3
Streblospio benedicti	15						5	4						12	36
Tharyx acutus	65														65
Haustoridae sp.													2		2
Mysidacea														1	1
Totals	94	78	47	1	4	5	10	7	1	—	3	21	4	23	299

*Most, when opened, were found to be filled with mud.
[a]See Figure II.C-21 for location of Sample Stations.

TABLE II.C-13

CHECKLIST OF ORGANISMS COLLECTED IN BIOLOGICAL DREDGE, OCTOBER 26 and 28, 1977

	Trawls					
	T1	T2	T3	T4	T5	T6
Cnidaria						
Anthozoa						
Hydractinia echinata	-	-	-	P	-	-
Mollusca						
Gastropoda						
Nassarius trivittatus	P	P	-	-	-	P
N. obsoletus	-	P	-	-	-	-
Bivalvia						
Mercenaria mercenaria	-	-	-	P	-	P
Mytilus edulis	-	-	A	C	-	-
Annelida						
Polychaeta						
Harmothoe extenuata	-	-	C	-	-	-
Lepidonatus squamata	-	-	C	-	-	-
Arthropod						
Crustacea						
Cancer irroratus	-	-	A	A	-	-
Crangon septemspinosa	-	P	-	-	-	-
Paleomonetes pugio	-	-	-	P	-	P
Echinodermata						
Asterias forbesi	P	-	A	C	-	-
A. vulgaris	-	-	C	C	-	-
Chordata						
Osteichthys						
Paralichthys oblongus	-	-	P	-	-	-

A - Abundant
C - Common
P - Present

At 14 benthic grab stations and 6 trawl stations sampled as part of this study (see Appendix F for a discussion of sampling and analysis procedures), 16 taxa were observed (Tables II.C-12 and II.C-13). Only four species occurred at four or more stations, three being the bivalves Mulinia lateralis, Mercenaria mercenaria, and Tellina agilis. Streblospio benedicti occurred at four stations. Mulinia lateralis was most abundant. However, most shells were found to be filled with silty mud.

Two benthic communities were identified by McGrath (1974), and can be related to distinct sediment substrata: 1) the Tellina agilis - Streblospio benedicti community in sand bottoms; and 2) the Mulinia lateralis - Nephtys incisa community in mud bottoms. Results of this study indicate greatly depressed macrofaunal densities in comparison with other areas. The results reported by McGrath are supported by data from the benthic surveys for this project. The sandy mud stations at BS7, BS8 (Figure II.C-21) showed Tellina agilis and Streblospio benedicti to be the only species present, whereas the muddy areas indicated a Mulinia lateralis - Nephyts community. A general survey of the Raritan Bay area in April 1971 (U.S. Army Corps of Engineers, New York District 1976a) found groups of Foraminifera and Nematoda to be numerous, with arthropods and pelecypods also being observed. McGrath (1974) found Mulinia lateralis to be the most characteristic species in mud strata with the polychaetes Nephtys incisa associated with silty-clay sediments. Nassarius trivittatus is found in sand and mud substrates. These results are comparable with results obtained by the field program for this project (Table II.C-12).

Polychaete worms are common throughout the tidal portions of Sandy Hook Bay (U.S. Army, 1976b). Decapod larvae are more abundant in the summer. Nearshore benthic invertebrates found in the project area include the periwinkle snail (Littorina littorea), fiddler crab (Uca minax), blue mussel (Mytilus edulis), ribbed mussels (Volsella demissa), sea anemones (Metridium senile), horseshoe crab (Limulus polyphemus) and hermit crabs (Pagurus sp). Balanus sp. are also found throughout the area wherever there are places to attach (USACOE, 1976b).

Attached benthic invertebrates are considered to be bioindicators of prevailing chemical and physical conditions because they are unable to escape from the aquatic substrate. Modifications of the physical and chemical environment are usually manifested in an alteration in the composition, density or distribution of these benthic organisms. Blumer, et al., (1970) have found that Ampeliscid amphipods are extremely sensitive to small concentrations of oil and serve as excellent indicators of chronic petrochemical pollution. Abundant evidence indicates that many areas of sediment in Raritan Bay contain hydrocarbon residues which increase in an up-bay direction (McGrath, 1974).

Lamellibranch veligers (mollusk larvae) occur widely in eastern Sandy Hook Bay and nearby tributaries. The bottom substrate here produces commercial quantities of hard- and soft-shelled clams (USACOE, 1976b). Prominent hardshell clam (Mercenaria mercenaria) beds are found from Plum Island to an area northwest of Skeleton Hill Island and in the vicinty of Horseshoe Cove (U.S. Department of Health, Education and Welfare, et al., 1967). In the general area of Sandy Hook Bay, hard shell clams represent less than 25 percent of benthic populations. Clam densities range from 0.2 to 1.0 clam per square foot. These data are at least 12 years old and may be unrealistic (Dames & Moore, 1976). No other shellfish beds have been mapped. Some softshell clam beds have been found in Spermaceti Cove waters. Due to the unsafe fecal coliform levels, however, Mya arenaria must first undergo a three-day depuration process to cleanse the organisms (Jeruso, 1976). The quahog or hardshell clam does not cleanse itself as readily and cannot be taken for commercial purposes. Clam consumption from Raritan Bay has been legally restricted since 1961. In years past, the Bay was an important fisheries center for fish and shellfish, which were harvested for great commercial value.

A third commerically important species distributed throughout the area is the blue crab, Callinectes sapidus. Adults move into shallow waters to reproduce when the waters warm. The crab hibernates in deep water muds during the winter. The lobster, Homarus americanus, is not taken commercially in the project area.

e. Related Habitats

Two related habitat types of importance occur within the project area and deserve particular attention. These are: 1) the high-energy intertidal sandy beach habitat which occurs at the northern tip and along the eastern shore of Sandy Hook; and 2) the substrata habitat on NWS Earle pier pilings.

1. Intertidal Sandy Beach - This area receives waves from the New York Bight region which are somewhat deflected by Long Island. Sandy Hook spit absorbs much of the wave energy approaching the coastal zone and affords some protection to the bay system (see Coastal Processes, section C.7d of this chapter). Most of the beach fauna are hardy, filter-feeding sand dwellers who are able to inhabit this shifting substrata which is periodically flooded and exposed. Common organisms of this area are the surf clam, Spisula solidissima; the mole crab, Emerita talpoida; and the horseshoe crab, Limulus polyphemus. Emerita is a rapid burrowing organism which migrates up and down the beach in response to wave action. Dominant crustacea are the beach hoppers or Amphipoda which feed on organic detritus in the intertidal zone. The higher level carnivores of this zone consist of birds such as herring gulls, ring-billed gulls, common terns, sandpipers and plovers. They feed on various mollusks, crustaceans and other invertebrates at low tide.

2. Pier Piling Substrata Habitat - Structures such as the pilings for the pier supply a hard substrata to the aqueous environment of an area which did not previously exist. Colonization of this substrata will locally alter the structure of the adjacent ecosystem. In order to establish the existing nature of this community, a sampling program was conducted for the pier pilings. Scrapings were taken from three depths on the pier: 1) surface waters; 2) mid-depth waters; and 3) bottom waters. The results of the identifications of these scrapings are presented in Table II.C-14. In general, benthic composition present on the pilings was different from that noted for the mud and sand communities of the nearby bottom, discussed above.

TABLE II.C-14

DISTRIBUTION OF INVERTEBRATES TAKEN FROM NWS EARLE PIER, NOVEMBER 1, 1977

Species	Surface Water Level	Mid Water Level	Bottom Water Level
Cnidaria			
Hydrozoa			
Tubularia sp.	-	C	-
Anthozoa			
Hydractinia echinata	-	C	-
Medtridium senile	C	-	P
Platyhelminthes	A	P	-
Mollusca			
Gastropoda			
Urosalpinx cinerea	-	-	P
Bivalvia			
Mya arenaria	P	P	-
Mytilus edulis	C	C	C
Petricola pholadiformis	-	-	P
Annelida			
Polychaeta			
Caprellidae	-	P	-
Hydroides dianthus	P	-	-
Lepidonatus squamata	-	C	C
Nereis succinea	A	C	C
Protula tubularia	P	-	-
Sabella microphthalma	C	P	A
Arthropod			
Crustacea			
Balanus crenatus	A	C	-
B. eburneus	A	C	-
B. improvisus			
Elasmopus laevis	-	P	-
Gammaridea	-	P	P
Hexapanopeus angustifrons	-	C	A
Ischyroceridae sp.	-	P	-
Chordata - Tunicates	-	C	C

A - Abundant
C - Common
P - Present

The pier surface zone was characterized by attached green algae which are utilizing the available light penetration for photosynthesis. Species of green algae noted here were Enteromorpha and Chaetomorpha. Also present in the upper zone but situated below the level of the algae were barnacles which comprised a white zone. Other forms present in the white zone were the anemone, Metridium senile, and the mussel, Mytilus edulis. The presence of these forms and the barnacles indicate that current flow is great enough to bring food and nutrients to this level. These organisms require a hard substrata for attachment. Also present in this zone were polychaetes such as Nereis succinea and Sabella microphthalma.

The mid-zone was not dominated by any one organism. However, Mytilus eduis, Nereis succinea, Hexapanopeus angustifrons, Lepidonotus squamatus, barnacles and tunicates were common. In this zone diversity increased and more motile (unattached) species were observed.

The bottom zone was dominated by a crab Hexapanopeus angustifrons and the polychaete Sabella microphthalma. Long tubes from S. microphthalma were abundant and both the crab Hexapanopeus angustifrons and S. microphthalma were larger size in this zone. Nereis succinea size decreased with depth and was thus smallest in this zone. The increase in biomass to this area is able to support a larger consumer population and supplements the food supply of mollusks, crustacea, polychaetes and fish of the area.

f. Fish

In general, the fish fauna in the study area are small, euryhaline species that are adapted to continuous residence, juvenile fishes that use the estuaries as nursery grounds, large species using the area for feeding or spawning, or diadromous species that use the estuaries as pathways to and from spawning grounds (TRIGOM, 1974). Sandy and muddy shores, as occur in the project area, have more fluctuating populations than do rocky shores, which have more resident populations.

As many as 118 different species of fish have been reported in the waters of Sandy Hook Bay (Eisler, 1961). Appendix G-4 lists the species and provides data on occurrence. The most common species together with information on their distribution, spawning areas and eating habits is presented in Table II.C-15.

The estuary is important for both the commercial and sport fisheries. Commercial fishing has declined since the turn of the century (USACOE, 1976b). The peak of fish production from the south shore of Sandy Hook to Union Beach and north from the Kills to Swinburne Island occurred over 30 years ago, when 100-pound nets harvested fish from around the bay (Sandy Hook Marine Laboratory Staff, 1971). In 1970, six operators fished 13-pound nets from the south shore of Sandy Hook to Ideal Beach. Shad, once taken by gill net in the bay, are no longer present. In addition, fyke netting and lobstering in bay waters have ceased. Blue crab (Callinectes sapidus) harvesting continues but is diminished.

Some winter dredging of crabs occurs from November through February. Sport fishing continues from March to late autumn. The largest total fish catch for Monmouth County is for menhaden which is processed into fish meal, oil, and solubles and is also used as bait fish for anglers. No longer taken, or seen only sporadically, are the croaker, (Micropogon undulatus), spot (Leiostomus xanthurus), sheepshead (Archosargus probatocephalus), and spanish mackerel (Scomberomorus maculatus). Although commercial fishing in the bay declined, recreational sport fishing has expanded greatly in recent years. Sportfish include striped bass, flounders, weakfish, porgies, bluefish, black sea bass, tautog, kingfish and northern puffer (USACOE, 1976b; and Sandy Hook Marine Laboratory, 1971).

g. Endangered and Threatened Species

An endangered species is one whose overall survival or whose survival in a particular region or locality is in jeopardy. Its peril may result from loss of habitat, change in habitat, overexploitation by man, predation, adverse interspecies competition, or disease. Unless an endangered species receives protective assistance, extinction may occur. A species may also be considered as threatened or

TABLE II.C-15

COMMON FISH FAUNA OF RARITAN AND SANDY HOOK BAYS

Fish	Distribution	Spawning Areas	Eating Habits	Comments
Menhaden (Brevoortia tyrannus)	coastal water areas from May to October	on continental shelf	plankton and small crustaceans	used as chum and as bait for recreational fisheries
Stripped Bass (Morone saxatitis)	coastal areas	Hudson River and other brackish to fresh water (temperatrure 58° to 70°F)	wide variety of fish, crustaceans, shellfish and polychaetes	a major game fish
Bluefish (Pamatomus saltitrix)	coastal areas and continental shelf "Snappers" (young) in Sandy Hook Bay from August to September	continental shelf (18 m deep to shelf edge)	Copepods, crustaceans, molluscan larvae and several fish fauna	"Snappers" are popular game fish in Sandy Hook Bay
Winter Flounder (Pseudopleurinectes americanus)	bottom dweller in bays and continental shelf	bays and estuaries in water 2 to 5 meters deep	variable - shellfish, polychaetes, small fish and crustaceans	popular recreational fishing in coastal areas
River Herrings The Alewife (Alosa pseudoherengus) and the Blueback (Alosa aestivales)	coastal areas	Alewife - ponds and sluggish streams Blueback herring - brackish waters	Alewife - plankton feeder	commercial fishing
Scup (Stenotomus chrysops)	coastal areas; bottom waters	shallow coastal areas and bays	crustaceans, polychaetes and other bottom forms	commercial and recreational fishing

Source: TRIGOM (1974); Eisler (1961)

rare if its population becomes notably decreased because of the development of any number of limiting factors leading to a deterioration of the environment.

Species which fall into these categories and have the potential for occurrence in the Raritan Estuary are listed in Table II.C-16.

The shortnose sturgeon (Acipenser brevirostrum) is an endangered species which may occasionally venture into the Raritan Estuary on its way to the Hudson River (Dovel, 1977; US Fish and Wildlife Service, 1976). The fish's decline in New Jersey has been attributed primarily to pollution of the sturgeon's habitat (Heitzelman, 1972). It is difficult to predict the shortnose sturgeon's presence in or use of the project area since very little is known of its local distribution, biology or behavior. It does not use this area for breeding (Dovel, 1977).

The Atlantic tomcod lives mostly in shallow areas of harbors and bays, and spawns in winter in the Raritan River and other streams (U.S. Fish and Wildlife Service, 1976). Thus, it may utilize the project area during seasonal migrations.

The sea turtles are widely ranging, predominantly ocean dwelling species which may occur in Raritan Esturay.

D. OCEAN ENVIRONMENT-DREDGE MATERIAL DISPOSAL SITE

D.1 Introduction

a. Geographic Setting

The dredge material disposal site lies within the apex of the New York Bight. The New York Bight is that section of the Atlantic Ocean that extends from Cape May, New Jersey north and east to Montauk, Long Island, New York. The Bight covers more than 39,000 square kilometers, an area about twice the size of New Jersey. It extends off the Long Island and New Jersey coasts to the outer edge of the continental shelf, approximately 150 to 180 kilometers seaward of the coast.

TABLE II.C-16

ENDANGERED AND THREATENED SPECIES WITH POTENTIAL FOR OCCURRENCE IN THE RARITAN ESTUARY

	Endangered	Threatened
Finfish	Shortnose Sturgeon (*Acipenser brevirostrum*)	Atlantic Tomcod (*Microgadus tomcod*)
Sea Turtles	Hawksbill (*Eretmochelys imbricata*)	
	Leatherback (*Dermochelys coriacea*)	
	American Ridley (*Lepidochelys kempii*)	
	Green Turtle (*Chelenia mydas*)	
	Loggerhead (*Caretta caretta*)	

Source: USDI (1977)
USEPA (1975)

The coastline of the Bight is characterized by sandy beaches and by numerous bays and estuaries.

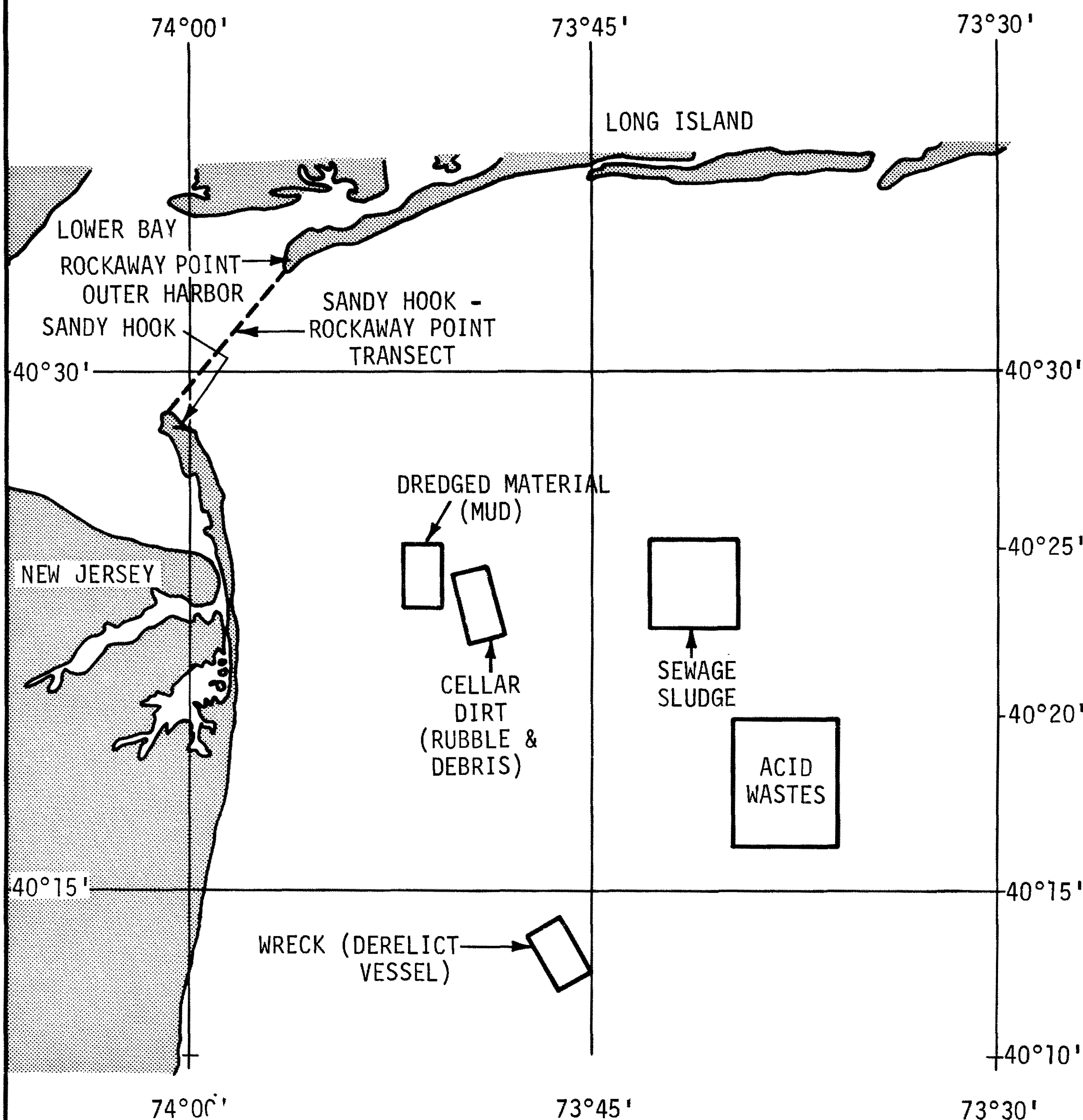
The Bight Apex extends from Atlantic Beach, New York, south and west to Manasquan, New Jersey. It covers approximately 2000 square kilometers and lies immediately adjacent to the New York-New Jersey metropolitan area.

The New York Bight/Bight Apex is delineated from the estuarine waters of Outer New York Harbor by the Sandy Hook-Rockaway Point Transect (Figure II.D-1). The Outer Harbor (Lower Bay, Sandy Hook Bay, and Raritan Bay) includes the waters south of Staten Island lying between the Narrows and the Harbor entrance. It is commonly differentiated from the Inner Harbor (Hudson River, East River, Arthur Kill, Kill Van Kull, Passaic River, Harlem River, Hackensack River, Newark Bay and Upper Bay).

b. Background

Ocean dumping in the New York Bight was authorized by the New York Harbor Act in 1888. The Corps of Engineers had jurisdiction over all ocean dumping until the Marine Protection Research, and Sanctuaries Act of 1972 (Public Law 92-532) was enacted. Since April 1973, the Corps has been responsible for issuing permits for transportation and dumping of dredge material and the U.S. Environmental Protection Agency (USEPA) has been responsible for granting permits for other material. The EPA also has the authority to review the permits for dredge disposal. The U.S. Coast Guard has the responsibility to conduct surveillance of dumping activities and to enforce regulations. The National Oceanographic and Atmospheric Administration (NOAA) is to monitor and research the effects of ocean dumping through its Marine EcoSystems Analysis (MESA) New York Bight Project.

The New York Bight Apex is currently the depository for five types of wastes. They include dredged material, sewage sludge, cellar dirt, acid wastes and



EXISTING DUMP SITES: NEW YORK BIGHT APEX

5 0 5

NAUTICAL MILES

SOURCE: USEPA, JULY 1974

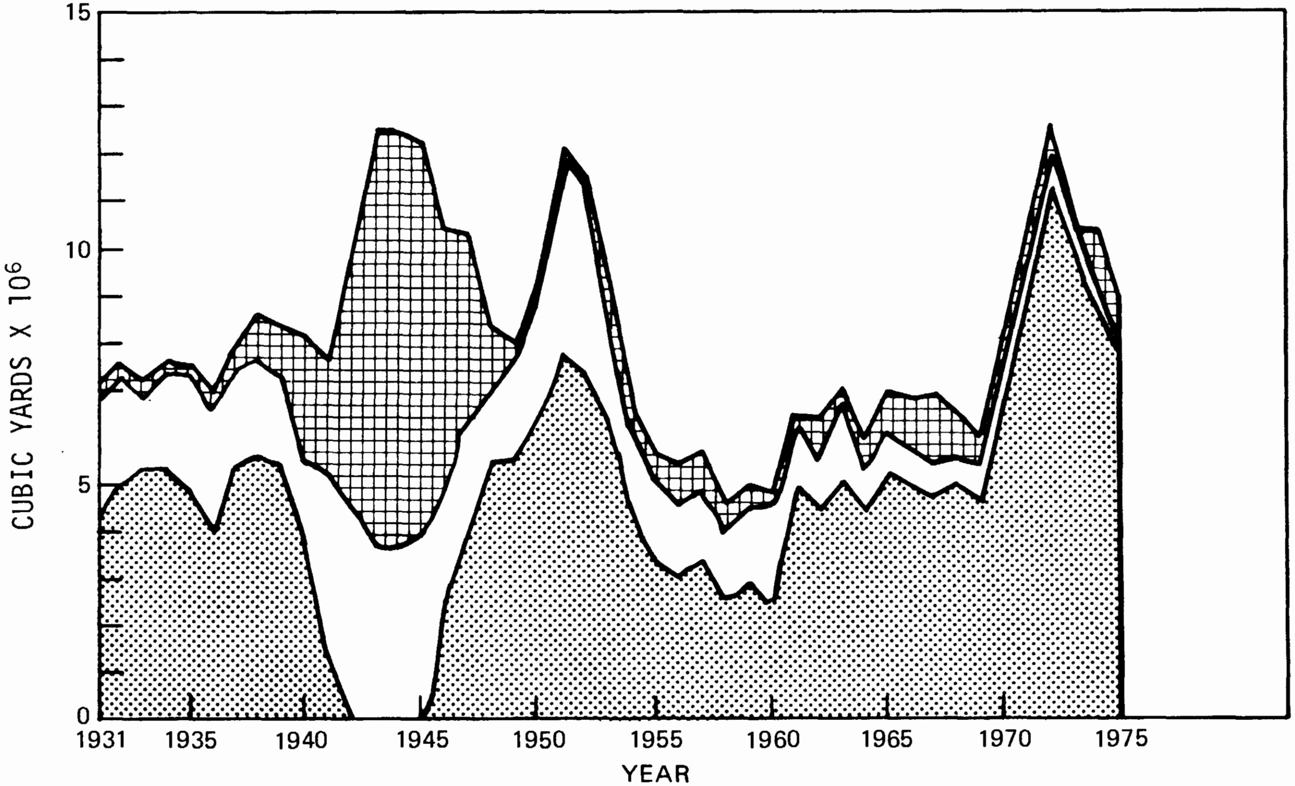
FIGURE II.D-1

wrecks (derelict vessels). A sixth dump site, (chemical wastes), is located approximately 196 km from the harbor entrance, on the edge of the continental shelf. This dump site is just outside the New York Bight. The dredge material disposal site is located at latitude $40^{o}23'48''$ north and longitude $73^{o}51'21''$ west (Figure II.D-1). The principal wastes dumped at this site are materials dredged from navigable waterways (including channels, harbors, anchorage grounds, and vessel berths) in the New York-New Jersey metropolitan area. The dredged material currently dumped here results from maintenance dredging operations, channel improvements and new dredging. Prior to 1973, ash residues from fossil-fueled power plants were also dumped at this site. Hopper dredges owned by the U.S. Army Corps of Engineers (USACOE) and privately owned bottom-dump scows both use this site.

The original dredged material dump site was established in 1888 inside New York Harbor. As the designated area decreased noticeably in depth, its location was changed several times; the existing dredged material site was designated for use in 1940. Based on estimated annual volumes, dredged material has generally been the major source of wastes dumped in the New York Bight.

The yearly volume of dredge material taken from New York Harbor for the period 1931 to 1975, using a moving three year average, is presented in Figure II.D-2 (USACOE, N.Y. District, October, 1977). Figure II.D-2 also indicates the volume of material disposed of at the dredge material disposal site or "Mud Dump", at upland disposal sites and at smaller local water disposal sites during this period. The average maintenance dredging during this period has been approximately four million cubic yards per year.

The variation in total dredge volume reflects the influence of various new dredging projects during this period. For instance, the peak between 1972 and 1975 represents a large portion of new dredging work that was accomplished in the channel improvements for New York Harbor and Newark Bay.



NEW YORK HARBOR DREDGING AND DISPOSAL

(3 YEAR MOVING AVERAGE)

KEY.

- OTHER DISPOSAL SITES (IN N.Y. HARBOR, L.I. SOUND, ETC.)
- UPLAND DISPOSAL SITE
- MUD DUMP SITE

SOURCE: U.S. ARMY COE, OCT., 1977

FIGURE II.D-2

In October 1974, EPA requested that the COE-New York District submit a plan for phasing out the existing dredged material dump site by 1976, and for possibly using an alternate dump site further out on the shelf. The plan was also to consider alternatives to ocean dumping, potential hazards to navigation, and economic impacts, and was to include an implementation schedule. The request was made because of the significant volume of dredged material being dumped annually, its high pollutant loading, and EPA's preliminary decision to move the sewage sludge dump site farther offshore (USEPA, October 9, 1974).

The COE-New York District maintains that relocating the dredged material dump site is not currently justified in terms of its potential effects on water quality, shellfish beds or fisheries resources, wildlife, or recreational areas. In addition, the COE indicates that transporting dredged material to an alternate dump site further out on the shelf will significantly increase the cost of waterways dredging and port development in the metropolitan area. However, the COE is currently studying alternative sites and methods of dredged material disposal and has indicated a willingness to relocate the dump site if studies show that the existing site presents a hazard to navigation or public health (USACOE, December 12, 1974). A workshop on dredged material disposal alternatives was conducted by COE in October, 1977 and public hearings were held in December, 1977. An environmental report incorporating these results will be completed in 1979.

Monitoring studies conducted under the National Oceanic and Atmospheric Administration - Marine Ecosystems Analysis (NOAA-MESA) program indicate that the "great bulk" of dredged material already dumped at the site has not been transported any significant distance from the release point (NOAA, March 14, 1975). In February 1976, NOAA-MESA stated that use of the existing dredged material and sewage sludge dump sites has resulted in significant adverse environmental impacts over a localized area of several hundred square meters. Nevertheless, NOAA does not recommend moving the existing dump site unless it presents a hazard to navigation or public health (NOAA, October 6, 1975).

In July 1975, the COE suggested that dredged material dumping be shifted slightly offshore and to the southeast of the existing disposal site. This proposal was prompted by an accumulation of solids at the disposal site, the trend toward increased vessel draft, and the need for maintaining a minimum 15 m (50 ft) water depth onsite. (USACOE, July 14, 1975.) The EPA has directed the COE to utilize the southern portion of the existing dump site which has not been affected by shoaling from previous dumping. Depth in this area is about 80 feet (21 meters) (Figure II-D-3).

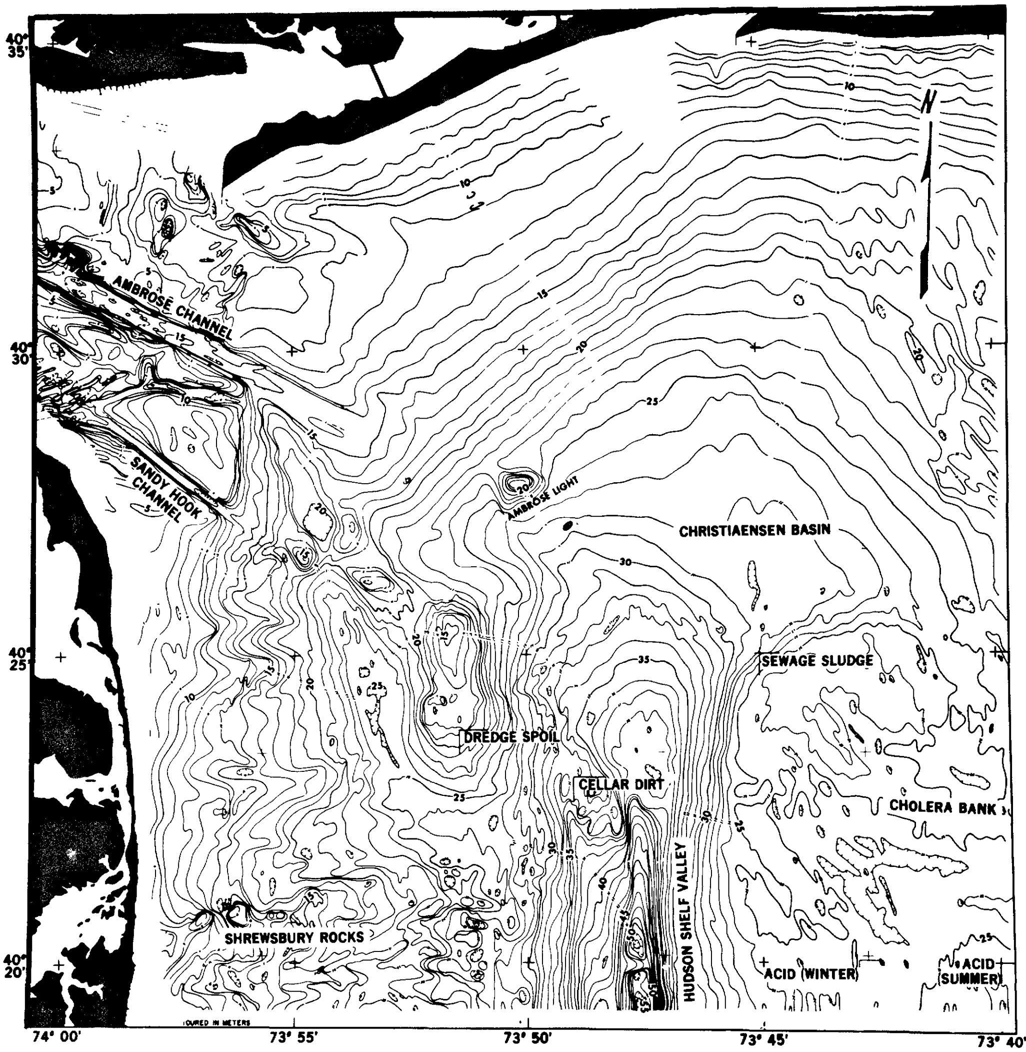
D.2 Bathymetry

The sea floor is not a smooth, featureless plain. It is characterized by forms and structures just as the land surface is characterized by hills and valleys.

The continental shelf, including the portion that underlies the New York Bight, exhibits a variety of bathymetric features, such as relict drainage channels, scarps and terraces, systems of sand ridges, and smaller features (bedforms). In general, the bathymetry of the continental shelf reflects the cumulative processes of erosion and deposition by streams and near-shore currents.

In 1936 the Coast and Geodetic Survey (now the National Ocean Survey) initiated periodic surveys of coastal waters. A 1973 bathymetric map (Figure II.D-3) of the Bight Apex was made as a result of a NOAA-Corps of Engineers survey. The most significant topographic features of this region are the northern end of the Hudson Shelf Valley, Cholera Bank and the Christiaensen Basin, an amphitheater-like feature which terminates the Hudson Shelf Valley (Freeland, et al., 1976).

A less prominent submarine channel, Highland Channel, extends in a south-east orientation from the midpoint of Sandy Hook. It appears to merge with the Hudson Channel in 90 feet of water south of Castle Hill. The Highland Channel is interpreted as an extension of the ancentral Raritan River which flowed eastward across the exposed shelf during the Late Pleistocene (Williams and Duane, 1974).



BATHYMETRY: NEW YORK BIGHT APEX IN 1973

DEPTH IN METERS
(CONTOUR INTERVAL 1 METER)

0 1 2 3 4 5 NAUTICAL MILES

SCALE

SOURCE: FREELAND ET AL. (1976)

Very little natural sedimentation has occurred in the Bight Apex since the last rise of sea level. Significant modifications of the shelf topography have been induced however, by dumping of man's waste materials during the last 85-90 years (Paranas-Carayannis, 1973). The physical manifestations of this dumping are two knolls lying north and northwest of the dredge disposal site and another immediately northwest of Ambrose Light. They have been formed by dumping; 1) assorted building excavation material during the development of the New York metropolitan area, and 2) sand and gravel dredged from the Sandy Hook and Ambrose Channels (Freeland, et al.,1976).

Analysis of historical changes in bathymetry and estimates of volumes of dredged material dumped at the site between 1936 and 1973 (140 million cubic meters) indicate that most of the predominantly coarser materials, have accumulated in a sediment mound (nine million cubic meters) which is over 10 meters (m) high and covers over 50 square kilometers (km) of seafloor.

D.3 Water Circulation and Properties

The hydrographic characteristics of the Bight Apex water (its temperature and salinity) are predominantly controlled by seasonal sea-air exchange processes (such as precipitation, evaporation, and heat exchange) and by the influx of fresh water from the Hudson-Raritan Estuary.

As discussed in Section C-4, the Raritan Estuary exhibits the typical two-layer estuarine circulation pattern (Figure II.C-6). Brackish surface water moves seaward and parallels the New Jersey coastline. At depth, denser Bight water moves into the estuary.

The hydrographic properties of the New York Bight have been studied by Bowman and Wunderlich (1976). During the late spring and summer, the water is stratified by intense heating of the upper layer into two distinct layers; an upper warmer and lighter layer above the thermocline and a cooler bottom layer. In the fall and winter, cooling of surface waters and wind-driven mixing breakdown the thermocline and the summer two-layer pattern. This results in a more homogeneous water mass. In the spring, fresh water outflow into the Apex increases, producing a low salinity plume which tends to flow south along the New Jersey coastline. This fresh water input is lighter water and tends to ride out into the Apex in the upper water layer. The saltier bottom water drifts shoreward into the estuary.

The water movements within the New York Bight Apex are predominantly controlled by variations in river discharge and in wind patterns and wind intensities.

Although considerable spatial and temporal variation may occur, the waters over the continental shelf generally flow to the south and southwest at average speeds between 5 and 10 centimeters per second (cm/sec) (Beardsley et al., 1976; EG&G, NOAA, 1975). Bottom circulation associated with this general net drift current, exhibits a slow net drift toward the estuary mouths at speeds of about 2 cm/sec (Bumpus, 1965; Hardy et al., 1975; USEPA, 1976).

Storm winds, especially northeasters, with strong winds out of the northeast, are capable of mixing the water column from top to bottom and moving the waters at speeds of from 25 to 50 cm/sec.

Due to the right-angle bend in the Apex coastline, the Bight Apex circulation is somewhat anomalous with respect to the general southwesterly circulation of shelf waters. Oceanographic studies by the Marine EcoSystems Analysis Program (MESA) of NOAA have suggested evidence that a slow (4 to 10 cm/sec) clockwise circulation existed within the Apex for the period late summer and early fall of 1973 (Hazelworth et al., 1975, 1975a, b).

The circulation in the Apex is further complicated by the presence of the deep Hudson Shelf Valley and the variations in the discharge of fresh water from the estuary. Bottom current measurements within the inner portions of the Hudson Shelf Valley by Lavelle et al. (1975) have indicated that during the summer, when the water column is stratified into two layers, surface winds may produce an upwelling or downwelling of water within the Valley. Offshore winds (toward the southeast) were related to bottom current flow directed up-channel in the Valley, while onshore winds caused a net down-channel flow. Additional studies will be required to establish a detailed understanding of the complex circulation patterns within the Bight Apex.

D.4 Water Quality

a. Dissolved Oxygen

With the exception of the waters near the Sandy Hook-Rockaway Point transect and in the Lower Bay (Figure II.D-1), surface waters in the New York Bight are saturated or nearly saturated with oxygen. Low levels of oxygen, generally less than 50 percent saturation, have been noted in surface waters off Cape May, New Jersey and in a corridor along the northern New Jersey Coast.

The oxygen levels in mid-depth waters are generally transitional between surface and bottom levels. Oxygen levels depend upon the degree of stratification and vertical mixing, which in turn depend upon seasonal changes.

Oxygen levels as low as 20 percent of saturation have been observed in the bottom waters of the New York Bight Apex during summer stratification. An area of several hundred square kilometers near the existing dredged material and sewage sludge dump sites is characterized by oxygen depleted bottom waters (less than 50 percent of saturation) during the summer. Oxygen depletion increases gradually beginning in spring, as the thermocline develops, and reaches a maximum in late summer. Oxygen saturation levels increase in the fall, following breakup of the thermocline, and continue to increase as greater mixing occurs (Segar and Berberian, 1976).

The principal cause of oxygen depletion in bottom waters is the large input of oxidizable organic carbon to the Bight Apex (Segar and Berberian, 1976). The sources are in situ (in place) photosynthetically-fixed carbon, river-borne particulate carbon, and ocean dumped carbonaceous materials. In situ photosynthetically-fixed carbon is the dominant source of oxidizable carbon in the Bight Apex.

Seabed oxygen demand appears to be responsible for only a small fraction of the oxygen depletion in the Bight Apex (Segar and Berberian, 1976). In the vicinity of the existing sludge dump site, the total seabed oxygen consumption rates (NOAA-MESA, November, 1975) in late August and early September (stratified column) ranged from 10 to 60 ml/sq m/hr. Highest values were noted near wastewater effluent outfalls along the New Jersey coast.

During the summer of 1976, unusual weather conditions, combined with other factors, resulted in a period of anoxic conditions and a massive fish kill in this region. A five week period of persistent winds from the south and southwest occurred during May and June, 1976. This pattern apparently resulted in the upwelling of cold nutrient-rich water adding to the existing high productivity noted during previous months. Segar and Berberian (1976) conclude that nitrogen supplied to Apex by rivers in forms suitable to support photosynthetic production is the cause of the low oxygen concentrations found in summer. Most of this nitrogen comes from liquid effluents of sewage treatment plants discharging into the river.

O'Connor et al, (1977) have analyzed the results of water quality data collected for the years 1949, 1969 and 1974. This analysis indicates that mean August dissolved oxygen levels in the lower water levels (5m) in the disposal area of the Apex have decreased from 67 percent saturation in 1949 to 30 percent satura-tion in 1974. These authors suggest that this may be the result of increase waste disposal in the Apex and increased volumes of oxygen-demanding bottom sediments. They point out however, that other areas of the Bight, far removed from the disposal areas also exhibited average summer dissolved oxygen saturation ranges of less than 60 percent, with average values as low as 45 percent. Thus, naturally occurring, low "background" levels of dissolved oxygen may exist.

b. Nitrogen

Mueller et al (1976), estimated that the Bight Apex receives a total nitrogen load of 520 metric tons/day (573 tons/day). Of this daily load, 210 metric tons (231 tons) are in the form of ammonium, 190 metric tons (209 tons) are incorporated in organic compounds, and 120 metric tons (132 tons) occur as nitrate and nitrite. Sixty percent of the nitrate and nitrite including agriculatural sources is from natural river runoff. Another 30 percent is from atmospheric fallout. The two major sources of ammonium loadings are wastewater discharges, including 50 cu m/sec of primary and secondary effluents and 13 cu m/sec of raw sewage discharge, and sludge dumping (O'Connors and Duedall, 1975).

In the Bight Apex, the concentration of total nitrogen largely depends on the extent to which the nutrient-rich river waters are diluted by seawater and on the use of nitrogen by phytoplankton. Generalized concentration ranges of nitrogen in the Bight are shown in Table II.D-1.

Studies by NOAA-MESA on nitrate distribution in the Bight Apex during the Fall of 1973 indicates that the major controlling factor in this area is the outflow of Hudson River nutrient-rich water, especially along the New Jersey coastal sector (NOAA-MESA, 1975).

Productivity in the Apex during the summer months is higher than that observed in similar temperate coastal zones (Segar et al., 1975). This appears to be the result of the relatively high nutrient loading within the photic (light penetrating) zone. The river-borne nitrogen may exert a significant influence on photosynthetically-fixed carbon because the river-borne nitrogen has a lower density than nitrogen from other sources and, therefore, remains in the photic zone longer. A large proportion of the nutrients in dredged material are buried on the

TABLE II.D-1

NUTRIENT CONCENTRATIONS IN THE NEW YORK BIGHT

Sampling Location	Ammonia (NH_3N)[a] (ppm)	Nitrite (NO_2N)[b] (ppm)	Nitrate (NO_3-N)[b] (ppm)	Ortho-Phosphate[b] (ppm)
Bight Apex	<2 to 126	<2 to 59	<7 to 252	< 10 to 133
Mud Dump	30	38	130	20

Sources:

[a] Alexander and Alexander, 1977

[b] NOAA-MESA, October 16, 1975

[c] This Study, see Appendix F

bottom and therefore unavailable for photosynthesis (Segar, personnel communication, 1977).

c. Phosphorous

Phosphorous occurs in the Bight as total phosphorous, reactive (ionic forms) phosphorous, particulate phosphorous, ortho-phosphorous, and meta-phosphorous. Reactive phosphorous in the surface waters of the Bight Apex ranges from 38 microgram/l to more than 95 micrograms/l. Particulate phosphorous concentrations also range from less than 10 microgram/l to more than 95 microgram/l (Alexander and Alexander, 1977).

During the summer, when the water column is stratified, total phosphorous concentrations appear to be higher in the deeper waters of the Bight than in the surface waters (Corwin, 1970). In the winter months, total phosphorous concentrations are relatively uniform throughout the water column.

Eighty-five percent of the total phosphorous load to the Bight is contributed by dredged material and wastewater discharges (Mueller et al, 1976).

d. Heavy Metals

The concentration of dissolved heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc) in the water column of the New York Bight varies according to the location and the time of year. However, background concentrations are generally higher than those reported for the open ocean (Table II.D-2). The generally higher concentrations in the Bight are related to many factors, but especially to the proximity of the sources of heavy metals (metropolitan area) and to the higher concentrations of suspended matter in the Bight waters (Benninger et al., 1975). Suspended matter, including clay minerals, organic matter, and finely dispersed iron and manganese oxides, can influence the distribution of dissolved metals. High concentrations of dissolved metals are often

TABLE II.D-2

COMPARISON OF DISSOLVED TRACE METAL CONCENTRATIONS IN THE NEW YORK BIGHT APEX AND OTHER OCEAN AREAS
(micrograms/liter)

	Cadmium Cd	Chromium Cr	Copper Cu	Lead Pb	Mercury Hg	Zinc Zn
New York Bight outside the Bight Apex[a]	0.06 to 19	3 to 15	0.23 to 18	0.69 to 2.4	0.05 to 0.24	1.8 to 3.8
Average Ocean Water[d]	0.05	0.6	3	0.03	0.05	5
Bight Apex[b]	0.06 to 7.0	NA	1.0 to 29.	NA	NA	4.2 to 152
Bight Apex[a]	0.11 to 46	NA[1]	0.6 to 47	NA	NA	2.1 - 19.0
Mud Dump[c]	1.3	1.6	6	6.5	1	20.4
Marine Water Quality Criteria[e]	5.0	100.	NA	NA	0.10	NA

Sources:
[a]USEPA, 1976
[b]Segar and Cantillo, 1976
[c]This Study (see Appendix F for details)
[d]Riley and Chester, 1971
[e]USEPA, 1976

Note 1: NA - Not Available

noticeable in summer, when waters are stratified (oxygen depletion near the bottom mobilizes metals), and in winter after storm activity (sediment overturning contributes metals to the water column).

In general, concentrations of dissolved heavy metals are higher in the Bight Apex, where the influences of man are strongest (Table II.D-2).

Segar and Cantillo (1976), reported that seasonal average concentrations of cadmium, iron, manganese and copper in the area of the sewage and dredge dump sites were not significantly higher than in the rest of the Apex, although the levels of zinc in the immediate vicinity of the sewage sludge dump site were often anomalously high.

Segar and Cantillo (1976) through budget calculations for zinc and copper, indicate that contaminant metals do not accummulate in the Apex but are rapidly removed either to the estuaries or to the surrounding shelf waters. The mean residence time of contaminant metals in the Apex waters was calculated to be less than 6 months, perhaps considerably less.

e. Coliforms

Traditionally, coliform bacteria have been used as indicators of pollution from municipal wastewater discharges. Although coliforms do not pose a threat to public health, their presence in large numbers suggest that pathogenic organisms may also be present. Only recently has it become possible to monitor directly for pathogenic organisms <u>in situ</u> (in place); therefore, most of the available data are for only the coliform group.

Since 1968, EPA and Food and Drug Administration (FDA) have been monitoring the bottom sediments and water column in the Bight Apex, especially in the vicinity of the existing sewage sludge dump site, for indications of coliform contamination. This monitoring activity has produced the following observations and actions.

In 1970, FDA prohibited shellfishing in an area of 11.1 km (6.0 nautical miles) radius around the existing dump site based on high coliform counts in the water column and bottom sediments (Buelow et al., 1968; McGraw, 1969) and on the potential for shellfish contamination.

In 1972, FDA extended the prohibited shellfishing zone to the Long Island and New Jersey shorelines. Nearshore waters out to the 3-mile (5.6 km) limit had previously been closed because of potential coliform contamination from onshore sources (FDA, 1972). Coliform sampling data strongly suggest that contamination of shellfish waters beyond the 3-mile (5.6 km) limit is attributable to onshore sources. The incidence of coliforms in nearshore bottom sediments was low and decreased significantly seaward, indicating onshore sources of contamination.

Recent FDA (1974) and EPA (July, 1974 and April, 1975) studies in the Apex showed no significant coliform contamination. EPA's monitoring program for the Bight Apex continues to show excellent surface and bottom water quality with regard to coliform densities (USEPA, 1976).

The geometric mean for total coliforms on an apex-wide basis was 36 MPN per 100 ml for the top water layer and 15 MPN per 100 ml for the bottom (USEPA, 1974). The nearshore New Jersey area had the highest geometric mean (62 MPN per 100/ml; top and bottom) but still below the criteria level of 200 MPN per 100 ml.

D.5 Bottom Sediments

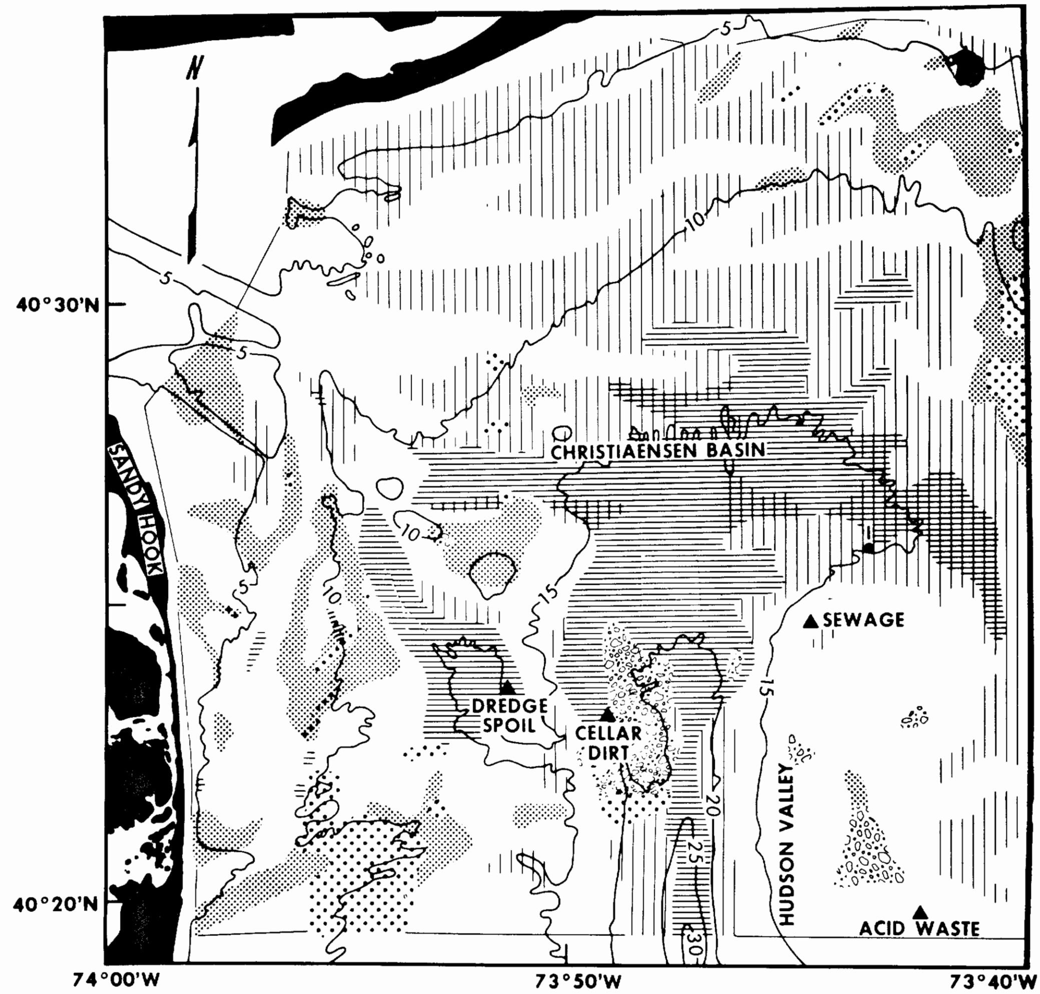
The Coastal Engineering Research Center (CERC) of the Corps of Engineers has collected extensive geophysical data and more than 300 cores as part of the Inner Continental Shelf Study Program (ICONS) (Pararas-Carayannis, 1973; Duane 1969; and Williams and Duane, 1974). In addition, the geological oceanography program of the NOAA-MESA New York Bight Project has conducted extensive surveys related to problems of waste disposal (Swift, et al., 1975).

Analysis of over 700 bottom grab samples has shown a systematic distribution of surficial sediments in the Bight Apex (Figure II.D-4) (Swift, et al., 1975; Freeland, et al., 1976). Fine-grained sediment (mud) occurs in the topographically low areas (Hudson Shelf Valley and the Christiaensen Basin) with assorted sizes of sand and gravel (both from waste dumping and natural sources) occurring throughout the remaining areas.

D.6 Sediment Quality

a. General

The sediment quality within the New York Bight Apex is degraded due to the combined pollutant inputs associated with disposal at the dredge material site, the sewage sludge site, the acid waste site, and the construction rubble site (cellar dirt). In addition, this region receives the Hudson-Raritan estuarine outflow of polluted suspended sediments (Mueller et al., 1976). The solid wastes disposed of in the New York Bight Apex constitute the largest sediment source in the Middle Atlantic Bight (coastal region between Cape Cod, Massachusetts and Cape Hatteras, North Carolina) (Gross, 1970b). The deposits resulting from the disposal activities can be differentiated by their anomalously high carbon and metal contents (Gross, 1972) (Figure II.D-5).



DISTRIBUTION OF BOTTOM SEDIMENTS: NEW YORK BIGHT APEX

DEPTH IN FATHOMS
(CONTOUR INTERVAL 5 FATHOMS)

0 1 2 3 4 5 NAUTICAL MILES
SCALE

KEY:

MUD
SILTY-FINE SANDS
FINE-MED. SANDS
COARSE SANDS
SANDY GRAVEL
ARTIFACT GRAVEL

SOURCE: FREELAND ET AL. (1976)

FIGURE II.D-4

b. Heavy Metals

The concentrations of heavy metals in bottom sediments are not uniformly distributed throughout the New York Bight. Metal levels vary principally according to sediment grain size, mineral composition, organic material content and the proximity of metal pollution sources (e.g. waste dumping and metropolitan area).

Metal concentrations in surficial sediments in areas of the Bight outside of the Bight Apex are extremely low and comparable to levels reported for deep sea carbonate sediments (Table II.D-3). Sediment within the Apex but outside of the disposal sites, generally had low levels of heavy metals.

Grieg et al., (1974) reported a significant variation in heavy metal levels in the non-disposal areas of the Apex. However, the majority of the sediment samples had low metal levels, e.g. less than 10 ppm for chromium and copper, less than 20 ppm for lead and less than 30 ppm for zinc. In addition, Graikoski et al., (1974) reported that sediment collected at one of 31 stations in the nearshore area off Long Beach, New York, had significantly higher metal levels, 3 ppm for cadmium, 102 ppm for chromium, 108 ppm for copper, 130 ppm for lead and 155 ppm for zinc. The higher metal concentrations found in the Apex are likely due to substrate mobility and metal dispersion from the disposal sites by bottom currents, the lateral dispersion of dissolved and suspended metals during disposal operations, and the accidental or intentional disposal of wastes outside the designated areas.

As Table II.D-3 indicates, metal concentrations in surficial sediments at the waste disposal areas are ten to a hundred times greater than in uncontaminated sediments of the New York Bight. Sediments from these dumping sites generally have a high variation in metal levels (Carmody et al., 1973). In severely polluted sediment samples, metal levels occasionally varied as much as 50 percent between subsamples taken from the same grab sample. In addition, variations of up to four-

TABLE II.D-3

HEAVY METAL CONCENTRATIONS IN SURFICIAL SEDIMENTS OF THE NEW YORK BIGHT

Location	Metal Concentration (parts per million)					
	Cadmium Cd	Chromium Cr	Copper Cu	Lead Pb	Mercury Hg	Zinc Zn
1) Outside the Bight Apex						
Outer New York Bight[c] (128 stations)	<1	< 4 to 6.1	< 4	< 4 to 8.0	NA[a]	<3 to 29.2
Outer New York Bight[d]	ND to 1.4	ND to 22	ND to 8	3 to 6	< .05	6 to 32
2) Within the Bight Apex						
Nearshore area south of Long Beach, N.Y. (30 stations)[e]	<1	1.0 to 17.1	<4 to 12.1	<6 to 25	NA	3.2 to 43.5
Sandy sediment outside of[f] disposal areas (average of 40 stations)	NA	6	3	12	NA	18
Non-disposal areas of Bight[g] Apex (97 stations)	NA	0.8 to 165	0.2 to 205	0.8 to 266	NA	1.3 to 275
Non-disposal areas of Bight[h] Apex (119 stations)	NA	6 to 343	NA	NA	NA	15 to 374
3) Within Dredged Material Disposal Area						
Vicinity of "Mud Dump"[i] (8 stations)	NA	50 to 400	20 to 220	330 to 770	NA	NA
Vicinity of "Mud Dump"[g] (5 stations)	NA	<2.4 to 190	< 2.0 to 215	<8 to 260	NA	5.4 to 520
"Mud Dump" (average of[f] 9 stations:	NA	160	141	144	NA	264
"Mud Dump" (9 stations)[h]	NA	15 to 166	NA	NA	NA	51 to 320

TABLE II.D-3 (Continued)

HEAVY METAL CONCENTRATIONS IN SURFICIAL SEDIMENTS OF THE NEW YORK BIGHT

Location	Metal Concentration (parts per million)					
	Cadmium Cd	Chromium Cr	Copper Cu	Lead Pb	Mercury Hg	Zinc Zn
4) Within Sewage Sludge Disposal Area						
Sewage Sludge Disposal Area[g] (5 stations)	NA	4.0 to 300	2.4 to 430	6.0 to 252	NA	10.8 to 412
Sewage Sludge Disposal Area[f] (average of 12 stations)	NA	105	141	170	NA	254
Sewage Sludge Disposal Area[h] (5 stations)	NA	13 to 28	NA	NA	NA	33 - 67
Vicinity of Sewage Sludge[i] Disposal Area (7 stations)	NA	140 to 350	20 to 100	270 to 380	NA	NA
Deep sea carbonate sediments[j]	0.0X"	11	3	9	0.0X	35

Notes:

[a]NA - Not Available

[b]ND - Not Determinable

Sources:

[c]Greig and Pearce, 1975

[d]USEPA, 1975

[e]Graikoski et al., 1974; one station had significantly higher levels (see text for data)

[f]Carmody et al., 1974

[g]Greig et al., 1974

[h]Harris, 1976

[i]Gross et al., 1971

[j]Turekian and Wedepohl in Riley and Chester, 1971

"Only order of magnitude estimates could be made, indicated by the symbol X.

fold occurred in subsamples at intervals within the top 15 cm of sediment and no consistent trend in metal concentration was discernable with depth.

c. Total Organic Carbon (TOC)

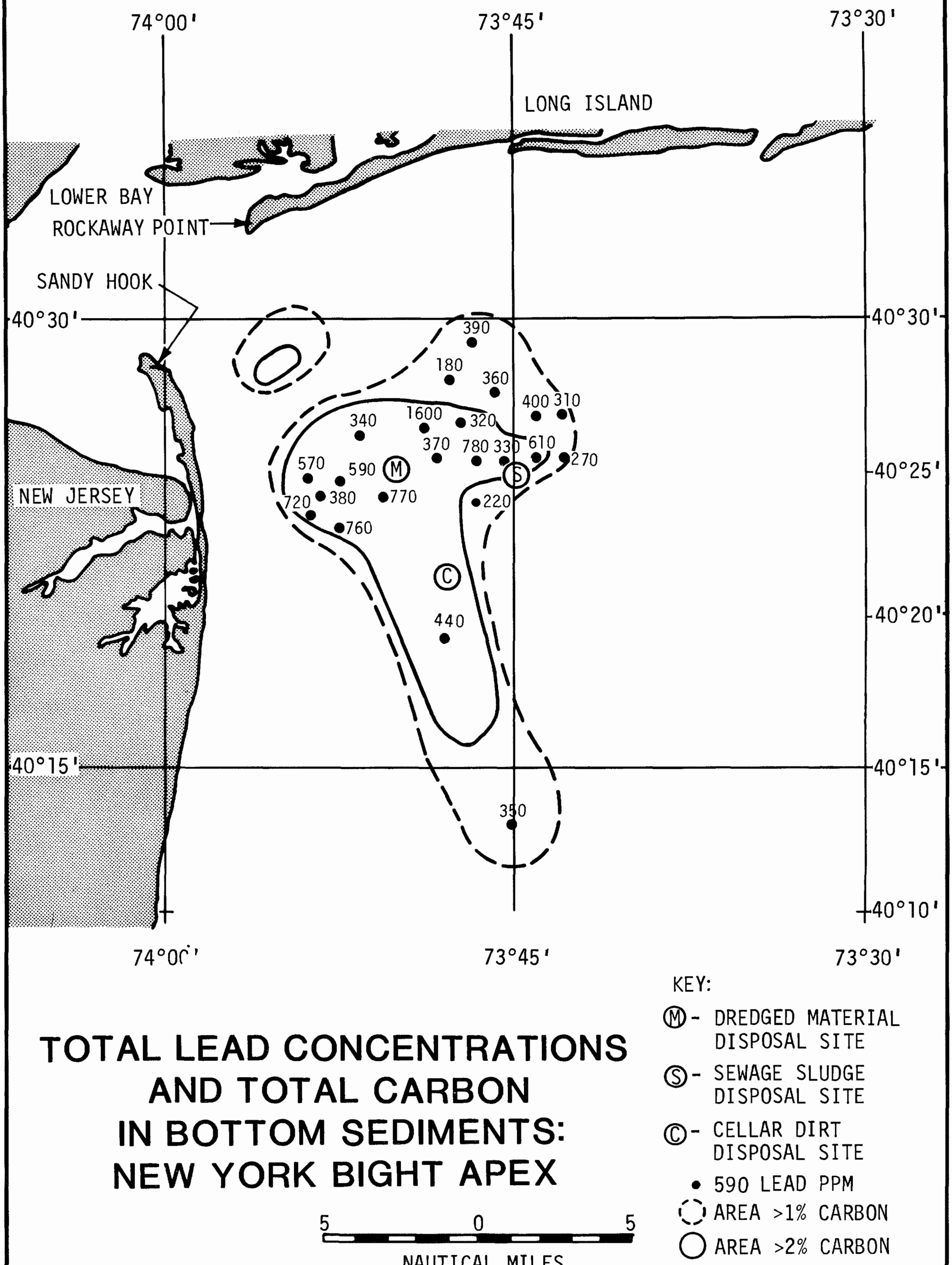
The total organic carbon content of bottom sediments provides an indication of not only organic pollution but also of increased levels of other contaminants such as heavy metals.

The Total Organic Carbon (TOC) in Bight sediments varies according to distance from waste inputs. "Pristine" continental shelf areas generally contain less than 0.2 percent TOC. Sediments containing more than 2 percent TOC are probably contaminated by wastewater discharges, ocean dumping, and other waste inputs (Gross, 1972) (Figure II.D-5). Forty-one percent of New York Harbor sediments is characterized by significant TOC content (greater than 2 percent); the average is 5.6 percent. Near the sewage sludge, dredged material, and cellar dirt dump sites, more than 52 sq km of bottom area are covered by sediments containing more than 2 percent TOC. The highest TOC concentration (6.4 percent) occurs at the dredged material dump site (Gross, 1972). Subsequent studies (Ali, et al., 1973; Pararas-Carayannis, 1975) also report values of TOC at the dredged material site which are higher than at other sites in the New York Bight.

d. Chlorinated Hydrocarbons

Because of the persistence and toxicity of the chlorinated hydrocarbons, such as DDT (dichlorodiphenyltrichloroethane) and PCB (polychlorinated biphenyl), there is a great concern about their abundance and distribution in the marine environment. However, almost no chlorinated hydrocarbon data are available for the New York Bight.

Although specific information on chlorinated hydrocarbons in the New York Bight is not available, some insights can be gained from a recent California



TOTAL LEAD CONCENTRATIONS AND TOTAL CARBON IN BOTTOM SEDIMENTS: NEW YORK BIGHT APEX

SOURCE: GROSS ET AL (1971) GROSS (1976)

FIGURE II.D-5

study (Young et al., 1974a, and b, and Young and Pearce, 1975). The California study evaluated the percentage contribution of chlorinated hydrocarbons by source. It showed that 77 percent of the DDT mass loading in the Southern California Bight was introduced by surface runoff, 14 percent by direct industrial discharge, 6 percent by atmospheric fallout, 3 percent by municipal discharge, 6 percent by atmospheric fallout, 3 percent by municipal wastewater discharge, and less than 0.1 percent by marines antifouling paints. For Arochlor 1254, a PCB, calculations showed that 64 percent was contributed by surface runoff, 34 percent by direct industrial discharge, one percent by atmospheric fallout, one percent by municipal wastewater discharge, and less than 0.1 percent by marine antifouling paints. Although these data cannot be applied directly to the New York Bight, they do indicate potential sources of chlorinated hydrocarbons.

Published data on chlorinated hydrocarbons distribution in the New York Bight are scarce. Results from a small number of sediment samples taken in the vicinity of the dredged material and sewerage sludge dump sites show slightly elevated levels of DDD (DDT breakdown product) and an anomalously high DDT concentration at one station (Table II.D-4).

e. Total Heavy Hydrocarbons

Studies by NOAA (1976) for samples collected in an east-west transect through the designated sewage sludge and dredged material disposal sites indicated that the sediments at center of the dredge material sites are more heavily contaminated with petroleum and petroleum products than sediments elsewhere.

f. Coliforms

The results of EPA and FDA monitoring programs and the resulting closure of shellfishing within the Apex are discussed in the Water Quality section (D.4). The results of NOAA studies near the dredge disposal site and the sewage sludge site indicate that the counts near the dredge site are low and are many orders of magnitude lower than at the sewage sludge site (Table II.D-5).

TABLE II.D-4

CHLORINATED HYDROCARBONS IN THE SEDIMENTS OF THE NEW YORK BIGHT APEX

Vicinity of Dredged Material and Sewage Sludge Dump Sites

Sampling Station		Concentration ug/kg dry weight DDE	DDD	DDT
X	4	13	48	126
X	5	17	81	13
X	3	19	61	19
Z	5	15	39	16

Source: NOAA-NMFS, 1972

TABLE II.D-5

TOTAL AND FECAL COLIFORM COUNTS FOR BOTTOM SEDIMENT STATIONS AT THE SEWAGE SLUDGE DISPOSAL SITE AND AT THE DREDGED MATERIAL DISPOSAL SITE

	Total Coliform MPN	Total Coliform MPN
Dredge Material Disposal Site		
1	1,300	330
2	2,700	310
3	1,300	220
Sewage Sludge Site		
1	540,000	33,000
2	542,000	46,000

Source: NOAA-MESA, November 1975; MPN - mean probable number.

D.7 Marine Ecology

a. Benthos

Benthic organisms include those marine species whose life cycles are intimately associated with the substrate. Characteristically they have little or no mobility, but do possess a relatively long lifespan. For this reason examination of benthic communities is often considered the most direct method of evaluating both water and sediment quality.

The composition and distribution of benthic communities is primarily determined by sediment type, but there are numerous other contributing factors. Sandy Hook Laboratory (SHL) and the State University of New York at Stony Brook (SUNY-SB) have both conducted studies of benthic communities in the New York Bight and have reached differing conclusions. The SHL study indicated that benthic communities were greatly reduced in population size and species diversity surrounding the waste disposal areas. The reconnaissance survey performed by SUNY-SB studied New York Harbor and its adjacent waters (Bight Apex). They found reduced species diversity and population size within New York Harbor, but near-normal benthic communities at the harbor entrance on the continental shelf (Gross et al., 1971).

In June 1973, the Middle Atlantic Coastal Fisheries Center (MACFC) began a MESA-sponsored study of the benthic macrofauna in the Bight Apex (NOAA-MESA, 1976). The results of this study are discussed below.

Meiofauna are defined as those organisms that will pass through the 100 micron sieve, but are retained on the 63 micron sieve. The meiofauna, particularly the Foraminifera, comprise the most ubiquitous group of organisms in the sediments of the New York Bight. They are near the base of the benthic food chain, are immobile and generally indicative of the environment in which they are found. For these reasons they have become an ecologically significant group of animals analyzed to ascertain the effects of ocean dumping.

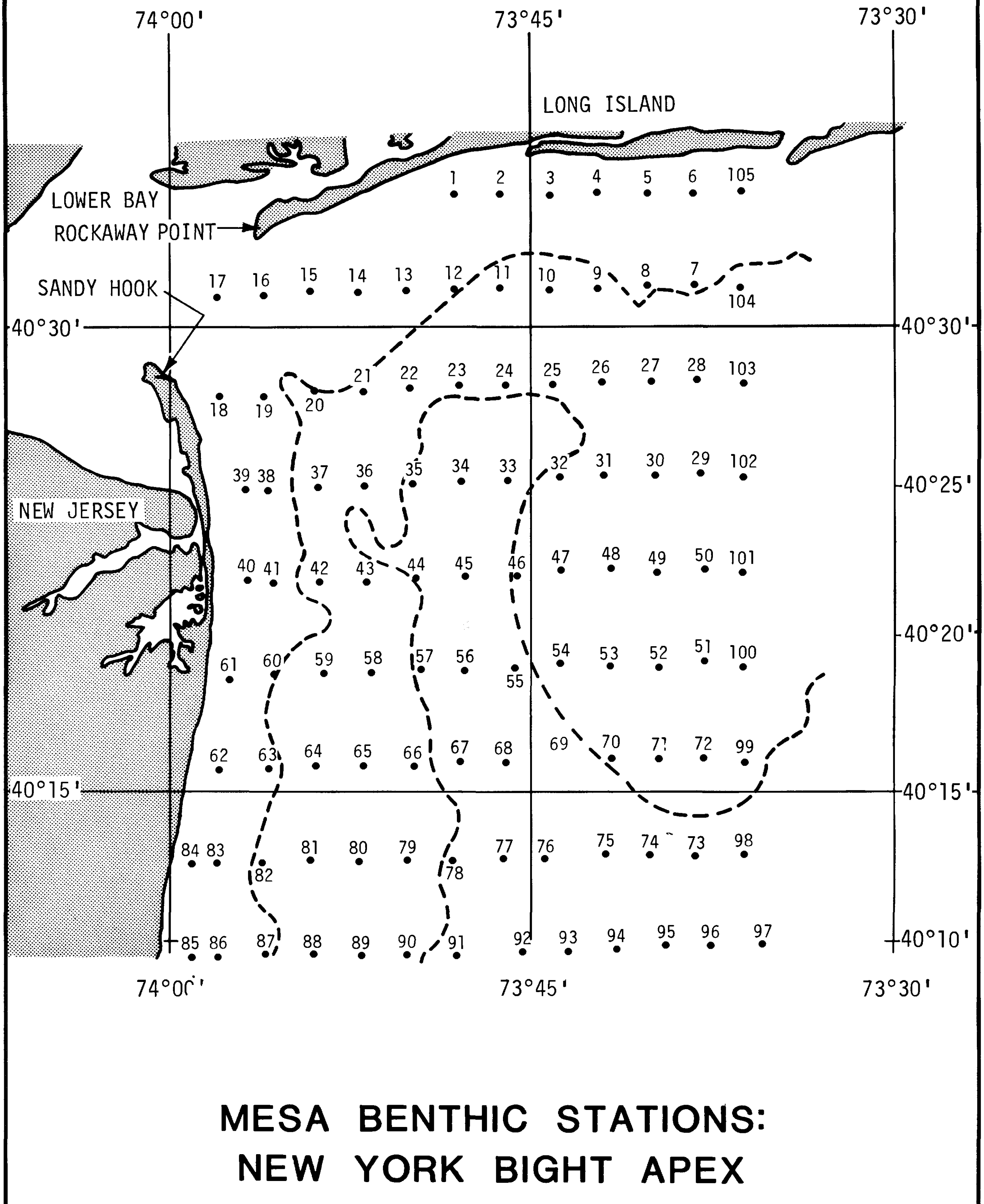
Of the 36 meiofaunal taxa identified by MACFC from sediment samples in and around the dredge spoil disposal site, 23 were Foraminifera. Table II.D-6 lists the meiofaunal communities found at two stations near the dredged material disposal site. The SHL results indicated a reduced species diversity and a decrease in the number of individuals within each taxa found in the dredge disposal area compared with an adjacent station.

Macrofauna area defined as those organisms larger than 1 millimeter (mm). Benthic samples were taken during August 1973 at a standard sampling grid in the Bight Apex (Figure II.D-6). A total of 146 species were identified from 65 sampling stations.

The results of this survey were as follows:

> "seven species were found to occur at 50 percent or more of the sampling stations. These were a rhyncocoel (found at 42 stations); the polychetes, Glycera dibranchiata (33), Nepthys bucera (35), Spiophanes bombyx (43), and Tharyx acutus (49); a bivalve, Tellina agilis (46); and a brachyuran crab, Cancer irroratus (46). In addition, eight species were found at 25 or more stations (40% of the total stations). These included the burrowing sea anemone, Cerianthus americanus (29); an archiannelid, Protodrilus sp. (25); and polychaetes, Aricidea jeffreysii (25), Lumbrineris fragilis (25) and Asabellides oculate (28); two bivalves, Nucula proxima (30) and Spisula solidissima (23); and the grass shrimp, Crangon septemspinosa (29). The most widely distributed amphipod, Unciola irrorata, was usually represented by 1 to 12 individuals, but station 55 and 108. A few species, including the deposit feeding bivalve, Tellina agilis, apparently remained more or less constant in their distribution between August 1973 and August 1974."

In the NOAA-NMFS (1972) study, a total of 81 species were identified in sufficient quantity to plot horizontal distributions. Results again showed a zone around the disposal area to be reduced in normal species diversity and with a reduced population size for those species that were present. A list of all benthic macrofaunal species found in the vicinity (2 nautical mile radius) of the dredged material disposal site is contained in Table II.D-7. The reduced species diversity appear to be related to environmental stresses induced by waste disposal.



MESA BENTHIC STATIONS: NEW YORK BIGHT APEX

SOURCE: NOAA-MESA (1976)

FIGURE II.D-6

TABLE II.D-6

COMPARISON OF BENTHIC MEIOFAUNA SPECIES DIVERSITY IN AND ADJACENT TO THE DREDGED MATERIAL DISPOSAL SITE

Species	Station 39 Out of Dredge Disposal Site (1.6 n. Miles East of Station 82)	Station 82 within Dredge Disposal Site
Ammotrypane sp.	9%[a]	NP[b]
Cerastoderma pinnulatum	46%	NP
Sthenelais limicola	18%	NP
Pagurus longicarpus	9%	NP
Astarte castanea	18%	NP
Diastylis sculpta	10%	NP
Holothuroides	72%	NP
Thyasira gouldi	9%	NP
Pitar morrhuana	9%	NP
Spisula solidissima	18%	NP
Sabellidae	36%	NP
Arctica islandica	36%	NP
Yoldia limatula	72%	NP
Dervilleidae	9%	NP
Leptocheirus pinguis	18%	NP
Paraonis fulgena	82%	NP
Harmothoe imbricata	27%	NP
Cossura sp.	64%	NP
Phoronia architecta	46%	NP
Aricidea jeffreysii	64%	NP
Ninoe nigripes	9%	NP
Ampharete sp.	72%	NP
Monoculodes edwardsi	18%	NP
Crangon septemspinosus	27%	save 12%
Cancer irroratus	54%	save 12%
Unciola irrorata	18%	save 12%

TABLE II.D-6 (Continued)

COMPARISON OF BENTHIC MEIOFAUNA SPECIES DIVERSITY IN AND ADJACENT TO THE DREDGED MATERIAL DISPOSAL SITE

Species	Station 39 Out of Dredge Disposal Site (1.6 n. Miles East of Station 82)	Station 82 within Dredge Disposal Site
Mytilus edulis	46%[a]	save 12%
Polinices duplicatus	9%	save 12%
Nucula proxima	82%	save 12%
Spiophanes bombyx	27%	save 12%
Glycera sp.	27%	save 12%
Lumbrineris fragilis	90%	save 12%
Nereis sp.	36%	save 12%
Phyllodoce sp.	82%	save 12%
Clymenella sp.	64%	save 12%
Pherusa sp.	82%	save 12%
Prianospio sp.	100%	save 12%
Spio filicornis	9%	save 12%
Nassarius trivittatus	36%	save 12%
Neomysis americana	9%	save 12%
Tellina agilis	18%	save 12%
Capitellidae	90%	save 12%
Nepthys incisa	100%	save 12%
Cerebratulus sp.	82%	save 12%
Cerianthus americanus	100%	save 12%

[a]Percent denotes occurrence at each station: (i.e. Neomysis americana was taken at Station 39 9% of the time.)

[b]NP - Not present

Source: NOAA- NMFS, 1972

TABLE II.D-7

BENTHIC MACROFAUNA OCCURRING WITHIN A NAUTICAL MILE RADIUS OF DREDGE DISPOSAL SITE

Arranged in a Standard Phylogenetic Order

Jassa falcata	Dorvilleidae
Monoculodes edwardsi	Pherusa affinis
Trichophoxus epistomus	Glycera sp.
Dulichia monocantha	Lumbrineris fragilis
Neomysis americana	Clymenella sp.
Crangon septemspinosus	Nephtys incisa
Cancer irroratus	Nereis sp.
Nucula proxima	Aricidea jeffreysii
Yoldia limatula	Paraonis fulgens
Mytilus edulis	Phyllodoce sp.
Astarte castanea	Harmothoe imbricata
Cerastoderma pinnulatum	Sabellidae
Cyprina islandica	Pholoe minuta
Ensis directus	Dispio uncinata
Spisula solidissima	Prionospio malmgreni
Tellina agilis	Spio filicornis
Phoronis architecta	Spiophanes bombyx
Holothuroidea	Copepoda
Cerianhus americanus	Edotea triloba
Cerebratulus lacteus	Ampelisca valdorum
Ampharete sp.	Leptocheirus pinguis
Cirratulidae	Argissa hamatipes
Cossura sp.	Unciola irrorata

Source: NOAA-NMFS, 1972

b. Fisheries

From June 1974 to May 1975 Middle Atlantic Fisheries Center (MAFC) conducted 10 groundfish survey cruises in the New York Bight. This survey provides a seasonal estimate of distribution and relative abundance of groundfish. Inshore trawls reflected larger catches of those fishes inhabiting estuarine and nearshore environments: Atlantic menhaden, Atlantic silverside, striped bass, bluefish, weakfish and tautog. The data also showed consistently low fish population in areas containing greater than 1 percent carbon in the sediments (NOAA-MESA, 1976).

Data collected by NOAA-NMFS between 1975 and 1976 within the Bight Apex is tabulated in Table II.D-8. The most frequently occurring species are silver and red hake, winter and summer flounder, spring and smooth dogfish, cod, black sea bass, sea herring and scup. Other varieties found but with less frequency and abundance were yellowtail flounder, squid (Loligo), bluefish, and weakfish.

c. Shellfish

Shellfishing is closed to commercial operations in and around the various disposal sites of the New York Bight. However, significant quantities are taken in other areas within the Bight. There are five major shellfish resources in the New York Bight of significant commercial importance: Surf clam (Spisula solidissima), sea scallop (Palcopecten magellanicus), ocean quahog (Artica islandica), lobster (Honarus americanus), and the red crab (Geryan quinquidens).

Particularly low densities of surf clams were noted within the Bight Apex (NOAA-MESA 1976, NOAA-NMFS, 1976b). Ocean quahogs were found to be most abundant with record catches being recorded off the coasts of New Jersey and Long Island (NOAA-NMFS, 1976b). Sea scallops were also found to be plentiful between 30-25 fathoms (NOAA-NMFS, 1976b). Both the red crab and the American lobster are reported to be numerous in the outer portions of the Hudson Shelf Valley, with breeding zones being located in the inner reaches (Buelow et al., 1968).

TABLE II.D-8

FISH CATCHES IN NEW YORK BIGHT APEX
1975-1976

	October-November 1975	December 1975	March 1976	September-October 1976
White Hake	—	No	No	—
Silver Hake	—	TR	2 stations + TR	1 station + TR
Red Hake	—	TR	2 stations + Tr	—
Winter Flounder	—	2 stations + TR	2 stations + TR	—
Summer Flounder	1 station + TR	No	NO	1 station + TR
Yellowtail Flounder	—	TR	TR	—
Spiny Dogfish	3 stations +TR	2 stations + TR	NO	—
Smooth Dogfish	TR	NO	—	1 station + TR
Squid (Loligo)	TR	TR	No	TR
Squid (Illex)	No	No	—	No
Northern Searobin	—	No	No	—
Striped Searobin	—	—	—	—
Cod	—	3 stations + TR	2 stations	—
Atlantic Mackerel	—	—	No	—
Black Sea Bass	—	—	No	5 stations
Sea Herring	—	—	2 stations + TR	—

TABLE II.D-8 (Continued)

FISH CATCHES IN NEW YORK BIGHT APEX
1975-1976

	October-November 1975	December 1975	March 1976	September-October 1976
Spot	NO	—	—	TR
Bluefish	TR	No	—	TR
Weakfish	TR	TR	—	1 station + TR
Scup	1 station + TR	No	—	1 station + TR
Butterfish	—	—	—	TR
Atlantic Croaker	No	—	—	No
Little Skates	—	TR	—	—

TR - Trace, not in large quantity

No - Not found within Apex

— - Not reported

Source: NOAA-NMFS, 1975a, b, 1976a, b

d. Plankton

Plankton are those plants (phytoplankton) and animals (zooplankton) which float in the water column. Phytoplankton are the primary producers at the base of the food chain; zooplankton, for the most part, are herbivores that feed on the phytoplankton. The high degree of spatial and temporal variation inherent in plankton populations makes study of their abundance, composition, and distribution extremely difficult.

The productivity in an area is a function of many environmental variables, especially available nutrients and salinity. Malone (1977) recently prepared a review of plankton taxonomy and distribution for the Bight. Examining 75 years of published and unpublished data, he determined that phytoplankton species compo sition in the Bight was influenced most strongly by estuarine processes. Conversely, zooplankton composition is influenced most strongly by oceanic processes. Malone's summarized data provide a baseline from which future changes can be projected; however, they are insufficient to show definitively the effect of man's activities on plankton populations. Malone attributed this insufficiency to a lack of standardized methodology and to inadequate temporal and spartial coverage.

Ryther and Dunstan (1971) found nitrate-nitrogen to be the limiting factor in plankton productivity within coastal waters. However, this does not appear to be the case in the Bight Apex. A high nutrient input from the Hudson River estuary results in an estimated 2,000 metric tons (2,200 tons) per day of carbon available to phytoplankton production in the Apex (NOAA-MESA, 1975).

The New York Ocean Sciences Laboratory (1973) correlated physical and chemical characteristics of water in the Bight with zooplankton species and biomass. Their results included the identification of four water masses:

1. New York Harbor waters, with salinity values of less than 20 parts per thousand ($^{o}/oo$), form a shallow tongue of surface water within the estuary (Ketchum et al., 1951). This water mass supports a predominantly estuarine species population characterized by season variations and low biomass. Pelagic plankton are scarce, but veliger larvae and barnacle cyprids are common.

2. New York Bight waters, with salinity values of 29 to 31 $^{o}/oo$, are found seaward of the harbor waters and down to the thermocline. Diversity of species is greater than in harbor waters. A significant number of eggs spawned by fish, such as anchovy and menhaden, are found in this water mass. These phenomena were also observed by NOAA-MESA (1975). Plankton species are similar to those of the harbor water mass.

3. Atlantic Shelf waters, with salinity values of more than 31.5 $^{o}/oo$, usually occur below the thermocline except in areas of upwelling or mixing. The source of these waters is off the continental shelf. Pelagic shelf plankton dominate.

4. Mixing or transition zone waters, with salinity values of 31 to 31.5 $^{o}/oo$, separate Bight waters from shelf waters. The largest biomass is found in this transitional zone. The dominant plankton species in these waters are the same as those found in shelf waters.

E. MAN-MADE ENVIRONMENT

E.1 Introduction

NWS Earle is located approximately 47 miles south of New York City, at Colts Neck, Monmouth County, New Jersey. For the purpose of this statement, Monmouth County is considered as the general area influenced by the proposed action. The Main Station is located within the corporate limits of the Borough of Tinton Falls and the Townships of Colts Neck, Howell and Wall. The Waterfront Area is located on Sandy Hook Bay adjacent to the Town of Leonardo in Middletown Township.

Under the New Jersey State law, the county is subordinate to the State government, having neither sovereign nor constitutional powers. Acting as an agent of the State, the county performs certain mandated functions in whole or part, as delegated by the State. Mandatory functions relate to five areas 1) courts and law enforcement, 2) welfare, 3) education, 4) roads and 5) the conduct of elections. In addition, State law authorizes limited powers for county action in other areas, such as health, parks and planning. The county's powers with respect to land planning are advisory only. Monmouth County is governed by a five-member Board of freeholders. As the legislative and administrative head of County government, the Board oversees the operations of over 70 County departments.

Middletown, Colts Neck and Howell Townships use the township-committee form of government. Under this form, a mayor is elected from among the members of the township committee and acts primarily as committee chairman with voice and vote. Township policies and programs are established by the township committee. It controls township finances, including the borrowing of money, appropriation of funds and levying of taxes. Each township committee has appointed and administrator who is responsible to the township committee.

Tinton Falls Borough is administered by the borough-council form of government. The council and mayor are elected independently, with the borough administrator appointed by the mayor. The mayor is chief executive and supervises administration, while the council has legislative authority, except as delegated to government boards or agencies.

Under State law, a municipality must have a planning or zoning board regardless of the form of municipal government. These duties and powers are initially exercised by a semi-autonomous board subject to final approval by the municipal governing body.

Monmouth County has been divided into six planning areas by the Monmouth County Planning Board, as shown in Figure II.E-1. The area primarily influenced by the proposed action to defined by Planning Areas I, II and V. The NWS Earle Waterfront Area is located in Area I. The Main Station is located primarily in Area V. Ft. Monmouth, which would provide housing for relocated families is located in Area II. When appropriate, information will be provided by planning area.

Situated in the "outer ring" of the New York Standard Consolidated Statistical area, Monmouth County has benefited immensely by its geographic location. Characteristically rural in nature for most of its history, parts of Monmouth County today are highly urbanized. The County still retains a rural setting, however, with over 56 percent of its total land area remaining undeveloped in 1974. Influenced by seasonal recreation opportunties afforded by its coastal location and improved transportation systems to New York and Northern New Jersey, population and economic activity in the County have increased significantly. The presence in the County of federal installations such as Ft. Monmouth, NWS Earle, Sea Girt and Ft. Hancock, has played an important role in the area's economic development.

E.2 Population

a. Monmouth County

In 1970, total population for Monmouth County was 461,849 persons. The 1977 population of the County is estimated at 524,320 persons, an increase of 13.5 percent since 1970. As indicated in Table II.E-1, net migration was twice as important as the natural increase component of population growth during the period of 1960-1970. Population density in the County has more than doubled since 1950.

TABLE II.E-1

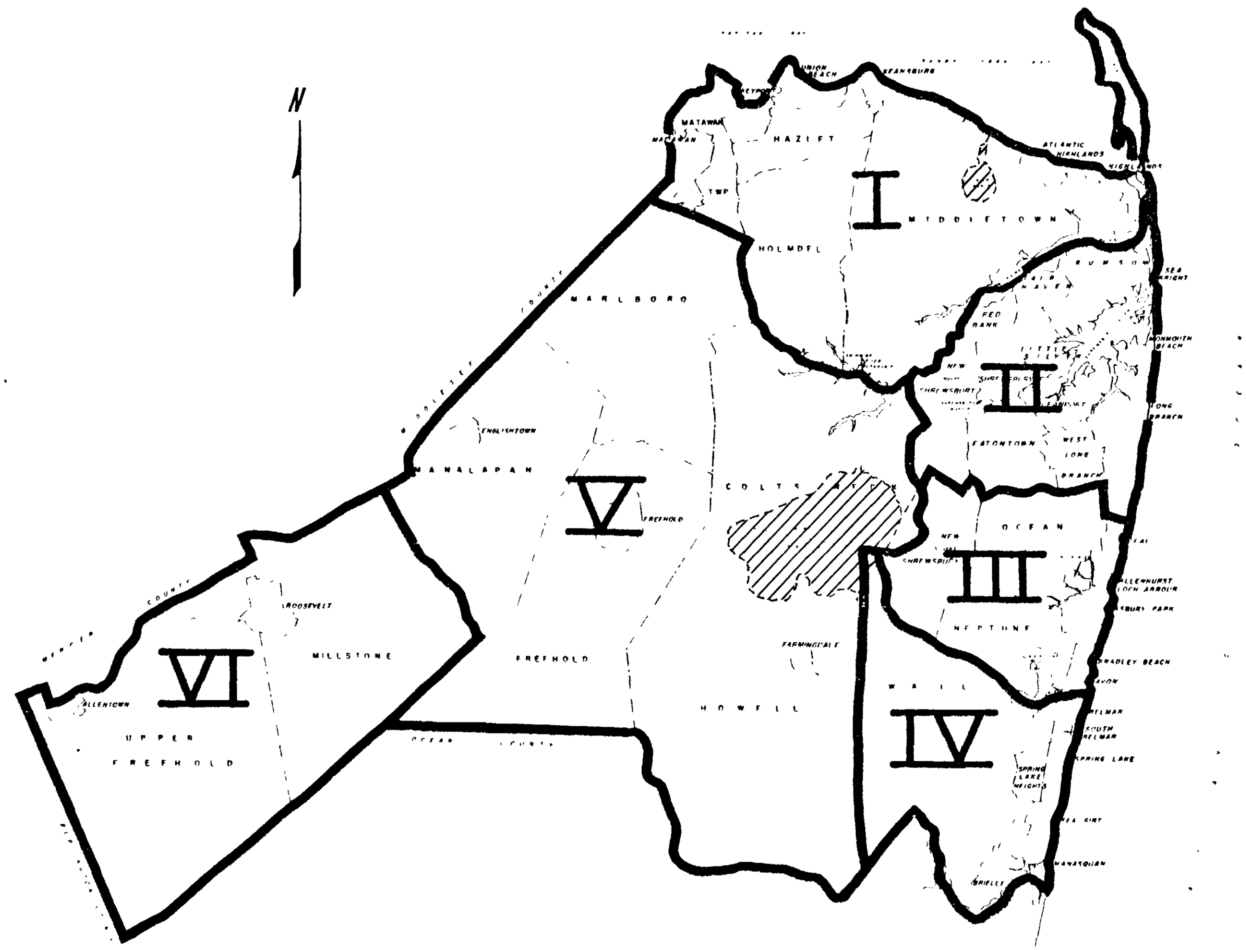
COMPONENTS OF POPULATION CHANGE IN SELECTED MUNICIPALITIES AND MONMOUTH COUNTY
1960-1970

Governmental Unit	Population April 1, 1960	Births (+)	Deaths (-)	Natural Increase	Net Migration	Population April 1, 1970
Middletown (I)[a]	39,675	9,107	3,538	5,569	9,379	54,623
Atlantic Highlands (I)	4,119	1,176	605	571	412	5,102
Colts Neck (V)	2,117	611	286	325	3,377	5,819
Fair Haven (II)	5,678	844	546	298	166	6,142
Hazlet (I)	15,334	4,798	1,130	3,668	3,237	22,239
Highlands (I)	3,536	978	573	405	-25	3,916
Holmdel (I)	2,959	717	265	452	2,706	6,117
Keansburg (I)	6,854	1,918	1,193	725	2,141	9,720
New Shrewsbury (II)	7,313	992	522	470	612	8,395
Red Bank (II)	12,482	2,871	2,242	629	-264	12,847
Rumson (II)	6,405	842	685	157	859	7,421
Monmouth County	334,401	85,189	42,978	42,211	82,766	459,378

[a](I) designates planning area in which municipality is located

Sources:

U.S. Census of Population 1960, 1970
New Jersey Department of Health
Monmouth County Planning Board



MONMOUTH COUNTY PLANNING AREAS

SOURCE: MONMOUTH COUNTY PLANNING BOARD, 1975

FIGURE II.E-1

While no official estimate of summer populations has been made by the Monmouth County Planning Board, estimates have been made by private firms conducting special studies in the County. These estimates indicate that the majority of the County's summer population reside in the oceanside communites, particularly in Planning Area III, where total population increased by an estimated 66,722 persons during the summer of 1970. The County's population increased by some 100,000 to 150,000 persons during that same summer period (Havens & Emerson Ltd., 1970).

Table II.E-2 shows the stratification of the population in Monmouth County by age, sex and by race. Statistics from the 1970 census show Monmouth County residents to be younger, on average, than the population of the State of New Jersey. Median age for the County was 28.2 years compared with the statewide median of 30.1 years. The County generally showed higher portions of population in the younger age groups and lower percentages for older people, with the exception of the group over 65 years of age. A breakdown of racial data from the 1970 census shows the County with a lower than average number of blacks and only small numbers of other non-whites. The County has a higher ratio of men to women than the State as a whole.

The most significant changes in population in the County since 1970 have occurred in Planning Areas V and VI, while moderate increases have been registered in Planning Areas I, III and IV (Figure II.E-2). Planning Areas I and V grew rapidly from 1950 to 1970, but growth appears to have slowed in recent years. In these same two planning areas, population density more than tripled since 1950. Planning Area II has the highest density in the County but its growth has been below the County average in recent years.

Various population projections have been developed for Monmouth County. Figure II.E-2 indicates that the County population is projected to increase by 92.7 percent to 890,000 persons by the year 2000. Planning Area V is projected to have the largest population increase.

TABLE II.E-2

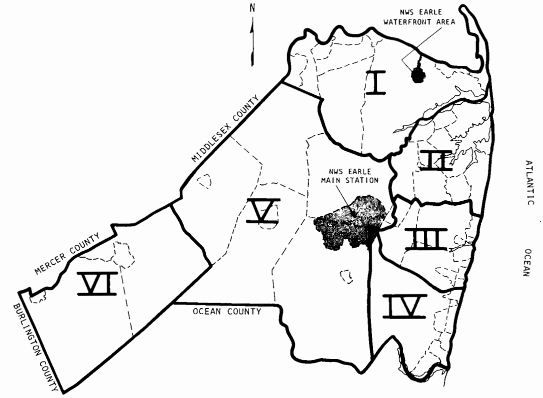
SELECTED POPULATION CHARACTERISTICS
MONMOUTH COUNTY AND NEW JERSEY
(1970)

	Monmouth County		New Jersey	
	Number	Percentage	Number	Percentage
Age Group				
under 5 years	40,440	8.8	587,563	8.2
5 to 18 years	132,028	28.7	1,909,652	26.4
19 to 64 years	241,989	52.7	3,971,925	55.4
65 years and over	44,912	9.8	699,024	9.8
All Ages	459,379	100.0	7,168,164	100.0
Median Age	28.2		30.1	
Dependency Ratio[a]	0.84		0.75	
Sex				
Male	224,076	48.8	3,466,530	48.4
Femal	235,303	51.2	3,701,634	51.6
Males per 100 Females	95.2		93.7	
Race				
White	418,352	91.1	6,362,337	88.8
Negro	38,128	8.3	766,994	10.7
Other Non-White	2,899	0.6	38,823	0.5

[a]Dependency Ratio is defined as the following:

$$\frac{\text{persons under 18 years + persons 65 and older}}{\text{persons 18 to 64 years}}$$

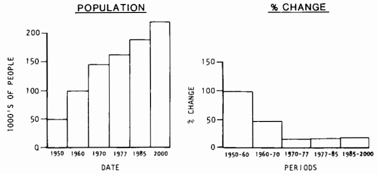
Source: U.S. Census of Population, 1970



MONMOUTH COUNTY PLANNING AREAS

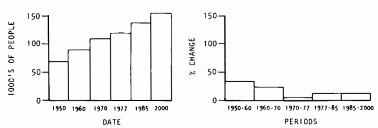
AREA I

POPULATION | % CHANGE



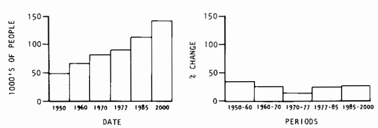
AREA II

POPULATION | % CHANGE



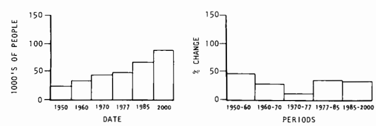
AREA III

POPULATION | % CHANGE



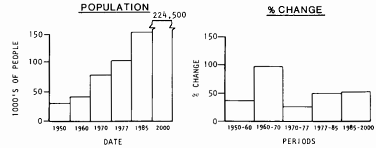
AREA IV

POPULATION | % CHANGE



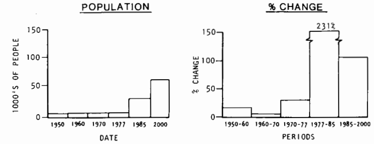
AREA V

POPULATION | % CHANGE



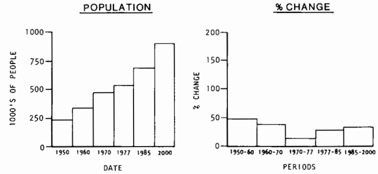
AREA VI

POPULATION | % CHANGE



COUNTY WIDE

POPULATION | % CHANGE



POPULATION PROJECTION AND PERCENT CHANGE FOR MONMOUTH COUNTY

FIGURE II.E-2

b. Naval Weapons Station Earle

By mid-1979, about 2100 personnel will be stationed at NWS Earle. Present personnel at NWS Earle totals approximately 1780, of which 648 are associated with the USS NITRO (AE) and USS SURIBACHI (AE). Approximately 39 percent of the present base loading are civilians. Current staffing levels represent only one-fifth of the peak World War II staffing at NWS Earle.

E.3 Economy

Employment in Monmouth County generally approximates statewide trends. The exceptions occur in the manufacturing category, which showed an increase in the Country compared with decreases statewide. On the whole, employment in Planning Areas I, II and V has registered a greater percent increase than statewide. Currently, wholesale and retail trade is the largest employment sector in Monmouth County, accounting for 32 percent of total employment.

a. Work Force

In 1970, the work force in Monmouth County (those who held jobs located in the County) totalled 153,800 persons. Of these, 20.7 percent (29,897) commuted from other counties. Table II.E-3 lists employment of the work force by sector in Monmouth County for 1963, 1968 and 1974, with projections for 1980. As projected by the State Department of Labor and Industry, the most significant change from 1974 to 1980 is expected to occur in services, with a 50.3 percent increase in employment. This projection reflects the national shift from goods to services consumption. All other sectors are expected to increase employment, with the exception of agriculture.

TABLE II.E-3

WORK FORCE DISTRIBUTION IN MONMOUTH COUNTY
(Annual Average)

	(SIC)	1963	% of Total Employment	1968	% of Total Employment	1974	% of Total Employment	1980	% of Total Employment	% Change 1974-1980
Agriculture	01	3,900	3.5	3,300	2.4	2,800[a]	1.7	2,600	1.3	-7.1
Construction	10	6,100	5.5	6,800	4.9	8,100	5.0	10,000	5.1	24.7
Manufacturing	20	18,100	16.4	22,600	16.4	23,400	14.3	30,400	15.2	29.9
Transportation Communications and Utilities	40	4,700	4.3	5,600	4.1	5,800	3.5	7,300	3.7	25.9
Trade	50	19,300	17.5	23,900	17.3	35,900	22.0	38,900	19.5	8.4
Finance, Insurance and Real Estate	60	2,000	1.8	4,000	2.9	5,300	3.2	6,100	3.1	15.1
Services	70	15,000	13.6	24,200	17.5	29,600	18.1	44,500	22.3	50.3
Government	90	20,700	18.8	26,500	19.2	30,700	18.8	35,500	17.8	15.6
Other Non Farm	99	20,200	18.4	21,000	15.2	21,600[a]	13.2	24,200	12.1	12.0
TOTAL EMPLOYMENT		110,000	100.0	137,900	100.0	163,200	100.0	199,600	100.0	22.3

[a]Estimated

Sources:
N.J. Department of Labor and Industry
Monmouth County Planning Board

b. Labor Force

Labor force refers to residents of the County who are in the labor market, whether or not they are employed in Monmouth County. In 1970, of the 169,600 persons in the Monmouth County civilian labor force, 162,646 were employed. Of these, 29.7 percent or 48,343 commuted to other counties.

The largest contribution sector in providing employment opportunities to residents of Monmouth County in 1970 was the services industry, in particular professional services. As indicated in Table II.E-4, approximately 26 percent of all employed persons in the County held service related jobs in 1970.

Distribution of the labor force by Planning Area in Monmouth County is shown in Table II.E-5. As indicated, size of the labor force, as well as unemployment varies greatly among Planning Areas. Approximately 55 percent of the County labor force lived in Planning Areas I and II in 1970.

c. Military Employment

An important factor associated with economic development in Monmouth County has been the presence of U.S. military personnel. In 1970, approximately 10,000 armed forces personnel were employed at various installations in the County. The County's largest employer is Ft. Monmouth, which employs a civilian labor force of approximately 8,900 persons and has an annual payroll of $196.8 million. As indicated in Table II.E-6, the Fort employs more than twice as many civilian workers as the next largest employer. According to the Monmouth County Planning Board, employment in industries which have located in the County, due to the presence of Ft. Monmouth, total approximately 10,700 workers. This amounted to 8.0 percent of the County's May 1975 total non-agricultural wage and salary employment.

TABLE II.E-4

LABOR FORCE DISTRIBUTION IN MONMOUTH COUNTY
(1970)

	Employment	
Industry	Number	Percent
Agriculture, Forestry and Fisheries	2,260	1.4
Mining	394	0.2
Construction	10,588	6.5
Manufacturing	36,661	22.6
Transportation, Communication and Public Utilities	13,715	8.4
Wholesale Trade	5,327	3.4
Retail Trade	27,834	17.1
Finance, Insurance and Real Estate	10,092	6.2
Services	41,890	25.7
Public Administration	13,998	8.6
Total Employment (16 years and over)	162,759	100.0

Source: U.S. Census of Population, 1970.

TABLE II.E-5

LABOR FORCE AND EMPLOYMENT BY PLANNING AREA -- MONMOUTH COUNTY
(1970)

			Civilian Labor Force			Employed			Unemployed			Unemployment Rate		
Area	Population	Labor Force	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
I	142,210	52,654	51,978	35,064	16,914	50,065	34,045	16,020	1,913	1,019	894	3.68	2.91	5.29
II	108,606	47,216	39,160	23,538	14,959	37,336	22,735	14,601	1,824	803	1,021	4.65	3.41	6.53
III	80,667	31,877	31,120	18,607	12,513	29,615	17,875	11,740	1,505	732	773	4.84	3.93	6.18
IV	43,040	16,135	16,072	10,336	5,736	15,583	10,076	5,507	489	260	229	3.04	2.52	3.99
V	79,823	28,441	28,199	19,334	8,865	27,133	18,678	8,455	1,066	656	410	3.78	3.39	4.62
VI	7,503	3,113	3,095	1,976	1,119	3,027	1,921	1,106	68	55	13	2.20	2.78	1.16
TOTAL	461,849	179,406	169,624	108,855	60,769	162,759	105,330	57,429	6,865	3,525	3,340	4.10	3.24	5.50

Source: Monmouth County Planning Board, June 1975

TABLE II.E-6

LARGEST CIVILIAN EMPLOYERS IN MONMOUTH COUNTY
(1975)

Name of Employer	Standard Industrial Classification Code	Approximate Civilian Employment 1975
Fort Monmouth	9190	8,900
Bell Telephone Laboratories	7390	3,800
Monmouth Medical Center	8060	1,700
Riverview Hospital	8060	1,300
N.J. State Hospital, Marlboro	9280	1,200
Interdata, Inc.	3573	1,100
Lilly Tulip Cup Corp.	2654	900
Brookdale Community College	9382	800
Electronic Assoc., Inc.	3573	800
International Flavors and Fragrances	2818	800
Lanvin-Charles of the Ritz	2844	700
NWS Earle	9190	691

Source: N.J. Department of Labor and Industry, 1975

NWS Earle accounted for nearly 14.2 percent of the Federal government employment associated with military installations in the County. With a total military and civilian employment of 1,418 persons and 691 persons respectively, NWS Earle accounted for approximately 1.6 percent of total non-agricultural wage and salary employment in the County. NWS Earle has an annual civilian payroll of $9.9 million. In addition, NWS Earle contract procurements for supplies and services, obtained both locally and in the region, totalled $6.2 million in 1977.

d. Income

The income characteristics of residents of Monmouth County are generally quite similar to those of the State. A detailed breakdown of income for the County and the State appears in Table II.E-7. Per capita income in the County has grown from $3,629 in 1969 to $5,222 in 1974.

e. Government Finance

Expenditures by both Monmouth County and its local municipalities are largely financed through property taxes, supplemented with other taxes and revenues. Total revenues realized from all sources for Monmouth County in 1975 were $54.5 million. Of this amount, 71 percent was collected through property tax assessments. Total value of "taxable" land (excludes tax-exempt property), as listed in the 1976 "Abstract of Ratables of the Monmouth County Board of Taxation", was $1.6 billion. Together with taxable improvements, total assessed value in 1976 was slightly more than $5.0 billion. As indicated in Table II.E-8, residential property accounted for 70.1 percent of all taxable real property in 1976.

Local municipalities in Monmouth County, including Middletown Township, obtain well over 70 percent of all revenues received from the property tax. In Middletown Township, total assessed value of taxable land in 1977 was $223.3 million. Real property in the Township was taxed at a rate of $3.77 per $100 assessed value, down by 12.5 percent from the previous year's tax rate. The tax rate

TABLE II.E-7

INCOME AND POVERTY STATISTICS: MONMOUTH COUNTY AND NEW JERSEY

Number of Families Family Income (1969)	Monmouth County 114,097 Percent Distribution	New Jersey 1,838,809 Percent Distribution
Up to $1,999	3.5	3.4
$2,000 to $2,999	2.5	2.7
$3,000 to $4,999	7.0	6.8
$5,000 to $7,999	14.6	14.5
$8,000 to $9,999	12.1	13.0
$10,000 to $14,999	28.6	30.1
$15,000 to $24,999	23.9	22.5
$25,000 and over	7.8	7.0
Median Family Income	$ 11,635	$ 11,407
Median Income Unrelated Individuals	$ 2,846	$ 3,199
Percent with income below poverty level[a]:		
persons	7.7	8.1
families	5.9	6.1
Per-Capita Income:		
1969	$ 3,629	$ 3,674
1972	$ 4,460	$ 4,460
1974	$ 5,222	$ 5,237

[a]"Poverty" level varies with such factors as family size, sex of family head, number of children and farm or nonfarm residence. The average poverty threshold for a nonfarm family of four headed by a male was $3,745.

Sources:

1970 Census of Population
New Jersey Office of Demographic and Economic Analysis

TABLE II.E-8

DISTRIBUTION OF REAL PROPERTY ASSESSMENTS BY LAND USE CATEGORY FOR MONMOUTH COUNTY
(1976)

Planning Area	Percent Vacant	Percent Residential	Percent Farm	Percent Commerical	Percent Industrial	Percent Apartments
Area I	3.83	76.75	0.09	10.10	5.81	2.61
Middletown Twp.	4.38	84.74	1.16	9.12	0.32	0.28
Area II	3.52	64.73	0.13	20.98	1.61	9.03
Area III	4.07	64.06	0.28	18.44	1.39	11.76
Area IV	4.94	74.18	1.11	12.78	1.89	5.10
Area V	4.01	70.90	6.85	12.34	4.38	1.52
Area VI	5.43	56.55	28.0	6.98	1.40	1.64
Monmouth County Total	3.98	70.10	2.14	14.82	3.24	5.70

Source: Monmouth County Board of Taxation, 1977 for Middletown is expected to continue to decline in 1978, by as much as 10 percent, due to an increase of ratables of about $18.0 million over those listed for 1977.

E.4 Housing

a. Monmouth County

The present housing market within Monmouth County is very complex. Highly specialized submarkets exist, e.g., demand for adult communities and season al units, as well as the traditional demands for adequate and affordable homes. Residents and prospective residents are often faced with restricted choices when selecting a place to live. These restrictions relate not only to the price of housing in the County, but also to development policies which restrict housing type and location.

The total number of housing units in Monmouth County increased from about 116,000 to 166,000 between 1960 and 1975 (Table II.E-9). Area V had the fastest rate of change. Single family homes are the predominant type of dwelling unit in the County (Table II.E-9), accounting for 74.6 percent of all housing units in 1975. About two-thirds of all occupied units are owner-occupied (Table II.E-10). Between 1960 and 1970, about 14,000 multi-family units were constructed in the County. Planning Area II was the location of most new multi-family residential construction (Table II.E-11).

The 1970 Census of Housing determined that the median value of housing in the Country was $23,300. However, a 1971 survey of major builders and financial institutions in Monmouth County indicated that the average home in the County sold for $38,000 and that a minimum qualifying income of $19,000 was needed to maintain the home, assuming no other encumbrances. Today, the single family home is selling for an average price of $50,000 throughout the County. Based on interviews with local realtors, some lower-cost housing ($25,000 -

TABLE II.E-9

HOUSING INVENTORY FOR MONMOUTH COUNTY
(1960-1975)

Planning Area	Total Housing Units 1960	Total Housing Units 1970	Total Housing Units 1975	Percent Change 1960-70	Percent Change 1970-75	Percent Single-Family 1975	Vacant Seasonal and Migratory 1970	
Area I	31,837	41,389	45,371	30.0	9.6	83.8	1,301	3.1
Area II	29,000	34,805	37,411	20.0	7.5	60.3	782	2.3
Area III	24,745	30,734	33,672	24.2	9.6	62.1	2,178	8.8
Area IV	15,658	18,724	19,947	19.6	6.5	83.2	2,976	19.0
Area V	12,152	21,951	27,182	80.6	23.8	86.5	160	1.3
Area VI	2,227	2,371	2,697	4.0	13.7	89.8	24	1.1
County Total	115,619	149,920	166,280	29.7	10.9	74.6	7,421	4.9

Source: Monmouth County Planning Board, 1971, 1975

TABLE II.E-10

SELECTED HOUSING CHARACTERISTICS FOR MONMOUTH COUNTY (1970)

	Monmouth County	New Jersey
Total Housing Units	149,920	2,387,915
Total Occupied	135,230	2,218,182
Percent Owner Occupied	69.8	60.9
Total Year-Round	142,927	2,305,293
Percent over 30 years old	36.2	46.1
Median Value	$ 23,300	$ 23,500
Median Rent	$ 123	$ 112

Source: 1970 Census of Housing

TABLE II.E-11

RESIDENTIAL CONSTRUCTION IN MONMOUTH COUNTY
(1960-1970)

Planning Area	Total Units	Single Family Number	Single Family Percent	Multi-Family Number	Multi-Family Percent
Area I	11,364	9,024	79.8	2,280	20.2
Area II	7,738	2,722	35.2	5,016	64.8
Area III	7,137	3,243	45.4	3,894	54.6
Area IV	3,970	2,380	60.0	1,590	40.0
Area V	10,492	9,593	91.4	899	8.6
Area VI	355	355	100.0	—	—
County Total	40,996	27,317	66.6	13,679	33.4

Note: Figures do not include demolitions

Source: Monmouth County Planning Board, 1971

$40,000) is available in communities near the Bay, both east and west of the NWS Earle Waterfront Area.

Approximately five percent of all housing units in the County were vacant in 1970. A 1973 survey indicated a vacancy rate of two percent for single family homes and five percent for multi-family apartments.

Table II.E-12 presents the results of an apartment survey completed recently for selected areas in the County. In the municipalities surveyed, apartment vacancies were few and rental costs high. Numerous municipalities have effectively placed a moratorium on multi-family housing development, thereby limiting the amount of housing available in the low and moderate price range in the County.

The shortage of low and moderate income housing in Monmouth County is indicated in Table II.E-13. The table presents data for selected municipalities, primarily located in the coastal area of the County. The greatest housing need occurs in the northeast Monmouth County, particularly in Planning Area I.

b. Naval Weapons Station Earle

Housing at NWS Earle includes bachelor quarters and barracks (207 spaces) and 65 family housing units. Family housing units, located at the Main Station, have an occupancy rate of 99.8 percent, with a waiting list of 18 families. At present, of the 1420 military personnel assigned to NWS Earle, 565 are married and eligible for military family housing. Due to the limited availability of housing at NWS Earle, married personnel assigned to the Station also live at nearby Ft. Monmouth (Figure I-5).

Ft. Monmouth has a total of 1,167 family housing units located at four different locations, primarily in and around Eatontown. As of March 31, 1979, family housing units on the post had an occupancy rate of 98.0 percent (see Table

TABLE II.E-12

AVAILABILITY AND COST OF RENTALS MONMOUTH COUNTY (SELECTED AREAS)
(1977)

	Atlantic Highlands	Highlands	Matawan	Monmouth Beach	Red Bank	Sea Bright
Number of Units Surveyed	300	333	2713	270	1277	372
Total number of vacancies in 3 month period	2	4	10	0	0	0
Average Monthly Rent (excluding utilities):						
All apartments	$250					
1 Bedroom		$215	$235	$270	$240	$270
2 Bedroom		$300	$300	$350	$300	$350
Most recent 1 BR	$250	$310	$295		$380	$225-$260
Most recent 2 BR	$300		$380		$400	$300-$350
Townhouse			$430			

Source: A.P. Busch, Inc., 1977

TABLE II.E-13

EXISTING HOUSING NEEDS
SELECTED MUNICIPALITIES, MONMOUTH COUNTY
(1975)

Planning Area	Municipality		Total Units Needed
Area I	Hazel Twp.		756
	Highlands Boro.		456
	Keansburg Boro.		1,044
	Keyport Boro.		680
	Matawan Twp.		683
	Middletown Twp.[a]		6,348
	Union Beach Boro.		464
		Area Total	10,431
Area II	Eatontown Boro.		1,062
	Long Branch City[a]		4,284
	Oceanport Boro.[a]		254
	Red Bank Boro.		1,690
	Rumson Boro.		251
	Sea Bright Boro.		181
	West Long Branch Boro.		267
		Area Total	7,989
Area III	Asbury Park City[a]		2,760
	Neptune City Boro.		426
	Neptune Twp.		2,605
		Area Total	5,791
Area IV	Manasquan Boro.		291
	South Belmar Boro.		156
	Spring Lake Boro.		104
	Spring Lake Heights Boro.		332
	Wall Twp.		975
		Area Total	1,858
	County Total 22 Municipalities		26,069

[a]Denotes Municipalities which have summarzied their own housing needs

Source: New Jersey Department of Community Affairs, 1976

II.E-14). Family housing accommodations provided to Naval personnel totalled 265 units, of which 79.6 percent (211) were assigned to NWS Earle personnel. These accommodations have been provided by the Army under an InterService Support Agreement (ISSA) with the Navy, wherein housing is made available to Naval personnel on an equal basis.

E.5 Land Use and Zoning

Development patterns in Monmouth County were shown in Figure II.E-3. Despite the recent high rates of growth, developed land in the County in 1974 was estimated to account for less than 45 percent of the total County acreage, as shown in Table II.E-15. The unusually large amount of land devoted to public and quasi-public uses, 42,392 acres, is accounted for by the large number of government installations located in the County, the largest of which is NWS Earle. NWS Earle controls approximately 11,714 acres or about 26 percent of public and quasi-public lands. Most of the NWS Earle land is undeveloped.

Development patterns are generally subject to several major influences; employment/service centers, the waterfront/coastal area and heavily travelled highways. The land in the central and south/southwest portion of the County, including the area around NWS Earle Main Station, is primarily vacant or farmland.

NWS Earle Waterfront Area is surrounded by a mixture of residential and vacant lands. Most of the residential development is composed of single family homes. The Waterfront Area is adjacent to areas zoned for medium to low residential densities (Figure II.E-4). The land to be acquired for the ship fuel replenishment system is zoned Light Industry (M-2) as set forth in the Middletown Township Zoning Ordinance. The 309 acres of land to be acquired represents approximately 27 percent of all land zoned light industrial within the Township of Middletown.

TABLE II.E-14

MILITARY HOUSING NWS EARLE AND FORT MONMOUTH

NWS Earle:

Quarters	Personnel
1 BOQ	5
5 Barracks	202
65 Public Quarters:	17 Officers 48 Enlisted men
Total	272
Occupany Rate:	99.8%

Fort Monmouth:

NAVY PERSONNEL		ARMY PERSONNEL		TOTAL
NWS Earle Assigned:				
Marines	35			
Permanent Party	54			
AEs	89			
Subtotal	178		760	
Other Navy Personnel[a]		Other personnel not assigned to Fort Monmouth	72	
Permanent Party	23			
Naval Vessels	33			
Subtotal	56			
Navy Subtotal	234	Army Subtotal	832	1066
Occupany Rate:	91.3%			

[a]Navy personnel associated with Navy recruitment, Navy Reserve Center, USS DIRECT, USS EXULTANT, USS DOMINANT, USS FISKE

Source: Housing Office, NWS Earle, 1977

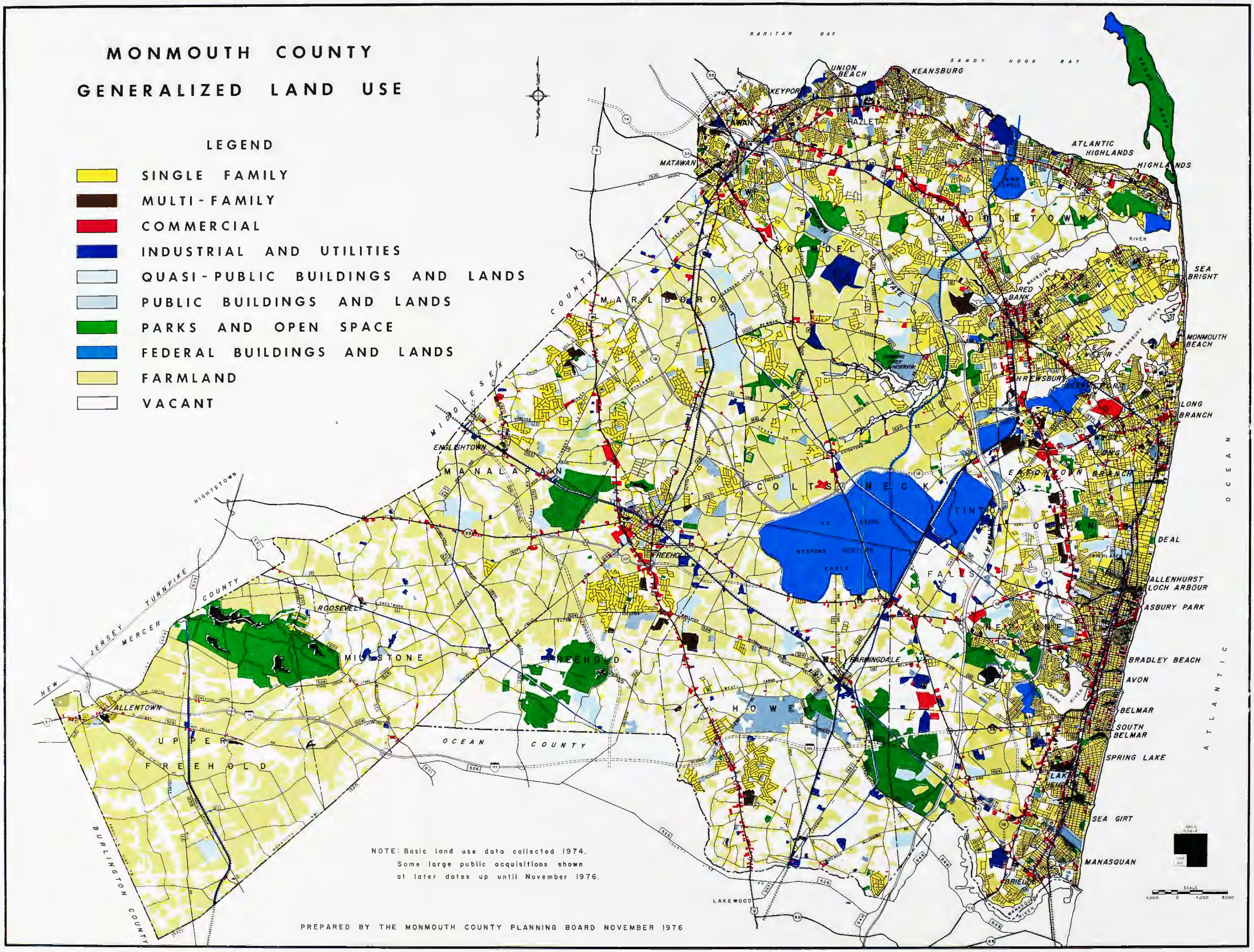
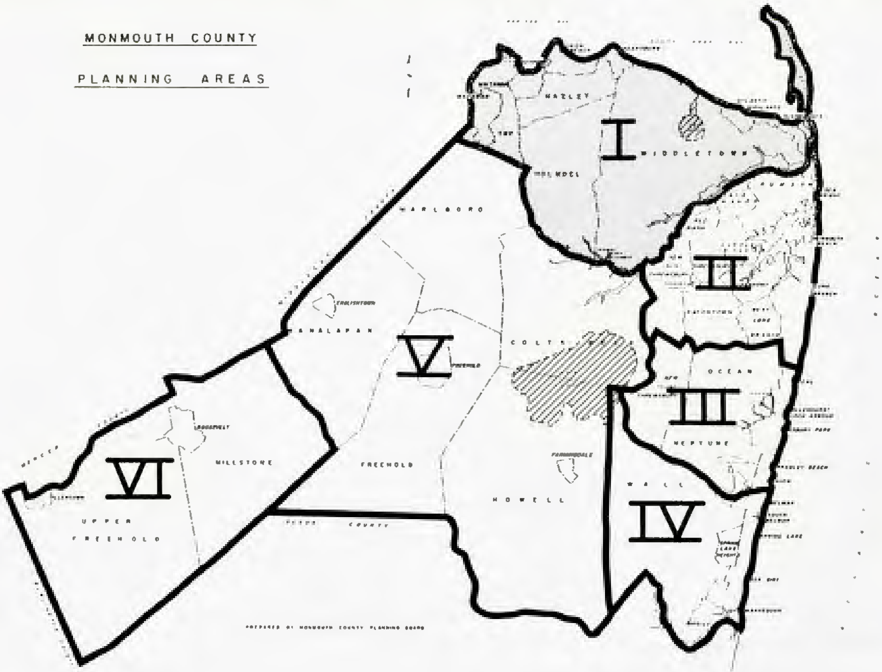
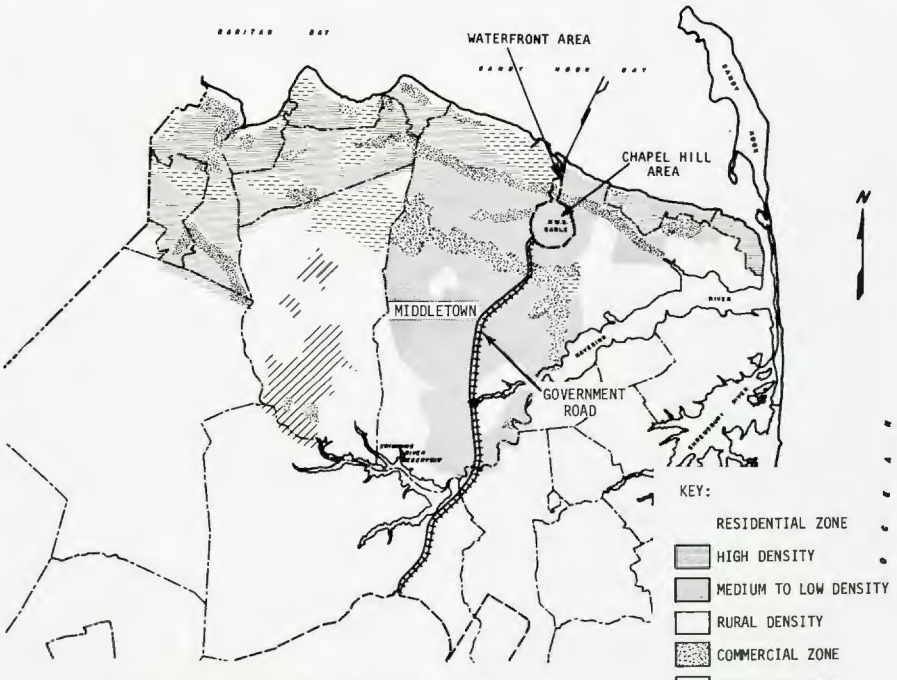

MONMOUTH COUNTY
GENERALIZED LAND USE
LEGEND
SINGLE FAMILY
MULTI-FAMILY
COMMERCIAL
INDUSTRIAL AND UTILITIES
QUASI-PUBLIC BUILDINGS AND LANDS
PUBLIC BUILDINGS AND LANDS
PARKS AND OPEN SPACE
FEDERAL BUILDINGS AND LANDS
FARMLAND
VACANT
RARITAN BAY
SANDY HOOK BAY
UNION BEACH
KEANSBURG
KEYPORT
HAZLET
MATAWAN
ATLANTIC HIGHLANDS
HIGHLANDS
MIDDLETOWN
HOLMDEL
SEA BRIGHT
RED BANK
MARLBORO
MONMOUTH BEACH
SHREWSBURY
LONG BRANCH
ENGLISHTOWN
MANALAPAN
COLTS NECK
EATONTOWN
FREEHOLD
DEAL
ALLENHURST
LOCH ARBOUR
ASBURY PARK
ROOSEVELT
MILLSTONE
FARMINGDALE
BRADLEY BEACH
AVON
BELMAR
SOUTH BELMAR
SPRING LAKE
ALLENTOWN
UPPER FREEHOLD
HOWELL
SEA GIRT
MANASQUAN
LAKEWOOD
OCEAN COUNTY
MERCER COUNTY
BURLINGTON COUNTY
MIDDLESEX COUNTY
NEW JERSEY TURNPIKE
HIGHTSTOWN
ATLANTIC OCEAN
U.S. NAVAL WEAPONS STATION EARLE
NOTE: Basic land use data collected 1974. Some large public acquisitions shown at later dates up until November 1976.
PREPARED BY THE MONMOUTH COUNTY PLANNING BOARD NOVEMBER 1976

FIGURE II.E-3





GENERALIZED ZONING MAP

NORTHERN MONMOUTH COUNTY (PLANNING AREA I)

8000 0 8000 16000 FEET

FIGURE II.E-4

TABLE II.E-15

EXISTING LAND USE SUMMARY: MONMOUTH COUNTY
(1974)

Land Use	Acreage	Percent of Developed Land	Percent of Total Area
Developed Land	133,462	100.0	45.0
Residential	54,785	41.1	18.1
Commercial	9,033	6.8	3.0
Industrial, Public Utilities Railroads	4,775	3.6	1.6
Heavy Industry	1,921	1.4	0.6
Public, Quasi-Public	42,392	31.8	14.0
Beaches	385	0.2	0.1
Streets	16,733	12.5	5.5
Garden State Parkway	3,438	2.6	1.1
Undeveloped Land			
Agricultural and Vacant	169,897	—	55.0
TOTAL	303,359	—	100.0

Source: Monmouth County Planning Board, 1977

E.6 Recreation

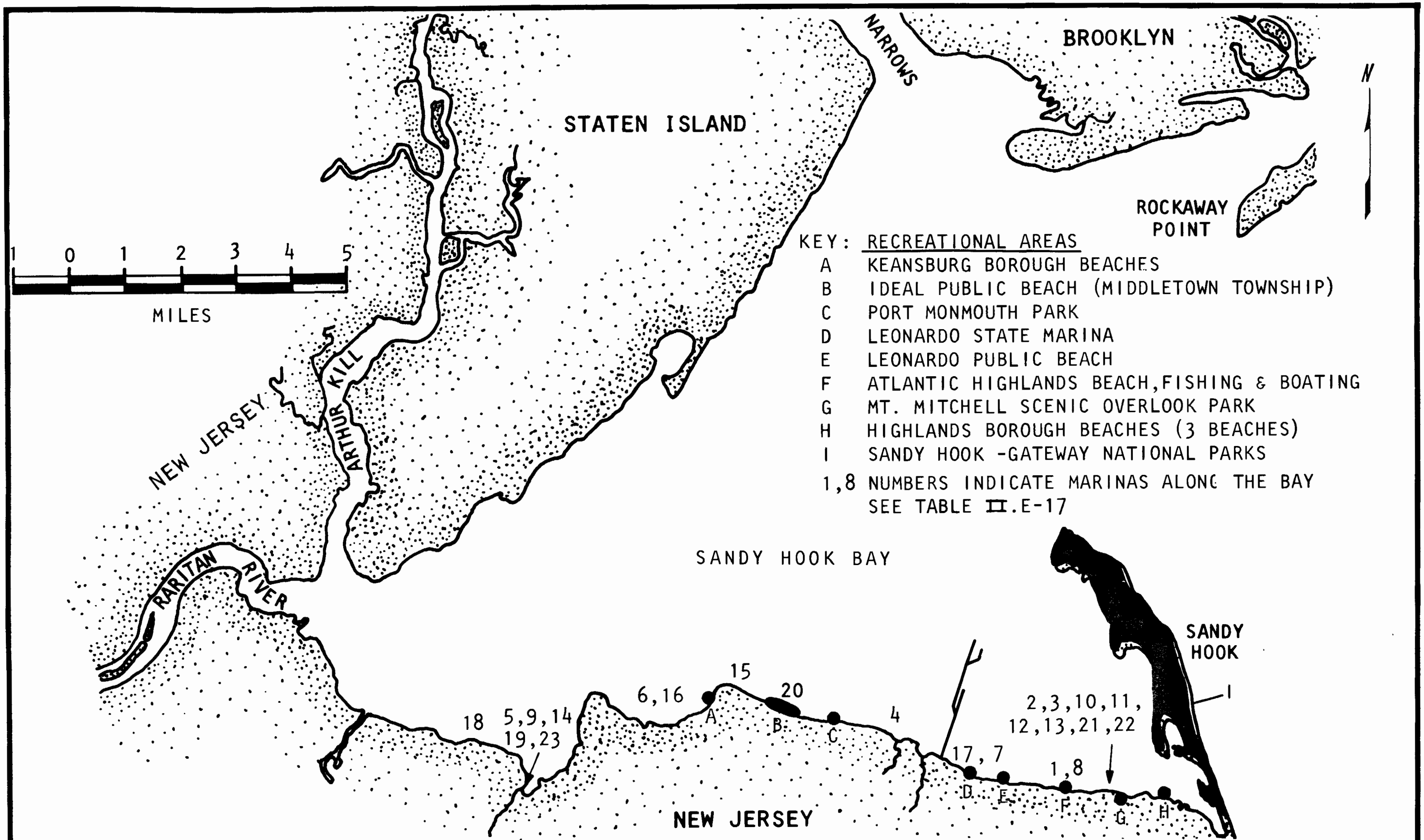
In 1976, Monmouth County reported recreation acreage totalling 32,222 acres (Table II.E-16). With 27 miles of ocean and 26 miles of bay coastline, recreation in Monmouth County is highly water-oriented. In Sandy Hook Bay, fishing, boating, and to a limited extent, swimming are major recreation activities. The highest reported daily swimming capacities in the State of New Jersey were in Monmouth County, which accommodated 376,000 persons per day in 1976 (NJDEP, 1977). However, most swimming occurs in the Atlantic Ocean.

In the immediate area of NWS Earle pier area, public beaches are located in Atlantic Highlands, Highlands Borough (3 beaches), Keansburg (3 miles of beach), Middletown Township (Ideal Public Beach: 3000 feet on the bay) and Gateway National Recreation Area at Sandy Hook (Figure II.E-5) (NJDEP, 1977a). Swimming at the municipal beaches is generally below capacity due to poor water quality in Sandy Hook Bay. Marina facilities located in the immediate area of the piers at NWS Earle are listed in Table II.E-17 and located on Figure II.E-5. In addition to those listed, Atlantic Highlands municipal marina has recently applied for a permit to add 500 berths to the existing facility. NJDEP has acted favorably on this and at present is pending with USACOE.

Open space areas in the area surrounding the NWS Earle Main Station are limited primarily to County park lands. These include the Shark River Park (Wall Twp.), Howell Park (Howell Twp.), Turkey Swamp Park (Freehold Twp.), and Thompson Park (Middletown Twp.). In addition, Allaire State Park (Wall Twp.) is located in the general vicinity of NWS Earle Main Station. These areas provide passive, as well as active, recreational opportunities for the general public.

E.7 Aesthetics

Monmouth County was a predominantly open natural setting, as evidenced by the fact that approximately 55 percent of the County remains undeveloped or in a near natural state, while another 14 percent of the County is of a public or quasi-public nature (Table II.E-15). Major urban concentrations are



RECREATIONAL AREAS AND MARINAS ON SANDY HOOK BAY

FIGURE II.E-5

TABLE II.E-16

REPORTED RECREATION ACREAGE: MONMOUTH COUNTY
(1976)

	Acreage	% of Total
Federal Recreation Areas	1,668	5.20
State:		
Parks	4,145	12.90
Forest	—	
Recreation Areas	—	
Fish & Wildlife Management Areas	6,206	19.30
Natural Areas	109	0.30
Reservoir Sites	1,359	4.20
Marinas	11	0.03
Historic Sites	7	0.02
County Parks	3,308	10.30
Municipals:		
Parks	1,252	3.88
School and Playgrounds	606	1.81
Private Recreation Enterprises	13,554	42.06
TOTAL	32,222	100.00

Source: New Jersey Department of Environmental Protection, 1977

TABLE II.E-17

MARINA FACILITIES IN MONMOUTH COUNTY ALONG SANDY HOOK BAY

Figure II.E-5 Map No.	Marina	Location	Number Slips	Number Rentals[a] Type	Party Boats	Charter Boats	Draft	Lift	Ramp	Head
2	Henjo Dock	Highlands	6	10-1	2			X		X
3	Highlands Marina	Highlands	103			3	4'	X		X
10	Johnny's Landing	Highlands		30-1	1	4	8'			X
11	Kesgal Snug Harbor	Highlands	85			7	6'			X
12	Bahr's Landing	Highlands	40							
13	Bahr's Pier Seven	Highlands	41			1	2'			
21	Sandy Hook Bay Marina	Highlands	200			4				X
22	Schupp's Landing	Highlands	15							X
1	Frank's Boats, Inc.	Atlantic Highlands	30	116-1,2			4'			X[b]
8	Atlantic Highlands	Atlantic Highlands	350		7	4	7'	X	X	X
7	Wagner Boat Works	Leonardo						X		
17	Leonardo Marina	Leonardo	198							
20	Port Monmouth Marina	Port Monmouth	180				6'	X	X	X
4	Belford Marina	Belford	10				8'			X
15	Laurel Outboard Marina	Keansburg	45				14'	X	X	X
6	Grosbie's Marina	West Keansburg	75						X	X
16	Lentze Marine Inc.	West Keansburg	120					X		
19	Cottrell's Restaurant	Keyport	20							
9	Hans Pedersen & Son	Keyport	87				6'	X		X
5	Keyport Marine Basin	Keyport	210				4'	X		X
14	Olsen Boat Works	Keyport	10						X	
23	Snug Harbor Marine, Inc.	Keyport	38					X	X	
18	Matthew's Fising Center	Cliffwood	10					X		X
	Sandy Hook Total		1,873	156	10	23				

Notes:

[a]For rental boats: 1 = Rowboat; 2 = Skiffs

[b]X = Available at this facility

Source: William K. Frigley, Fishermen Access in New Jersey's Marine Environment, New Jersey Department of Environmental Protection, Division of Fish, Game and Shellfish, Bureau of Fisheries, Nacote Creek Research Station, August 20, 1976.

located primarily along the coastline, east of the Garden State Parkway (see Figure II.E-3). Outlying areas of the County exhibit a mixture of suburban residential development and open space, with residential concentrations becoming less concentrated in the southwestern part of the County. The NWS Earle Main Station, in keeping with its natural setting, is about 95 percent wooded.

As indicated previously, the Waterfront Area is located in an area where residential development predominates. Visually, the area in and around the Waterfront Area contains a random mixture of human activities associated with development along Route 36 and the waterfront. Strip commercialization along Route 36 in the vicinity of the Waterfront Area results in a visual experience of various shaped buildings, signs and billboards, and overgrown vacant lots and open spaces. Individually, these uses are not offensive to the eye. However, combined randomly along the highway, they lead to a visually chaotic setting.

To the east of the Waterfront Area, the urban setting is broken only by the bluffs overlooking Sandy Hook Bay in Atlantic Highlands. The whole of Sandy Hook Bay, along with parts of New York City are visible from the bluffs.

To the west of the Waterfront Area is an area of open space that previously had been used as a landfill. Now closed to such activities, the area exhibits a mixture of open field and wetlands associated with Ware Creek. Although residential development has occurred along the western edge of this open space area, the tall brush in association with the wetlands restrict visual access to the Waterfront Area from the west.

Along the water's edge, the piers and trestles are visible from most points in the lower New York Harbor area. From the outermost reaches of the piers, and from the higher coastal elevations, lower Manhattan and Coney Island are visible on clear days. From points on Sandy Hook Bay, a mixture of man-made and natural features are evident. The NWS Earle Waterfront Area is visible, along with a fish factory, a former land fill, petroleum storage tanks and several marinas. These land used are mixed in among prominent natural features visible from the Bay. The overall effect is a visual landscape of mixed aesthetic value.

E.8 Cultural Resources

The National Register of Historic places includes a listing of 29 sites of historic significance located in Monmouth County. In addition, the State Register of Historic places included five listings. None of these historic sites are located at NWS Earle or on property to be acquired for the ship fuel replenishment system.

The proposed site of the ship fuel replenishment system was thoroughly investigated with respect to prehistoric and historic cultural resources. The entire area was walked, visually inspected, selectively excavated, augered and tested. Avocational archaeologists and local collectors were interviewed and local historians and historical societies were consulted. A detailed description of this investigation is set forth in Appendix H.

No evidence of prehistoric aboriginal cultural materials or sites was encountered anywhere within the proposed area of study. Early reports show no prehistoric archaeological site in any proximity to the property. Most local archaeologists agree that the known productive Indian sites are considerably removed.

Review of National Ocean Survey charts and published surveys of shipwrecks (Krotee and Krotee, 1965) reveal no indication of shipwreck or artifacts in the offshore project areas. The possibility of occurrence of artifacts such as middens in the offshore area, related to Paleo-Indian occupation of this area when sea level was lower, is considered remote. As discussed in Appendix H, most of these shell midden sites have been destroyed by the rising waters. In addition, borings and grab samples collected in the offshore areas did not reveal any indications of such artifacts.

E.9 Transportation

Monmouth County's transportation network provides direct access to the adjacent metropolitan areas of New York, Northern New Jersey and Philadelphia by air, bus, and rail services and an extensive highway system.

Major highways in Monmouth County include the Garden State Parkway (Cape May-New York State Thruway) which runs north-south through the eastern portion of the County. The New Jersey Turnpike (Delaware Memorial Bridge-I-80) passes along the county's western boundary. Major state highways include Routes 9, 36, 35, 33, 34, and 18 (Figure II.E-6). However, state and interstate highways comprise only 8.2 percent of the total of 2,459 miles of roadway.

Most Monmouth County residents drive their cars to work (Table II.E-18). Monmouth County experiences traffic congestion on weekdays the year-round because of commuters traveling to Northern New Jersey and New York. Traffic on all major roads in the County is generally heavy (Figure II.E-6). This has forced primary and secondary arterials to accept a larger portion of the total traffic. The County also experiences seasonal congestion of major roadways heading to and from coastal resort areas.

The highest traffic volumes in the County are recorded on the Garden State Parkway and Route 35. However, the roads most directly related to NWS Earle are Routes 34 and 36. In 1976, traffic volume on Route 34, serving the Main Station area of NWS Earle, ranged between 13,400 to 28,300 annual average daily traffic volume (AADT). The AADT for Route 36 in the area immediately adjacent to the NWS Earle Waterfront Area was between 16,500 and 17,200 vehicles in 1976.

The Monmouth County Airport in Wall Township is the major airport in the study area, providing public transportation to New York metropolitan airports and Washington, D.C. A number of smaller airports, including Colts Neck Airport in Colts Neck, Preston Airport in Marlboro, and Asbury Air Terminal in Neptune

TRAFFIC VOLUMES MAP

8000 0 8000 16000
FEET

SOURCE:
N.J. TRANSPORTATION DEPARTMENT (1976) AADT VOLUMES AND RALPH MILLER, (1978) GARDEN STATE PARKWAY AUTHORITY.

KEY:
VEHICLES PER DAY
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
50,000
60,000
70,000

FIGURE II.E-6

TABLE II.E-18

MODE OF TRANSPORTATION TO WORK
MONMOUTH COUNTY LABOR FORCE
(1960-1970)

	Monmouth Co.[a] 1960	Monmouth Co.[a] 1970	New Jersey 1970
Private auto or carpool	72.0%	77.4%	74.1%
Railway or subway	6.5	5.2	3.6
Bus or streetcar	5.1	5.3	10.5
Walked to work	8.2	7.5	7.9
Other Means	2.8	2.4	1.9
Worked at home	5.4	2.2	2.0

[a]Calculated from 1960/70 Census of Populations

Source: New Jersey Department of Labor and Industry, 1975

Township, provide private and charter service. These airports are located within from 7 to 26 miles of the NWS Earle Waterfront Area.

Commuter bus service is provided from Asbury Park, Long Branch, Red Bank, Keyport, Lakewood, Freehold and intermediate points to Newark and New York City. Limited bus service is available to Jersey City, Trenton, Philadelphia and Atlantic City.

Commuter rail service is provided jointly by the New Jersey Department of Transportation and the New York and Long Branch Railroad (Conrail). This line provides service from Bay Head in Ocean County to New York City and parallels the coast in Monmouth County. Conrail provides freight service along four lines: the Seashore Branch from Matawan to the Belford area of Middletown, the Matawan-Freehold Branch, the Central Division from Red Bank to Ocean County and the Freehold-Jamesburg Branch from Englishtown and Freehold to Farmingdale.

E.10 Public Utilities

a. Water Supply

1. Monmouth County - The Monmouth Consolidated Water Company of Shrewsbury, New Jersey serves a franchise area of approximately 720 square miles in Monmouth County. In 1976, the company served 59,840 customers within the 23 municipalities in its franchise area, including the NWS Earle Waterfront Area. In the same year the Consolidated Water System had a water consumption of 8,289 million gallons. Average system delivery in 1976 was 28.8 million gallons per day (MGD). Present facilities allow production of 50 MGD of treated water. A problem faced by the water company is that, occasionally, peak usage or low rainfall results in low water pressure in higher elevations in the franchise area.

Potable water supplied to Middletown Township comes from the Swimming River Reservoir which has a storage capacity of 2.62 billion gallons. Water treatment facilities at the reservoir have a capacity of 24 MGD. This capacity is expected to increase to 36 MGD in the near future.

2. Naval Weapons Station Earle - NWS Earle's potable water supply is provided at the Main Station by wells. The pumping capacity of the Main Station water plant is 500 gallons per minute. A 1.25 million gallon above-ground tank provides the Main Station building complex with potable water and fire protection water at 57 psi. In 1976, average Station consumption from this system was 230,000 gallons per day (gpd), or 31 percent of the total operating peak capacity of 750,000 gpd.

Potable water supplies for the Waterfront Area of NWS Earle are provided at 110 psi by the Monmouth Consolidated Water Company. NWS Earle Waterfront Area water usage in 1976 was approximately 7.4 million gallons, or 20,000 gpd. Usage for the period of December 1976 to November 1977 was 9.0 million gallons, or approximately 24,542 gpd.

b. Sanitary Sewage

1. Monmouth County - The Middletown Sewerage Authority provides public sewerage collection and treatment to approximately 50,000 persons in Middletown Township.Current usage of the system is 4.8 million gallons a day (MGD), or about 74 percent of its design capacity of 6.5 MGD. The treatment facility can handle peak loads of approximately two and one half times its design capacity. Therefore, the need for future expansion of the facility is not anticipated. The treatment plant is located on a site adjoining the one proposed for a ship fuel replenishment system.

2. Naval Weapons Station Earle - Sanitary sewage at the Main Station is treated at a central sewage treatment plant located on Station property.

The plant has a design capacity of approximately 250,000 gpd. In 1976, the plant treated an estimated 43.8 million gallons, or approximately 120,000 gpd. The plant is designed to provide primary and secondary treatment consisting of an Inhoff tank and sand filtration. Both pre- and post-chlorination are used in the treatment process. The plant discharges directly into the Hockhockson Creek.

The Waterfront Area is served by the Middletown sewerage system operated by the Middletown Sewerage Authority. At present, the Authority treats approximately 5,000 gpd generated by shore facilities in the Waterfront Area.

The Navy is presently completing construction of a 75,000 gpd forced main sanitary sewerage system to accommodate the needs of the AEs berthed at the Station. This system will feed directly into the Middletown sewerage system. Ships currently berthed at NWS Earle have a storage capacity of 10,000 gpd of untreated effluent, which, under present procedures, is discharged at sea. This project provides facilities to adequately collect ships sewage by utilization of shore facilities that comply with Federal standards for sewage discharge from vessels.

c. Solid Waste

1. Monmouth County - Most solid waste generated in the County is hauled to landfills. There are six active landfills in the County, apart from a County operated Reclamation Center.

In 1978, 782 acres were committed to landfills. The rate of landfill use was 50 acres per year. However, a landfill deficit in the County is projected by 1982 because northern counties throughout New Jersey are expected to use Monmouth County sites. The only active incinerator in the County is located in Red Bank.

Monmouth County's Reclamation Center handles 10 to 15 percent of the County's solid waste. It shreds solid waste, thus minimizing landfill space requirements. Its current landfill capacity is estimated to be 20 years. (oral communication, Mr. T. Naroznick).

2. Naval Weapons Station Earle - In 1977, approximately 1500 cubic yards of waste material was generated by NWS Earle. Part of this material is sold for recycling through the Defense Property Disposal Office. Material such as glass, cardboard and newspaper have no local market, and therefore are discarded along with other solid wastes. Until recently, NWS Earle operated a large landfill at the Main Station and a smaller disposal site at the Waterfront Area. Both landfills were closed as of September 1977. Solid waste is now trucked to an off-base disposal site by a private contractor. The site, in Old Bridge Township, Middlesex County, has an estimated life of nine years.

d. Electricity and Telephone

1. Monmouth County - Electricity and telephone service for the area are provided by public utilities: Jersey Central Power and Light Company and New Jersey Bell Telephone Company.

2. Naval Weapons Station Earle - Electrical power requirements for both the Main Station and Waterfront Area for NWS Earle are supplied by the Jersey Central Power and Light Company (JCP&L). The Main Station is supplied through a single metered 34.5 KV source. The commercial source splits to supply two aerial radial feeders with one feeder connected to three 833 KVA transformers and the other feeder connected to a 1500 KVA transformer.

A new 3750 KVA, 34.5/13/2 KV substation has been installed in the Waterfront Area to accommodate electrical requirements in support of the three AEs. Electrical usage in 1977 for NWS Earle was approximately 180,000 kilowatt hours per month, 144,000 KV for the Main Station, and 36,000 KV for the Waterfront Area.

The telephone equipment at NWS Earle is leased from New Jersey Bell Telephone Company and is served by a government owned cable plant which is leased to and maintained by New Jersey Bell Telephone. The system consists of two dial systems: one at Main Station and a satellite system at the Waterfront Area.

At present, the telephone equipment at Leonardo and the tieline between the two switchboards are predicated on two ships being berthed on the piers. Four ships are being considered for berthing and additional equipment will be required.

E.11 Education

The Monmouth County school system has shown a decline in combined school enrollment over the past several years. As indicated in Table II.E-19, enrollments for 1976 totalled 106,639. Preliminary estimates for combined enrollments for 1977 showed a 4.0 percent increase over the previous year. However, final figures for 1977 indicate that enrollment actually dropped by 3.1 percent to total 103,381 students. Figures obtained for the 1978 school year show a continuation of this trend in enrollment. As of September 30, 1978. Combined enrollment in the Monmouth County school system totalled 99,646, a decline of 3.6 percent over the previous year. Schools in the county were therefore operating at 80.5 percent of their capacity. The trend in enrollments is showing a decline in the percentage of students in grades K-8 with a corresponding increase in the percentage of high school students.

TABLE II.E-19

SUMMARY OF MONMOUTH COUNTY SCHOOL SYSTEM
(1976-1977)

	Enrollment							
	1976			1977				
Planning Area	Total	Pre-8	9-12	Total	Pre-8	9-12	Percent Change 1976-1977	Total Peak Capacity
		Percentage			Percentage			
Area I	34,207	67.7	32.3	33,147	66.7	33.3	-3.1	38,995
Area II	18,426	65.0	35.0	18,071	62.7	37.3	-1.9	22,880
Area III	16,511	68.4	31.6	18,745	73.5	26.5	13.5	19,728
Area IV	9,493	57.5	42.5	8,096	64.8	35.2	-14.7	8,455
Area V	25,540	72.4	27.6	30,433	56.4	43.6	19.2	31,107
Area VI	2,461	56.5	43.5	2,447	55.9	44.1	-0.6	2,654
County Total	106,639	68.4	31.6	110,939	64.0	36.0	4.0	123,819

Note: Enrollment figures are for September 30, 1976 and September 30, 1977. Estimates were made to distribute Tinton Falls School District enrollments between Planning Area II and III; and special students and ungraded students between grades K-8 and 9-12. Vocational students are included in totals.

Source: New Jersey Department of Education, Monmouth County Office, 1977

Within Monmouth County combined enrollments varied greatly among the planning areas. Planning Area III and V registered an increase in enrollments while the remaing planning areas followed the trend for the county as a whole. Operating capacities among the Planning Areas ranged from a low of 79.0 percent (Area II) to a high of 97.8 percent (Area V) (Table II.E-19).

The drop in school enrollments in Monmouth County reflects a statewide trend, which is projected to continue over the next decade. Enrollments in grades K-12 are projected to decline throughout the state of New Jersey by 22.5 percent between 1978 and 1987 (New Jersey Department of Education, 1978).

The school cost per pupil in Monmouth County is $670 for elementary schools and $1,245 for high schools. For the 1978-79 school year, a statewide average of $1,659 per pupil cost is projected. According to New Jersey law, children must attend schools in the township in which they reside. In the case of Ft. Monmouth, dependents of military personnel attend Eatontown elementary schools (Planning Area II) and Monmouth Regional High School. NWS Earle military dependents attend Colts Neck (Planning Area V) and Middletown Township (Planning Area I) schools and Monmouth Regional High School. Under Public Law 874, school districts enrolling military dependents are reimbursed for most of the annual per-pupil cost directly by the Federal Government. As shown in Table II.E-20, a total of about $1.03 million was distributed to school districts in Monmouth County in 1977. About 70 percent of this was distributed to Eatontown in Area II.

E.12 Other Community Services

a. Public Safety

1. Monmouth County - The number of police personnel and ratio of residents to police by Planning Area are presented in Table II.E-21. In addition to municipal police, the New Jersey State Police serve several areas of the County.

TABLE II.E-20

FEDERAL AID TO LOCAL SCHOOL DISTRICTS FOR MILITARY DEPENDENTS

Planning Area	$ Amount Received (1977)	Percentage Of Total
Area I:		
Middletown Township	50,000	4.9
Area II:		
Eatontown Boro.	717,000	69.7
Little Silver Boro.	5,000	0.5
Area Total	722,000	70.2
Area III:		
Asbury Park City	15,000	1.5
Ocean Township	115,000	11.2
Area Total	130,000	12.7
Area IV:		
Brielle Boro.	15,000	1.5
Manasquan Boro.	10,000	1.0
Spring Lake Boro.	1,000	0.1
Spring Lake Heights Boro.	20,500	2.0
Wall Township	25,000	2.4
Area Total	71,500	7.0
Area V:		
Colts Neck Township	55,000	5.2
County Total	1,028,500	100.0

Source: Monmouth County School Board, 1977

TABLE II.E-21

POLICE OFFICERES AND EMPLOYEES AND RATIO OF CITIZENS TO POLICE OFFICERS AND EMPLOYEES (1974-1975)

Planning Area	Number of Police Officers		Total Police Employees		Residents per Police Officer		Residents per Police Employees	
	1974	1975	1974	1975	1974	1975	1974	1975
Area I	245	245	278	291	607	610	535	513
Area II	242	241	282	294	442	439	380	360
Area III	254	252	288	286	329	332	290	293
Area IV	129	132	153	156	340	331	287	280
Area V	123	141	150	170	662	581	543	482
Area VI	2	3	2	3	880	592	880	592
County Total	995	1,014	1,153	1,200	469	404	460	389

Note: Shrewsbury Township, Colts Neck Township, Millstone Township, Roosevelt Borough and Upper Freehold Township are not included in totals listed above, since law enforcement is covered by State Police in these municipalities.

Source: Uniform Crime Reporting Unit of New Jersey State Police, 1976.

Figure II.E-7 indicated the location of non-military fire companies and first aid squads in the immediate vicinity of NWS Earle. As is indicated, fire companies are located within a two mile radius of the Waterfront Area. The volunteer membership of each fire company consists of approximately 25 active firemen and 10 reserve firemen. The equipment maintained at each of these fire houses as of summer, 1978, is presented in Table II.E-22 and is keyed to locations shown in Figure II.E-7.

2. Naval Weapons Station Earle - Security for Special Weapons Area and Main Station NWS Earle is provided by about 240 Marines. They also enforce traffic regulations and investigate minor assaults, vandalism, and drug offenses. Security for the Waterfront Area is provided by civilian contract labor guards.

NWS Earle has three fire companies located at the Main Station and Waterfront Area. Total fire equipment consists of one fireboat, one railroad tank car and eight trucks. When necessary, Ft. Monmouth fire fighting facilities are also available for emergencies. Ft. Monmouth has two fire companies and nine fire fighting vehicles. Eight ambulances located at the base hospital are also used for fire-related emergencies.

Fire protection at the piers includes an all-weather fire protection system. Heated salt water is circulated in insulated fire mains at Piers 2 and 3. In addition to these adjacent facilities, NWS Earle is proceeding to upgrade its fire protection capability from Class B to Class A by the addition of one pumper /engine company to the Waterfront Area.

b. Medical

The Paterson Army Hospital, located at Ft. Monmouth, provided medical services for NWS Earle Personnel. Its capacity is 125 beds; the average number of beds occupied in 1977 was 30.

TABLE II.E-22

FIRE AND RESCUE EQUIPMENT FOR FIRE COMPANIES AND FIRST AID SQUADS IN THE IMMEDIATE VICINITY OF NWS EARLE, WATERFRONT AREA

Fire Companies

1. Brevent Park Fire Company -
On the corner of Center and Brevent Avenue.

    1949 White Pumper
    1964 American LaFrance Pumper
    1972 International High Pressure Fog Truck

2. Community Fire Company -
On the corner of Appleton and Highland Avenues.

    1944 Chevrolet Utility Truck
    1952 Oren Pumper
    1969 Maxim Pumper

3. Belford Engine Company -
On the corner of Irving Place and Main Street.

    1944 Mack Pumper
    1962 Hahn Ford Pumper

4. Belford Independent Fire Company -
On Route 36 between Church and Main Streets.

    1958 American LaFrance Aerial Truck
    1963 American LaFrance Pumper
    1963 American LaFrance Pumper

5. Port Monmouth Fire Company -
On corner of Wilson Avenue and Main Streets.

    1947 Ahrens Fox Pumper
    1939 GMC Pumper
    1959 American LaFrance Pumper

6. East Keansburg Fire Company -
On Raynor Avenue between Bray and Carter Avenues.

    1937 Diamond T Pumper
    1942 Ward LaFrance Pumper
    1966 Hahn Pumper
    1972 Hahn Pumper

TABLE II.E-22 (Continued)

FIRE AND RESCUE EQUIPMENT FOR FIRE COMPANIES AND FIRST AID SQUADS IN THE IMMEDIATE VICINITY OF NWS EARLE, WATERFRONT AREA

7. Navesink Fire Company -
   On Monmouth Avenue east of Jackson Street.

   1948 Mack Pumper
   1960 Mack Pumper
   1963 Dodge Brush Truck

First Aid Squads

8. Leonardo
9. Port Monmouth
10. Middletown Twp.

Note: a - Numbers indicate location as shown on Figure II.E-7.

Source: Middletown Township Planning Board, 1974, 1978.

Five County hospitals serve Monmouth County residents as indicated in Table II.E-23. Riverview Hospital, Red Bank (Planning Area II), had the lowest average occupancy rate at 78.3 percent, while Freehold Area Hospital, Freehold (Planning Area V), had the highest occupancy rate at 96.2 percent in 1976. In general, Monmouth County has 3.34 beds per 1,000 population. Overall, Monmouth County hospitals provide many specialized services to area residents including cardiac catherizatrion and radiation therapy.

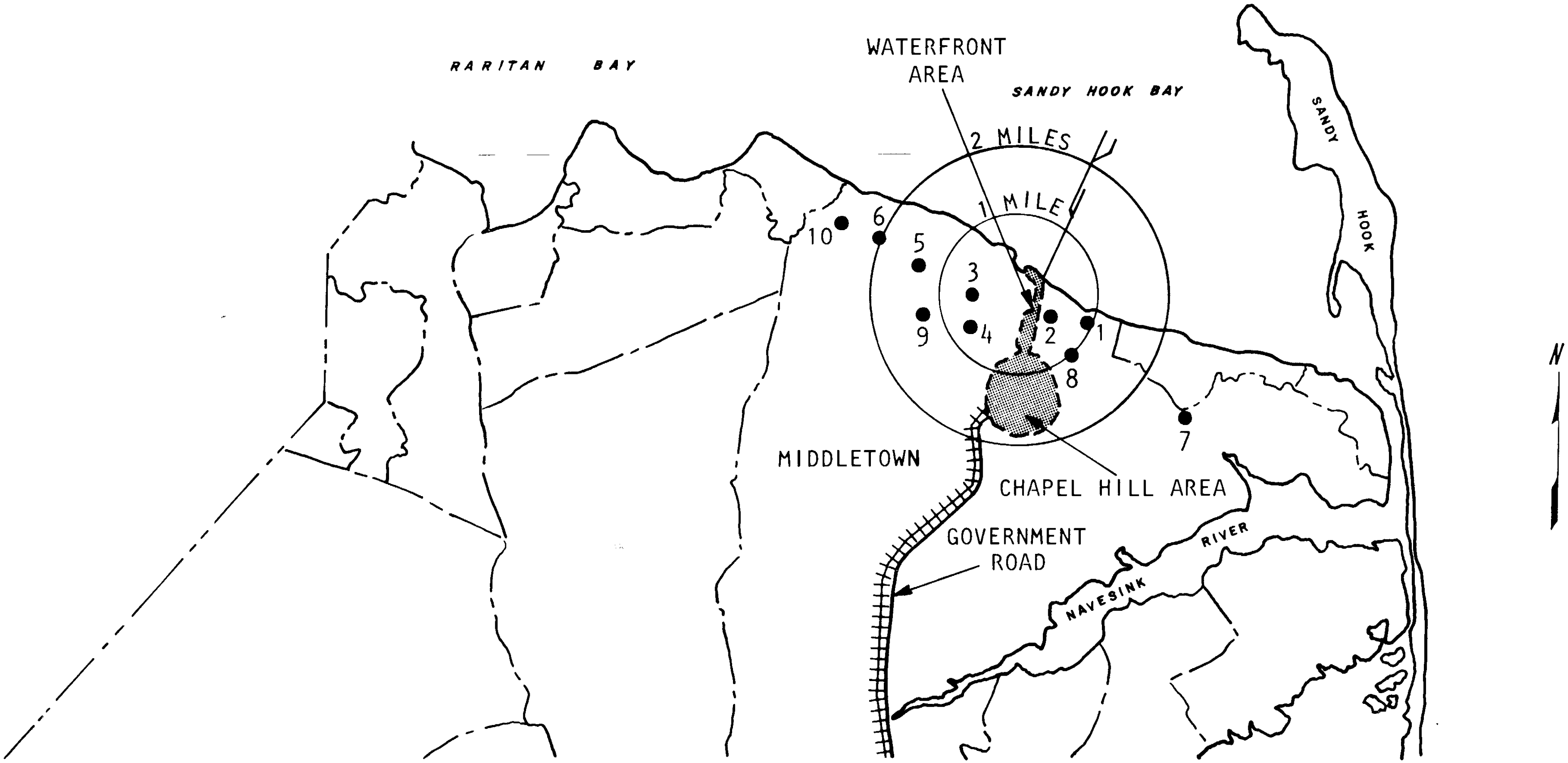
Approximately 252 licensed physicians practice within the County, providing a ratio of 2,000 people for every physician.

TABLE II.E-23

UTILIZATION OF ACUTE GENERAL CARE HOSPITALS IN MONMOUTH COUNTY (1976)

Hospital	Municipality	Planning Area	Total Licensed Capacity	Occupancy Rate	Admissions in 1976	Average Daily Census	Emergency Room Visits
Bayshore Community	Holmdel	I	158	89.4%	5,240	141.7	24,102
Freehold Area	Freehold	V	120	96.2%	6,128	115.5	26,100
Jersey Shore Medical Center	Neptune	III	482	83.2%	15,888	390.7	38,000
Monmouth Medical Center	Long Branch	II	487	88.6%	17,213	432.7	35,152
Riverview	Red Bank	II	492	78.3%	17,153	384.3	39,520
Total			1,739	84.8%	61,622	1,464.8	162,874

Source: Community Health Profile for Central Jersey, Central Jersey Health Planning Council, Inc., Hightstown, N.J., 1977, Tables VI-1-1 and IV-4-1.



EXISTING FIRE FACILITIES

NORTHERN MONMOUTH COUNTY (PLANNING AREA I)

8000 0 8000 16000 FEET

KEY:

● FIRE COMPANY OR FIRST AID SQUAD (SEE TABLE II.E-22)

FIGURE II.E-7

CHAPTER III

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Chapter III

III. RELATIONSHIP OF PROPOSED ACTION TO LOCAL, STATE AND FEDERAL LAND USE POLICIES, PLANS AND PROGRAMS

A. INTRODUCTION

Five sets of land use policies, plans or programs were identified that relate to the proposed action:

- Monmouth County General Development Plan;
- Middletown Township Planning Documents;
- State Coastal Zone Management Policies and Programs;
- State and Federal Recreation Plans; and
- Related Projects.

In addition, applicable federal, state and local laws and regulations were identified.

B. MONMOUTH COUNTY GENERAL DEVELOPMENT PLAN

The Monmouth County General Development Plan was prepared in 1969. It is a general statement of policy about how development should occur. These policies are depicted on Figure II.E-4 for planning area I. On this map, the proposed site for the ship fuel replenishment system is designated for industrial use. Therefore, the proposed use is consistent with this aspect of the County General Plan (Figure II.E-3).

The General Plan also recommends preservation of public open space. The proposed actions are consistent with this objective as they do not change the basic character of NWS Earle. Proposed development activities would occur in areas or extensions of areas that are already developed. About three percent of NWS Earle's open space would be used under the proposed action.

C. MIDDLETOWN TOWNSHIP PLANS

There are three planning documents for Middletown Township that bear on the proposed action:

- the adopted Master Plan
- the adopted Zoning Ordinance and Map; and
- the proposed Route 36 Plan.

Table III-1 compares present land use patterns with those resulting from the recommendations of the Master Plan. It can be seen from Table III-1 that the Master Plan contemplates significant increases in residential, industrial and recreational uses.

Both the Master Plan and the Zoning Map classify the site proposed for the ship fuel replenishment system as industrial. The Zoning Ordinance neither precludes nor authorizes fuel storage tanks. Therefore, the proposed action does not conflict with the adopted Master Plan or current zoning.

The waterfront adjoining this site is also mapped in the Master Plan as part of the Sandy Hook Bay Coastal Protection District. Acquisition of the site by the Department of the Navy would effectively preserve the wetlands along Ware Creek and Sandy Hook Bay. They would be retained to serve as a buffer zone around the fuel storage tanks.

In June 1977, the Middletown Township Planning Department published the Route 36 Plan, recommending land use changes along the Route 36 corridor. The Route 36 Plan recommends that the site proposed for acquisition be "marina oriented". No further action has been taken on plan recommendations by the Township Planning Department. However, in 1978, the Township Committee adopted a resolution creating the Middletown Housing and Redevelopment Authority. The Authority was created for the specific intention of acquiring and

TABLE III-1

MASTER PLAN SUMMARY
MIDDLETOWN TOWNSHIP AT MATURITY

	LAND USE							
	CURRENT				FUTURE			
Land Use Category	Acreage	Percent of total Area	Units	Population	Acreage	Percent of total Area	Units	Population
Residential:								
Single Family	8,900	36.0	16,191	59,306	11,254	46.0	18,545	72,000
Town House	0	0	0	0	485	2.0	3,100	9,600
Planned Adult Community	87	0.4	347	694	154	0.6	952	1,900
Garden Apartments	0	0	0	0	277	1.0	2,770	5,800
Senior Citizens	13	0.1	196	0	50	0.2	500	750
Commercial	610	3.0	—	—	850	3.0	—	—
Industrial	45	0.2	—	—	600	2.0	—	—
Recreation	1,220	5.0	—	—	3,300	14.0	—	—
Agricultural	1,605	7.0	—	—	1,605	7.0	—	—
Other	11,968	48.3	—	—	5,873	24.2	—	—
Township Total	24,448[a]	100.0	16,734	60,000	24,448[a]	100.0	25,867	90,050

[a]Does not include Sandy Hook (Gateway National Recreation Area).

Source: Middletown Township Planning Board, 1974.

developing the proposed ship fuel replenishment site for recreational purposes. As of May 1979, the Authority was pursuing its directive on two fronts: 1) planning requirements were being identified and a grant application had been submitted to the Department of Housing and Urban Development (HUD), and 2) an environmental feasibility study was being considered. Financial assistance for acquisition and development of the site had not been obtained. The New Jersey Science Consortium has shown an interest in providing financial assistance to develop a recreational-educational center, including an aquarium, should the Authority obtain funds to acquire and develop the site.

Under the proposed action, recommendations contained in the Route 36 Plan, as well as efforts by the Middletown Housing and Redevelopment Authority would be precluded from being implemented. However, as discussed below in Section F.2, two projects involving marina expansion or development have been proposed along Raritan Bay in the same general area. If developed, these would address the need for additional marina facilities in the Raritan Bay area.

While road circulation patterns in the Township are considered adequate for traffic in the near future, the Master Plan identifies a need for a north-south arterial road running across the center of the Township. The Plan recommends that the Township consider the construction of a limited-access four lane highway on or adjacent to the Government Road (Normandy Road) connecting Exit 109 on the Garden State Parkway with Routes 35 and 36. The recommendation to develop Normandy Road as a major arterial in the Township would not be practical, as Normandy Road must be maintained as a secure corridor for military traffic.

D. STATE COASTAL ZONE MANAGEMENT

D.1 State Laws

New Jersey's coastal zone management policies and programs are based on State laws designed to regulate usage of coastal resources and protect critical environmental areas: the Coastal Area Facility Review Act (CAFRA) of 1973; the Wetlands Act of 1970; and State laws addressing riparian land management. The New Jersey Department of Environmental Protection (NJDEP) has been designated the State agency to administer, plan and enforce provisions of these acts. Under these three acts, the State manages the coastal zone through the issuance of permits.

The proposed action would require the crossing of State riparian lands. Riparian lands are defined as "those lands now, formerly or hereafter formed by mean high tide, except where such tidal flow is caused by artificially produced changes in land or water elevation". In New Jersey, the private right to use "tide-flowed lands" is based on ownership of land adjacent to the waterway, but this right is subject to a dominant navigational servitude conferred upon the United States Government by its constitutional power to regulate commerce.

The State of New Jersey, as trustee for the public, owns all of these riparian lands subject to this federal dominant servitude (except those which have been subject to prior conveyance). This Draft Environmental Impact Statement (DEIS) represents a response to the State interest in riparian lands.

In addition to the three acts mentioned above, the State of New Jersey derives further authority to implement coastal management policies through the State's Shore Protection and Waterway Maintenance Program. This program is administered by the NJDEP. The Program is responsible for beach erosion control and efforts to maintain state waterways. It establishes priorities for pending shore protection and harbor cleanup funds. Various policies concerning coastal resource and development will, in part, be implemented through this Program.

D.2 Coastal Zone Management Program

New Jersey has proceeded to implement its responsibilities under the Federal Coastal Zone Management Act by the preparation a coastal zone management program in two phases. The Bay and Ocean Shore Segment is the geographic area addressed in the first part of the New Jersey Coastal Management Program and includes the area defined by the Coastal Area Facility Review Act of 1973, plus tidal wetland areas inland of the CAFRA boundary which are regulated under the Wetlands Act of 1970. The "Coastal Area" for state review is shown in Figure III-1. The Bay and Ocean boundary extends to the three-mile territorial limit along the Atlantic Coast and to the New York State boundary in Raritan Bay.

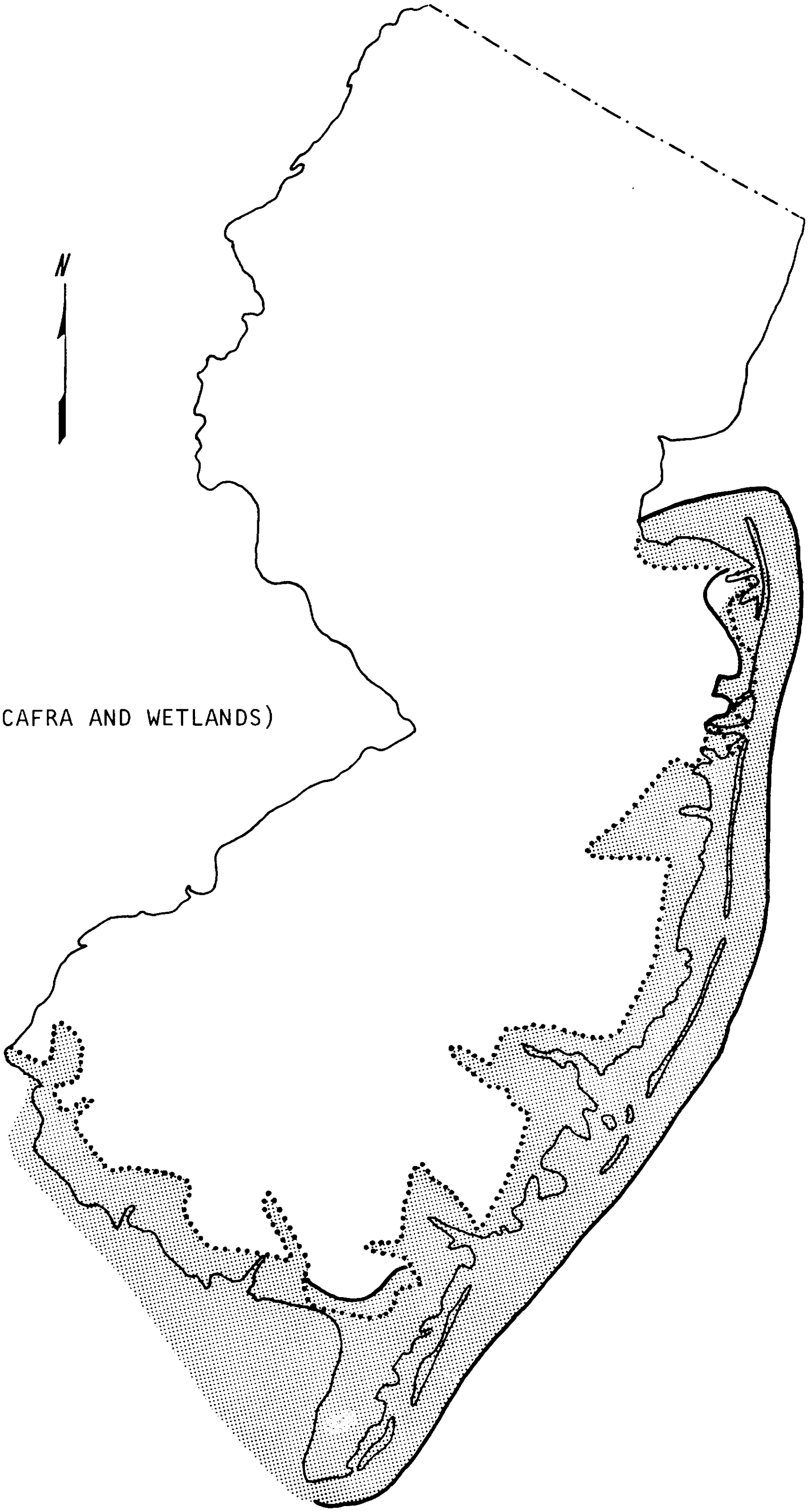
In compliance with the Federal Coastal Zone Management Act, the State of New Jersey has published (August, 1978) the New Jersey Coastal Management Program - Bay and Ocean Segment. This program has been approved by the National Oceanic and Atmospheric Administration (NOAA). Accordingly, federal agencies are required to act consistently, insofar as practical, with the program (CFR Part 923 FR 40 (6): 1683-1695). This impact statement represents the analysis which will accompany the consistency determination for the proposed actions in the Bay and Ocean segment.

The Program (NJDEP/NOAA, 1978) defines and explains the Coastal Resource and Development Policies and the system to be used in managing coastal activites.

D.3 Coastal Policies and Procedures

The basic direction of the New Jersey Coastal Management Program is represented by four basic coastal policies:

- Protect the coastal ecosystem.
- Concentrate rather than disperse the pattern of coastal residential, commercial, industrial, and resort-oriented development, and encourage the preservation of open space.



NEW JERSEY BAY AND OCEAN SHORE
SEGMENT BOUNDARY

SOURCE: N.J. DEPT OF ENVIRONMENTAL PROTECTION, 1978

FIGURE III-1

- Employ a method for decision-making which allows each coastal location to be evaluated in terms of both the advantages and the disadvantages it offers for development.

- Protect the health, safety and welfare of people who reside, work, and visit the coastal zone.

The Coastal Policies set forth in the Management Program are divided into three groups:

- Location Policies evaluate specific types of coastal locations;

- Use Policies are directed at different uses of the coastal zone;

- Resource Policies focus on controlling the effects of development.

A number of components of the proposed expansion of NWS Earle would occur in the Bay and Ocean Shore Segment; the new dredging, the construction of the pier and trestle and the ship fuel replenishment system (pipeline and storage tanks). Applicable location and use policies, as defined in the Program and related to these actions, are presented in Tables III-2 (New Dredging), III-3 (Pier and Trestle), III-4 (Ship Fuel Replenishment System - Pipeline), and III-5 (Ship Fuel Replenishment System - Storage tanks).

a. Location Policies

Location policies are divided into the following groups: 1) Water areas, 2) Water's Edge areas (Natural, Retained or Filled), and 3) Land areas. In addition, special areas are identified including:

- Shellfish Beds
- Surf Clam Areas

TABLE III-2

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR NEW DREDGING

LOCATION POLICIES	COMMENTS
Location	
Water Area Open Bay	
Special Areas	
None within; eelgrass and soft shell clam beds in bay adjacent to Sandy Hook	Would not be affected by new dredging
USE POLICIES	
Although generally discouraged, considered acceptable when:	
1) Need demonstrated	Condition is met, fully-loaded AOEs need depth to berth
2) Facilities served satisfy location requirements for water's edge areas	Condition is met (see pier and trestle Table III-3)
3) The adjacent water areas are currently used for recreational or commercial boating	Condition is met - used for recreational, military and commercial boating
4) The dredge area causes no significant disturbance to intertidal flats or subaqueous vegetation	Condition is met
5) The adverse impacts are minimized to the maximum extent feasible	Condition is met
6) An acceptable dredge spoil disposal area exists	Condition is met (Designated Ocean disposal site)
7) The dredge area is reduced to the minimum practical	Condition met

TABLE III-3

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM APPLICABLE LOCATION AND USE POLICIES FOR PIER AND TRESTLE

LOCATION POLICIES	COMMENTS
Location	
1) Water Area - Open Bay	
2) Water's edge (natural)	
Special Areas	
3) Navigation channel (approach)	
4) Eelgrass and soft shell clam beds in bay adjacent to Sandy Hook	Would not be affected by construction of new pier and trestle

USE POLICIES	
1) Water Area - Considered conditionally acceptable when:	
a) There is a need that cannot be satisfied by existing facilities	Condition is met
b) The adjacent shorefront is intensely used for coastal recreation	Not applicable to military pier and trestle
c) The location policies for water's edge areas are satisfied	Condition is met, see below
d) The construction minimizes adverse impact to the maximum extent feasible	Condition is met
e) The docks and piers are located so as not to hinder navigation or conflict with overhead transmission lines	To meet conditions, realignment of navigational approach to Compton Creek Channel will be necessary (see #3 below)
f) There is minimum feasible interruption of natural water flow patterns. Docks and pilings shall be preferred to solid construction on fill	Condition is met

TABLE III-3 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR PIER AND TRESTLE

USE POLICIES	COMMENTS
2) Water's Edge Policy (Natural) - Development discouraged unless it satisfies all of the following conditions:	
a) Requires water access or is water oriented as a central purpose of the basic function of the activity	Condition is met
b) Has no prudent or feasible alternative on a non-water's edge site	Condition is met
c) Is immediately adjacent to existing water edge development, and,	Condition is met
d) Would result in minimal feasible alteration of in-situ vegetation	Condition is met
3) Special Area - Navigation Channel (approach)	
Maintenance dredging of existing navigational channels is encouraged. Development which would cause terrestrial soil and shoreline erosion and siltation in channels shall utilize appropriate mitigation measures. Development which would result in loss of navigability is prohibited	The expansion of the security zone for the new pier and trestle would interfere with the outer few hundred feet of the Compton Creek Channel and its approach (Figure 1-8). This outer segment and the approach would have to be relocated toward the northwest away from the proposed security zone. No new dredging would be required and loss of navigability would not occur

TABLE III-4

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR SHIP FUEL REPLENISHMENT SYSTEM-PIPELINE TO TRESTLE

LOCATION POLICIES	COMMENTS
Location	
1) Water Area (Ware Creek)	
2) Natural water's edge	
3) Land Area (air strip)	
Special Areas	
4) Wetlands	
USE POLICIES	
1) Water Area (Ware Creek) Conditionally acceptable if all the following conditions are met:	
a) They are not sited within special areas, unless no prudent and feasible alternate route exists	Condition is met
b) Trenching takes place to a sufficient depth to avoid puncturing or snagging anchors or seal clam dredges	Not applicable, pipeline will be elevated across creek
c) The pipeline is sufficiently deep to avoid uncovering by erosion of water currents	Not applicable, pipeline will be elevated across creek
d) Conditions outlined for pipeline use policies are satisfied	Not applicable, applies to OCS-related pipeline routes in State
2) Natural Water's Edge Development discouraged unless the development satisfies all of the following conditions:	
a) Requires water access or is water-oriented as a central purpose of the basic function of the activity	Condition is met
b) Has no prudent or feasible alternative in a non-water's edge site	Condition is met
c) Is immediately adjacent to existing water edge development, and,	Condition is met
d) Would result in minimal feasible alteration of on-site vegetation	Condition is met

TABLE III-4 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR SHIP FUEL REPLENISHMENT SYSTEM-PIPELINE TO TRESTLE

USE POLICIES	COMMENTS
3) Land Area (air strip)	
a) Environmental Sensitivity	Low
b) Development Potential	High
c) Acceptable Development Potential	High
4) Special Areas-Wetlands Generally discouraged; but considered acceptable when the following development conditions are met:	
a) Requires water access or is water oriented as a central purpose of the basic function of the activity	Condition is met
b) Has no prudent or feasible alternative on a non-wetland site	Condition is met
c) Will result in minimum feasible alteration or impairment of natural tidal circulation	Condition met by a elevated pipeline
d) Will result in minimum feasible alteration or impairment of natural contour of the natural vegetation of the wetlands	Condition met by elevated pipeline

TABLE III-5

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR SHIP FUEL REPLENISHMENT SYSTEM-STORAGE TANKS

LOCATION POLICIES		COMMENTS
Location - Land Area (air strip)		
Special Areas - None		
USE POLICIES		
Port Uses	Port-related development and marine commerce is acceptable only in established port areas. Water dependent development shall not be preempted by non-water dependent development in these areas	The proposed action, composed of dredging, pier and trestle, and the ship fuel replenishment system, is considered a necessary expansion of the adjacent military port at NWS Earle and is consistent with New Jersey CZM policies
Energy Facility	The storage of crude oil, gases and other potentially hazardous liquid substances... related to offshore oil and gas production is prohibited on barrier islands and discouraged elsewhere in the bay and ocean shore segment	The energy use policies are not considered applicable to the storage facilities related to this military expansion
	Major new storage facilities for crude oil and gas, in the absence of processing facilities, will be permitted only outside the bay and ocean shore segment in the port of New York and New Jersey and the Delaware River port and where such storage will not contribute unacceptably to overall regional air or water quality degradation	Not applicable to proposed storage

TABLE III-5 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
APPLICABLE LOCATION AND USE POLICIES
FOR SHIP FUEL REPLENISHMENT SYSTEM-STORAGE TANKS

USE POLICIES (Continued)		COMMENTS
	Facilities for storing and distributing finished petroleum products on a wholesale or retail basis will be reviewed on a case-by-case basis	Not directly applicable to proposed action
Rationale	Major storage facilities for hazardous substances are not coastal-dependent and will not be permitted where storage might limit or conflict with recreational or open spaces uses of the coast	This area is not well suited for recreation. Access is restricted by existing Navy Pier and adjacent airstrip. Bay water quality, lack of scouring of surf to maintain attractive beaches and the close access to Sandy Hook, makes this area less suitable for bathing. (Nordstrom et al., 1977) The land acquisition for the ship fuel replenishment system would further limit other potential future open space recreational uses of this area. However, additional fencing of the area will be limited to immediate storage facilities and thus beach areas will remain open

Land Area (air strip)

a) Environmental Sensitivity	Low
b) Development Potential	High
c) Acceptable Development Potential	High

- Prime Fishing Areas
- Finfish Migratory Pathways
- Submerged Vegetation
- Navigation Channels
- Shipwrecks and Artificial Reefs
- Marine Sanctuaries
- Beaches
- Coastal Wetlands
- High Risk Beach Erosion Areas
- Dunes
- Central Barrier Island Corridor
- Historic Resources
- Specimen Trees
- White Cedar Stands
- Endangered or Threatened Wildlife or Vegetation Species Habitats
- Critical Wildlife Habitats
- Public Open Spaces
- Steep Slopes
- Farmland Conservation Areas
- Bogs and Freshwater Wetlands

No existing special areas would be affected by the proposed action except for the wetlands which would be encountered along the proposed pipeline route. The proposed action would provide for an elevated crossing of wetlands along Ware Creek. This would involve the minimum feasible alteration of tidal circulation and vegetation as discussed in Chapter IV. Alternatives are not considered feasible because they would place the pipeline out of the Navy's control. The special area related to subaqueous vegetation and softshell clam beds in the shallow bay waters adjacent to Sandy Hook are far removed from the areas of proposed dredging and pier and trestle construction and would not be affected by the short-term alterations in bay water quality resulting from these actions.

The New Jersey Department of Environmental Protection is currently considering various areas in the Sandy Hook Bay and the adjacent offshore area east of Sandy Hook for nomination as a Marine Sanctuary under the Marine Protection, Research and Sanctuaries Act of 1972 (P.L. 92-532, 16 U.S.C. 1431-1434). The largest area under consideration would encumber historically significant fishing grounds, a portion of Sandy Hook Channel, much of Sandy Hook Bay, the existing NWS Earle Pier and the currently active dredged material disposal site east of Sandy Hook. Designation and regulation of such an area would have a significant impact on Navy operations, dredging of access ways to the NWS Earle Pier and disposal of dredge spoils at the existing ocean disposal site. Lesser impacts would be involved if the final designated boundaries of the proposed Marine Santuary are modified to include the existing pier, ship channels and dredged material disposal site.

As of May 1979, the areas being considered by NJDEP for inclusion in the proposed marine santuary have not been submitted to the NOAA office of Coastal Zone Management for the formal analysis, review and selection processes as specified in Marine Santuaries Regulations (Federal Register, February 5, 1979).

Land areas are analysed for acceptability for development for a particular site. The land area involved is an upland area (unused paved air strip). The upland area is proposed as the site for storage tanks and a portion of the pipeline route for the ship fuel replenishment system. Following the procedures outlined by NJDEP/NOAA (1978), this site is classified as having low environmental sensitivity. Monmouth County is listed as an area of high growth potential. The site is considered as having a high development potential since it meets the development criteria related to roads, sewage and infill. The combination of high development potential and low environmental sensitivity for this site in a high growth area indicates that acceptable development is high. Therefore, the site would be considered acceptable for the proposed action.

b. Use Policies

The Coastal Management Program sets forth use policies that can be related to the proposed activities. The use policies most applicable to the proposed action are associated with Port-related development (Table III-5). The expansion of the military port facilities at NWS Earle at Leonardo are considered consistent with these use policies. In addition, the component projects are considered conditionally acceptable and consistent with the policies as outlined in Tables III-2 to III-5.

c. Resource Policies

In addition to location and use policies, resource policies have been developed by the State to insure that the effects of the proposed development on various resources of the built and natural environment of the coastal zone are properly considered. The policies are to serve as a standard to which proposed development should adhere. The resource policies relevant to the proposed action are presented in Table III-6. The relationships of the proposed action to these resources are assessed in Chapter IV and applicable mitigating measures summarized in Chapter VI. The proposed action will adhere to the resource policies to the maximum extent feasible.

E. STATE AND FEDERAL RECREATION PLANS

E.1 New Jersey Statewide Comprehensive Outdoor Recreation Plan

The 1977 New Jersey Statewide Comprehensive Outdoor Recreation Plan (SCORP) is designed to serve as the basis for sound decision making concerning open space and recreation in the State. The document serves as a reference for planning policy in the administration of New Jersey's Green Acres

TABLE III-6

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM RESOURCES POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
Marine fish and fisheries	Actions are conditionally acceptable to the extent that minimal feasible interference is caused to the natural functioning and migratory patterns of estuarine and marine estuarine dependent species of finfish and shellfish	IV-B.1b, B.2, B.5, C.1b & C.2b
Water quality	Coastal development shall conform with all applicable surface and groundwater quality statutes, regulations and standards as established and administered by DEP's Division of Water Resources	IV-A.1a, A.2e B.1a, C1.a & b, C.2a
Surface Water Use	Coastal development shall demonstrate that the anticipated surface water demand of the facility will not exceed the capacity, including phased planned increases, of the local potable water supply system or reserve capacity and that construction of the facility will not cause unacceptable surface water disturbances, such as drawdown, bottom scour, or alteration of flow patterns.	IV-A.2c
Groundwater Use	Coastal development shall demonstrate, to the maximum extent practicable, that the anticipated groundwater withdrawal demand of the development will not cause salinity intrusions into present potable groundwater well fields, significantly lower the water table, or significantly decrease the base flow of adjacent water courses.	IV-A.2f, A.2g, B.2a4, & D.21
	Coastal development shall conform with all applicable DEP requirements for groundwater withdrawal and water diversion rights.	

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCES POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
Runoff	(a) Coastal development shall minimize off-site storm water runoff, increase on-site infiltration and simulate natural drainage systems, to the maximum extent practicable, depending upon the soil, land, vegetation, topography, existing drainage system and other site characteristics. (b) The quantity of off-site storm water runoff, both during the construction and operation of a development, shall not exceed the quantity of runoff that would occur under the existing pre-development conditions of the site, to the maximum extent practicable. For some sites, with existing pre-development conditions such as cultivated land, bare earth, or partial paving, the requirement to reduce runoff to the maximum extent practicable means to achieve the runoff standard for good condition pasture land (SCS TR-55 Curve Number 39) which may result in a greater quantity of on-site retention and infiltration than under the existing pre-development conditions. (c) If the site is in a built-up urban area, or if the coastal runoff policy conflicts with runoff management requirements of local governmental agencies, then the acceptable quantity of off-site stormwater runoff may exceed the standard of existing pre-development site conditions, provided that DEP can determine, on a case-by-case basis, that the following requirements are met: (i) the runoff policy of (a) and (b) of existing pre-development site conditions has been met using the best available technology authorized by local regulations,	IV-A.2c & A.2d

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCE POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
	(ii) the off-site stormwater sewers do not discharge into sanitary sewer systems,	
	(iii) the amount of pollutants in the stormwater runoff discharge to surface water bodies is minimized and the discharge satisfies, to the maximum extent practicable, the application DEP-established surface water quality standards of the receiving water body using measures such as sediment traps, oil skimmers and vacuum street cleaners, and	
	(iv) the volume of stormwater discharged offsite will not cause significant adverse impacts to the receiving water body, must conform with the requirements of the DEP Stream Encroachment Permit Program (N.J.S.A. 58:1-26 and rules).	
Vegetation	Coastal development shall preserve, to the maximum extent practicable, existing vegetation within a development site. Coastal development shall plant new vegetation, particularly appropriate native coastal species, to the maximum extent practicable.	IV-A.1b, A.2a, & A.2b
Wildlife	The design of coastal development shall incorporate management techniques which favor or maintain native wildlife habitats, diversity, and numbers, to the maximum extent practicable. Development that would significantly restrict the movement of wildlife through the site to adjacent habitats and open space areas is discouraged.	IV-A.2a & A.2b

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCE POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
Air	Coastal development shall conform to all applicable state and federal emissions regulations, ambient air quality standards, prevention of significant deterioration criteria, nonattainment criteria, and other regulations and guidelines established to meet requirements of the Federal Clean Air Act as amended in 1977.	IV-A.2j
Public Access to Shorefront	Coastal development adjacent to coastal waters shall provide maximum practicable public access to the shorefront, including both beach and built-up waterfront areas and both visual and physical access. Shorefront development that limits public access and the diversity of shorefront experience is discouraged.	This Chapter
Scenic Resources and Design	New coastal development that is visually compatible, in terms of scale, height, materials, color, texture, and geometry of building and site design, with surrounding development and coastal resources, to the maximum extent practicable, is encouraged. Coastal development that is significantly different in design and visual impact than existing development is discouraged, unless the new development upgrades the scenic and aesthetic attributes of a site and its region.	IV-D.2h
Buffer and Compatibility of Uses	Development shall be compatible with adjacent land and water types, as defined in the Location Policies, to the maximum extent practicable. In particular, development that is likely to adversely affect adjacent or surrounding Water's Edge Areas or Special Area is discouraged. Developments that are incompatible with adjacent developments shall provide vegetated and other types of buffers at the site boundary of sufficient width to reduce the incompatibility, to the maximum extent practicable.	IV-D.21

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCE POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
Traffic	Coastal development that induces marine and/or land traffic is conditionally acceptable provided that it does not cause unacceptable congestion and safety problems.	IV-D.2k
Flood Hazard Areas	(a) In general, coastal development is discouraged in flood hazard areas.	IV-A.2d
	(b) Certain land uses are prohibited, under State Flood Plain law and rules in the floodway portion of fluvial flood hazard areas, including uses such as placing, depositing or dumping solid wastes on the delineated floodways; processing, storing or disposal of pesticides, domestic or industrial wastes, radioactive materials, petroleum products or hazardous materials; erection of structures for occupancy by humans or livestock or kennels for boarding of domestic pets; storage of materials or equipment or construction of spectic tanks for residential or commercial use. Not affected by this policy are hazard-free activities such as recreation, agriculture, soil conservation projects and similar uses which are not likely to cause obstructions, undue pollution, or intensify flooding. According to N.J.A.C. 7:13-1.4(c), any lawful, pre-existing prohibited uses may be maintained in a delineated floodway provided, that if expanded or enlarged, they do not increase the flood damage potential. Property owners in delineated floodways may rebuild damaged structures, providing that any expansion or enlargement will not increase the flood damage potential.	

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCES POLICIES APPLICABLE TO THE PROPOSED ACTION

Resource	Policy	Reference[a]
	(c) Most land uses are also regulated, under State Flood Plain law and rules, in the flood fringe. Structures for occupancy by humans are conditionally acceptable provided that: (a) the first habitable elevation is one foot above the 100 year flood prone line established by HUD Flood Insurance Maps, and (b) the structure will not increase flood damage potential, by obstructing flood waters.	
	(d) Construction acceptable in flood hazard areas must conform with applicable flood hazard reduction standards, as adopted by the Federal Insurance Administration in HUD (Federal Register, Vol. 41, No. 207, Part II, October 26, 1976), as amended.	

Source: NJDEP, 1978
Note: a) Refers to appropriate section of text for discussion of impacts on these resources.

TABLE III-6 (Continued)

NEW JERSEY COASTAL ZONE MANAGEMENT PROGRAM
RESOURCES POLCIES APPLICABLE TO THE PROPOSED ACTION

Resource	Reference[a]
Soil Erosion and Sedimentation	IV-A.1a
Public Services	IV-D.21, IV-D.2m
Secondary Impacts	Not applicable
Solid Waste	II-E.10c, IV-D.21
Energy Conservation	Compliance with Federal, DOD and Navy Policies
Neighborhoods and Special Communities	Not applicable
High Percolation Water Soils	Not applicable
Water Soils	Not applicable
Fertile Soils	Not applicable

Note: a) Refers to appropriate section of text for discussion of impacts on these resources.

land acquisition and facility development programs, and also meets requirements for the State's continued participation in the Land and Water Conservation Fund Program.

As a policy document, SCORP recommendations attempt to set priorities by which the objectives of the Plan can be met. With respect to Raritan Bay in particular, the plan calls for continued development of the Sandy Hook Unit of Gateway National Recreation Area, along with improving mass transit access to the area. In addition, the plan calls for upgrading of major salt water marinas on Raritan Bay. The proposed action would not significantly interfere with recreation objectives for Raritan and Sandy Hook Bays.

E.2 General Management Plan for Gateway National Recreational Area

The Sandy Hook Unit of Gateway National Recreation Area is located approximately six miles to the east of the NWS Earle Waterfront Area. Development recommendations for the unit are based on a peak day usage estimate of 40,000 people. Current usage is an estimated 31,000 visitors on peak days. Visitor use at Sandy Hook is expected to increase from the present two million people annually to an estimated 3.6 million at the end of Stage 1 (1985) (U.S. Department of Interior, 1978). To accommodate the increase of approximately 10,000 persons on a peak day, the management plan envisions development of additional beaches, parking and education facilities throughout the area. A major recommendation of the plan deals with waterborne transit. Of the 40,000 peak usage, approximately 10,000 would arrive by waterborne transportation (ferry).

The proposed action does not conflict with National Park Service recommendations for the Sandy Hook Unit. If material dredged to deepen the channel can be used for beach nourishment at the Sandy Hook Unit, this would help to maintain Gateway beaches and thus enhance future planned use.

F. RELATED PROJECTS

F.1 Wastewater Reclamation Plant

The Monmouth County Planning Board is presently studying the feasibility of constructing new facilities for additional treatment of the effluent from the Monmouth County Bayshore Outfall Authority's treatment facility located in Belford, Middletown Township. Under investigation is the possible expansion of the treatment facility to include tertiary treatment of effluent to levels high enough that it could be used as a source of potable water. The location under study for this water reclamation facility is the site proposed for the fuel replenishment system. Approximately 50 acres would be required for construction of the plant. As the fuel storage tanks require only a small portion of the site, it appears that both uses can be accommodated.

F.2 Marina Expansion

In addition to the proposed development of the land acquisition site for a marina site by the Middletown Housing and Redevelopment Authority, discussed above in section C, two other marina expansion projects have been proposed in adjacent areas. The Monmouth County Parks Commission is investigating the possible acquisition of property in the Port Monmouth area north of Route 36 for water-oriented recreational facilities. At present, a small private marina is located adjacent to the area under investigation. The Commission is investigating acquisition and expansion of this marina in conjunction with development of a $3.5 million park facility. In December 1978, the Monmouth County Board of Freeholders earmarked $1.2 million for park land acquisition. The present plan requires condemmation of about 50 private homes to clear a 300-acre bayshore tract. A matching State grant would be needed to finance the plan. The Middletown Township is presently opposed to the land acquisition plan.

The Atlantic Highlands Harbor Commission has submitted an application to the NJDEP for expansion of the public marina to accommodate approximately 500 new boat slips. This would double the present capacity of the marina. NJDEP has acted favorably on this and, at the present time, a permit is pending with USACOE.

Should these two marina projects proceed, additional recreational boating facilities would be available on Raritan Bay even though marina use would be precluded on the site proposed for the ship fuel replenishment system.

F.3 Outer Continental Shelf (OCS) Exploration and Development

Outer Continental Shelf (OCS) oil and gas exploration is occurring offshore New Jersey. Recent studies by State and regional agencies have identified potential sites in the Lower New York Harbor area for onshore facilities in support of OCS development (Port Authority of NY/NJ, 1977). As indicated in Figure III-2, one possible location suitable for OCS support facilities is south of the Outerbridge Crossing in Perth Amboy. This site is on the Arthur Kill, approximately 20 miles from the sea. Water access to the site is available via a series of Federal channels maintained to at least 35 feet depth at MLW. Initial access from the sea is provided via the Sandy Hook Channel. The proposed action, to dredge Sandy Hook Channel to a depth of -45 + 2 feet at MLW, would not significantly enhance the potential for OCS-related development in Raritan Bay, since OCS supply vessels and crew boats are not larger than many commercial fishing vessels presently using the channel. Typical OCS transportation and supply base criteria require MLW depths of at least 20 feet. In addition, the proposed action should not conflict with the movement of OCS-related vessels through Sandy Hook Channel.

F.4 Liquified Natural Gas (LNG) Marine Terminal

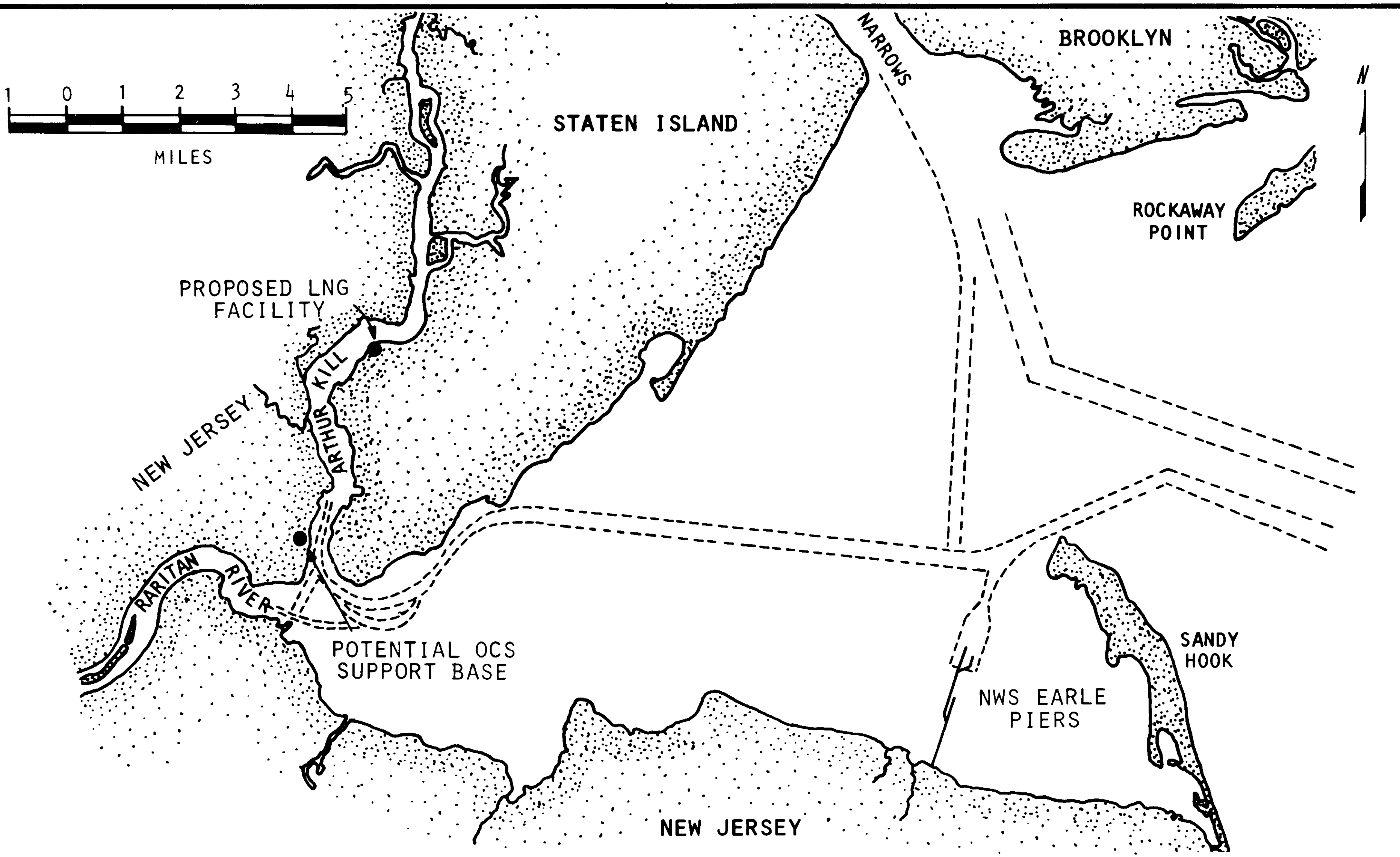
In 1973, Public Service Electric & Gas Company (PSE&G) applied to the Federal Power Commission for a certificate to operate a liquified natural gas

(LNG) facility in Rossville, Staten Island (see Figure III-2). Under the initial proposal, approximately 60 shipments of Algerian LNG per year would be transported by tanker up the Arthur Kill to the site via the Sandy Hook and Raritan East Reach Channels. Each shipment could be as large as 125,000 cubic meters of LNG. The passage of an LNG tanker through these channels might require the halting of all traffic in Raritan Bay while the Coast Guard escorts the ship to the terminal. This procedure is presently operative in Boston Harbor, to avoid possible collisions and groundings of the LNG tanker.

The principal hazard of LNG transport is the risk of a spill. In the event of a spill, LNG could vaporize, ignite and explode. A substantial difference of opinion exists as to the distance an LNG vapor cloud could travel and still ignite. A study by the U.S. Office of Technology Assessment (1977) indicates that an LNG spill could ignite one to 25 miles away from the release point. The NWS Earle piers are approximately 12 miles from the PSE&G facility and at least 7,000 feet from channels which the LNG tankers would use in passing through Raritan Bay. Juxtaposing the LNG tanker route in close proximity to NWS Earle ammunition piers and ships would increase the risk of a catastrophic accident.

At the present time, the option of utilizing the facility for LNG importation is not being actively considered. After the initial application for LNG importation was submitted, approval delays and contract problem with the Algerians resulted in the tabling of import plans. In March 1979, PSE&G filed an application with the Federal Energy Regulatory Commission to use one of the two tanks at the Staten Island Facility for domestic storage of natural gas, which would be supplied by pipeline. The facility would be used for LNG storage during the summer and would supply customers during heavy demand winter periods.

In addition, recent proposesd federal legislation (U.S. Department of Transportation, 8 February 1979 Federal Register Vol. 44, No. 28 and a proposed amendment to the Fuel Transportation Safety Amendment Act of 1979 (HR-51), filed May 10, 1979) would, if enacted, introduce new safety standards and siting



LOCATION OF POTENTIAL OCS SUPPORT BASE AND PROPOSED LNG TERMINAL

FIGURE III-2

criteria which could also affect the proposed LNG facility.

F.5 Hydrofoil Passenger Ship Ferry Services

The feasibility of utilizing hydrofoil passenger ships for a commuter ferry service between the Battery, New York City and the Monmouth County Bayshore at the Highlands is presently being studies by the New York City Department of Marine Transportation and Aviation. Also under consideration is the possibility of using the ships for ferrying people from Staten Island to Gateways National Park - Sandy Hook Unit. Considering the location of likely landing areas and routes, the proposed action would not effect this service should it become a reality.

G. GOVERNMENT AGENCIES AND REGULATIONS

Numerous Federal, State and local laws and regulations may be applicable to the proposed action. These are summarized in Table III-7.

TABLE III-7

SUMMARY OF FEDERAL, STATE, LOCAL STATUTES, REGULATIONS, AND POLICIES INFLUENCING NWS EARLE, COLTS NECK, NEW JERSEY

Regulatory Level and Agency	Statute, Regulation or Policy	Environmental Concern	Regulatory Effect	Commentary
INTERNATIONAL				
All Federal Agencies	1958 Convention on the Territorial Sea and the Territorial Sea and the Contiguous Zone (15 U.S.T. 1606; T.I.A.S. 5639)	None	Establishes limits of Territorial Sea and Contiguous Zone	Regulations on dumping in navigable and ocean waters are based on limits defined in the Convention
All Federal Agencies	1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	Protection of the Marine Environment	Requires signatory nations to establish permit procedures to regulate dumping in the sea. Provides criteria for evaluation of permit requests	EPA Ocean Dumping Regulations (40 CFR 220-227) were enacted in response to this Convention, and the requirements of Title I of the Marine Protection Research and Sanctuaries Act (P.L. 92-532).
FEDERAL				
U.S. Army Corps of Engineers	Marine Protection, Research and Sanctuaries Act (86 Statute 1052; 33 USC 1413): Section 103	Protection of Ocean Waters	Army may issue permits to transport dredged material in order to dump it in ocean waters	EPA may prohibit issuance of the permit if dumping of the material will result in an unacceptable adverse impact to municipal water supplies, shellfish and fishery areas, wildlife or recreation areas.
U.S. Army Corps of Engineers	Rivers and Harbors Act of 1899 (30 Statute 1151; 33 USC 401) Section 10	Protection of Navigable Waters	Construction, excavation or deposition of materials, or any other work affecting navigable waters requires Army authorization.	Section 10 affects the proposed action.
	Section 13	Protection of Navigable Waters	Section 13 authorized the Army to issue permits for dumping refuse in navigable waters. See Comentary.	Not applicable. The Army permit authority has been superceded by EPA authority under Sections 402 and 405 of Federal Water Pollution Control Act (86 Statute 816; 33 USC 1342 and 1345).
U.S. Army Corps of Engineers/ Environmental Protection Agency	Federal Water Pollution Control Act Amendments of 1972 and 1977 (P.L. 92-500) Section 404	Spoil disposal in navigable waters	Army may issue permits for discharge of dredged or fill material into navigable waters at specified disposal sites. Disposal sites will be selected in accordance with guidelines established by EPA in conjunction with the Army	EPA may prohibit use of a disposal site if use would cause unacceptable adverse impact to municipal water supplies, shellfishery areas, wildlife or recreation areas.

TABLE III-7 (Continued)

SUMMARY OF FEDERAL, STATE, LOCAL STATUTES, REGULATIONS, AND POLICIES INFLUENCING NWS EARLE, COLTS NECK, NEW JERSEY

Regulatory Level and Agency	Statute, Regulation or Policy	Environmental Concern	Regulatory Effect	Commentary
U.S. Fish and Wildlife Services or National Marine Fisheries Service, as appropriate	Fish and Wildlife Coordination Act (16 USC 661-66c)	Protection of surface waters and fish and wildlife habitat	Any Federal agency wishing to control or modify a wetland or body of water must consult with USF & WS or NMFS, as appropriate, and with state wildlife agencies	Purpose of consultation is to to identify potential impacts to wildlife and explore measures to minimize harm.
U.S. Department of Interior	Endangered Species Act (16 USC 668aa to 668cc-6)	Protection of endangered wildlife species or those threatened by extinction	Protects species officially listed as endangered by Department of Interior	No officially listed species are felt to be threatened by the project.
U.S. Advisory Council on Historic Preservation	National Historic Preservation Act of 1966 (80 Statute 915; 16 USC 470)	Protection of properties listed in National Register of Historic Places	Council reviews and comments on activities licensed by Federal government which will affect National Register properties	No officially listed historic places and landmarks would be affected by the project.
All Federal Agencies	Water Resources Planning Act (42 USC 1962 et seq.)	Coordination of Federal activities with state and local water resource	Federal permits of activities which will affect river basin plans must be coordinated with the appropriate river basin commission	No conflicts were found between the proposed action and water resource planning activities
All Federal Agencies	Coastal Zone Management Act (86 Statute 1280)	Protection of coastal resources	Compliance with State Coastal Zone Management Program (Bay and Ocean Segment)	Federal activities are required to be consistent with adopted CZM program to the maximum extent feasible
U.S. Department of Transportation: U.S. Coast Guard	Oil Pollution Act Amendments of 1973 (33 USC 1001-1015)	Protection of marine environment	Regulates discharge of oil by shipping within a 50 mile zone from nearest land	Although this law provides for the exemption of naval vessels, the U.S. Navy's policy is consistent, where feasible, with the requirements of the Maritime Community
U.S. Environmental Protection Agency	Clean Air Act Amendment of 1970 (42 USC 1957-1857f (1973) 40 CFS 50 FF); Amendments of 1977	Protection of Air Quality	Compliance with State comprehensive implementation plans	Federal activities must comply with state regulations
All Federal Agencies	National Environmental Policy Act of 1969 (NEPA) (42 USC 4321-4347 (1973); 40 CFR 30.100 Parts 50-122)	Environmental Protection	Any Federal Agency taking an action having significant environment impact is required to provide the assessment of that impact	Environmental impacts of proposed actions discussed in Chapter IV
All Federal Agencies	Executive Order 11988	Flood Plain Management	Requires agencies to avoid adverse impacts associated with the occupation and modification of floodplains and to avoid support of floodplain development whenever there is a practical alternative	Guidelines for agencies to amend and issue regulations and procedures in compliance with this order have been developed by the Water Resources Council

TABLE III-7 (Continued)

SUMMARY OF FEDERAL, STATE, LOCAL STATUTES, REGULATIONS, AND POLICIES INFLUENCING NWS EARLE, COLTS NECK, NEW JERSEY

Regulatory Level and Agency	Statute, Regulation or Policy	Environmental Concern	Regulatory Effect	Commentary
All Federal Agencies	Executive Order 11990	Protection of Wetlands	Requires agencies to avoid adverse impacts associated with the destruction or modification of wetlands and to avoid support of new construction in wetlands whenever there is a practical alternative	Relationship of proposed action to wetlands is discussed in Chapter IV
STATE				
Office of Management and Budget; Tri-State Regional Planning Commission; New Jersey Department of Community Development	OMB circular A-95 (Evaluation Review and Coordination of Federal and Federally Assisted Program and Projects); Executive Orders 11647 and 11892	Coordination with state and local environmental and planning agencies	Requires the coordination of federal and federally funded programs and projects with local programs and plans through review by state and area wide clearing houses	Requires that federal agency engaged in direct development of federal projects must consult with state and local governments that might be affected by those projects. Non-conformity with state, regional or local plans will require a justification for any departure by the federal agency
U.S. Department of Health, Education and Welfare	Educational Agencies Financial Aid Act of 1950 (P.L. 81874)	Finanacial Assistance to Federally impacted areas	Federal Impact Aid is provided to school districts where military dependents are enrolled	School districts would be eligible for assistance under the proposed action
New Jersey Department of Environmental Protection (NJDEP)	Wetlands Act of 1970	Protection of tidal wetlands	Requires permit for development activity in wetland areas	Incorporated into the State's Coastal Management Program. Consistency regulations of the CZM Act apply to federal activities
	Riparian Laws	Protection of "Tide-flowed lands."	Requires a lease, license and/or construction permit to develop state-owned Riparian lands	Permits for use of riparian lands based on a determination of public interest
	Coastal Area Facility Review of 1973	Coastal management and protection	Plan not yet complete; interim guidelines in effect	Consistency regulations of the CZM Act apply to Federal acitivities
	N.J. Flood Plain Law as amended in 1972	Compliance with federal flood insurance program requirements	Requires affected municipalities to adopt regulations concerning development and use of land in designated floodways	Federal activities will be consistent with local regulations where they apply
	Beaches and Harbors Bond Act of 1977 (P.L. 1977, C.208)	Shore protection and beach nourishment	Regulates use of dredge spoil for beach nourishment	Requires that beach disposal of dredge spoil be consistent with States' Shore Protection Master Plan which is now being drafted.

TABLE III-7 (Continued)

SUMMARY OF FEDERAL, STATE, LOCAL STATUTES REGULATIONS, AND POLICIES INFLUENCING NWS EARLE, COLTS NECK, NEW JERSEY

Regulatory Level and Agency	Statute, Regulation or Policy	Environmental Concern	Regulatory Effect	Commentary
New Jersey Department of Agriculture	Soil Erosion and Sediment Control Act of 1975	Soil conservation and erosion control and prevention	State Soil Conservation Committee (SSCC) sets standards for control of soil erosion and sediment control	Soil erosion and sediment control plan will be developed in conformance with SSCC provisions
MUNICIPALITIES				
All Municipalities	Municipal Land Use Law of 1975	Land management and zoning	Requires that land use controls, programs and plans be consistent with zoning and sub-division ordinance	Relationship to local land use policies, plans and programs is discussed in Chapter III
	Article 10	Joint exercise of powers of planning and land use control	Permits municipalities to enter into a join agreement with the county providing for joint adminsitration of the powers conferred under this act	Monmouth County Planning Board provides technical assistance to local municipalities regarding land use controls. Its main function is advisory

CHAPTER IV

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IV. PROBABLE IMPACTS OF THE PROPOSED ACTION ON THE ENVIRONMENT

The discussion of environmental impacts as presented in this chapter, parallels the subdivisions as presented in Chapter II, Description of the Existing Environment. Impacts on the terrestrial, estuarine, ocean-disposal site and man-made environments are treated separately in Sections A, B, C, and D, respectively.

A. IMPACTS ON THE TERRESTRIAL ENVIRONMENT

A.1 Short-Term Impacts

Short-term impacts would result from the construction of the various components of the proposed action. Major short-term impacts are described below:

a. Soil Erosion and Sedimentation

The implementation of the proposed project would require construction on approximately 313 acres of land. Approximately 280 acres would be used by the three components of the in-transit holding facilities; 25 acres for the fuel replenishment system, and approximately 8 acres for the various smaller projects located in the Waterfront Area and the Main Station. Construction of the in-transit holding facilities would require clearing woodland.

Once vegetation has been cleared or the ground is disturbed, exposed soils would be subject to the erosive forces of wind, water and the mechanical action of men and machines on site. Soil movement is generally maximized by factors which enhance the processes of erosion and overland flow. Major factors include soil erodibility, high rainfall energies and intensities, steep and long slopes, sparse vegetal cover and poor land treatment (Wishmeier, 1960 and 1971).

The effects of soil erosion on aquatic and terrestrial ecosystems include the following:

- Deposition of sediments in downstream watercourses can increase water turbidity; thereby reducing the photosynthetic activity of aquatic plants. Sediments can also settle on the bottoms of streams and ponds, smothering or destroying benthic biota.

- Deposition of sediments in storm sewers, culverts or drains will clog them or reduce their capacities. This, in turn, can result in flooding of downstream lands.

- Eroded sediments can be deposited in sources of public water supply.

- Eroded sediments transport, store and act as catalytic agents for pollutants such as pesticides, phosphorous, nitrogen and organic compounds, pathogenic bacteria and viruses.

- Fugitive dust can settle on adjacent vegetation, watercourses and human habitation causing decreased productivity and annoyance.

As discussed in Chapter II, areas on the Main Station where erosion has been a problem, are characterized by steep slopes on sandy soils where water infiltrates rapidly and seeps from hillsides and cuts (see Figure II.B-5). The areas to be cleared for the construction of facilities on the Main Station are not characterized by such steep slopes. This, in conjunction with the mitigating measures suggested in Chapter VI, should reduce the threat of major soil erosion or sedimentation.

Each of the proposed construction areas on the Main Station is characterized by the presence of acid-soils (pH 3.5 to 5). Revegetation on such soils can be slow. Construction in the areas of the distinct acid clay horizon is expected to result in increased acid runoff. This would result in lowered pH values in adjacent streams and affect aquatic fauna since a number of species, including trout, are not tolerant of acid waters. In addition, acid streams are usually deficient in nutrients. Only construction activities in the area of the proposed in-transit rail holding yard and proposed magazine areas would expose the acid horizon. Exposure of this layer is expected to result in lowered pH values in the headwater portions of Branch Mingamahone Brook and the tributaries of the Shark River. However, pH values are expected to return to normal levels within short distances downstream.

b. Salt Marsh Vegetation

Since the proposed pipeline connecting the fuel storage facilities with the pier would be elevated, adverse effects along the pipeline route would be limited to the short-term impacts of men and machines entering the marsh during construction. Even though skids can be used to distribute the weight of heavy machinery over a large area, some marsh vegetation and invertebrates would likely be destroyed for at least one season.

The depression in the marsh surface that results from the movement of construction machines and workers can have two effects, depending on the depth of the depression and the particular drainage and hydrologic characteristics of the area. If the depression allows more frequent tidal flooding and adequate drainage exists, increased productivity of smooth cord grass can be expected. If, however, drainage is inadequate, vegetation could be killed.

Additionally, should erosional materials and sediments enter the marsh from upland construction areas, the elevation of the marsh could increase, allowing common reed to displace more productive salt marsh vegetation.

c. Noise

In general, the noise impact of the construction of a proposed facility is evaluated by using baseline sound level data (Chapter II, B.10) and estimated ambient sound levels during construction. The impact assessment is then based on Federal guidelines and regulations and changes in ambient sound levels. The U.S. Environmental Protection Agency has promulgated guidelines suggesting that an annual ambient day/night average sound level below 55 decibels will not degrade public health or welfare.

At this early stage of conceptual planning no construction schedule or methodology is known. Therefore, construction is assumed to be similar to that for average industrial and non-residential facilities (USEPA, 1977). Appendix E-2 describes in detail the methodology for estimating construction noise impact.

The proposed project would require construction at several different areas. Noise will stem from construction of the proposed facilities. Since each of the projects would be constructed separately, the impacts of each on ambient noise levels will also be discussed separately.

1. Sandy Hook Bay - Construction of the pier and trestle would require the use of large pile drivers. The typical pile driver used for this type of construction has an impact energy of 60,000 to 100,000 ft. lb. per blow. The peak sound level is estimated to be 83 dB at 150 meters (New York City, 1973). The average sound level, L_{eq}, for this equipment operating 30 percent of the time is 73 dB at 150 meters. This equipment would be in operation at locations along the length of the proposed pier.

Table IV-1 presents ambient sound levels at noise sensitive locations during pile-driving operations. This table shows that ambient sound levels at the waterfront communities are expected to increase during this period. The town of Leonardo (Location 2) (See Figure II.B-19) would be subjected to a maximum increase of daytime average sound level, L_d, of 17 dB when pile-driving is near the waterfront. The daytime average sound levels at Locations 3 and 4 are expected to increase by 9 and 4 dB, respectively during the same period. These sound levels are expected to diminish and become almost negligible as pile-driving operations move further out on the trestle.

TABLE IV-1

AMBIENT SOUND LEVELS DURING PIER & TRESTLE CONSTRUCTION (Decibels)
(Pile-Driving Operations)

	Background Ambient Sound Level			Construction Ambient Sound Level			Change In Ambient Sound Level		
Location[a]	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
1	55.1	54.7	61.2	55	55	61	0	0	0
2	48.6	46.5	53.3	51-61	47	54-64	2-17	0	1-11
3	49.9	38.2	49.5	52-59	38	51-57	2-9	0	1-7
4	53.0	42.5	52.8	54-57	43	54-56	1-4	0	1-3
5	53.9	43.5	53.7	54	44	54	0	0	0
6	54.1	48.8	56.5	54	49	57	0	0	0

Notes:

[a]See Table II.B-22 for description of locations.

L_d = Daytime Average

L_n = Nighttime Average

L_{dn} = Daynight Average

In addition to the construction of a new pier and trestle, the new pier would have an oil spill containment facility, utilities (cold iron), and waste collection and fire protection systems. It is estimated that the noisiest equipment would be used during the excavation phase of construction. Table IV-2 lists the equipment expected to be used during this phase, its usage factors, and its sound levels.

As Table IV-2 shows, the average sound level, L_{eq}, during this period is estimated to be 86.9 dB at 15 meters from the center of construction activities. Since most of the construction at the pier would be conducted at distances in excess of 2000 meters from the shore, the average sound level contributed by the construction activities is estimated to be 41 dB at the shore location closest to the construction sites. This noise level contribution is at least 7 dB lower than any measured average daytime ambient sound level. Therefore, ambient sound levels at the shore communities would not be affected by the construction at the pier.

2. Waterfront Area - Table IV-3 is a list of equipment that would be utilized during the construction of projects in the Waterfront Area. This table also lists expected sound levels and usage factors. Location 2, in Leonardo, (Figure II.B-19) would experience a 15 dB increase during construction. At other locations there would be either no increase or one which would be barely noticeable. The increase in ambient sound levels at Leonardo might cause annoyance and speech interference for outdoor activities. However, since the construction period would be short and activities conducted during the daytime, the impact would be minimal.

3. Proposed Site of Ship Fuel Replenishment System - The fuel replenishment system includes fuel storage tanks and a pipeline system connected to the pier. Table IV-4 lists the construction equipment anticipated, its sound levels, and its usage factors. Table IV-5 compares ambient sound levels with expected construction sound levels.

TABLE IV-2

CONSTRUCTION EQUIPMENT, USAGE FACTORS AND SOUND LEVELS FOR THE EXCAVATION PHASE OF CONSTRUCTION (Pier and Trestle)

Equipment	Sound Level @ 15 m (50 ft) -dBA[a]	Number of Units	Usage Factor[b]
Air Compressor	67	1	.98
Concrete Mixer (Truck Mounted)	78	1	.50
Concrete Mixer (Non Truck Mounted)	85	1	.50
Mobile Crane	83	1	.50
Generator	78	1	1.00
Pneumatic Tool	85	1	.10
Pump	76	1	1.00
Saw	78	1	.04
Truck	78	2	.50
L_{eq} (total) @ 15 m	86.9 dB		

[a] USEPA, 1977.
[b] Usage Factors represent the time equipment is operating at its noisiest mode.

Source: CERL, 1977.

TABLE IV-3

CONSTRUCTION EQUIPMENT, USAGE FACTORS AND SOUND LEVELS FOR THE EXCAVATION PHASE OF CONSTRUCTION (Waterfront Support Facilities)

Equipment	Sound Level @ 15 m (50 ft) -dBA[a]	Number of Units	Usage Factor[b]
Crawler Tractor 29-199 hp	72	1	.50
Crawler Tractor 200-450 hp	78	1	.40
Excavator	82	1	.70
Generator	78	1	1.00
Backhoe Loader	77	1	.60
Pump	76	1	1.00
Truck	78	2	.50
L_{eq} (total) @ 15 m	85.3 dB		

[a] USEPA, 1977.

[b] Usage Factors represent the time equipment is operating at its noisiest mode.

Source: CERL, 1977.

TABLE IV-4

INDUSTRIAL-TYPE CONSTRUCTION EQUIPMENT, USAGE FACTORS AND SOUND LEVELS FOR THE EXCAVATION/SITE PREPARATION PHASE
(Ship Fuel Replenishment System)

Equipment	Sound Level @ 15 m (50 ft) -dBA[a]	Number of Units	Usage Factor[b]
Air Compressor	67	1	.98
Crawler Tractor 29-199 hp	72	1	.50
Crawler Tractor 200-450 hp	78	1	.40
Excavation	82	2	.70
Generator	78	1	1.00
Backhoe/Loader	77	1	.60
Pavement Breaker	85	2	.20
Pump	76	1	.50
Trencher	83	2	.70
Truck	78	2	.50
L_{eq} (total) @ 15 m	89.4 dB		

[a] USEPA, 1977.
[b] Usage Factors represent the time equipment is operating at its noisiest mode.

Source: CERL, 1977.

TABLE IV-5

AMBIENT SOUND LEVELS DURING CONSTRUCTION OF SHIP FUEL REPLENISHMENT SYSTEM

Location	Background Ambient Sound Level L_d	L_n	L_{dn}	Construction Ambient Sound Level L_d	L_n	L_{dn}	Change In Ambient Sound Level L_d	L_n	L_{dn}
1	55.1	54.7	61.2	55	55	61	0	0	0
2	48.6	46.5	53.3	53	47	55	4	0	2
3	49.9	38.2	49.3	57	38	55	7	0	6
4	53.0	42.5	52.8	54	43	54	1	0	1
5	53.9	43.5	53.7	54	44	54	0	0	0
6	54.1	48.8	56.5	54	49	57	0	0	0

As Table IV-5 indicates, ambient sound levels in the neighboring community would experience an increase ranging from 4 to 7 dB. This increase may cause some annoyance but this is expected to be minimal.

4. New Dredging - Maintenance dredging activities are currently conducted annually in the Sandy Hook Channel for a period of about 1 to 2 months. Noise levels from this operation have been estimated to be about 76 dB at 60 meters (USACOE, 1976b).

The proposed dredging operation, which is described in detail in Chapter I, would extend from the Sandy Hook Channel to the new pier. This activity would probably be conducted continuously, 24 hours a day, for a period of about a year. During this period, the dredging operation would move to within 4000 meters (2.5 miles) of any noise sensitive land uses. Areas which are likely to experience an increase in ambient average sound levels are communities along the waterfront (Table IV-6). These communities, as represented by measurement Locations 2 and 3, would be subjected to a maximum increase of 4 dB increase in nighttime average sound levels, while the dredging operation is closest to the shore. This increase is barely noticeable and would only occur for a short time. Average sound levels at other noise sensitive land uses would not be affected. The impact is therefore considered to be minimal.

5. Main Station - The proposed construction projects on the Main Station would require use of construction equipment similar to that shown in Table IV-3, having an L_{eq} of 85 dB at 15 meters. No impacts are anticipated as a result of construction activities in this area. Population concentrations are far removed from this area and the sites are surrounded by foliage.

d. Air Quality

The potential to degrade air quality during the construction of any facility exists primarily from fugitive dust caused by windblown disturbed earth

TABLE IV-6

AMBIENT AVERAGE SOUND LEVELS DURING PERIODS WHEN DREDGING OPERATION IS CLOSEST TO SHORE

Location	Background Ambient Sound Level - dB			Ambient Sound Level During Dredging			Change In Ambient		
	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}	L_d	L_n	L_{dn}
1	55.1	54.7	61.2	55.1	54.7	61.2	0	0	0
2	48.6	46.5	53.3	49.4	47.4	54.2	1	1	1
3	49.9	38.2	49.3	50.3	42.2	51.1	0	4	2
4	53.0	42.5	52.8	53.1	43.6	53.3	0	1	1
5	53.9	43.5	53.7	53.9	43.5	53.7	0	0	0
6	54.1	48.8	56.5	54.1	48.8	56.5	0	0	0

and emissions from construction vehicles. For the planned actions, however, the impact of such emissions are expected to be minor and confined to the immediate vicinity of the specific activity.

During construction, fugitive dust emissions can vary substantially from day to day depending on the level of effort, the specific operation performed, and the prevailing weather. In addition, the amount of suspended particulate matter introduced into the ambient air depends on the texture and moisture content of the surface soil. Since the silt content of the soil at the site of the proposed ship fuel replenishment system is very low (0-5 percent) and its moisture content very high, the amount of fugitive dust discharged into the ambient air is expected to be minor. The effects of fugitive dust during construction would be minimal, temporary, and very localized, e.q. most particles would settle out within 20-30 feet of the construction site (USEPA, 1975).

With regard to emissions from construction vehicles, the small number of diesel-powered vehicles utilized would not constitute a level of activity capable of generating enough pollutants to alter ambient air quality.

A.2 Long-Term Impacts

a. Removal of Vegetation

The total loss of vegetation resulting from the various projects would be approximately 313 acres. Table IV-7 shows the approximate loss from each project and the type of vegetation involved.

As described in Chapter II, most of the projects are situated in areas currently developed or which have experienced disturbance to the natural vegetation.

TABLE IV-7

EXPECTED VEGETATION REMOVAL REQUIRED BY THE PROPOSED ACTION

Project	Type of Vegtation Involved	Amount Of Vegetation Removal
AOE Related		
Naval Exchange Building	Grass	Approximately 8 acres total
Secured Parking Facility	Grass & Old Field	
Magazines	Woodlands (included within the rail holding yards)	
Fuel Replenishment System	Old Field	25 acres
VSS Related		
In-transit Holding Yards	Woodlands	280 acres

Biological systems are valuable because they control erosion, purify wastes, conserve nutrients, mediate fluctuations in runoff, temperature, wind, and humidity, and provide oxygen, food and wood products (Odum, 1971). Also, habitats for wildlife are provided by vegetation. The degree to which these functions are provided are dependent on the maturity and diversity of a system. Old field communities are young and easily replaced and provide these functions to a lesser degree than woodlands or forests. Mowed grass is low in diversity and highly stressed, and is the least valuable of the three habitats.

The woodlands affected by the in-transit holding facilities and magazines contain large portions of mature forest on moist wetland soils. Such associations provide rich habitat for wildlife species. Areas where rail lines and roads are placed will be permanently lost to biological use. Right-of-ways would be revegetated, but would be maintained in early successional stages, such as grass or old field habitats. Except for the construction of six magazines, areas between right-of-ways would either be left undisturbed or allowed to proceed undisturbed toward new forest. It is preferable to leave these areas undisturbed, to allow wildlife to reinhabit the area after construction. Changes in species composition of both plants and wildlife can be expected. Fewer animal species would remain which require large tracts of woodlands. They will be replaced by those favoring edge habitat.

No significant impacts to wildlife habitat would be associated with construction on old fields located at the site of the ship replenishment system. Perimeter fencing of the 25 acre site would cause a restriction of movement. This is not considered significant. The remainder of the acquisition area will be open to movement of wildlife.

b. Oil Spills on Vegetative Communities

Oil spills could originate from tankers bringing fuel to the storage tanks, the pipelines, the truck unloading area or the fuel storage tanks. It has been shown (NAVFAC, 1972) that the main cause in the majority of spills is human error, such as valve misalignment, monitoring error, structural or design failure, and tank overflow. Spills from any of these sources could reach the salt marshes of the Waterfront Area. The risk analysis associated with storage and transfer operations is discussed in Section B.4 of this chapter. The effects of oil spills on aquatic and oceanographic regimes is described in Section B.5.

Salt marsh vegetation acts as an adsorbant, confining the oil to the edges of the marsh. While this may prevent the oil from spreading into adjacent waterways, the edges of the marsh are generally the most productive and biologically significant. Oil adheres to the stems of the growing plants, causing the above-ground portion to die. If the oiling is light to moderate, from a single dose, the plants can generally resprout from the roots and rhizomes (USBLM, 1977). Multiple doses, however, cause considerably more damage. Depth of sediment contamination also appears to be a factor in revegetation. Slower revegetation occurs in areas of deeper oil penetration (USBLM, 1977).

Fauna of the salt marshes are also affected by oil spills. Benthic animals which showed declines after experimental spills in York River, Virginia marshes included hereid polychaetes, insect larvae and amphipods. Mortalities of fish, Fundulus heteroclitus, held live, in boxes, occurred in areas contaminated by artifically weathered crude oil (Bender, et al., 1977). Fiddler crab populations were severely affected by a 1969 oil spill in Falmouth, Massachusetts and are still showing adverse effects (Krebs and Burns, 1977).

In addition to the salt marsh area, the many waterfowl that winter in Raritan Bay would be highly susceptible to the affects of oil spills. Those birds that use intertidal habitat would suffer a loss of feeding habitat.

c. Surface Water Runoff

Development of an area can result in covering all or portions of that area with impervious structures, such as roads, sidewalks, parking lots and buildings, and changing the nature of land cover, i.e. from woodlands to grass land. Natural stream channels may be supplemented by artificial drainage systems such as gutters and storm sewers. As a result of these changes, the area's absorption of precipitation would be altered. The most common effects of changing the porous nature of the land are a reduction in water infiltration, and an increase in the volume and rate of surface water runoff. The degree of these effects depends on soil type, vegetational cover, degree of imperviousness and drainage used during operation of the project.

Using techniques recommended by the United States Department of Agriculture, Soil Conservation Service (USDA-SCS, 1975) the runoff from the areas of each project was calculated for both existing conditions and conditions as they would exist after the project was completed. These calculations estimated runoff for return periods of 2, 5, 25 and 100 years with a rainfall duration of 24 hours (Table IV-8).

Owing to the relatively small area of many of the projects and the fact that some projects are located in an undeveloped area with relatively permeable soils, the increase in runoff would be minimal and within the limits of existing systems. The single exception to this is the proposed daily parking area to be located on the north side of Route 36. This project would convert approximately 1.29 acres of grass and dirt into impervious surface. The flow generated from this parking lot is estimated at 6.6 cfs and 14.4 cfs for return periods two years and 100 years, respectively. Existing storm sewers in this area (Figure II.B-9) do not have the capacity to handle this additional flow. Therefore, either the capacity of the existing system must be increased or a new storm sewer would be required.

TABLE IV-8

COMPARISONS OF PRE- AND POST-CONSTRUCTION RUNOFF FOR CONSTRUCTION PROJECTS

Project Type	PROJECT DESCRIPTION	Area	Return Period (yrs)	PRE-CONSTRUCTION Natural Drainage	PRE-CONSTRUCTION Runoff (in)	PRE-CONSTRUCTION Discharge (cubic ft/sec)	POST-CONSTRUCTION Runoff (in)	POST-CONSTRUCTION Discharge (cfs)	Comments(1)
AOE	Naval Exchange - New Building (east of junction of Hwy. 34 and Esperance Rd.(MS)	16,000 sq. ft. (0.37 acres)	2 5 25 100	Excessive	0.15 0.47 0.7 1.75	0.08 0.24 0.35 0.88 (0.5 cfs/in of runoff)	0.25 0.65 1.4 2.2	0.14 0.09 0.76 1.19 (0.54 cfs/in of runoff)	<u>Runoff & Discharge Totals assume:</u> : 75% in lawn drainage : 25% is paved sidewalk : Roads with curbs and storm sewers.
AOE	6 Magazines to be built, Mag. SP&P (reinforced concrete earth cover) Area/SP&P mag = 19,600 sq/ft (assume each magazine introduces approx. 60 sq. ft. paved road since existing roads along the magazines are already paved) (MS)	Total for 6 magazines Approx. 2.7 acres, i.e. 1% of total area is paved roads	2 5 10 25	60% Poor 40% Excessive	0.16 0.5 1.1 1.85	0.34 1.05 2.31 3.89 2.1 cfs/in of runoff)	0.2 0.55 1.2 2.0	0.44 1.21 2.64 4.40 (2.2 cfs/in of runoff)	<u>Runoff & Discharge Totals Assume:</u> : Roads at magazine area have storm drains : The rest of the magazine area is grass with small vegetation
AOE	: Daily parking lot (100 car addition: north of Hwy. 36 behind Bldgs. R 11 & R 12) (WF)	1.29 acres	2 5 25 100	Excessive in most places Approx. 40% woods Approx. 60% earth	0.5 1.1 2.1 3.1	0.2 0.4 0.84 1.24 (0.4 cfs/in of runoff)	3.3 4.3 5.8 7.2	6.6 8.6 11.6 14.4 (2 cfs/in of runoff)	All parking lots are paved.
	: Secured Parking Lot (200 car addition between Hwy 36 & Leonardville Rd.)(WF). From scale (2), measure area required by 100 car lot = 56,000 sq. ft; 200 car lot = 112,000 sq. ft.	2.57 acres	2 5 25 100	Well drained Approx. 25% dirt Approx. 75% grass	1.2 2 3.25 4.4	3.48 5.80 9.43 12.76 (2.9 cfs/in of runoff)	3.3 4.3 5.8 7.2	11.88 15.48 20.88 25.92 (3.6 cfs/in of runoff)	

TABLE IV-8 (Continued)

COMPARISONS OF PRE- AND POST-CONSTRUCTION RUNOFF FOR CONSTRUCTION PROJECTS

Project Type	PROJECT DESCRIPTION	Area	Return Period (yrs)	PRE-CONSTRUCTION Natural Drainage	PRE-CONSTRUCTION Runoff (in)	PRE-CONSTRUCTION Discharge (cubic ft/sec)	POST-CONSTRUCTION Runoff (in)	POST-CONSTRUCTION Discharge (cfs)	Comments(1)
AOE	Warehouse - Bld. C-21 (MS)	8,000 sq. ft. (0.18 acres)	2 5 25 100	Poor	0.7 1.3 2.3 3.35	0.06 0.10 0.18 0.27 (0.08 cfs/in of runoff)	1.82 2.70 4.10 5.40	0.54 0.78 1.19 1.57 (0.29 cfs/in of runoff)	Runoff & Discharge Totals assume: : Roof leaders are used on the bldg. and are running into ground : Culverts and ditches assumed : Existing (preconstruction) area is 90% grass and shrubs and 10% trees
AOE	Bowling Alley (150' x 50') = 7,500 sq. ft. (WF)	0.17 acres	2 5 25 100	Excessive (open space)	0.15 0.42 1.06 1.80	0.04 0.12 0.31 0.52 (0.29 cfs/in of runoff)	0.25 0.60 1.40 2.20	0.08 0.19 0.43 0.68 (0.31 cfs/in of runoff)	Same as Naval Exchange Building
AOE	Fuel Storage Facility - Ship Fuel Replenishment System - Source: POL requirements for home porting AOEs, DPT of Navy (WF)	25 acres	2 5 25 100	65% Excessively drained in most places almost constantly saturated. 35% variable depends on fill material (assuming drainage is medium)	1.2 2.05 3.2 4.4	16.2 27.06 43.02 58.08 (13.5 cfs/in of runoff	3.3 4.3 5.8 7.2	59.2 78.13 109.4 142.4 (23 cfs/in of runoff with drainage adjustment of .81 x discharge at 22 cfs for swamp in area.)	Runoff & Discharge Totals Assume: : 50% of original land was filled (10% paved) 15% Tidal Marsh 35% Sanitary landfill Avg. Slope = 0-2% : Final area will be 100% paved.
VSS	In-transit Rail Holding Yard (Inert Storage) near Hockhockson Swamp (MS)	Area including that between rails 65.67 acres	2 5 25 100	Very Poor	0.7 1.3 2.3 3.3	24.5 45.5 80.5 115.50 (35 cfs/in of runoff)	Runoff would be same as pre-construction because only the rails would be added		Runoff & Discharge Totals Assume: : 60% of existing land is tree covered : Existing slope 2-5%

The development of the ship fuel replenishment system would cause approximately 25 acres of existing land to become 98 percent impervious. Future runoff from this area would be 59 cfs and 142.4 cfs for return periods of two and 100 years, respectively. Drainage patterns in this area are through the marsh area towards Ware Creek and Sandy Hook Bay. No adverse impacts from the additional runoff are anticipated.

d. Flooding

Flooding impacts are discussed in this section with respect to the Water Resources Council Guidelines For Implementing Executive Order 11988 on Floodplain Management (FR 43: 6030). Procedures provided in these guidelines are followed in the evaluation of the proposed and alternative sites for the fuel replenishment facilities.

The objective of Executive Order 11988 is to avoid the long- and short-term adverse impacts associated with the occupation and modification of floodplains. The guidelines define the base floodplain to be the 100-year floodplain, and the critical action floodplain to be the 500-year floodplain.

Actions which would create an added dimension to flooding disasters are generally considered by the guidelines to be critical actions requiring use of the more conservative 500-year floodplain definition. Examples of such actions as provided by the guidelines are given as, liquefied natural gas terminals and facilities producing and storing highly volatile, toxic or water-reactive materials.

The proposed replenishment facilities would transfer and store marine diesel and JP-5 turbine fuels. Both these fuels have a low volatility and a moderate flash point. Leakage from the storage tanks or pipelines during flood events would not represent a significant explosive hazard. Any such leakage would not add a major new dimension to a flooding disaster. Therefore, the ship fuel replenishment facilities are not considered to represent a "critical action" according to the definition (and examples) provided in the guidelines. The applicable floodplain definition is taken to be the base (100-year) floodplain.

The proposed site for the ship fuel replenishment facilities is shown on Figure II.C-4. The storage tanks would be located in an area almost entirely above the 100-year flood level of 11.3 ft. MSL. Spill containment dikes which would surround the tanks would provide additional flood protection up to at least the 500-year flood level of 15.7 ft. MSL. Major flooding conditions in the area are tidal in origin. Flooding of this type is characterized by a simple inundation because of an area-wide occurrence of an extreme high tide level. Under such conditions, the presence of structures in the flooded area does not represent a blockage or constriction of floodways as it would if the flooding were associated with river flows. Therefore, the presence of the tanks and their dikes would not adversely affect flood levels in the area.

The transfer pipelines which connect the storage facilities to the pier are also shown on Figure II.C-4. The pipeline route runs through the 100-year floodplain area which lies between the storage area and the shoreline. Flood protection for this line calls for its elevation above the 100-year flood level. The pipeline would be supported on open-framed structure which would not restrict flood water movement. The use of an open-framed support structure would also minimize the disturbance to the wetland areas along the pipeline route.

e. Surface Water Quality

The paving of previously vegetated land can also affect the quality of the water. Pollutant loads are often introduced into storm water from contamination of rain water, washout from urban area surfaces, and deposits inside catch basins and storm sewers. The most significant contributions are the streets, gutters and other impervious areas directly connected to streets and storm sewers. In an urban area, COD, BOD, bacteria, nitrogen and phosphorous are found associated with dirt and dust on street surfaces. Field studies in different areas of the United States (American Public Works Association, 1973) show that an average of 1.5 pounds of dust and dirt are found per 100 feet of curb.

It is anticipated that the development of the Naval Exchange Building, the AOE warehouse and bowling alley in the Main Station would not have significant impact on storm water quality. This is attributed to the fact that these facilities occupy less than one acre, which is a negligible increase in the amount of impervious area currently in this portion of the Station.

The development of the parking lots in the Waterfront Area and the truck holding yards in the Main Station would have an impact on water quality. Studies (Moe, 1976) show that areas with heavy use by vehicular traffic have concentrations of heavy metals (copper, lead, zinc, and cadmium) approximately 210 times that of sanitary sewage. In a study in Saddle River, New Jersey, Wilber and Hurter (1977) found that peak concentrations of heavy metals were generally observed within the first 30 minutes of precipitation, thus giving a "flush effect". Other studies have also shown that motor vehicles generate exhaust products, such as oil and grease, and asbestos fibers from brake linings. High concentrations of heavy metals are toxid to a wide variety of aquatic plants and animals. Stream biota are also affected by chlorides that result from the use of de-icing salts in the winter.

The impact on water quality from these areas is not expected to be significant. Most ship crew members prefer not to use the secured parking areas and leave their cars with relatives or friends. The truck holding yard would only be used during a national emergency. As use of these areas should be low, additional pollutant contributions to surface runoff should be minimal. The impacts that could result from potential oil spills at the ship fuel replenishment system are discussed above in section b. of this section.

f. Water Consumption

Most of the increased population resulting from the proposed action would occupy existing housing at Ft. Monmouth. They would use existing water supplies and should not generate any impact on ground water resources.

Many of the crew would reside on board ship at the Waterfront Area. The Waterfront Area is supplied with water from the Monmouth Consolidated Water Company which uses ground-water as a secondary source. Five of the eight wells in the service area tap the Raritan-Magothy Aquifer, two tap the Englishtown Aquifer and one well taps the Mount Laurel-Wenonah Aquifer. These wells are located at Jumping Brook, Asbury Park, and Ocean Grove. The average daily water consumption for the Waterfront Area in 1976 was about 0.025 MGD. It is estimated that the population in the Waterfront Area would increase by about 80 percent due to the homeporting action. This would increase water consumption to about 0.045 MGD.

Total present water production capacity for Monmouth Consolidated Water Company is 28.8 MGD. About 2.9 MGD comes from the water wells and the balance of 25.9 MGD comes from surface water sources. Ground-water thus makes up about 10 percent of the total water supply for the Company. Water from both surface and ground sources becomes mixed when it enters the distribution system. Thus, one cannot usually specify whether water at a particular location comes from ground or surface sources.

The water company has a treatment capacity of 50 MGD of which only 28.8 MGD is being utilized. The increased demand of 0.02 MGD for the Waterfront Area is only about 0.1 of one percent of the unused water capacity of the company, most of which is from surface water. Thus the additional water required by the Waterfront Area would have a negligible effect upon the water resources of the area.

g. Ground-Water Resources

1. Changes in Aquifer Recharge - The loss of recharge due to construction of impermeable surfaces on the Main Station is very small (about 0.003 percent) compared to total recharge available in the Vincentown Aquifer in Monmouth County.

The proposed site for the ship fuel replenishment system and Waterfront Area are within the zone of recharge of the Englishtown Aquifer. The Englishtown is not exposed at the surface but is obscured beneath a thin cover of Quaternary alluvium and sandy fill. The loss of permeable surface in this area would probably represent a loss to the Englishtown. However, the presence of impermeable marsh deposits below sanitary landfill inhibits recharge into the aquifer and may redirect it to the Bay. The loss of recharge from the construction projects in this area represents a very small (about 0.1) percent of the total recharge (25 MGD) for the Englishtown aquifer in Monmouth County (Jablonski, 1968) and it would be an insignificant impact on the ground-water resources.

2. Contamination of Ground-Water - Oil spills could soak into the ground and enter the water table. The impervious cover within the area enclosed by the protective berm of the fuel storage tanks would act to prevent seepage of spills into the ground-water system. Spills occurring along the landward segments of the pipelines have a slight potential for impacting the Englishtown Aquifer. Spills would have to seep through the sandy landfill as well as the more impervious marsh sediment in order to contaminate the Englishtown Aquifer. It is unlikely that this would occur prior to clean-up operations under the oil spill contingency plan which would be implemented by the Navy. The probabilities associated with the chance of a spill from the pipeline are small (see Section B.4).

h. Sanitary Sewer Loadings

The proposed action would increase loads on existing sanitary sewerage facilities at the Waterfront Area. This area is served by the Middletown Township Sewerage Authority (MTSA) which will receive sanitary wastes from the crews of the homeported AOEs and civilian personnel working in the Waterfront Area.

If both AOEs are in port at the same time (approximately two weeks each year), approximately 1,237 personnel would be using the waterfront facilities. This assumes the "worst case" condition in which all of the personnel assigned to each AOE are working at the Waterfront Area. Based on historical data, the average waste generation is 120 gallons per resident AOE personnel per day and 60 gallons per transient personnel per day. Therefore, the net increase in sewage at the Waterfront Area is estimated at 0.144 MGD from 1158 AOE resident personnel and 79 transient personnel.

Sewage from the AOEs would be pumped to an aeration tank in the Waterfront Area for chloride treatment. The wastes would then enter the existing sewer line from the administration area. Sewage in this line travels by gravity to Middletown Township Sewage Authority's treatment plant at Belford. As described in Chapter II, this plant has a design capacity of 6.5 MGD and has an average flow of approximately 5.0 MGD. Therefore, the increases of 0.144 MGD (2.2 percent of the plant capacity) generated by the homeporting action would have no significant impact on MTSA's facilities.

Approximately 30 additional civilians would be working in the Main Station area in the AOE Warehouse, Naval Exhcange, etc. The 1800 gallons per day (30 people x 60 gallons/person/day) generated by these people would have no significant impact on the Navy's 350,000 gallons per day treatment plant operating in this area.

About 373 of the married AOE personnel would be housed in Ft. Monmouth. In recent years, the installation has suffered a reduction in personnel of approximately 7,600 people. The resultant population increase is only about 20 percent of the number of people who no longer reside at Ft. Monmouth. Existing Ft. Monmouth sewage treatment facilities should be adequate to handle the additional Navy people.

i. Operational Noise

Operation of the facilities associated with AOE homeporting, VSS and the fuel replenishment system would in most cases produce no noticeable increase in ambient sound levels.

The major noise sources associated with AOE facilities would be from increased rail, personnel vehicle and tractor-trailer operations along the Government Road connecting the Main Station and the Waterfront Area. Although activity levels are expected to fluctuate from day to day, the major noise source along this road would be the movement of freight trains. During a typical freight train passby, the peak sound level is expected to be 83 dB at 40 meters (130 feet) (USEPA, 1975). For a 50 car train, this sound level is expected to last about 80 seconds. At the Waterfront Area itself, locomotive switching and idling is also a noise source, having an average sound level of 70.5 dB at 30 meters (100 feet) from the center of operations (Rickley, et al., 1974). These sound level increases are expected to be indiscernable in most instances.

The purpose of the VSS is to provide rapid outloadings of ammunition and cargo during national emergencies. During peacetime, these facilities are maintained in a standby status. Therefore, no operating noise is expected. Some nearby residents would probably be affected by traffic noise during a national emergency.

The major noise source associated with the operation of the fuel replenishment system would be the operation of the pumps. These would be centrifugal pumps enclosed in a prefabricated metal structure. The pumping station would only be used during tank and/or ship loading or offloading operations. Assuming that the structure is of 1/16 of an inch thick steel construction, its sound level contribution is estimated at 53 dB at 10 meters during operation (Barenek, 1971). This noise level would be barely noticeable at distances in excess of 100 meters. At the site of the proposed fuel replenishment system, no private homes or other noise sensitive receptors are within this distance. Therefore, no noise impact is expected.

j. Air Quality

The analysis of long-term air quality impacts of the proposed action is presented below for the following major elements: 1) increased vehicular traffic associated with the additional parking areas; 2) the operation and berthing of the vessels and 3) the operation of the ship fuel replenishment system. The results indicate that the proposed action would not have a significant impact on the air quality of the region.

1. Increased Vehicular Traffic - Increased vehicular traffic to and from the Waterfront Area would increase carbon monoxide emissions. To estimate peak carbon monoxide concentrations associated with these sources, a dispersion modeling technique was used (USEPA, 1974). For event-oriented traffic situations, a convenient indicator of traffic congestion near parking facility is the ratio of the traffic volume demand flow rate at the facility gate to the traffic capacity of the gate. Observations have indicated that periods of extreme congestion occur for a fraction of an hour after the event with practically no traffic for the remaining portion of the hour. Accordingly, it is realistic to assume that the volume demand-capacity ratio is one (1) and prevails during the entire period of time required to accomodate all vehicles wishing to pass through the gate and is zero (0) for the remainder of the hour. The details of this impact analysis are presented in Appendix I.

The results of this analysis indicate that during AOE homeporting, maximum 1-hour increases of carbon monoxide at a nearby receptor (10 meters) may be 15.7 ppm. This level is well below the 1-hour carbon monoxide ambient air quality standard of 35 ppm. As the distance between the receptor and the gate increases, the concentration levels of carbon monoxide decrease significantly due to atmospheric dilution. Hence, carbon monoxide emissions from vehicles would not measureably alter the level of carbon monoxide in the ambient air for receptor sites removed from the gate by distances of 2000-3000 feet or more.

As the Waterfront Area operates on a standard shift, there are normally two daily one-hour traffic peaks. Minimum traffic levels are expected at intervals between the two peaks. This traffic pattern and the maximum 1-hour values noted above indicate that the 8-hour standard for carbon monoxide would also not be exceeded.

Total emissions resulting from increased vehicular traffic due to the proposed action are summarized below:

	Tons per year
Carbon Monoxide	199.70
Nitrogen Oxides	7.24
Hydrocarbons	16.64

This is based on conservative emission rates of 82.8 grams per mile, 3.0 grams per mile and 6.9 grams per mile (CO, NOx, and HC respectively) for a 1974 car operating in 1980 (USEPA, 1978) and a 20-mile daily round trip for 300 cars.

These values indicate that significant impacts would not occur due to increased vehicular traffic.

2. Operation of Vessels - For the projected level of ship activity in the Waterfront Area, the impact on air quality is expected to be minor and transitory. The relatively infrequent visits by vessels, estimated at about 40-60 per year and low emissions from the vessels would yield insignificant increases in air pollution.

When an AOE homeports, it would connect to onshore utility systems. However, on entering and leaving port, it would emit pollutants at pierside. It is unlikely that more than one AOE would enter or leave port at a time. To estimate the maximum possible concentrations of air pollutants discharged during berthing, a mathematical dispersion modeling technique was used (Turner, 1969). The details of this analysis are presented in Appendix I.

Table IV-9 summarizes the maximum possible contaminant concentration levels during the berthing of one ship at several downwind distances during the worst possible meteorological conditions (i.e., F stability and a wind speed of one meter per second). The ground level concentrations for all pollutants which have been computed are low and should not threaten the ambient air quality standards. With regard to the Federal significant deterioration standards, the berthing of one ship would not exceed the area's allowed 24-hour particulate increment of 37 micrograms/m^3, nor the allowed 3-hour sulfur dioxide increment of 512 micrograms/m^3.

Because the emissions of air pollutants that occur during the maneuvering of vessels are of the same order of magnitude as during berthing and since the anticipated maneuvering time in the port area is of short duration, the impact on ambient air quality during the arrival and departure of vessels is not expected to be great.

Total yearly hydrocarbon emissions were conservatively calculated for in-berth AOEs by using a 33 pound per day emission factor (conservative considering that base power from cold iron would be supplied to in-berth AOEs) and a one year residence time. The total hydrocarbon emission for in-berth AOEs is thus estimated at 6.02 tons per year.

3. Ship Fuel Replenishment System - The Amendments to the Clean Air Act require a Prevention of Significant Deterioration (PSD) analysis for any source which emits more than 250 tons per year for any source which emits

TABLE IV-9

MAXIMUM POSSIBLE AIR CONTAMINANT CONCENTRATION LEVELS DURING THE BERTHING OF ONE AOE
POLLUTANT CONCENTRATION

Downwind Distance (m)	Particulates (24-hour standard: 150 $\mu g/m^3$)	Sulfur Oxides (3-hour standard: 1300 $\mu g/m^3$)	Carbon Monoxide (1-hour standard: 40 mg/m^3)	Carbon Monoxide (8-hour standard: 10 mg/m^3)	Hydrocarbons (3-hour standard: 160 $\mu g/m^3$)	Nitrogen Oxides[a]
100	7.3	28.6	0.06	0.04	21.7	59.3
150	8.0	31.6	0.07	0.05	24.1	65.6
200	8.4	32.9	0.07	0.05	25.1	68.3
250	9.1	36.0	0.08	0.05	27.4	74.7
300	9.5	37.0	0.09	0.06	28.4	77.4
400	9.7	38.2	0.09	0.06	29.1	79.2
500	9.3	36.6	0.08	0.06	27.8	75.9
750	8.3	32.5	0.07	0.05	24.7	67.4
1000	7.2	28.4	0.06	0.04	21.7	58.9
1500	5.4	21.4	0.05	0.03	16.3	44.4
2000	4.2	16.5	0.04	0.03	12.5	34.2
3000	2.8	11.1	0.03	0.02	8.4	23.0
4000	2.0	8.0	0.02	0.01	6.1	16.7
5000	1.6	6.3	0.01	0.01	4.8	13.0

[a] There is no short-term ambient air quality standard for nitrogen oxides. The tabulated values are those likely to occur during a 10-min. sampling period.

more than 100 tons per year and falls within a specified set of source types. Petroleum storage and transfer facilities with a capacity exceeding three hundred thousand barrels are among the specified sources.

Although the proposed storage facility exceeds this capacity, the PSD requirement does not apply to NWS Earle ship fuel replenishment system because it does not emit more than 100 tons per year of any air pollutant. The analysis of emission loss from the ship fuel replenishment system is presented in Appendix I and indicates that total hydrocarbon emissions would be 35.01 tons per year (33.95 tons for breathing loss and 1.06 tons, working loss).

In the event that the source is located in a non-attainment area, the Clean Air Act requires that the offset policy be applied only when the source would require a PSD analysis for an attainment area. The offset policy does not apply to NWS Earle projects for the same reasons that the PSD analysis is not required.

Since the vapor pressures of Diesel Fuel Marine (DFM) and JP-5 under normal atmospheric conditions, are below 0.02 psia (API, 1977; Navy, 1977), vaporization of significant amounts of hydrocarbons from these petroleum substances is not indicated. Therefore, the operation of a fuel replenishment system at NWS Earle would not have a significant impact on ambient air quality.

In addition ot considerations of PSD for storage facilities, the New Jersey Department of Environmental Protection has promulgated a set of regulations to control emission of hydrocarbons from the storage and transfer of volatile organic substances (N.J. Administrative Code 7:27-16.1 et. seq.). The vapor pressures of Diesel Fuel Marine (DFM) and JP-5 fuel under normal atmospheric conditions are below the 0.02 psia regulatory threshold (API, 1977; Navy, 1977). Hence, no control devices are required for the storage and pipeline elements under New Jersey law.

B. IMPACTS ON THE ESTUARINE ENVIRONMENT

B.1 Dredging Impacts

a. Impacts on Physical and Chemical Systems

1. Waves, Currents and Bottom Sediments - The deepening of the existing Sandy Hook Channel and the dredging of the approach channel to the new pier would not significantly affect wave patterns within Sandy Hook Bay. Storm waves which attack the shore of Sandy Hook Bay are normally generated by persistent high winds blowing out of the northwest. A wave refraction analysis conducted for this study indicates that the deepened channel sections would change neither the focusing nor the divergence of these characteristic storm waves. Therefore, the general distribution of storm wave energy on the bayside beaches would remain unchanged. The deepening of the offshore portions of the Sandy Hook Channel would not alter the False Hook Shoal and adjacent shoal platform (Figure II.C-21). These shoals provide protection to the northern end of Sandy Hook by dissipating waves from the open ocean. Significant alterations in the longshore transport of sand and growth of the spit have already occurred at the tip of Sandy Hook Channel due to the establishment and maintenance of the Sandy Hook Channel adjacent to the tip. The proposed deepening of the channel in this area would have no further impact on the coastal processes, as existing channel depths there are equal to or greater than the project depth.

The channel and turning basin dredging would not result in a significant alteration of the water circulation within Sandy Hook Bay or in the area offshore of Sandy Hook. The highest tidal current magnitudes are found in the reach of the Sandy Hook Channel directly off the northern tip of Sandy Hook. Existing depths in this area are in excess of the planned project depth. Since no dredging would be required in this area, local flow conditions would not be affected.

Within Sandy Hook Bay, there may be a reduction of circulation in the lower depths of the deepened channels and turning basin. However, mixing conditions within the Bay, as well as flushing by tidal currents which generally flow along the channel axes, would prevent these deepened areas from stagnating.

The removal of the bottom materials may expose sediment types not previously present. The deepened areas at the existing and proposed turning basins and channels would tend to accumulate muddy sediments, resulting in the need for periodic maintenance dredging. The tip of Sandy Hook would continue to act as a sediment sink for the sands transported to the north along the Sandy Hook shore.

2. Suspended Sediments - The channel dredging operations would be accomplished by mechanical dredging methods using a clamshell bucket. This method disturbs and resuspends bottom material as the bucket bites into the bottom and breaks free upon being hoisted. Sediment is also lost from the bucket as it is raised to the surface. The area experiencing significant increases in suspended sediment concentrations tends to be localized in the vicinity of the dredge. Studies of a clamshell dredging operation in San Francisco Bay muds (up to 95 percent silt and clay) showed that suspended sediment concentrations decrease to background levels within 100 meters of dredging operations. (Sustar et al, 1976). Similar measurements made during clamshell dredging on the Thames River of Connecticut show that the sediment disturbance was undetectable beyond 150 meters downstream of the dredge (U.S. Dept. of Navy, 1973).

The turbidity plume associated with suspended sediments is also limited in duration. The San Francisco Bay studies showed that the high level of suspended sediments in the vicinity of the dredge immediately dispersed to the ranges shown in Table IV-10. Duration of these concentrations was typically less than 15 minutes when salinity was at a level sufficient to initiate flocculation (salinity greater than 1.$^{o}/oo$). During turbulent conditions the elevated concentrations may persist for an hour or more (Sustar, et al, 1976).

TABLE IV-10

SEDIMENT DISTURBANCE IN WATER COLUMN DURING DREDGING
Clamshell Dredging - San Francisco Bay

Depth (m)	Background Suspended Sediment Concentration mg/l	Disturbance Along Lines Parallel To Dredge: Centerline mg/l Max.	Centerline mg/l Avg.	50 m of Centerline mg/l Max.	50 m of Centerline mg/l Avg.	100 m of Centerline mg/l Max.	100 m of Centerline mg/l Avg.
1	24	170	70	40	29	—	—
5	34	172	88	214	68	33	29
10	37	118	33	—	—	—	—

Source: Sustar *et al.*, 1976.

It is expected that this short-term impact would be confined largely to the areas of the new channel and turning basin where the sediments are predominantly silts and clays. Approximately 40 percent of the dredging area would involve medium to fine sands which would not produce turbid plumes of significant duration.

3. Water Quality - The impacts of the dredging at the proposed project site would include the alteration of the sediment-water interface, the release of small quantities of trace metals, hydrocarbons and nutrients to the water column, and the creation of a turbidity plume in the area being dredged. The release of contaminant materials would be associated with only the upper portions of the muddy areas near the proposed turning basin and terminal channel (about 1 million cubic yards). These impacts are for the most part short-term and localized. A change in sediment type from a silty bottom to a sandy bottom may also affect the chemistry of the bottom waters and the pore waters as the chemical gradients are altered.

Grab samples of the surficial sediments in the area of the proposed dredging were taken in July, 1978 for purposes of elutriate chemical analysis. A resampling of the project area was conducted in April of 1979 for solid phase bioassay and bioacculuation testing in conjunction with revised testing requirements (USACOE, February, 1979). Biological testing results are provided as an addendum to this DEIS. The new guidelines (USACOE, February, 1979) also presented new detection limits for chemical elutriate analysis for mercury, cadmium, PCB and DDT. The chemical constituents tested for and the resulting concentrations of three replicate samples are presented in Table IV-11 for both sample periods. Criteria levels for water quality recommended by the U.S. Environmental Protection Agency (USEPA, 1976) and applicable New Jersey water quality criteria for Raritan and Sandy Hook Bay (TW - 1 Class Waters) (NJDEP, 1974) are also presented.

TABLE IV-11

DREDGE MATERIAL ELUTRIATE ANALYSIS AND WATER QUALITY CRITERIA

Constituent		DREDGE MATERIAL CONCENTRATION(1)(9) Sample A	Sample B	Sample C	WATER QUALITY CRITERIA EPA(2)	New Jersey(3)(4)
Volatile Solids	(mg/l)	1162	1241	1187	—	
Oil & Grease	(mg/l)	54.9	53.8	54.6	0.01 (96 HR LC_{50})	(7)
Total Phosphate	(mg/l)	0.49	0.46	0.47	—	(8),(5)
Ortho Phosphate	(mg/l)	0.18	0.18	0.17	—	(8),(5)
Phenols	(μg/l)	<1.0	<1.0	<1.0	1.0 μg/l	(8),(5)
Nitrates	(mg/l)	<0.01	<0.01	<0.01	10 mg/l	(8),(5)
Nitrites	(mg/l)	0.003	0.002	0.003	10 mg/l	(8),(5)
Ammonia	(mg/l)	0.74	0.71	0.73	0.02 mg/l (unionized)	(8),(5)
TKN	(mg/l)	0.83	0.81	0.82	—	(8),(5)
COD	(mg/l)	72	70	72	—	—
DDT	(μg/l)	< 0.05	< 0.05	< 0.05	0.001 μg/l	(8),(6)
PCB	(μg/l)	0.27	.035	.020	0.001 μg/l	(8),(5)
Mercury	(μg/l)	0.01	0.01	0.01	0.1 μg/l	(5) 0.05 mg/l
Lead	(μg/l)	<1.0	<1.0	<1.0	0.01 (96 Hr LC_{50})	(5) 0.05 mg/l
Zinc	(μg/l)	<1.0	<1.0	<1.0	0.01 (96 Hr LC_{50})	(8),(5)
Copper	(μg/l)	<1.0	<1.0	<1.0	0.1 (96 Hr LC_{50})	(8),(5)
Chromium	(μg/l)	<1.0	<1.0	<1.0	100 μg/l	(5) 0.05 mg/l
Cadmium	(μg/l)	1.6	1.7	1.8	5 μg/l	(5) 0.01 mg/l
Sulfide	(μg/l)	<1.0	<1.0	<1.0	2 μg/l	(8),(5)
Cyanide	(μg/l)	<1.0	<1.0	<1.0	5 μg/l	(8),(5)
Fluoride	(mg/l)	<0.2	<0.2	<0.2	—	(8),(5)

(1) Samples collected from dredging site in June, 1978 and May 1979 (see Appendix F).

(2) EPA, 1976.

(3) New Jersey Dept. of Environmental Protection, 1974.

(4) Standards for TW-1 Class Waters.

(5) Concentration of toxic substance in surface waters not to exceed 0.05 of the 96 Hr TL_{50} determined by appropriate bioassay. Number in column is the maximum allowable in any case. (Guideline value for interpretation of (8).)

(6) Concentrations of persistent pesticides in surface waters shall not exceed 0.01 of the 96 Hr TL_{50} as determined by appropriate bioassay. (Guideline value for interpretation of (8).)

(7) None noticeable in water or deposited along the shore or on aquatic substrata in quantities detrimental to natural biota for "petroleum hydrocarbons". The goal is non detectable (New Jersey Department of Environmental Protection, 1976).

(8) None, either alone or in combination with other substances in such concentrations as to affect humans or be detrimental to the natural aquatic biota, produce undesirable aquatic growth or which would render waters unsuitable for designated uses.

(9) Chemical testing of Hg, Cd, PCB's and DDT was performed in May 1979 in accordance with Revised Dredged Material Testing Requirements (USACOE, February 1979) (Aqua Survey, Inc. May, 1979).

Examination of Table IV-11 shows that several chemical constituents are already at or below the criteria levels shown without considering dilution effects. These include mercury, chromium and cadmium which satisfy both the recommended EPA criteria and the maximum allowable concentrations as specified by the N.J. Standards. In addition, phenols, sulfide, cyanide, nitrates and nitrites are at or below the EPA criteria. Numerical criteria are not provided in the New Jersey Standards for these constituents and appropriate bioassay results must be relied upon. Lead concentrations in the dredged material are below the New Jersey criteria. The EPA recommendations, however, call for bioassay evaluation.

Other chemical constituents do not contravene the numerical criteria when the effect of dilution is considered. Agitation of the sediment as a result of the dredging operations will reduce these concentrations by diluting the sediment with the ambient water. Under such conditions these chemical constituents would be diluted to concentrations far below the appropriate water quality criteria. Typical dilution estimates are discussed later in this section with respect to the interpretation of the bioassay results. Reduction of initial concentrations by a factor on the order of 300 are shown to be achieved within a short distance of the disturbance. Therefore, even relatively high concentrations such as PCB's, are expected to be diluted to acceptable levels.

The values measured and presented in Table IV-11 for the elutriate test are for total ammonia. The EPA criteria is based on un-ionized ammonia (0.02 microgram/l). The relationship between total ammonia and the toxic un-ionized ammonia is a defined function of temperature and salinity (USEPA, 1976). Considerations of temperature and salinity ranges for Sandy Hook Bay and the total ammonia concentrations of the elutriate test, indicate that the EPA criteria for un-ionized ammonia would not be exceeded during dredging operations.

Phosphorus in its elemental form is particularly toxic and a national criterion for its concentration in marine and estuarine waters has been established. No national water quality criterion has, however, been established for phosphorus as phosphates (USEPA, 1976). In excess of critical concentrations, phophates stimulate plant growth. Naturally occurring phenomena at the dredge site limit the development of plant nuisances which could be stimulated by mixing the phosphates in the sediment into the water column. These phenomena include the limited penetration of sunlight required for plant photosynthesis as a result of the somewhat turbid waters of Raritan Bay, the depth of the water, the substantial tidal flow across the area, and the relatively short time frame of the dredging operations. Therefore, the presence of phosphates in the sediment should not have a significant impact on water quality during the dredging operations.

The remainder of the chemical constituent list either requires bioassay evaluation or does not have a determined criterion of acceptability. New Jersey guidelines range from 0.01 of the TL_{50} value at 96 hours for pesticides to 0.05 of the TL_{50} value at 96 hours for other toxic substances. EPA criteria range from 0.1 to 0.01 of the LC_{50} value at 96 hours. TL_{50} relates to the concentration of a test material at which only 50 percent of the test animals are to survive under specified test conditions. LC_{50} relates to the concentrations of a toxicant which is lethal to 50 percent of the organisms tested under the specified test conditions. Bioassays were not conducted using the dredging site water as a mixing medium. However, such bioassays were conducted for the offshore disposal site (Appendix F). Although such analysis is not a precise measure of the water quality impacts within Sandy Hook Bay itself, it does allow the magnitude of the impact to be estimated. The bioassay results are therefore discussed in the following paragraphs along with an extrapolation of these results to Sandy Hook Bay.

Most bioassay tests showed no response of sensitive marine organisms to sediment exposure. A 100 percent survival rate was obtained in these bioassay tests, indicating that the water quality criteria would not be contravened. Only in the suspended particulate and liquid phase bioassays using the phytoplankton Skeletonema Costatum was there any biological response to exposure to the test sediment. Effective concentrations causing 50 percent inhibition (EC_{50}) at 96 hours were calculated to be 22 percent and 24 percent of the test medium concentrations for the suspended particulate and the liquid phase tests.

Table IV-12 shows how the bioassay results relate these two exceptions to the water quality criteria. Dilution factors required to reduce the initial liquid phase and suspended particulate phase concentrations to limiting permissible concentrations are calculated and provided in Table IV-12 for various application factors required by the water quality criteria. (The application factor is taken to mean the fraction of the 96 hour value of the LC_{50} or EC_{50} which is considered acceptable (see Table IV-11.) The most restrictive condition is shown to be for the liquid phase with an application factor of 0.01. The resulting dilution factor of 288 is required. Achievement of this dilution ratio in the Sandy Hook Bay area is reasonable. Assuming that a maximum of one percent by volume of the sediment is resuspended during dredging operations (as suggested by Mackin, 1961), approximately 22 m^3 sediment would be resuspended during the filling of a typical 2200 m^3 capacity scow. Sufficient mixing water is available to dilute the sediment concentration to water quality limits within a zone bounded on the surface by a circle with a radius of about 14 meters centered at the point of dredging. In addition, the action of tidal currents would provide additional dilution water to keep the sediment concentrations relatively low.

In summary, the above analysis has shown that the disturbance of the sediment during dredging should not cause a significant contravention of appropriate State and Federal water quality criteria. Deterioration of ambient water quality would be limited to the immediate vicinity of the dredging operations.

A fraction of the oxygen-demanding substances within the dredged material would be utilized causing a small reduction in oxygen levels. However, this effect should be negated within a few hours following mixing and dilution. A detailed discussion of trace metal geochemistry and the potential for biouptake and

TABLE IV-12

APPLICATION OF BIOASSAY RESULTS TO WATER QUALITY CRITERIA

Phase	EC_{50} (%)	Portion of Total Sediment (%)	Application Factor Required	Limiting[a] Permissible Concentration (%)	Equivalent[b] Concentration of All Sediment (%)	Dilution[c] Factor Required
Liquid	24	69	0.1	2.40	3.5	29
			0.05	1.20	1.7	58
			0.01	0.24	0.35	288
Suspended Particulate	22	22	0.1	2.20	10.0	10
			0.05	1.10	5.0	20
			0.01	0.22	1.0	100

[a] Limiting Permissible Concentration (LPC) = F_{APP} (EC_{50})

[b] Where F_{APP} = Application Factor required by water quality criteria

[c] Dilution Factor = 1/Concentration.

[d] Sediment concentration equivalent to LPC considering the relative proportion of each phase of the total sediment volume.

accumulation as it relates to the impacts of dredging and dredged material disposal is presented in Appendix K.

4. Ground-Water - The dredging of the inner portions of the proposed turning basin to -45 + 2 feet MLW would remove muddy sediment and expose sand and gravel beds. The sand and gravel beds are in direct connection with the Englishtown Formation, a principal aquifer in the Monmouth County area. The removal of the muddy sediments in the basin would thus result in an additional hydraulic connection between the waters of Sandy Hook Bay and the Englishtown Aquifer through the sand and gravel beds. Intrusion of salt water would occur when the Englishtown ground-water table is lower than the level of this connection (negative head).

At the present time, there already appears to be a hydraulic connection with the aquifer further out in the Bay and in the vicinity of the tip of Sandy Hook where muddy sediments are discontinuous or absent. As discussed in Chapter II, a baseline ground-water hydrology study was conducted in July of 1978 in portions of Sandy Hook Bay (two wells) and on Sandy Hook (one well) to assess the potential for the proposed dredging to cause salt water intrusion of the Englishtown Aquifer. The results of water quality analysis of the Englishtown Aquifer (Table II.B-12) indicate that the Englishtown is intruded by salt water from the bay. The results of water level measurements (slight negative head in the bay area) and temperature profiles within the wells together with the water quality data indicate that the aquifer is contaminated to the maximum extent. Bay water is in direct contact with the aquifer in the adjacent area and is being flushed in response to tidal fluctuations. Based on these results, it is expected that removal of the confining layer (muds) for the Englishtown Aquifer at the proposed dredging areas would have no additional deleterious effect on the aquifer.

The monitoring of water quality in the Englishtown Aquifer indicates that no salt water intrusion is presently occurring in the coastal area. Heavy pumping of the Englishtown Aquifer in the Manasquan-Point Pleasant areas has resulted in the increase in size of areas having negative head. As a result, the State of New Jersey has discouraged additional development of the Englishtown as a precaution against future salt water intrusion. This moratorium should stabilize water levels in the Englishtown as a precaution against future salt water intrusion. This moratorium should stabilize water levels in the Englishtown Aquifer for the near future. No large capacity water wells are presently producing water from the Englishtown Aquifer in the Sandy Hook-Raritan Bay area. As discussed in Section IV.A-2, the proposed action would not have an impact on water levels of the Englishtown Aquifer in the coastal area or a significant effect on water consumption.

b. Biological Impacts

1. Plankton - The short-term turbidity from the dredging operations would temporarily decrease light penetration. This reduces productivity near the dredge site. As discussed above, studies of dredging operations in estuarine environments show that turbidities from dredging return to background levels within a few days. Increased nutrient levels from stirring of muddy bottom sediments may result in local blooms of phytoplankton.

A local and short-term decrease in zooplankton populations may occur due to the smothering effect of the increased turbidity which tends to obstruct the filter-feeding apparatus. Such local alterations would be readily replaced by circulation of waters from adjacent unaffected areas. Upper trophic level organisms would not be significantly affected by these temporary reductions in plankton densities.

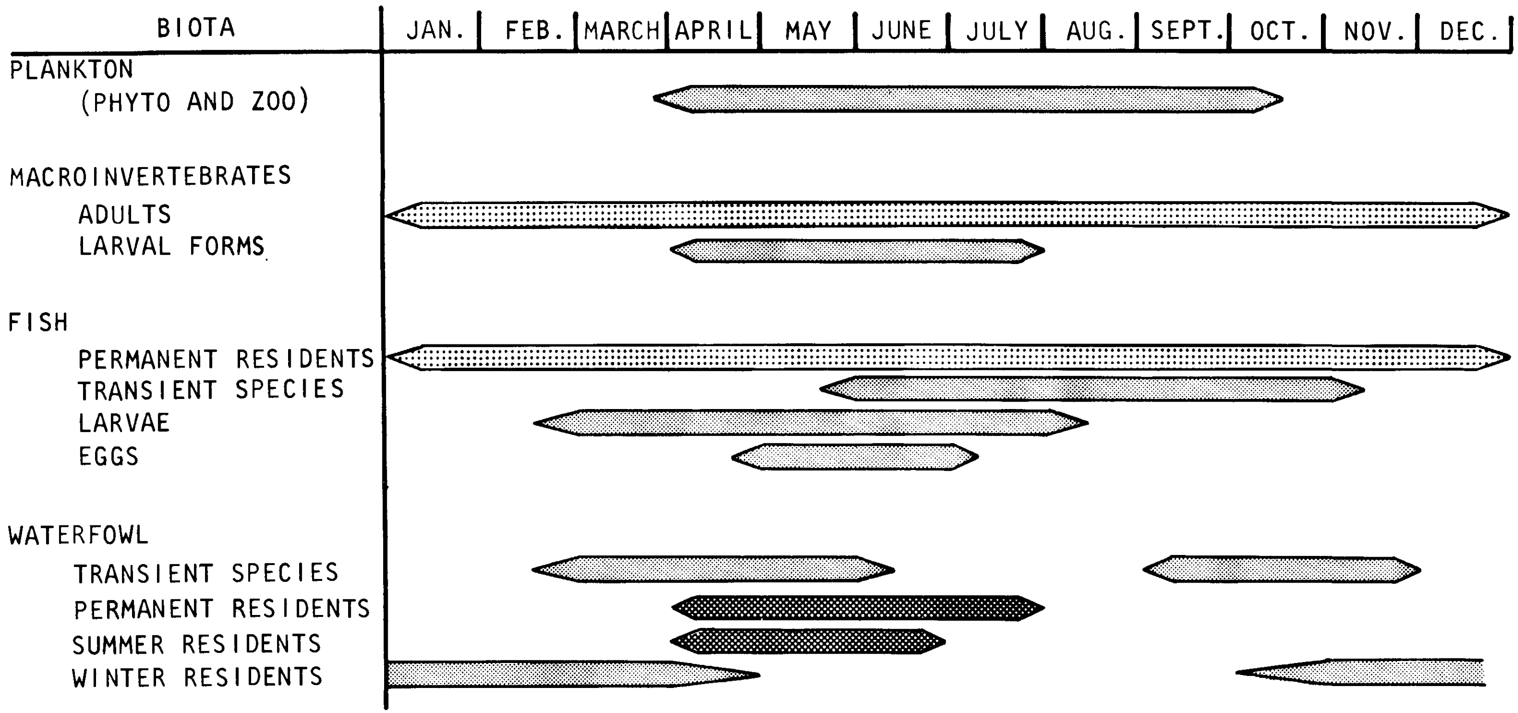
2. Benthos - The greates impact of the proposed dredging would be the removal of benthic organisms which presently inhabit the 209 acres of bottom in the new dredge areas and 447 acres in existing channels. This removal will result in reduced benthic populations in the area and reduced food source for upper level organisms. However, much of the project area (about 68 percent) represents existing navigational channels where removal of initial benthic populations has already occurred.

The removal of the benthic communities would be a short-term impact. Numerous studies of the effects of dredging operations indicate that repopulation of dredged areas may be accomplished within time periods of a few weeks to a few years (Rounsefell, 1972; Bybee, 1969; and Kaplan et al., 1974).

The dredging of the proposed turning basin and channel would result in the establishment of a new channel side wall habitat in this area. Hard sand and gravel substrate would be created locally by dredging in the Bay and allow the attachment of new organisms such as the mussel.

Clogging of the filter-feeding mechanisms of macroinvertebrates may occur from the increased turbidity near the project area, especially near the proposed turning basin and channel. It is expected that the temporary turdibity would have a minimal impact on adult populations. Crabs, shrimp and motile inverte-brates would be able to avoid these areas.

3. Fish - The physical dredging process would have little effect on most fish species. Dredging may mechanically destroy some sedentary species such as white flounder. However, the mobility of most fish species will allow them to avoid the project dredging areas. Depending upon the season when the proposed action occurs, increased turbidity resulting from dredging could have a severe impact on fish eggs and larvae (Figure IV-1)(USACOE, 1976b). Settling out of suspended sediments can impact the buoyancy of pelagic fish eggs and larvae such as the bay anchovy, Tautoga and windowpane and force their smothering in the sediment. Those fish with demersal eggs would be most susceptible to increased turbidity. Settling of suspended particulates can smother the eggs of these species including Mummichog, Atlantic menhaden, Atlantic croaker, Atlantic silverside and, butterfish. Dredging from March to August would have the most serious impacts since this is the most critical period for development of fish eggs and larval fish (USACOE, 1976b).



SEASONAL DISTRIBUTION OF THE BIOTA OF THE SHREWSBURY RIVER SYSTEM

KEY:

PERIOD OF GREATEST ABUNDANCE

PRESENT ALL YEAR

BREEDING SEASON

SOURCE: ADAPTED FROM U.S. ARMY COE, (1976b)

FIGURE IV-1

The turbidity plume from offshore dredging operations is not expected to reach near-shore areas. Shallow water fish species and less motile fish which occur in the march areas would thus be unaffected by dredging operations.

c. Summary

The major impacts associated with the dredging operations would be short-term, local and not significant. The most significant impact involves the removal of benthic fauna and habitat, espcially in areas not previously dredged. Repopulation of these areas is expected to occur within a year or two, at most. The local increases in turbidity may result in reducing photosynthetic activity of nearby plankton, clogging and smothering of feeding and respiratory mechanisms of certain zooplankton, benthic invertebrates, fish eggs and larvae. These impacts would be short-term and localized in dredging areas near the proposed terminal channel and turning basin where muddy sediments occur. A short-term increase of contaminants would occur within the water column in these same areas but the effects would not be significant.

Since the Englishtown Aquifer is presently intruded by salty bay water to a maximum extent, the initial or subsequent maintenance dredging in the area of the proposed terminal channels and basins is not expected to cause additional degradation of the Englishtown Aquifer.

B.2 Pier and Trestle Construction Impacts

a. Short-Term

The construction of the pier and trestle would disturb the bottom area as a result of pile installation. This would result in the loss of sediment habitat and the associated benthic organisms at the site of each piling. It is expected that greater losses would occur in the nearshore (less than 10 feet deep) sandy-silt area, due to the higher species diversity and abundance of this area.

Short-term and local increases in suspended sediment would occur due to the driving of the piles. The pile driving would probably have short-term impacts on the behavioral patterns of the local fauna, particularly fish.

b. Long-Term

In general, the long-term impacts of building the new pier and trestle are positive and relate to the placement of a new hard substrate. The placement of a hard substrate allow the settling of fouling communities composed of algae, barnacles, tunicates, sponges, mussels, polychaetes and crustracea. The annual dying back of the fouling organisms, ususally greates in the fall, supplies organic detritus to the area. During the summer the intact communities are also an important food source for fish (Sutherland, 1972).

The introduction of solid substrate into a sedimentary habitat ususally results in increases in species diversity and primary productivity. The availability of epifaunal and benthic species as prey and the presence of both shelter and vertical relief will tend to aggregate and maintain populations of fish currently either absent from or uncommon to the site area.

B.3 Navigational Safety

a. Comparative Safety

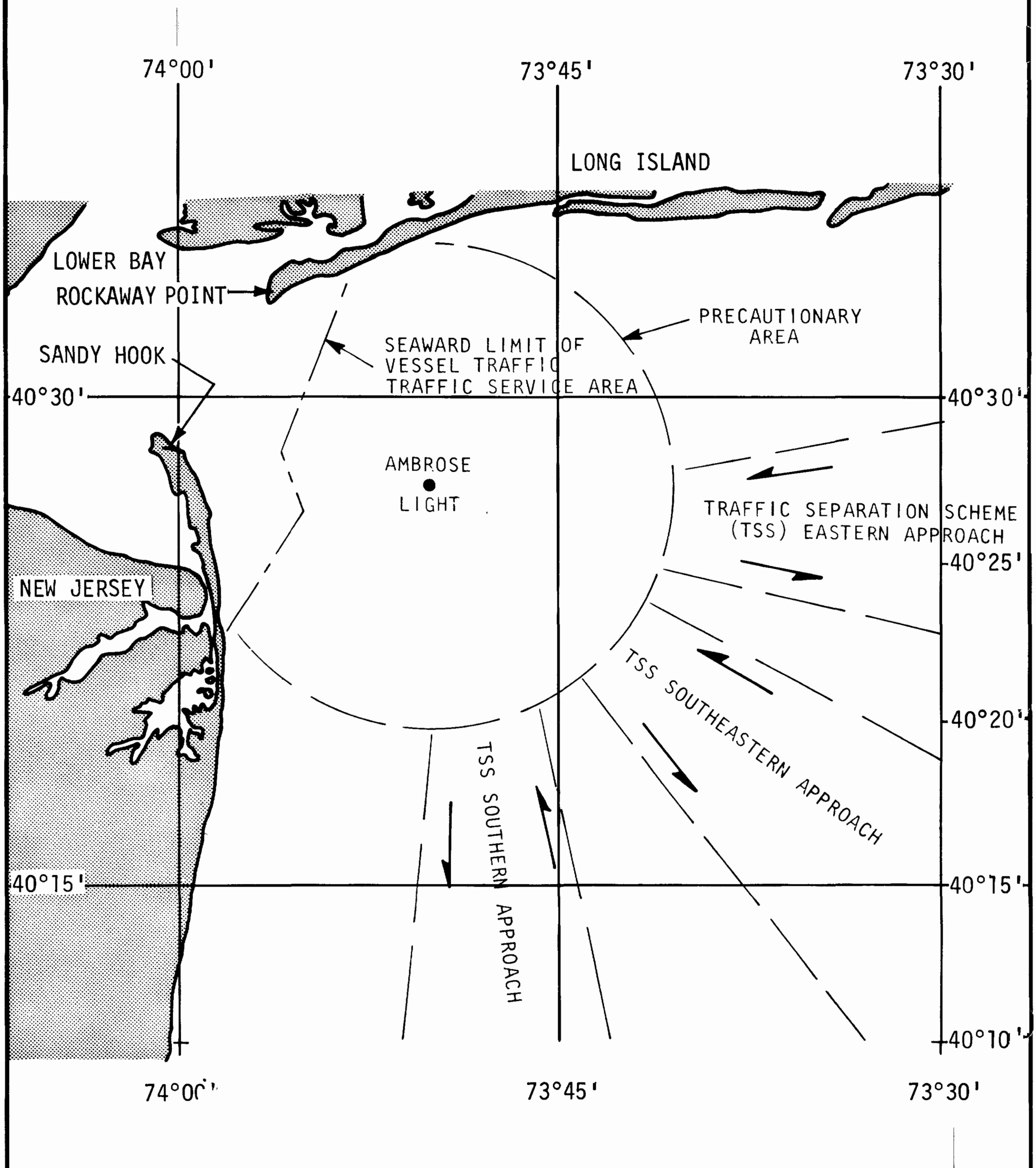
The proposed action represents a substantial improvement with respect to navigational safety compared to the present AOE homeporting at NS Norfolk. This improvement in navigational safety represents a positive impact of AOE home-porting at NWS Earle. Factors leading to this conclusion are discussed separately for the major elements of navigational safety. These are habor approaches, harbor traffic control, vessel traffic density, vessel exposure in port and channel sailing and special hazards. The findings are confirmed by other comparative studies of navigational safety which have examined conditions in the New York and Chesapeake Bay Area.

b. Harbor Approaches

Similar schemes are in effect for the offshore approaches to Chesapeake Bay Entrance and New York Harbor (approaches to existing and proposed homeports, respectively). These schemes are designed as Traffic Separation Schemes (TSS). These TSS impose regulatory controls on vessel movements (traffic lane use and vessel direction requirements) within the TSS approach lanes. TSS are approved by the Intergovernmental Maritime Consultative Organization (IMCO) and are enforced by the U.S. Coast Guard. The regulatory control is imposed only on those vessels actually within the TSS lanes which are registered in nations signatory to IMCO. There is no requirement to use the TSS lanes. Vessels are free to use other approaches if desired.

Traffic separation schemes for the entrances to New York Habor and Chesapeake Bay are shown on Figures IV-2 and IV-3, respectively. In the New York Area the TSS extend out from the precautionary area surrounding the Ambrose Light to a distance of about 35 miles. In the Chesapeake Bay Entrance Area, the TSS extend out to about 11 miles from the Cape Henry Light. A convergence of TSS lanes occurs in both areas. Vessels are advised to exercise extreme caution when traversing these convergence areas (NOAA, 1977 and 1978). This advisory applies to both the New York and the Chesapeake Bay Approaches. Pilotage is required in both areas once the inbound vessels exit the TSS lanes.

Nearshore approaches for both the New York Harbor and Chesapeake Bay Entrances are comparable. Similar schemes of vessel traffic control are in effect. Likewise, similar hazards in traffic convergence areas also exist. Therefore, no significant differences in navigational safety is noted in comparing the approaches to these two areas.



NEW YORK HARBOR APPROACHES

FIGURE IV-2

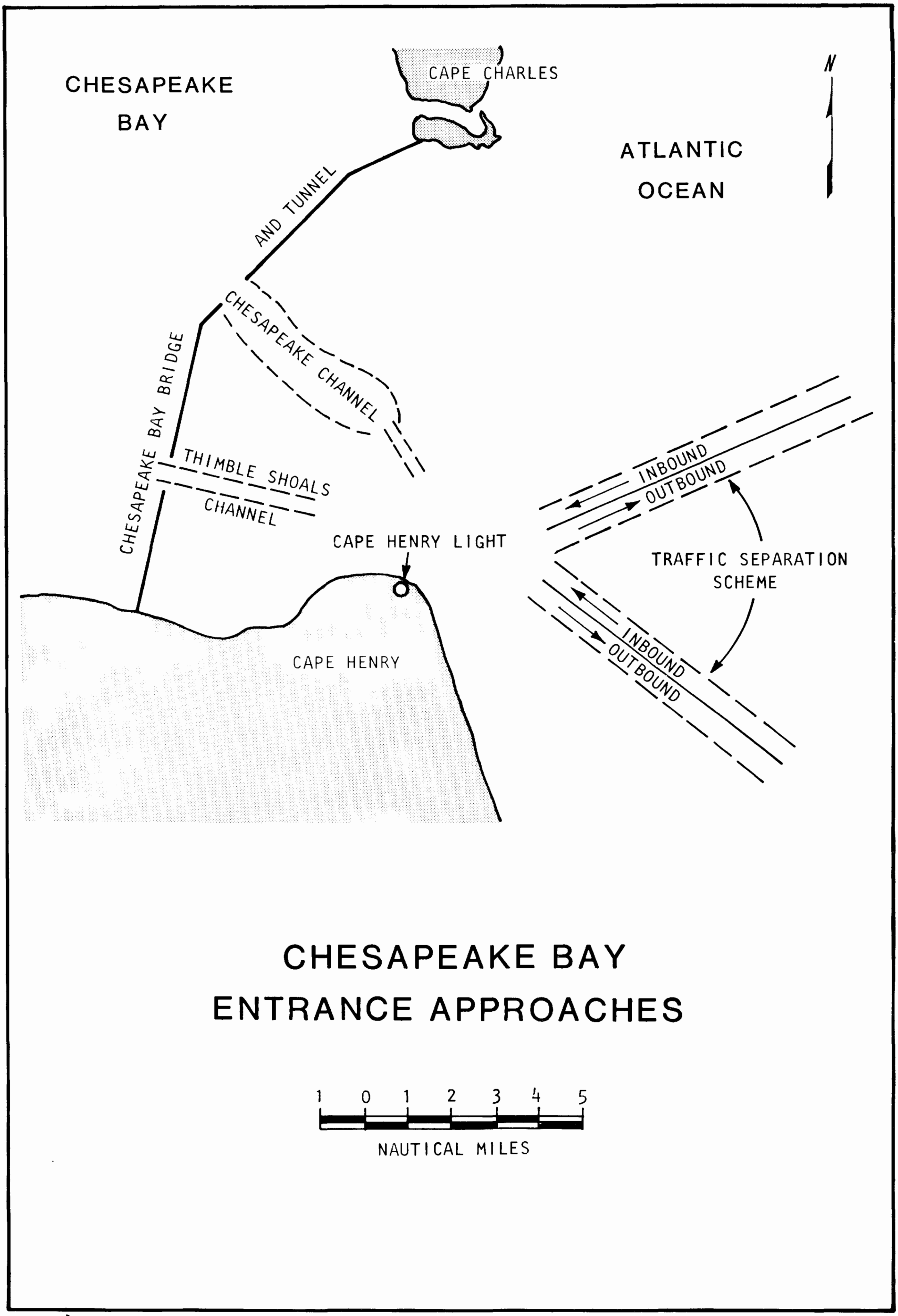

CHESAPEAKE
BAY
CAPE CHARLES
ATLANTIC
OCEAN
N
CHESAPEAKE BAY BRIDGE
AND TUNNEL
CHESAPEAKE CHANNEL
THIMBLE SHOALS
CHANNEL
INBOUND
OUTBOUND
CAPE HENRY LIGHT
TRAFFIC SEPARATION
SCHEME
CAPE HENRY
INBOUND
OUTBOUND
CHESAPEAKE BAY
ENTRANCE APPROACHES
1 0 1 2 3 4 5
NAUTICAL MILES

FIGURE IV-3

c. Harbor Traffic Control

Similar means of Harbor traffic control are in effect in both the existing and proposed homesports. The Coast Guard monitors vessel to vessel communications of vessels subject to the provisions of the Bridge to Bridge Radiotelephone Act (Generally 100 gross tons and above as described in 33 CFR 26). Vessel movement control is exercised by means of this communications net.

The Coast Guard will be implementing Vessel Traffic Service (VTS) in the New York Harbor in the near future (U.S. Dept. of Transportation Feb. 16, 1978). The VTS is a major expansion of the vessel tracking and control capabilities. The system will include the New York Harbor Area, Lower New York Bay, Raritan Bay and the seaward approaches from Ambrose Light. The seaward limits of the proposed VTS area are shown on Figure IV-2. The entire length of the Sandy Hook Channel approach to NWS, Earle is within the VTS area.

Surveillance in the VTS area will be by a combination of radar, low light television and VHF-FM radiocommunications. A computer at the Vessel Traffic Center at Governor's Island will maintain a constant deadreckoning plot of all vessels participating in the VTS. This computer-generated vessel position plot could provide advance warning of encounters between vessels.

The proposed VTS is intended to handle the problems of vessel congestion, reduced visibility, and navigational hazards, not only by requiring vessels to comply with VTS rules but also by providing VTS users with timely, pertinent information needed for safe navigation. With this information, each vessel would be aware of surrounding vessel traffic, developing congestion, and unusual navigational circum-stances. Adjustment of course, speed or route could accordingly be made to avoid the hazardous situations.

The Coast Guard estimates that about 40 percent of collisions and about 31 percent of all accidents could have been prevented in the New York Area by use of a VTS (U.S. Dept. of Transportation, Feb. 16, 1978). The implementation of Vessel Traffic Service is therefore a step which would result in a significant improve-ment in navigational safety both in overall terms with respect to the New York area and in relative terms with respect to the Hampton Roads Area.

d. Traffic Density

New York Harbor proper has approximately three times the reported traffic volume of Hampton Roads (USACOE, 1977). Vessels utilizing Sandy Hook Channel avoid this high density traffic. However, comparative reported vessel traffic totals for the Upper New York Harbor, the New York Habor lower entrance channels and Hampton Roads are provided below. It should be noted that Sandy Hook Channel traffic is reported together with the three other entrance channels (Ambrose, Mainship and Bayside Channels). The actual traffic through Sandy Hook Channel is thus a fraction of the total Entrance Channel traffic.

Reported Vessel Traffic - 1976

	Upper New York Habor	New York Harbor Lower Entrance Channels	Hampton Road
Inbound	101,204	13,711	36,212
Outbound	83,500	13,561	37,559

These figures indicate that vessel traffic in Sandy Hook Channel is significantly lower than Hampton Roads.

e. Vessel Exposure In-Port and Channel Sailing

Current operations at NS Norfolk require three passages through the Hampton Roads area an two passages through the York River Area (approximately 10,000 inbound/outbound vessels per year). Three passages through the area of the Chesapeake Bay Bridge-Tunnel and the convergence zone for the traffic separation scheme near Cape Henry would also be required for each inbound or outbound AOE movement (see Chapter I for discussion of these operational requirements). A typical inbound or outbound movement requires approximately 130 nautical miles of port and channel sailing. A comparable movement into or out of NWS Earle would require only a single 8 mile passage through Sandy Hook Channel. Therefore homeporting at NWS Earle would result in a reduction in the AOE exposure in port and channel sailing of about 94 percent.

f. Special Hazards

Mariners are especially cautioned about conditions in the vicinity of the Chesapeake Bay entrance (NOAA, 1977). These sailing directions warn than:

> "The Chesapeake Bay Bridge-Tunnel complex has an on several occasions suffered damage from vessels. In every case, adverse weather prevailed with accompanying strong winds from the north-west quadrant generally related to a frontal system. Weather deterioration in the Lower Bay is quite often sudden and violent and constitutes an extreme hazard to vessels operating in this area. The proximity of the Bridge-Tunnel complex to main shipping channels and anchorages adds to the danger. Currents in excess of 3.0 knots can be expected in the area."

It should also be recalled that present conditions at NS, Norfolk require that an AOE must make three passages of this area for each inbound or outbound movement (see Chapter I for details). Such conditions greatly increase the risk of collision or ramming of an AOE operating in the Chesapeake Bay Entrance Area.

The constructoin of permanent production platforms related to oil and gas development onthe outer Continental Shelf could provide a possible hazard in the offshore approaches to New York Harbor. The Coast Guard is considering a system of Port Access Routes (PAR's) to provide unobstructed passages through the oil and gas lease areas (USACOE, June 30, 1978). Under the proposed scheme, the Corps of Engineers will control the erection of artificial islands and fixed structures through the issuance of permits pursuant to Law (67 Stat. 462; 43 U.S.C. 1333(f)). Such structures would be prohibited from designated approach lanes. These approach lanes would be alternated on a two year cycle to allow exploration and development over the entire lease area.

In the New York Area, the proposed PAR's would extend seaward from the east and southeast traffic separation scheme approaches (see Figure IV-2). PAR lanes from 2.5 miles to 3.25 miles wide would provide sufficient unobstructed clearance to prevent vessel passage through the oil and gas lease areas from becoming an actual hazard.

g. Other Comparative Studies

Navigational conditions in Sandy Hook Channel have also been studied by the General Accounting Office as a part of an investigation of the safety of the proposed Staten Island LNG Terminal. (General Accounting Office, 1978.) The report concluded that the navigational aids in the New York Area were good to excellent, the traffic into Staten Island (via Sandy Hook Channel) was relatively light and that the harbor depths and minimal currents indicate low to medium navigational risk. The report also studied approaches to Cove Point, Maryland on Chesapeake Bay. The report concluded that the transit of the lower Chesapeake Bay "with its large volume of commercial and naval traffic in and out of the Hampton Roads Area" represented a problem in terms of navigational safety.

B.4 Oil Spill Risk

a. Introduction

Operations which can be characterized as having potential for resulting in oil spills at and in the vicinity of NWS Earle include: (1) the bulk transfer of petroleum products (DFM and JP-5) between the AOEs and the fuel storage tanks; (2) the transfer of oily waste water, including ballast, tank stripping, bilge water, contaminated fuel and other oily waste from the AOEs to the oily waste treatment facilities at the ship fuel replenishment system; and (3) the replenishment of fuel storage via transfer from commercial tankers. In addition to spills which occur during routine port operations, oil can also enter the marine environment as a result of ship collisions and groundings during movements into and out of the Sandy Hook Bay area. The following sections discuss the risk assocaited with these operations.

b. Scope of Petroleum Handling Operations

Petroleum handling operations at NWS Earle are based on the planned homeporting of two AOEs. The total fuel cargo capacity per AOE with allowance for trim and draft is 105,000 bbls of diesel fuel marine (DFM) and 65,000 bbls for jet fuel (JP-5). Thus, in terms of fuel cargo capacity, an AOE is approximately equivalent to a relatively small 30,000 DWT class tanker. Average monthly fuel receipts for two AOEs operating in U.S. waters is approximately 60,000 bbls of DFM and 30,000 bbls of JP-5 for a gross annual total of 1,080,000 bbls. Replenishment of the fuel storage tanks by commercial tanker would occur at the same annualized rate. It is assumed that the fuel replenishment system will operate with a minimum of 50 percent of its design 300,000 bbl capacity on hand at all times. Replenishment would therefore be limited to about 150,000 bbl per delivery. Unit shipments could therefore, be delivered by tankers of a 30,000 DWT class or smaller.

The amount of ballast and other oily wastewaters which must be transferred ashore is extremely variable. Experience has shown the ballast load can range from 0 to 50,000 bbls. Such ballast transfer would take place when AOEs enter port in a light condition.

c. Analysis Approach

A comprehensive examination of the statistics of petroleum spills has been performed by Devanney and Stewart (1974) for the Council of Environmental Quality. They concluded that the underlying random causes of spill occurrences are fairly constant over selected time periods and are independent of each other. Therefore, spill frequency projections can be reasonably made on the basis of frequency counts of spills which have already occurred.

Spill size, however, was concluded to be extremely variable. Most of the spill incidents contained in the data base are very small. The bulk of the volume comes from a few very large spills. Consequently, use of an average spill as a basis for characterization of a spill tends to be misleading. Devanney and Stewart (1974) found that size-frequency data could be approximated by a gamma distribution. The gamma distribution is therefore used in this analysis as a basis of estimating the distribution for frequency an volume of projected spills during homeport activities. The results of separate analyses for AOE related spills and pipeline related spills are presented in later sections.

Assumptions made with respect to this analysis are:

- AOEs are very conservatively taken to be comparable to equivalent weight class tankers. This assumption ignores the differences in overall design, speed and maneuverability, maintenance and operation which if quantified would show the AOE to have a sub-stantially lower risk of an oil spill casuality than the typical world fleet tanker.

- World wide tanker fleet data is taken to be applicable to AOE operations in homeport areas. This assumption ignores the fact that adverse weather and rocky shoal areas near ports, which are contributing factors in the majority of shipping casualties, affect U.S. shipping less than worldwide averages.

- Annual in-port oil spill projections can be obtained by adjusting the annual spill rates by the proportion of in-port time to toal time and in-port spills to total spills.

- All time in-port is very conservatively assumed to be "at risk" time. No reduction in exposure is incurred for periods of mainten-ance and limited operational status during which the probability of spill occurrence is almost nil.

- Reduction in pipeline spill frequency by up to 60 percent can probably be expected for pipelines designed to current standards (Seadock Report, 1975). The historical pipeline spill rate is heavily influenced by incidents involving lines 30 years old or more. The 60 percent reduction in spill frequency makes the historical data more applicable to modern pipeline systems which are hydrostatically tested to Department of Transportation standards.

d. Tanker Spill Data

Spill statistics for tankers are drawn from a worldwide compilation prepared for the U.S. Coast Guard (J.J. Henry Co., 1973). Additional data is available in the form of 1) U.S. Coast Guard Reports (1971 and annually thereafter) which cover all spills within 12 miles of the U.S. Coast and 2) U.S. Navy Reports (Naval Environmental Support Office, 1973 and thereafter) which cover all Navy related spills worldwide. The U.S. data bases (Coast Guard and Navy) do not include the full loss of a loaded vessel. As a result, they do not adequately reflect the possibility of very large spill events. Upper limits on AOE-related spills are estimated using the worldwide data while lower limits are obtained using the U.S. data.

Table IV-13 presents the annual probabilities of a tanker polluting incident as obtained from the worldwide data base. The overall probability of occurrence of a spill event is 0.03334 per vessel-year. Table IV-13 also presents the annual probabilities for a coastal spill. These coastal probabilities are obtained by adjustment for vessel time in coastal waters and the percentages of accidents occurring in coastal waters. The overall probability of occurrence of a coastal spill is 0.02584 per vessel-year.

This probability can be applied to AOE operations at NWS Earle by considering the total AOE coastal exposure time. The proposed action calls for two AOEs to be homeported at NWS Earle. A maximum total exposure time of 8.5 months (0.71 vessel-years) is estimated from a review of the operations and homeport cycles of these vessels. The resultant annual probability of an AOE-related spill occurring in the vicinity of NWS Earle is 0.01830. This is equivalent to an average spill recurrence interval of about 55 years.

Table IV-14 presents the mean size of tankers spills as obtained from the various data bases. As indicated earlier, these values can be misleading when considered by themselves. The mean values are used in a size-frequency analysis which gives a more accurate picture of the spill volume-frequency relationship.

e. Pipeline Spill Data

Spill data for pipeline systems are obtained from pipeline failures during the six year period of 1968 to 1973 (U.S. Dept. of Transportation, 1969-1974). Table IV-15 provides the breakdown of pipeline spills by cause. These data are then adjusted to take into account the rigid standards which the proposed pipeline system must meet compared to the conditions of the 30 year and older pipelines whose failures account for a significant portion of all pipeline failures. The annual ffrequency of a pipeline failure at NWS Earle is also projected based on the adjusted frequencies and the total length of pipeline in the proposed system. The resulting annual frequenct of failure is 0.00425. This is equivalent to an average spill recurrence interval of about 235 years.

TABLE IV-13

ANNUAL PROBAILITY OF TANKER POLLUTING INCIDENTS

Casual Factor	Worldwide[a] Data Base Spill Probabiity (Per Vessel-Year)	Coastal Spill Probability (Per Vessel-Year)
Collision	0.00785	0.00897
Grounding	0.00745	0.00532
Structural Failure	0.00887	0.00408
Ramming	0.00177	0.00051
Fire	0.00292	0.00338
Explosion	0.00250	0.00220
Capsizing	0.00088	0.00045
Breakdown	0.00110	0.00093
All Causes	0.03334	0.02584

(a) Source: J.J. Henry Co, 1973, Probabilities for Tankers in 30-70,000 DWT range.

TABLE IV-14

MEAN SIZE OF TANKER SPILLS

Data Base	Vessel Types	Number of Spills	Total Volume Spilled (BBLS)	Mean Spill Volume (BBLS)
Worldwide[(a)]	Tankers	376	3,208,784	8,534
U.S. Coastal[(b)]	Commercial Tankers Only	3,318	284,452	86
U.S. Navy[(c)]	AO Class Vessels Only[(d)]	111	8,119	73

[(a)] 1971-1972 Source: J.J. Henry Co, 1973.
[(b)] 1971-1975 Source: U.S. Coast Guard, 1972-1976.
[(c)] 1972-1976 Source: Navy Environmental Support Office, 1973-1977.
[(d)] Auxiliary, Oil Class Includes AO, AOE, AOG, AOR, etc.

TABLE IV-15

ANNUAL FREQUENCY OF PIPELINE SPILLS

Causal Factor	Annual Frequency[a] Per Mile	Adjusted[a] Annual Frequency Per Mile	Projected[b] Annual Frequency At Earle
Corrosion, External	0.00054	0.00022	0.00179
Equipment Rupturing Line	0.00032	0.00013	0.00106
Defective Pipe Seam	0.00012	0.00005	0.00040
Corrosion, Internal	0.00009	0.00004	0.00030
Rupture of Previously Damaged Pipe	0.00003	0.00001	0.00010
Various System Defects	0.00005	0.00002	0.00017
Various External Events	0.00005	0.00002	0.00017
Other	0.00009	0.00004	0.00030
All Causes	0.00128	0.00051	0.00425

[a] Source: Dept. of Transportation, 1969-1974.

[b] 60 percent reduction in frequency to account for rigid design standards.

[c] Pipeline arrangement at Naval Weapons Station, Earle

Marine Diesel Fuel (DFM)	One -	16 in. dia. pipeline
Turbine Fuel (JP-5)	One -	10 in. dia. pipeline
Ballast and Oily Waste	One -	10 in. dia. pipeline
Total Pipeline Length	8.3 miles	

The mean size of the pipeline reported to the Department of Transportation during the six year analysis period is 1083 bbl. The volume of the individual pipelines flowing full are 1311 bbl each for the two 10 inch lines and 2623 bbl for the 16 inch line. The mean spill size thus represents a significant portion of the individual line capacity. A major failure would be required to achieve spill volumes of this quantity. As indicated earlier, the mean spill value can be misleading when considered by itself. The mean spill volume is used in a size-frequency analysis which gives a more accurate picture of the spill volume-frequency relationship.

f. AOE-Related Spill Estimates

The result of the frequency analysis of the tanker spill data are provided in Table IV-16. The smallest spill class (less than 1000 bbl) has the highest relative frequency of occurance. The next largest spill class (1000-10000 bbl) is 9 times larger in range but has a frequency of occurance of only about 2 times as high. The largest spill class (greater than 10,000 bbl) has a range nearly 210 times as large but only an annual frequency of occurance which is comparable to that of the smallest spill class. Therefore, most of the spills can be expected to be small (less than 100 bbl). Larger spills have a very low probability of occuring.

The spill expectation is a useful indicator of anticipated oil spill effects. The expectation of the outcome of a set of events, each of which has a certain probability of occurence associated with it, is the probability-weighted average of those events occurences. In this analysis, the spill expectation is the annual average volume of the projected spills, as it would develop over a long period of time. This analysis uses the worldwide data base to arrive at an extreme upper limit to the annual homeport spil volume expectation. The Navy data base is used to estimate a lower limit. Using these limits, the projected annual spill expec-tancy ranges from a low of 1.3 bbl (55 gal.) to a high of 156 bbl (6552 gal.). A qualitative evaluation of the effects of the very conservative assumptions used in this analysis suggests that the actual annual spill volume expectation lies closer to the lower limit value. In any case, the expected spill volumes are low and do not provide a reason for major concern.

TABLE IV-16

HOMEPORT SPILL SIZE AND FREQUENCY

Spill Class (bbl)	Annual Frequency	Spill Expectation (bbl)	Return Period (Years)
Less than 1,000[c]	0.004	3.1	256
1,000 - 10,000[a][c]	0.009	42.7	116
Greater than 10,000[b][c]	0.005	110.2	218
All Spills[c]	0.018	156	55
All Spills[d]	0.018	1.3	55

[a]Note: Maximum credible spill for homeport conditions is considered to be the total volume of the largest wing tank - 7,800 bbl.

[b]Maximum capacity of an AOE is 224,000 bbls

[c]Worldwide data base projections (upper limit values)

[d]Navy data base projections (lower limit values)

g. Pipeline Related Oil Spills

The annual spill volume expectation for the proposed pipeline system is conservatively estimated to be 4.6 bbl. The low expectation indicates that the pipeline does not represent a dominant environmental factor. Since the spill expectation for the pipeline is small compared to the upper limit for the AOE (156 bbl), the discussion of spill impacts in the following sections will focus primarily on AOE-related spills.

h. Oil Released Into The Environment

Not all fuel spilled woul;d be released into the environment. The capability to control and recover spilled fuels depends on the volume of the spill. Discussion of the possibility of release of fuels into the environment is provided in this section with respect to three spill size classes defined by the U.S. Navy (NAVFAC, 1977) as:

- Minor Discharge: A discharge of less than 1000 gallons (24 bbl) of oil in inland waters.

- Medium Discharge: A discharge of 1000 to 10000 gallons (24 to 240 bbl) in inland waters.

- Major Discharge: A discharge of more than 10,000 gallons (more than 24 bbl) in inland waters; discharges that (1) generate critical public concern; or (2) poses a substantial threat to public health or welfare are also clasified as major discharges.

Minor discharges characterize most of the Navy spills including AOE spills. Table IV-17 shows that 96.8 percent of all Navy spills fall within the definition. Such spills are easily controled and cleaned up by on-site equipment provided specifically for that purpose (see Chapter I). Very little oil, if any, from

TABLE IV-17

DISTRIBUTION OF NAVY SPILLS BY VOLUME

Spill Volume Class (Gallons)	Cumulative Percentage (Spill Less Than or Equal To Spill Volume Class)
0 - 50	69.2
51 - 100	80.8
101 - 200	87.4
201 - 300	90.0
301 - 400	91.5
401 - 500	93.6
501 - 1000	96.8
1001 - 2000	98.2
2001 - 5000	99.4
75,000	100.0

Source: Navy Environmental Support Office (NESO) 1973-1977.

over water spills of this nature would be released into the environment. Any sized spill from sections of the pipeline passing through the wetlands would, however, be difficult to clean up so as to prevent or reduce damages to these areas.

Medium spills can be contained by on site equipment if the spill occurs in the general vicinity of the pier. The higher volume of this spill class suggest that minor collision and grounding damage while in transit through the approach channels can be contributing causes to this class of spill. In such cases, spill contain-ment equipment located on the Navy pier would be less effective in controlling the spill, primarly because of the time lost in transferring the equipment to the spill site and because of the more open water conditions of the channels. Depending on the actual location of the spill and conditions at that location, outside assistance may be required to control and clean up such a spill.

Major spills would provide the greatest possibility for the uncontrolled release of fuels into the Raritan Estuary. Spills in the range of 1,000 to 10,000 bbls have a very low probability of occurrence and have a very conservatively projected recurrence interval of 116 years (see Table IV-16). Substantial quantities of spilled fuels could escape recovery efforts. Discussion provided in the following paragraphs describe the nature and effects of such unrecovered spills.

i. Fuel Characteristics

The principal petroleum products transferred to and from the AOEs are JP-5 turbine fuel and Marine Diesel Fuel (DFM). The various properties of these two fuels with respect to oil spill behavior are provided in Table IV-18.

Turbine fuel is a clean, light colored, close cut distillate fuel of low volatility. When spilled on water, JP-5 spreads rapidly into a thin film from which evaporation can proceed at a moderate rate. Evaporation leaves little undesirable residue. Because of these characteristics, the decision to recover and/or control JP-5 spills depends primarily upon the criteria of spill magnitude, location and

TABLE IV-18

PROPERTIES OF FUELS RELATIVE TO SPILL BEHAVIOR

Property	Description	Turbine Fuel JP-5	Marine Fuel Fuel	Relationship to Spill Behavior
Viscosity	Resistance to flow	Low	Low	Low viscosity fuels spread easily over surface
Surface Tension	Resistance to spread over another liquid	Low	Moderate	Low surface tension liquids will spread more readily
Volatility	Tendency to evaporate	Low	Low	High volatility favors evaporation - if combined with low flash point, explosive hazard
Relative Solubility	Tendency for all or portion of spill to dissolve in water	Very Low	Very Low	Soluble components of spill may be toxic to aquatic organisms
Density (specific gravity)	Mass per unit volume relative to water	Low	Low	Fuels with high specific gravities (water SP GR = 1) will generally sink - smother bottom organisms and affect shellfish
Emulsibility	Tendency to form stable suspensions with water	Very Low	Low	High emulsibility spreads fuel throughout water column, extends possible contamination range. Affects free swimming species.
Pour Point (maximum)	Lowest temperature at oil will pour	Low	Low ($\sim 20^{\circ}F$)	As pour point is approached, spill spread decreases
Flash Point (minimum)	Tendency to ignite	Moderate ($\sim 140^{\circ}F$)	Moderate ($140^{\circ}F$)	Low flash point combined with high volatility results in explosive hazard.

Source: NAVFAC, 1977.

environmental conditions. In general, open area recovery is not recommended unless the spill is large or is likely to reach shore (NAVFAC, 1977).

The overall properties of marine diesel fuel are also provided in Table IV-18. It is slow to evaporate and may leave a large and undesirable residue. It is a heavier fuel and is more visible than is JP-5. Marine diesel fuel is somewhat slower in spreading than is JP-5.

j. Fuel Slick Spreading

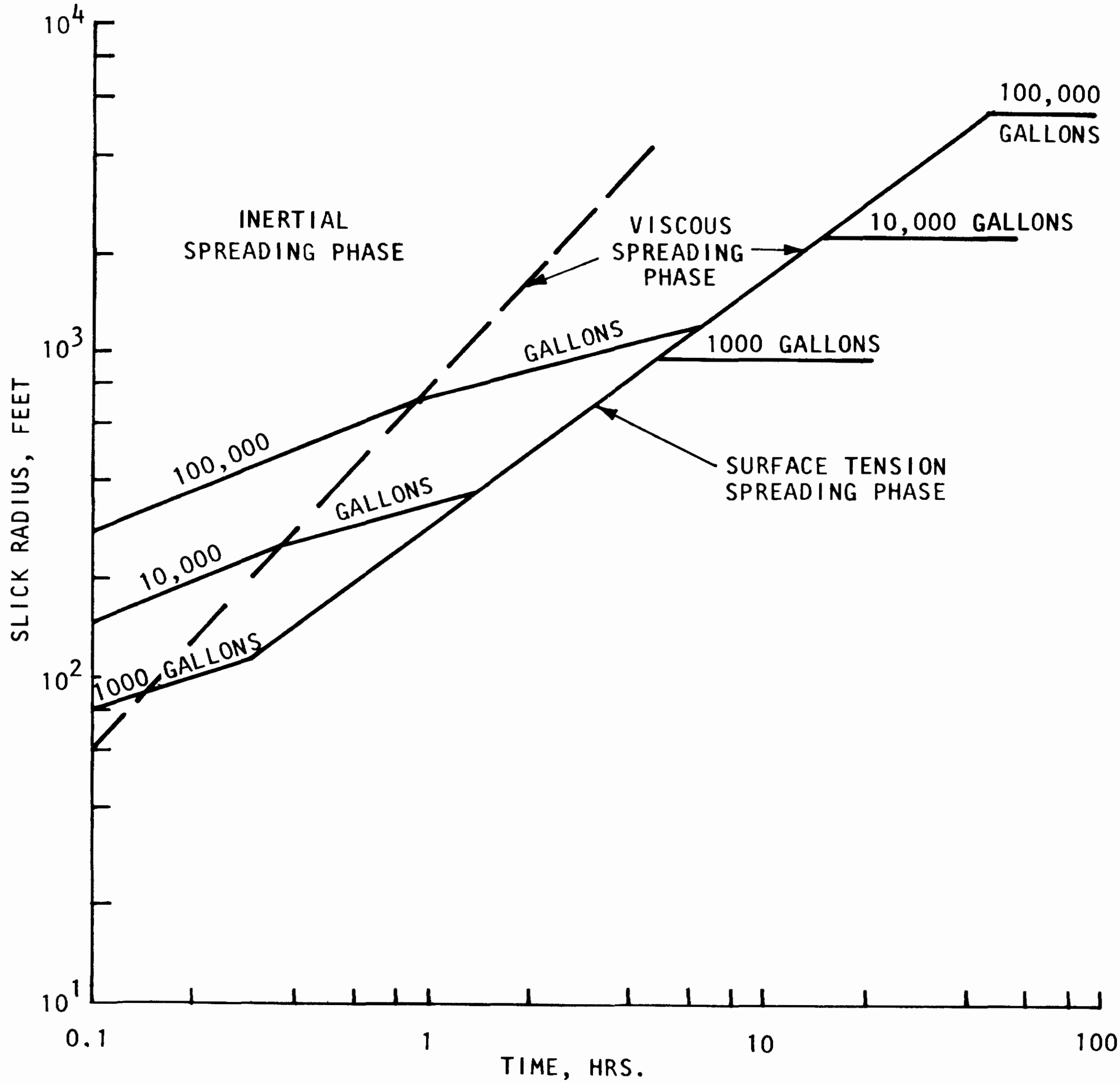
The areal spreading of fuel oils passes quickly through a gravity controlled regime, then into a viscous spreading regime and finally into a surface tension spreading regime. The slick spreads and thins out to a film thickness on the order of 0.001 inches in thickness. At some limiting thickness, the surface tension forces of water and oil balance and the spreading ceases. This resultant film thickness involves a surface density of about 1 to 2 bbl/acre. Approximate densities and surface areas of different spills are:

Spill Size		Density	Area
(Gal)	(bbl)	(bbl/acre)	(sq mi)
1,000	(24)	0.4	0.1
10,000	(238)	0.6	0.6
100,000	(2381)	1.1	3.3

The growth of the slick as a function of time is shown on Figure IV-4 for these three different spill sizes.

k. Fuel Slick Transport

The drift of the fuel slick from the site of a slipp is governed by the combined effects of current, wind and waves. It is generally agreed that on calm water, oil drifts at approximately three percent of the overwater wind speed,



SLICK SIZE AS A FUNCTION OF TIME FOR VARIOUS SPILL SIZES

FIGURE IV-4

regardless of the physical properties of oil and water, size of spill and its spreading tendency. This wind drift is then subject to modification by currents and waves. The apparent contribution of a water current to the combined wind-current drift seems to be less than the current drift in the absence of wind. Experimental data suggests that about 56 percent of the current drift may be taken as a contribution to the combined wind-current drift. Water waves by themselves produce a surface drift due to a second-order mass transport effect, but the joint magnitude of the wind-wave effects is not yet fully understood (Tayfun and Wang, 1973).

Figure II.C-5 shows the net circulation within the Raritan Estuary. The shore areas most subject to fuel spill grounding due to a spill in Sandy Hook Channel or in the vicinity of the Navy pier include the norther portion of Sandy Hook Unit of the Gateway National Recreation Area, the New Jersey shore of Raritan Estuary to the west of the pier and the southeast tip of Staten Island. The most frequently occurring wind direction is in the sector between NNW to SSW (totals to 56 percent of mean annual wind direction distribution). Winds in the sector between NNE to ENE contributes about 18 percent of the mean annual wind direction distribution.

Winds from the NW would subject the Sandy Hook western shore to oil spill groundings. Currents, especially the long duration ebb flow out of the mouth of the Shrewsbury River in the southern extremity of Sandy Hook Bay, act in opposition to these winds and may afford some protection to the Shrewsbury River mouth area and nearby portions of Sandy Hook.

Winds from the NE would act in conjunction with the net circulation and drive fuel to the New Jersey bay shore between the Raritan River mouth and the Navy pier. Winds from the SW would help to push any fuel slick out of the estuary.

Other portions of the Sandy Hook Bay shore area could also be subject to spill grounding. However, opposition of average winds and currents reduce the potential for such groundings.

B.5 Oil Spill Impacts

As indicated by the above risk analysis, it is unlikely that oil would enter the estuarine environment in sufficient quantity to cause significant impact on the system. However, should this occur, several impacts are possible.

Physical effects of spilled oil relate to the soiling of structures and pleasure craft and the potential disruption of navigation.

Oil is harmful to living organisms because it can: (1) physically interfere with movement, respiration or habitat availability; (2) release toxic substances to plants and animals; (3) reduce or eliminate food sources; and (4) change behavior patterns.

a. Plankton

In general, unless a very large spill occurs, the effects on plankton are likely to be of short-duration due to their short reproductive, and life cycles, and the flushing action of currents. However, a large spill which results in extensive mortality to young planktonic forms of larger invertebrates (meroplankton) could affect the species population for several years.

b. Benthos

Benthic organisms, due to their limited mobility are more susceptible to oil spill impacts. Adverse impacts on benthic populations relate to the sinking and accumulation of oil on the bottom. This bottom accumulation can limit mobility of benthic organisms and cause asphyxiation. Weathered oil particles which sink to the bottom would have a relatively minor impact.

c. Fish and Other Nekton

Oil spills may affect fish by: (1) releasing toxic portions of oil dissolved in the water column; (2) coating gills with oily residue; (3) reduction in oxygen levels; (4) uptake in food web of oil contaminated organisms; and (5) loss of food supply or habitat.

Direct oil effects from toxicity or coating of gills is not considered to result in significant loss for fish of the upper waters like bluefish and weak-fish which are highly mobile and range widely. Demersal fish such as the flounder are not as mobile as upper water level species. However, significant losses are not anticipated either due to gill coating or direct toxicity. The impact here would be reduction in abundance due to reduced food supply. Water movement in the project area should be sufficient to prevent oxygen suppression in an oil slick area. Sinking oil could, however, add to the BOD of bottom waters and lower oxygen levels in confined areas. Fish and larger nekton would avoid areas of low oxygen and the resulting impact would be a temporary reduced bottom habitat and food supply.

Tainting of flesh in fish can occur directly through concentration of hydrocarbons in the food web. Mass fish kills are not expected in the open waters of the project area due to an oil spill. Mortality of larval and juvenile forms can occur in these more sensitive life stages. Fish and other nekton in a reproductive state are more susceptible to oil spill impacts. Proportional losses of benthos as a food supply would be reflected in the recovery rate for repopulation of fish or in their ability to find a suitable food supply elsewhere.

d. Chronic Oil

Certain small amounts of oil can be expected to spill during loading and unloading operations at the pier area. These should be very minimal considering such operations would be manned. These can occur during pipeline connection operations or from leaks in the pipelines used for moving the oil.

Some effect to fish, plankton and benthos can be anticipated from chronic spill problems. These effects would be localized and of no significance. Depending on size of such spills, some mortality of upper zone intertidal organisms (nereid polychaetes, barnacles, algae, mussels, tunicates) on pier pilings can be expected from oiling as tide levels rise and fall. However, this same tidal action will also remove oil previously deposited.

C. IMPACTS ON THE OCEAN ENVIRONMENT FROM DREDGE DISPOSAL

C.1 Generic Impacts

a. Physical and Chemical Impacts

The proposed action calls for the dredging of approximately 11.1 million cubic yards of sediment in the proposed terminal channel and basin at NWS Earle and the existing channels leading out into the open ocean. The projected depth of the proposed action is -45+2 feet MLW. The quantity of dredged material in the proposed action exceeds the average annual total of maintenance and new dredging for New York Harbor and adjacent waterways, which are currently dumped at the dredged disposal site (Mud Dump). However, the overall chemical impact of the dredged material disposal would not be nearly as large as the associated with the currently dumped dredged materials.

Approximately 64.5 percent (7.29 million cubic yards) of the volume of materials which would be dredged for the proposed project is composed of muds. The remaining 35.5 percent (4.01 million cubic yards) is composed of predominantly medium to fine sands with small gravel and silt components. Only the mud fraction need be considered for disposal at the dredge material disposal site.

One of the most important impact considerations is the degree to which the dredged materials are contaminated. Of the 7.29 million cubic yards of mud materials to be dredged, only a small fraction (1.01 million cubic yards) is expected to be contaminated to any significant degree. The dredged materials would consist of a large fraction of material never directly subjected to industralized society's heavy pollutant loading. Based on expected sedimentation rates within the muddy portion of the project area, it is expected that only the top one to three feet of sediment has been exposed directly to these waste loadings. However, it is believed that the organic content of the pre-industrial age (beyond two centuries ago) may have a small short-term impact upon disposal.

The dredged material disposal site in the New York Bight Apex is located within the zone of influence of a number of major contaminant sources including: (1) the sewage sludge disposal site; (2) the acid waste disposal site; (3) the Hudson-Raritan estuarine outflow; (4) the cellar dirt (construction rubble) disposal site; and (5) coastal sewage outfalls (Figure II.D-1). In view of the complexity of contaminant sources and oceanographic processes within the Apex, it is exceedingly difficult to distinguish the impacts on the ecosystem that have resulted from dredge disposal alone.

Significant impacts which have been potentially ascribed to the disposal of contaminated dredge material include:

- direct oxygen depletion associated with the oxygen-demanding substances within the dredge spoil;
- indirect oxygen depletion occurring as a result of excess nutrient loading from the dredge material;
- increases in trace metal concentrations in the water column and within the sediments;
- increases in organic compound concentrations in the water column and within the sediments; and
- increased turbidity within the water column in the general vicinity of the disposal site.

1. Oxygen Depletion - The summertime depletion of oxygen in bottom waters of the New York Bight Apex has been identified as one of the most serious current problems of the ecosystem. When a stable thermocline is formed, several factors contribute to the depletion of oxygen in these bottom waters. The resultant low oxygen concentrations have been linked to shellfish and fish mortal-

ities in the Bight Apex (NOAA-NMFS, 1977). Segar and Berberian (1976), have attributed the oxygen depletion to the oxidation of oxidizable organic carbon generated by in situ primary production and the numerous waste sources of oxygen-demanding materials.

Estimates of oxygen demand attributable to primary production have been estimated at 17 million kilograms of oxygen per day (Kg 0_2/day) and those from dredge spoil and sewage sludge disposal at 2.1 million and 1.1 million Kg 0_2/day, respectively (Segar and Berberian, 1976). Oxygen demand originating from substances contained within the Hudson-Raritan estuarine outflow has been estimated to be on the order of 5.0 million Kg 0_2/day (Segar and Berberian, 1976).

The anomalously high primary productivity is most probably a result of the large inorganic nitrogen input from sewage treatment plant effluents. The observed variability in oxygen depletion can be attributed to both the variability in primary production and physical mixing processes. Extreme anoxic conditions, such as those observed in the summer of 1976, have been linked to both high nutrient loading as well as persistent southerly winds which may have induced upwelling of nutrient-rich waters from below the thermocline.

The contribution of dredge spoil disposal to oxygen depletion in bottom waters is certainly important, but not the major cause of this condition. If the entire oxygen demand of the dumped dredge spoil were to be utilized to consume oxygen in the water column, the total consumed oxygen would be an order of magnitude less than that attributable to the decomposing organic carbon resulting from photosynthetic production. However, it is not expected that the total oxygen demand in dredge spoil will ever be fully utilized both because a large fraction of the demand is from slowly oxidizing refractory materials, and because a large fraction will be sequestered by burial and will not be available for use. Based on the seabed oxygen consumption rates observed at the dredge disposal site (Thomas et. al., 1976), it has been suggested that as little as two percent of the daily input of oxygen demand from dumped dredge material contributes to seabed oxygen consumption after the settling of the dumped material to the bottom (Segar, 1977, written communication).

As the dredge material settles through the water column, it consumes oxygen on the same order of magnitude as that expected from dredge materials on the sea floor. Experimental work performed by Lee et. al. (1975) has indicated that the oxygen demand occurring in the water column during the first hour of disposal from a wide variety of polluted dredge spoil types ranges from 1.6×10^5 to 2.5×10^6 milligrams of oxygen per cubic meter (mg $0_2/m^3$) of dredged material. It has been suggested that in waters with low levels of oxygen saturation, the act of dumping could result in short-term periods of anoxic conditions within small pockets of the water column (Segar, 1977, written communication). However, dilution and mixing should confine these episodes to an appreciable degree. Another mitigating effect on this water column oxygen depletion is that entrained, relatively oxygen-saturated water is held with the dredge spoil. These waters may aid in raising oxygen concentrations to a small degree.

2. Nutrient Loading - Segar and Berberian (1976), have estimated that 6.3×10^4 kilograms of nitrogen per day are supplied to the New York Bight Apex by dredge spoil disposal (based on average daily loadings). This amount can be compared with the estuarine outflow nitrogen input of 1.2×10^5 Kg/day, the atmospheric input of approximately 6.4×10^4 Kg/day, and the sewage sludge dumping input of 1.7×10^4 Kg/day (Segar and Berberian, 1976). These estimates suggest that dredge disposal nitrogen inputs represent approximately one percent of the total nitrogen supply to the New York Bight Apex.

The most important element of nutrient loading impact assessment is the determination of the availability of the nutrient (in this case the limiting nutrient, nitrogen) to phytoplankton. The rather large input of inorganic nitrogen compounds in the Hudson-Raritan estuarine outflow probably remains in the euphotic zone long enough to be entirely consumed by phytoplankton production. The atmospheric input of nitrogen delivered by rainfall, is likewise probably entirely available for photosynthesis. On the other hand, a large fraction of dredge spoil nitrogen is not present in forms readily available for photosynthesis (Segar, 1977, written communication).

It is also expected that a large portion of the nitrogen in dumped dredge spoil will be carried down relatively rapidly through the thermocline and away from the euphotic zone where thorough utilization can generally occur. One possible negative impact of the dredge disposal with respect to nutrient loading is the potential for short-term toxic concentrations of ammonium which may occur as a result of the release of ammonium during disposal (Segar, 1977, written communication).

3. Trace Metal Loading - Since there exists a wide temporal and spatial variability in trace metal concentrations in the water column throughout the New York Bight, only significant observed alterations in ambient conditions can be clearly established as being related to any given point source (e.g. dumpsite, outfall) of trace metals. The only anomalous trace metal concentrations that has been suggested in the water column over the dredge disposal site are manganese and cadmium (Segar and Cartillo, 1976). They reported that high cadmium and manganese concentrations were generally observed in near bottom water at a station nearest to the dredged material disposal site. They suggest that these high concentrations were caused by the disposal of dredged material.

Although trace metal concentrations in bottom sediments through out the New York Bight Apex are quite elevated, the concentrations observed at the dredge disposal site are the highest of all. The average concentrations of iron, cobalt, nickel, silver, lead and copper in sediments at the dredge disposal site are significantly higher than anywhere else in the Bight Apex (Segar, 1977, written communication). The impact of anomalously high metal concentrations in sediments is related to the quantity of metals released to solution and also the bioavailability of the metals from the sediments. The quantity of metals released to solution with the exception of manganese and cadmium is probably quite small, and toxic concentrations are generally not expected in bottom and pore waters (Segar and Cantillo, 1976). Segar and Cantillo (1976) using conservative assumptions regarding additional metal inputs from seawater in the Apex, conclude that copper and zinc (as examples of heavy metal flux) mean residence time could not exceed six months and probably was closer to 10 to 50 days. This suggests that such contaminants are removed from the Apex only a little slower than the water column is flushed (about one week) (Ketchum et al., 1951).

The long-term hazards of dredged material polluted with metals are unknown. The accumulation of metals in marine organisms may be lethal, sub-lethal yet deleterious or may render a resource unfit for human consumption. A detailed discussion of the mechanisms and conditions important to the mobility and availability of trace metals from dredge disposal is presented in Appendix J and a discussion of bioaccumulation related to these contaminants is pre-sented in Section C.2b, below.

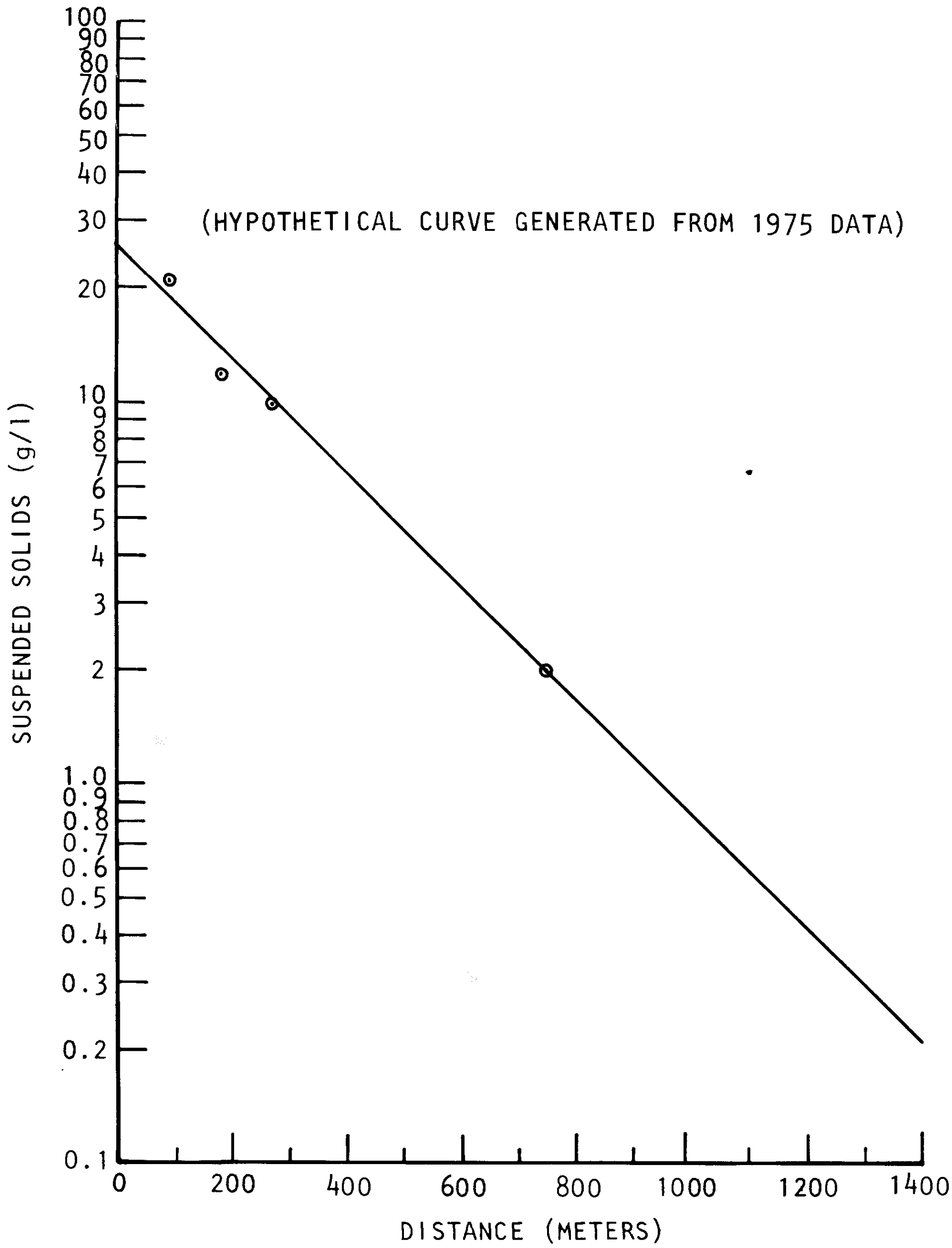
4. Organic Compound Loading - Important organic compound contaminant inputs include large quantities of petroleum hydrocarbons and chlorinated hydrocarbons such as pesticides like aldrin, dieldrin, DDT, DDE, and TDE as well as polychlorinated biphenyls and many other more exotic compounds. The importance of these compounds as threats to the environment is based on their relatively slow decomposition and their tendency to concentrate in the fatty tissues of organisms (Goldberg, 1972).

Data on the distribution of chlorinated hydrocarbons in both the water column and sediments is extremely scarce for both the New York Bight Apex and for the dredge disposal site. Because of this marked paucity of data, it is very difficult to determine the extent of specific impacts from individual point sources such as the dredge disposal site. However, it is expected that short-term increases in water column concentrations of chlorinated hydrocarbons does occur, and build up in sediment concentrations of these compounds is expected. The overall impact on the biota is difficult to assess.

The input of petroleum hydrocarbons from dredged materials is evidenced by the anomalously high concentrations of C_{15+} saturated hydrocarbon and C_{15+} aromatic hydrocarbons at the dredge disposal site. Although these compounds are generally less toxic than the chlorinated hydrocarbons, they may still pose a threat to organisms in the vicinity of the disposal site. The scope and nature of this impact cannot be defined with the data currently available.

5. Turbidity - Sediments with cohesive properties behave differently when released. Laboratory simulations of minimally disturbed sediment with a water content near its in-channel value (sediment clumps from the clam shell operation) will pass through the water column and mound temporarily on the bottom. The slurry associated with the clumps in the clam shell will also pass through the water column relatively intact, and upon impact with the bottom, will develop a density flow or a turbidity cloud confined to the bottom (Sustar et al., 1976).

For disturbed mud type sediments (high clay-silt content), the released materials will settle in the form of a cloud, or density current. Settling velocities calculated for individual particles do not apply during this convective descent phase. The time during which the cloud is within the upper portions of the water column is short, so that ambient water currents, except near the bottom, are of little consequence in material placement. Once the cloud contacts the bottom, the transport is characterized by horizontal spreading. Studies by Sustar et al. (1976), have measured the horizontal decay of the plume during disposal operations. Figure IV-5 is a hypothetical curve generated from these measurements. The curve indicates that the suspended sediment cloud could travel as far as 1400 meters before approaching background concentration.



SUSPENDED SOLIDS CONCENTRATION DECAY

SOURCE: SUSTAR ET AL, 1976

FIGURE IV-5

The dumping of dredge material is known to increase turbidity in the water column for several hours following discharge. This increased turbidity causes a decrease in light transmission, which can result in the reduction of primary production. The reduction in primary production may possibly be thought of as beneficial since the excessive photosynthetic production in summertime can lead to episodes of anoxia below the thermocline as the organic carbon settles and decomposes. It is not expected that the suspended solids concentration is appreciably affected over the long-term. The suspended particle load in bottom waters, however, is expected to be relatively significant. It is not possible to accurately define the overall impact of suspended solids in near-bottom waters on the indigenous biota.

6. Summary - The following impacts are expected based on the foregoing analysis:

- Short-term localized decreases in the degree of oxygen saturation in the water column in the vicinity of the dredge disposal site are expected. Should ambient oxygen concentrations be sufficiently low prior to disposal and oceanographic mixing be quite low, initial oxygen demand from the dredge material may be sufficient to promote short-term localized zones of anoxia. However, it is expected that these negative effects should last only several hours at most. No significant long-term effects on the oxygen concentration are expected.

- Minor modifications in the pH, redox potential, and ionic strength of the sea water would occur in the near vicinity of the disposal site. Moderate mixing should result in the returning of conditions to original status very shortly after disposal.

- Some contaminants present in the pore waters of the dredged material would be released in the upper portions of the water column. The release should not appreciably affect the concentration of toxic trace elements and organic compounds in the water column. Thorough mixing in the water column should rapidly dilute any concentrations which may prove deleterious to the local biota.

- The majority of contaminant release from pore waters, desorption, dissolution, and other mobilizing mechanisms should take place in the near-bottom waters. Minor short-term increases in the concentration of trace metals and organic compounds is expected in near-bottom waters. This impact should also be considered readily reversible.

- Measurable quantities of manganese may be released to the water column. Should the water column remain moderately oxygenated, release of significant quantities of other trace metals is not expected to occur. Slow release of cadmium in very small quantities might occur.

- The release of ammonium to the water column may result in short-lived episodes of toxic concentrations of ammonium. However, mixing is expected to rapidly (within hours) alleviate this problem.

- Chlorinated hydrocarbon releases to the water column would probably not be significant.

- The majority of the hydrocarbon and trace metal contaminant load is expected to remain associated with particulates.

- There would be increased concentrations of trace metals and organic compounds in bottom sediments at the disposal site and the surrounding area.

- Some nutrients, especially nitrogen, would be released to the water column resulting in the stimulation of productivity in the euphotic zone. This stimulation is not expected to be significant.

- The release of nutrients below the euphotic zone may result in stimulation of productivity to a minor extent. However, it is not expected to result in the production of significant quantities of oxygen-demanding substances (i.e., oxidizable organic carbon).

b. Biological Impacts

1. Benthos - Benthic organisms are most sensitive to environmental stresses due to their specialized adaptations and limited mobility (Pararas-Carayannis, 1973). Sandy Hook Lab (NOAA-NMFS, 1972) noted the dredge spoil and the sewage sludge dump areas were generally characterized by greatly reduced benthic macrofaunal populations. Adverse environmental effects resulting from dumping were found to be from burial and suffocation (NOAA-NMFS, 1975a). Pararas-Carayannis (1973) noted that burial of benthic organisms depends on the quality of material, the rate of disposal, settling rate of material and areal extent of dumping and settling.

A study of a dredge spoil disposal site in Rhode Island Sound (Saila, et al, 1971) concluded that (1) most mollusk species could reach the sediment surface after shallow burial; (2) less mobile forms were buried; (3) fish and lobsters could withstand high concentrations of suspended sediment for short periods, and lobstering on the perimeter of the dump was good; (4) quahogs were killed by burial near the dump center, but not on the perimeter; and (5) amphipods were found throughout in great densities. Similarly, in a study of a shallow-water dredge spoil disposal site in upper Chesapeake Bay, Cronin et al. (1967), observed no significant losses of benthic organisms as a result of burial. Certain species began repopulation soon after deposition, and one a half years later were repopulated to previous levels.

Both meiofauna and macrofauna are generally susceptible to burial at the New York Bight dredge disposal site. Considering the already depleted species diversity and abundance at the disposal site, the dumping identified in the proposed action for this project should have no additional adverse impact on the commercial availability of the surf clam, ocean quahog, rock crab or American lobster in the New York Bight area.

2. Fish - Fish resources in the New York Bight include both pelagic and demersal fish. The motile and highly migratory nature of most finfish species aids in avoiding adverse impacts of dumping at the disposal site. Of the adult fish population, filter feeders like menhaden exhibit the greatest susceptibility to detrimental impact from dumping. Fish eggs and largae will be impacted by, (1) adherance to suspended particulates and reduced bouyancy of pelagic eggs; and (2) burial of demersal eggs. The number of eggs and larvae impacted would be small compared to the Bight area. The impacts are short-term and should have no impact on forage or commercial fish populations in the New York Bight.

It is possible that ocean disposal increases contaminants in the food web which may make marine organisms more susceptible to diseases. Several disease conditions have been observed in a variety of marine organisms in the Bight Apex. These include occurrences of fin rot, lobster dieoff, necrosis of crustacean exoskeletons, gill fouling, and protozoan parasites on gill tissues. To date, the causative agents have not been isolated.

The occurrence of fin rot has been linked to environmental stress, as evidenced by the inability to induce the condition in test fish by innoculation with bacterial isolates (Mahoney et al., 1973). Ziskowski and Murchelano (1975) found that fin rot was confined largely to bottom dwelling flat fish in Raritan Bay and the Bight Apex, with no occurrence among fish in the relatively pristine Great South Bay on Long Island. Fin rot was also observed in pelagic species, such as weakfish, from the western end of Raritan Bay.

The occurrence of fin rot in winter flounder, the most commonly affected species, was statistically greater in the Bight Apex than in seaward areas of the Bight. The percent of occurrence was statistically greatest in areas characterized by sediments of high-carbon content. Also, no diseased fish were found in the vicinity of ocean outfalls (NOAA-MESA, 1975). Preliminary results from ongoing experiments indicate that survival of caged fish in the Christiaensen Basin, where organic material is accumulating, is low compared to fish survival in unpolluted areas (Murchelano and Ziskowski, 1975).

Pathological conditions of shells and gills have been observed in crustaceans, including rock crab, lobster, and shrimp (NOAA-NMFS, 1975a; Young and Pearce, 1975). Crabs with coated gills have been observed in the Bight Apex. This "black gill" disease was prevalent except during the molting season. Necrosis of the exoskeleton and appendages of shrimp, lobster, and crab was also reported in the vicinity of the sludge and dredged material dump sites. It is postulated that the degraded conditions of the Bight Apex and the occurrence of high concentrations of bacteria found there may contribute to diseases of marine organisms.

3. Rare, Endangered and Threatened Species - No adverse impact on the rare, endangered and threatened species (see Chapter II) is anticipated from dredge material dumping at the disposal site.

C.2 Specific Impacts

a. Water Quality - Chemical Tests

The evaluation of environmental impacts associated with the disposal of the contaminated portions of the proposed material to be dredged, is based on procedures outlined in the Ocean Dumping Regulations (FR 42, #7, 1977; Section 227, Subpart B) and the results of chemical and bioassay testing on project dredge materials (see Appendix F for details). The results of the chemical analysis of the liquid phase of the bioassay tests are presented in Table IV-11. Also presented for comparison are the EPA (1976) applicable marine water quality criteria for the constituents measured.

The following constituents are identified in the Ocean Dumping Regulations as being of particular concern: 1) Organohalogen compounds (DDT and PCB), 2) mercury, 3) cadmium, 4) oil and 5) known carcinogens, mutagens or teratogins. Dredge material is deemed environmentally acceptable for ocean dumping when a number of conditions are satisfied. One condition of acceptability provides that these constituents should not, after allowance for initial mixing, exceed concentrations of applicable marine water quality criteria. Mercury is an exception, in that concentrations may not exceed by more than 50 percent, the normal ambient concentration of mercury in the ocean at the dump site which would occur in the absence of dumping. USEPA (personal communication, 1978) recommends that the value of 0.1 micrograms/l be considered as the ambient concentration for mercury in ocean waters at the dump site. Dilution factors resulting from initial mixing which would occur as a result of the dumping of the most contaminated portions of the dredge material were determined following U.S. Environmental Protection and Army Corps of Engineers procedures (July, 1977). After allowance for initial mixing, these constituents would not exceed the applicable marine water quality criteria or in the case of mercury, would not exceed the EPA recommended values.

b. Biological Impacts - Bioassay Tests

The results of bioassays on the liquid, suspended particulate and solid phases for the project dredge material must be evaluated with regard to significant mortality, sublethal effects and effects of bioaccumulation on appro-priate sensitive marine organisms (USEPA/USACOE, July, 1977)

1. Significant Mortality - The results of the three phase bioassay testing on samples of dredge material from the project area are presented in Appendix F. Data from these tests indicate no significant adverse impact during any of the bioassay tests. Bioassays were carried out using EPA/COE approved procedures (July, 1977) and all tests showed a 99 to 100 percent survival rate except for the phytoplankton Skeletonema Costatum in the suspended particulate and liquid phase of bioassays. Concentrations in these tests causing 50 percent effective inhibition (EC_{50}) at 96 hours were calculated to be 22 percent and 24 percent of the test medium concentrations for the suspended particulate and the liquid phase tests.

In order to assess the impacts that disposal of the tested dredge material would have on the related marine organisms, the concentrations of the liquid phase (Cw), and the suspended particulate phase (Csp) after initial mixing, must be compared to the Limiting Permissible Concentrations (LPC). The LPC is defined as 0.01 of the acutely toxic concentrations, (EC_{50}). Thus, the concentrations of the liquid phase (Cw) and the suspended particulate phase (Csp) after initial mixing cannot exceed the appropriate LPC. Initial mixing is defined as the diffusion or dispersion of liquid, suspended particulate and solid phases of dredge material that occurs four hours after dumping.

The analysis of initial mixing concentrations for the liquid (Cw) and suspended particulate (Csp) was conducted for two cases of depth limitations following procedures outlined in the EPA/COE guidelines (July, 1977): 1) using a 10-meter depth limit (thermocline controls depth) as in the summertime and 2) using a 20-meter depth limit (maximum depth for mixing zone allowed). The comparison of initial mixing concentrations for these cases is presented in Table

IV-19, together with the LPC values for the liquid and suspended particulate phases. This comparison indicates that the LPC values would not be exceeded after initial mixing. Thus, disposal of the most contaminated portions of the project dredge material is not expected to result in significant mortality to marine organisms in the vicinity of the dump site.

2. Sublethal Effects - Sublethal effects can be detected during the solid phase bioassay. These effects are manifested by observations of loss of ability to burrow in sediments and other unusual behavior patterns such as partial paralysis or inability to excavate burrows. Observations during the required 10-day bioassay solid phase test did not indicate any unusual behavior indicative of sublethal effects. In fact, the test medium used was allowed to continue a few weeks beyond the required 10-day period and organisms continued to thrive in it with no indications of sublethal effects (Pedneault Associates, August, 1978).

3. Bioaccumulation - Due to the complex interactions between regulatory mechanisms in the exchange of metals between sediments and water, it is difficult to predict the extent of release of bioavailable metals during dredging and disposal operations. However, it can be tentatively concluded that the release of metals, if any, during the proposed operations would result in soluble metal-levels well below the allowable water quality concentrations.

Very little research has been carried out on the availability of metals in dredge spoils on the ocean floor. Gross et al (1971) concluded that because of low metal extraction efficiency from sediments in the sewage sludge dump, in the New York Bight Apex, very little amounts of trace metals in sediments move into the water column above.

The magnitude of adverse impacts would be primarily a function of the concentration of bioavailable metals in the sedimented material which reaches the bottom, the areal extent of its coverage on the bottom and its subsequent transport by physical processes which serves to increase the lateral extent of the impacted area.

TABLE IV-19

COMPARISON OF INITIAL MIXING CONCENTRATIONS
AND LIMITING PERMISSIBLE CONCENTRATIONS (LPC)

Condition	Time to Dump (sec)	Phase	Initial Mixing Concentrations C_w	C_{sp}	LPC
Case 1 Summer	120	Liquid	0.215		0.24
10 meters		Sus. part.		0.067	0.22
Case 2 Fall-Spring	120	Liquid	0.107		0.24
20 meters		Sus. part.		0.034	0.22

In general, those metals which were not mobilized during dredging and disposal operations would remain associated with the deposited sediment material on the ocean floor. The release of these metals to the water column during disposal would be dependent upon changes in redox potential and on the physiochemical nature of the metals. However, there would be a net accumulation of the metals in bottom sediment.

The release of metals during the disposal operations may impact on the biota. However, the US Army COE (1975a) reported that experimental dredging operations in San Francisco Bay did not significantly affect trace metal (cadmium, copper, mercury, lead and zinc) concentations in local benthic invertebrate populations at the dredge site. Mean metal levels in the organisms examined changed by less than a factor of two or three. The dredging operations, however, coincided with a period of heavy rainfall and changes in metal levels in the dredge zone may have been influenced by the surface runoff in the area. This is supported by the fact that changes in metal levels at control stations outside the dredge area were of comparable magnitude to those exposed to dredging activity. Similarly, disposal operations did not appreciably affect trace metal concentrations in the benthic invertebrates examined (USACOE, 1956).

However, the long-term hazards of sedimented dredge material polluted with metals are presently unknown. The accumulation of metals in organisms may be lethal, sub-lethal yet deleterious through physiological or behavioral adaptations (e.g. reduced vitality or growth and reproductive failure), or may render the resources, e.g. shellfish, unfit for consumption by man. For example, Segar and Cantillo (1976) reported that although the highest zinc concentrations found in waters at the disposal sites of the Bight were below levels known to be acutely toxic to marine organisms, the levels are still high enough to cause concern about potential chronic toxic effects. Interactions between toxic contaminants must also be taken into account.

Bioaccumulation assessment is called for in USEPA Ocean Dumping Regulations and guidelines for procedures to implement the regulations are presented in the USEPA/USACOE manual (July, 1977). Testing may be field testing or laboratory testing. The field assessments are considered more meaningful than laboratory tests for assessing the long-term exposures and the influence of mixing and sediment transport at the disposal site. The U.S. Army Corps of Engineers has initiated a field bioaccumulation testing program at the designated disposal site. The results of these field tests will not be available in the near future (2 years). In the interim, laboratory bioaccumulation tests will be used as regulatory guides to evaluate the impact of dredge materials on the bioaccumulation of contaminant substances in appropriate marine organisms (USEPA, Mr. P. Andersen, September, 1978). On February 15, 1979, U.S. Army COE, New York District, after consultation with EPA, Region II, released an implementation guideline for conducting chemical, bioassay and bioaccumulation testing for the assessment of impacts of ocean deposal of dredged material in the New York Bight. Additional solid phase bioassays and new bioaccumulation testing have been conducted using the February 1979 guidelines. The results of this analysis are provided as an addendum to this Draft Environmental Impact Statement.

However, since only a small percentage of the project dredged materials are considered as contaminated, the opportunity exists for capping these materials with clean sediment at the disposal site. This would reduce the potential for exposure to benthic organisms and the possibility of uptake and bioaccumulation (see alternative to Dredge Disposal, Chapter V).

C.3 Cumulative Impacts

An important consideration regarding the evaluation of cumulative impacts of the proposed action involves the physical effects of Navy-related dredging on the disposal site capacity and utilization. To assess this effect, the volume of dredge material from future Navy and non-Navy dredging projects must be projected. The historic data as presented in Figure II.D-2 indicate that in the

1970s approximately 8 to 10 million cubic yards were dredged annually from New York Harbor with most of this (average of 6 to 8 million cubic yards) being disposed at the dredge material disposal site (Mud Dump). Tabulation of maintenance dredging projects by Mueller et al. (1976) indicates than on a yearly average, 11.6 million cubic yards can be anticipated to be disposed of at the disposal site. In addition to maintenance dredging, other proposed new dredging projects must be considered. Two large new dredging projects are anticipated for the near future by the Corps of Engineers: 1) the deepening of the Kill Van Kull Channel from 35 to 45 feet MLW (8 million cubic yards) and 2) the deepening of the Raritan River from 25 to 35 feet MLW (2 to 4 million cubic yards).

Utilizing historical bathymetric surveys of the mud dump site, Freeland et al. (1976) have determined the rate of shoaling over the last 30 years at the northern portion of the disposal site. The depth of water at the southern portion of the site, where dumping is presently carried out, is about 80 feet. This would allow 50 feet of deposition in this area or, using the shoaling rate measured from previous dumping, a capacity of about 125 million cubic yards. Assuming 11.6 million cubic yards for ocean disposal of annual maintenance dredging, 12 million cubic yards for the two known new dredging projects at Kill Van Kull and Raritan River and a projection of an additional 2 million for other small new dredging projects, the presently utilized southern portion of the disposal site would have about 9.5 years available before capacity is reached. The proposed Navy project would add about 7.3 million cubic yards, at most, to this site in 1982 and would decrease the life span of the site from 9.5 years to 8.9 years (reduction of about 6.3%). This reduction in site life is not significant in itself. However, the utilization of the present site is projected as being relatively short (9.5 years) and a new site would be required if ocean disposal of dredge material is to continue. The proposed action would shorten the time period for such an eventuality by about 7 to 8 months.

The proposed action is not expected to occur in the same year as other large disposal actions. This fact and the fact that only a small quantity of the 7.3

million cubic yards (about 1 million cubic yards) is contaminated indicate that cumulative adverse impacts on the New York Bight ecosystem are not anticipated. In addition, 1981 is the year that ocean disposal of sewage sludge will be discontinued. Plans for restoring and revitalizing this site may include considerations for capping with uncontaminated sediments. The proposed action could provide in 1982 considerable quantities of uncontaminated fine grained material (about 6.2 million cubic yards) or sandy material (about 4.0 million cubic yards) for such capping of the closed sewage sludge disposal site, should this be deemed appropriate by EPA. If this alternative use is made available for the fine grained uncontaminated portion, only the 1 million cubic yards of contaminated materials would have to be disposed at the existing dredged material disposal site and thus there would be a negligible impact on its site capacity and projected life.

D. IMPACTS ON THE MAN-MADE ENVIRONMENT

D.1 Short-Term

Short-term effects would result primarily from construction of the various projects required by the proposed action. These projects are described in detail in Chapter I. These effects are temporary in nature and last only during the anticipated construction period of 1981 to 1983.

Construction costs associated with the proposed action are estimated at \$152.0 million. Temporary employment associated with construction projects is projected at about 560 persons, including off-site employment. Local wages and salaries associated with construction projects are estimated to be \$22.8 million.

These totals are broken down by various elements of the proposed action in Table IV-20.

Due to the conceptual nature of many of the projects proposed to be constructed, the level of construction employment has to be estimated. After a detailed assessment of the proposed projects, and based on discussions with industry representatives, construction employment impacts were based on the following assumptions:

- Total investment cost for labor would approximate 25 percent of total project costs, excluding the dredging project. This is based on the fact that the nature of the construction involved under the proposed action is highly capital intensive, that is, materials and equipment constitute the bulk of the financial outlay.

- An expenditure of \$20,000 would generate one man year of labor.

TABLE IV-20

ESTIMATED TEMPORARY EMPLOYMENT AND WAGES GENERATED BY CONSTRUCTION PROJECTS REQUIRED BY THE PROPOSED ACTION (1980-1982)

Action	Cost ($ Million)	Temporary Employment (Full Time Equivalent Jobs) Total	Off-Site	Annual Wage ($ Million)
AOE Support	13.4	62	6	0.93[a]
VSS Support	67.9	310	31	4.65[a]
Fuel Replenishment System	16.7	69	6	1.04[a]
Dredging	51.3	75	—	0.98[b]
Total	149.3	516	43	7.60

[a]Assumes $15,000 Annual Salary

[b]Assumes $13,000 Annual Salary

SOURCE: NAVFAC, 1977; Dames & Moore, this study.

- The dredging project would probably require the use of three dredges continuously for approximately one year. Each dredge requires 25 people (including tug requirements).

- A recent study by the Port Authority of New York and New Jersey suggests that a multiplier of 0.1 could be used to determine the level of off-site employment generated for Outer Continental Shelf (OCS) development. Because of the similarity of construction work required for OCS support base development to the projects required by the proposed action, the 0.1 multiplier has been applied to obtain the total level of temporary construction employment.

In the event of a national emergency, the use of VSS capability at NWS Earle would generate substantial civilian employment. However, it is not possible to predict either the occurrence or the duration of such an event.

An AOE related oil spill could have a significant impact on recreation in Sandy Hook Bay, Raritan Bay, and Gateway National Recreation Area. The average Navy spill of 156 bbl would have no significant impact on water-oriented recreation in the Bay area. Existing and new oil spill equipment to be installed on the piers would be adequate for containment of such spills. However, a major oil spill during the summer season would have a dramatic impact on recreation and sport and commercial fishing. Such a major spill would close beaches, and severely restrict recreation boating throughout the affected area. If a major spill occurred during the summer season, it could result in significant tourist-related economic losses in the Sandy Hook Bay region. The potential for such a spill is discussed in Section B.4 of this Chapter.

It is possible that, during construction of various projects, some specialized labor may have to be imported to Monmouth County. These personnel would use transient housing accomodations. The total number of such personnel is expected to be small as most labor skills are available in the region within commuting distance of NWS Earle. The housing needs of these personnel can be easily met by existing accomodations in the County.

No relocation of individuals or businesses is required by the proposed action. During the construction process, short-term disturbances of properties adjoining construction sites would occur. These are described in detail in Section A of this Chapter.

The construction process and construction equipment may be unsightly to adjoining properties. Where appropriate, steps should be taken to screen construction sites from nearby properties.

A negligible increase in electrical, water and sanitary sewerage demand would take place during construction activities.

D.2 Long-Term

a. Population

The primary social impact of the proposed action will be the relocation of military personnel and their dependents from the Norfolk, Virginia area to Monmouth County. Without the proposed action, manpower loading at NWS Earle is expected to total 2,134 military and civilian personnel in July 1979. Under the proposed action, personnel loading would increase by 1,158 persons, representing a 54.3 percent increase in total military personnel assigned to NWS Earle. Dependents would increase by 79.2 percent, from 1,436 dependents in July 1979 to a total of 2,589 dependents (Table I-1).

Manpower loading at Naval Station (NS) Norfolk totaled 60,000 military and 30,000 civilian personnel in 1976. Approximately 83 percent, or about 50,000 of the military personnel assigned to the Station are associated with homeported ships. Under the proposed action, total military loading at NS Norfolk would decline by approximately two percent. The overall population impact of the proposed action in the Norfolk area is not expected to be significant. Since total military personnel assigned to NS Norfolk is projected to increase by 12.5 percent (10,500 persons) by 1982, the proposed action would exert only a slight slowing effect on this projected rate of growth.

b. Housing

The impact of the proposed action on the local housing market is not expected to be significant.

Three groups of persons associated with the relocation of AOEs will require housing: (1) single personnel; (2) married personnel eligible for military family housing; and (3) married personnel ineligible for military family housing. The distribution of the AOE crews within these categories is shown below:

Single	684
Married (Eligible)	373
Married (Ineligible)	101

Housing for each of these categories is discussed separately.

1. Single Personnel - Usually, only one AOE would be homeported at any given time. This means that only about 342 single personnel would have to be provided for. Some of these would band together to rent homes or apartments. For the most part, however, single personnel would remain onboard ship. Full services are available on the ship while it is homeported. Accordingly, no significant impact on the private housing market is anticipated from single personnel.

2. Married (Eligible) - A total of 1,167 military family housing units are located at Ft. Monmouth. Currently, 1,144 are in use; an occupancy rate

of 98.0 percent. Under an Inter Service Support agreement (ISSA) between the Army and Navy, married personnel assigned to NWS Earle eligible for military family housing can obtain housing at Ft. Monmouth on an equal basis with Army personnel. At present, a total of 211 personnel associated with NWS Earle are housed at Ft. Monmouth (see Table I-2).

Officials at Ft. Monmouth have indicated that approximately 67 families, who would normally be ineligible for military housing are presently housed at the base. Of these, 42 families are associated with personnel assigned to NWS Earle. Given timely notification, housing occupied by ineligibles could be made available through attrition. These units, together with those presently unoccupied (30), would be sufficient to meet slightly more than one quarter of the housing needs of married personnel transferred to NWS Earle eligible for military housing.

Army officials at Ft. Monmouth have indicated that, given enough lead time, housing could be made available by 1983-1985 to meet the remaining housing requirements of married personnel eligible for military housing. Mission changes requiring the relocation of Army personnel, together with elimination of ISSA's with other military organizations not assigned to Ft. Monmouth, could increase the housing available at Ft. Monmouth to a level adequate to meet the requirements of this group of Naval personnel.

If Ft. Monmouth housing were available, then most married Naval personnel eligible for military family housing would not need to obtain private housing. However, married personnel who would have been eligible under terminated ISSA's and ineligibles could be adversely affected by implementation of the proposed action in 1983-1985 and thereafter. These personnel may have to obtain housing in the private sector. Although it is not possible to determine how many of these families would be affected in the future, their numbers would not exceed 200-300.

If housing should not become available at Ft. Monmouth, then Navy personnel would have to obtain private housing. Most families would prefer to rent rather than buy because of the short-term nature of their assignments. Between 1960 and 1970, nearly 14,000 multi-family units were constructed through out Monmouth County. About one-half of these multi-family units were constructed in Planning Areas I and II (Table II.E-10). Another 1,600 multi-family units were constructed in Planning Areas I and II between 1974 to 1976 (Table IV-21). Therefore, the influx of Navy personnel into the Monmouth County area should not have a significant impact on the local housing market.

However, it is doubtful that private housing in the County would be available within a price range which is affordable to married military personnel being assigned to NWS Earle. As indicated in Section II.E.4, the average price for a single family home in Monmouth County in 1977 was approximately $50,000; today it is conservatively estimated to be in the range of $60,000-$70,000. If Navy personnel are required to obtain private housing they would either have to devote a large percentage of family income to housing payments or they would have to locate in areas where housing is more affordable. In the latter case, these personnel may be forced to live in communities much further from NWS Earle. The U.S. government maximum allowable housing cost (rental cost plus utilities for a 3-bedroom unit) for junior enlisted men (E-4, E-5 and E-6) is $252 per month. A recent Naval Facilities Engineering Command (NAVFAC) housing survey (1979) indicates that housing which is considered suitable within the cost and travel distance guidelines is not currently available or would not be projected to be available for projected AOE and AE personnel increases at NWS Earle.

Should availability of sufficient military housing at Ft. Monmouth not materialize, construction of a military family housing project at NWS Earle might be considered as an alternative because of the lack of suitable private housing. This alternative is discussed in Chapter V and would be the subject of a separate environmental impact evaluation should it become necessary.

TABLE IV-21

RESIDENTIAL CONSTRUCTION BY PLANNING AREAS
1974-1976

Planning Area	Total Units	Single Family		Multi-Family	
		Number	Percent of Total Units	Number	Percent of Total Units
I	2,322	1,286	55.4	1,036	44.6
II	1,020	410	40.2	610	59.8
III	1,058	426	40.3	632	59.7
IV	289	258	89.3	31	10.7
V	1,707	970	56.8	737	43.2
VI	208	208	100.0	0	0
TOTAL	6,604	3,558	53.9	3,046	46.1

SOURCE: Monmouth County Planning Board, 1977.

3. Married (Ineligible) - Married personnel ineligible for military family housing must seek housing in the private market. These are personnel in the lower grade levels, with low annual incomes. Annual income of married personnel in grade level 3 was about $7,500 in 1977. As a general rule, personnel in the lower grade levels are new enlistees, young, and if married, have no more than one child. It is expected that these personnel will rent apartments.

In spite of land use controls intended to limit the construction of multi-family housing, total number of units in Monmouth County increased by some 6,600 units between 1974 and 1976. The largest numerical increase occurred in Planning Area I, as shown in Table IV-21. As this trend is expected to continue, rental housing units sufficient to accommodate the needs of married personnel ineligible for military housing are expected to be available by 1983-1985.

However, the cost of rental housing in Monmouth County is high, as indicated in Table II.E-12. The average cost of a two bedroom apartment ranges from $300 to $400 per month. Given these costs for rental units in Monmouth County, married personnel ineligible for military family housing may seek lower cost housing in other areas some distance from NWS Earle.

Because of the small number of personnel involved (143), no significant effects are expected on the private housing market from the relocation of married military personnel ineligible for military family housing.

While the impact of the proposed action on housing in Monmouth County is not considered to be significant, neither will the action have an adverse impact in the Norfolk area. At present, there is a severe shortage of acceptable housing in the Norfolk area.

NS Norfolk currently is faced with a deficiency of some 8,000 housing units for homeported personnel. Since no new military construction is planned, the proposed action is expected to aid in reducing the number of families unable to find acceptable housing at Norfolk.

c. Education

The transfer of military personnel and their dependents into local school districts, primarily Planning Area II, is not expected to create school overcrowding.

As indicated in Table IV-22, schools in Planning Area II had a combined 1976-1977 enrollment of 18,071, 1.9 percent less than the previous school year. The greatest decline occurred in grades K-8, where enrollments dropped 5.4 percent. The major factor contributing to this decline was the reduction in Army personnel at Ft. Monmouth. Nearly all schools in Planning Area II had enrollments well below capacity. Dependents of military personnel living at Ft. Monmouth attend elementary school in Eatontown school district and high school at Monmouth Regional High School. In 1977, enrollment at Eatontown schools in grades K-8 totalled 1,941. Projected enrollment for the next five years is about 2,000 students. Schools in the district are operating at 75.4 percent of capacity and have space for 634 additional children. Enrollment at Monmouth Regional High School was 1,267. Space was available for 221 additional children.

Under the proposed action, it is estimated that about 680 child dependents would relocate with the AOE crews. Assuming that all 374 eligible married personnel are housed at Ft. Monmouth, about 560 children would attend schools in Eatontown school district and Monmouth Regional High School. It is estimated that about 470 children would attend grades K-8 and that about 90 children would attend grades 9-12. These are within the capacities of Eatontown school district and Monmouth Regional High School. Distribution of the 101 families ineligible for military housing would be such that no one school district would experience a significant increase in enrollments.

TABLE IV-22

SCHOOL ENROLLMENTS
PLANNING AREA II MONMOUTH COUNTY
1976-1977

District	ENROLLMENT 1976 K-8	1976 9-12	1976 Total	1977 K-8	1977 9-12	1977 Total	Capacity
Eatontown	1,940	-	1,940	1,941	-	1,941	2,575
Fair Haven	852	-	852	845	-	845	1,075
Little Silver	877	-	877	824	-	824	1,150
Long Branch	3,733	1,596	5,329	3,226	2,060	5,286	6,339
Monmouth Beach	377	-	377	387	-	387	475
Monmouth Regional	-	1,324	1,324	-	1,267	1,267	1,488
Oceanport	797	-	797	771	-	771	975
Red Bank Borough	1,118	-	1,118	1,098	-	1,098	1,750
Red Bank Regional	-	1,147	1,147	-	1,136	1,136	1,555
Rumson Borough	882	-	882	876	-	876	1,175
Rumson-Fair Haven Regional	-	1,190	1,190	-	1,143	1,143	1,400
Sea Bright	97	-	97	85	-	85	175
Shore Regional	-	1,186	1,186	-	1,130	1,130	1,418
Shrewsbury Borough	426	-	426	437	-	437	530
West Long Branch	884	-	884	845	-	845	800
District Total	11,983	6,443	18,426	11,335	6,736	18,071	22,880

SOURCE: N.J. Department of Education, Monmouth County School District, 1977; Dames & Moore, this study.

Increases in the number of school-age children from the proposed action would partially offset projected declines in school enrollment.

d. Economics

There are long-term impacts on four sectors of the local economy:

- direct employment;
- induced employment;
- wages; and
- property taxes.

Employment and wage effects would result from the relocation of the AOE crews. Property tax impacts would result from the acquisition of land for construction of the ship fuel replenishment system.

1. Employment and Wages - The total long-term employment gains from the proposed action are estimated to be 2,930 jobs. This represents an increase of approximately two percent in the total employment projected for Monmouth County in 1980. The total long-term wage gains are estimated to be $33.7 million. The basis for these estimates is explained below.

The relocation of the AOE crews would increase total direct employment in Monmouth County by 1,158 people. This direct employment would create induced employment of 1,772 jobs. Induced employment refers to the impact of the expenditures generated by new jobs as wages and salaries enter the general income stream. Wage and salary expenditures for permanent federal jobs translates into increased levels of spending for retail purchases, services, transportation, etc. In turn, employment gains are made in the secondary (support) sector of the local economy.

Research on the impact of military induced employment for a receiving area suggests that, on a statewide basis, the employment impact of defense expenditures has been found to vary between 0.2 and 3.0 (exclusive of direct employment) with a mean of 1.53 supporting sector jobs (NAVFAC, 1976). Increased direct employment of 1,158 persons would yield induced employment of 1.53 times as much, or 1,772 secondary jobs.

The calculation of long-term wage gains is based on assumptions with respect to annual salaries for different types of personnel. These are shown in Table IV-23.

The impact of relocation of the AOEs on the Norfolk area would not be significant. Projections to 1980 indicate that military employment would increase to about 90,000, while federal civilian employment would continue to gain by some 1,200 jobs. Relocation would reduce direct military employment by 1.3 percent below projected levels for 1980.

2. Reduction in Property Taxes - Acquisition of land for the ship fuel replenishment system would remove 309 acres from local tax rolls. This would reduce tax revenue to Middletown Township. The property to be acquired generated approximately $25,990.00 in tax revenue in 1977, based on a total assessed value of $689,400. Assuming no change in the current tax rate of $3.77 per $100 assessed value, total taxes collected from real property in Middletown would be reduced by 0.1 percent, to $22,493,958. This compares with $22,519,948 collected in 1977. Tax revenue generated by the land to be acquired would be lost permanently. In addition, tax revenues that would have been expected from future development of the site would also be lost. This tax loss could be avoided if the Navy entered into a long-term lease instead of acquiring the property. This would undoubtedly increase the overall cost for the Navy.

TABLE IV-23

LONG-TERM LOCAL WAGE GAINS GENERATED BY AOE RELOCATION

Type	Number	Assumed Annual Salary	Wage Gain
DIRECT			
Military	$1,158	$ 8,500	$ 9,843,000
INDUCED	$1,772	$13,500	$23,922,000
TOTAL	$2,930	$37,000	$33,765,000

SOURCE: NAVFAC, 1977; Dames & Moore, this study.

e. Land Use

The major land use impact results from the acquisition of 309 acres of land for construction of the ship fuel replenishment system. Table IV-24 compares acreage affected by the proposed action to comparable acreage presently available in Middletown Township by land use category and zoning classification. As indicated, the land to be acquired represents 3.7 percent of existing vacant land and 25.8 percent zoned industrial in Middletown, Township.

Under the proposed action, approximately 25 acres of the site would be fully developed, as shown in Figure I-8. The remaining acreage would be retained in a near natural state. However, the proposed action would eliminate the possible future use of the area for a marina complex, as proposed in the Master Plan Amendment (see Chapter III).

No other elements of the proposed action would affect existing land use patterns off the base.

f. Explosive Safety

The proposed homeporting action is intended to reduce the risk of an explosion that could cause loss of life and injury to persons and damage to property. While the possibility of such an event cannot be completely eliminated, it can be minimized by ensuring a safe distance between the homeport pier and inhabitated buildings.

A detonation of explosives could occur onboard an AOE, during explosive handling at the pier, or, during transport of explosives to storage facilities. While handling operations would be conducted by qualified personnel under strict supervision in accordance with U.S. Navy Safety Requirements, Standards and Practices, there is a possibility that an explosion might occur. An explosion, if it did occur, would have a major impact on the surrounding environment.

TABLE IV-24

COMPARISON OF SITE TO BE ACQUIRED WITH EXISTING LAND USE AND ZONING IN MIDDLETOWN TOWNSHIP

Location	Existing Land Use Vacant (Acres)	Present Zone Classification[a] Light Industry/M-2 (Acres)
Middletown Township	8,253.3	1,195.2
Proposal Acquisition Site	309.0	309.0
Percent of Township	3.7	25.8

Note:

[a] As established by zoning ordinance of the Township of Middletown, New Jersey.

SOURCE: Middletown Township Planning Board, 1974; Dames & Moore, this study.

Damage to the government pier and trestle from an explosion would be extensive. The explosion would create a series of waves moving outward from the center of the explosion across the surface of Sandy Hook Bay. Empirical formulas established by conventional explosives indicate that wave heights (crest to trough) generated by an explosion of ten million pounds Net Explosive Weight (NEW) can reach five feet and four feet, two and three miles away respectively. Severity of damage to shoreside facilities located at and beyond the periphery of the 10,770-foot explosive safety distance zone would probably be minimal. In addition, secondary damage resulting from the explosion may occur as a result of fires created by oil stored aboard the AOE.

The Explosive Safety Quantity Distance (ESQD) requirements established for this project are based on records of actual fires and explosions involving ammunition and explosives; the safety standards adopted in House of Representatives Document No. 199, 70th Congress, including the American Table of Distances; the laws of the State of New Jersey; and the recommended standards of the Department of Defense Explosives Safety Board (DDESB). The requirements are designed to render the inhabitants of nearby communities, the personnel of Navy Shore Establishments, and adjacent public and private property reasonably safe from injury or destruction by possible fires or explosions and to keep the loss of valuable ammunition stores (including inert ordnance items) through a fire or explosion to a minimum.

The 10,770 foot ESQD arc for ten million pounds NEW represents the distance at which inhabited buildings would not undergo substantial structural damage. Minor damage which is readily repairable, such as the breaking of window glass, the shaking down of plaster, and possible damage from flying fragments, is not considered as substantial structural damage. The ESQD arc is designed to protect buildings against substantial structural damage to the following general extent:

- In stone, brick, or masonary buildings: serious weakening or displacement of portions of supporting walls (foundations, side walls, or interior supports) and the breaking of rafters or other important roof supports or floor joists.

- In frame buildings: serious weakening or displacement of foundations, the breaking of any of the main supports in the side walls or interior supporting walls, and the breaking of any main supports of the roof or floors.

- In reinforced concrete structures: serious displacement of any floor, wall, or ceiling structural member or the failure of any supporting member.

All structures within the 10,770 feet ESQD hazard zone belong to the U.S. Government. Only ordnance related activities are located within the new hazard zone, as shown in Figure I-8. No permanently inhabited buildings are encumbered by the hazard zone. As indicated in Figure I-8, a small portion of beach immediately west of the Waterfront Area at NWS Earle would fall within the hazard zone. This is part of the land to be acquired. No other privately owned land would be encumbered by the ESQD hazard zone.

Under the proposed action ordnance loading/downloading for the AOEs would be conducted at the new pier which would be sited at a distance which is not encumbered by ESQD arcs drawn from the existing piers. Separation distance requirements for explosives handling piers and main ship channel would also be satisfied under the proposed action. The new pier would also be safely located with respect to ESQD hazard zone for the NEW associated with the 2 VSS. This ESQD arc is 9,300 feet.

Implementation of the project would eliminate ammunition handling operations at NS Norfolk which endangers approximately 1,800 acres of surrounding property. Between 3,600 to 4,000 personnel not associated with ordnance operation work within these zones. Relocation of the AOEs to NWS Earle would eliminate the life-threatening situation at NS Norfolk and reduce the possibility of structural damage to the more than 500 buildings located within the present hazard zone.

g. Fire Hazards

A major safety concern with regard to the operation of the fuel storage facility is fire hazard. Because of the potential for fire related events, fire prevention and fire fighting capability are integral parts of tank farm operation.

A worst-case event for fire at a storage tank would involve the following events:

- Fire initiation in the seal area (the periphery of the tank).

- Failure of the initial fire fighting efforts (including fixed-foam protection systems) and fire becomes uncontrolled.

- Radiant heat generated is intense and causes adjacent tanks to catch fire or explode.

Such a large uncontrolled fire would provide a significant fire threat to adjacent residential areas of Belford and to adjacent wetlands. A number of factors influence the probabilities of the occurrance of such a worse case event:

- The structural type of tank.

- Utilization and availability of fixed-foam protection systems and other fire fighting equipment.

- The spacing between tanks and tank size.

The safest type of tank structure with regard to fire hazard is the floating-roof type. These structures, due to their excellent fire record, are not required to be equipped with fixed foam internal fire protection systems (Herzog, 1974; National Fire Protection Association, 1976).

The proposed action calls for the construction of six cone-roof, 50,000 bbl, above ground steel tanks and three cone-roof, 10,000 bbl steel tanks. While most tank fires are associated with this type of fixed-roof tank, Hydrocarbon Processing magazine indicates that based on 1971-1974 data, tank farm fires occur at a rate equivalent to one fire per tank farm every 100 years.

In addition, as required, the proposed tanks will be provided with a fixed-foam internal fire protection system to be used to control a fire quickly, should it occur.

As a further design mitigation against the possibility of a worst-case event, the tank (relatively small in diameter, 50 feet, compared to other tanks) will be spaced at sufficient distance to prevent a single seal fire from emitting sufficient radiant heat to involve adjacent tanks. These small tanks will be spaced at 150 feet. In order to ameliorate radiant heat transfer, the National Fire Protection Association requires, that tanks be separated by a distance equivalent to the sum of the adjacent diameters divided by four; but not less than 150 feet. Tank farm insurers recommend separation distances equivalent to one tank diameter of the larger tank where different tank sizes are involved.

Fires in other parts of a tank farm are also possible, particularly at pump stations or in valving manifolds. Such fires as do occur in these areas are unlikely to be associated with individual tanks so that the capability of the fire system need not cover both contingencies. Fire in these operational areas, once detected, is controlled by first cutting off the fuel supply, that is, shutting down pumping, and then by application of foam or heavy water if the fire persists.

Early detection of fire is essential to its ultimate control. Detectors have now reached a stage of development where they are both reliable and insensitive to spurious signals. When triggered by fire, such sensors would, in a manned station, alert the nearby control room where action could be taken to control the fire either by activating fixed systems or by calling out fire fighting units.

Thus, the proposed construction of the tank farm does not represent a serious safety hazard to adjacent areas. It does however, increase the overall fire hazard in this area.

The potential for fire is increased on the new pier which would handle the fueling operations for the AOEs. The pier would be equipped with adequate fire fighting facilities. Again, should a fire occur, pumping in the pipeline will be shut down. Fires located on the pier would not pose any safety hazard to non-Navy areas or personnel.

h. Aesthetics

Under the proposed action, the fuel storage tanks would be built in approximately the same area in which the airstrip and hangar are located (see Figure I-8). The tanks are expected to range from 30 to 40 feet in height. This is slightly higher than the hangar building on site. Figure IV-6 is a conceptual representation of how the storage facility and pipelines would be viewed from the immediate shore area of Sandy Hook Bay. As indicated, the tanks will be a prominent feature on the landscape. While the tanks will obstruct views as seen from the Bay, their visual impact would be significantly reduced because the boating public will see them from a distance of over three miles straight on. From this distance, the fuel storage complex (when visible) would become indistinguishable from other man-made uses along the waterfront. Immediately to the west of the site is a fish factory; similar storage tank facilities are visible as well as the pier facilities of NWS Earle to the east. As viewed from Route 36, the fuel storage

CONCEPTUAL VIEW OF FUEL STORAGE TANKS

tanks would not be visible. Dense vegetative growth along the highway obstructs the motorist view looking north. The Navy will provide appropriate landscaping to screen the fuel storage tanks. All other elements of the proposed action are similar to nearby facilities already in place.

i. Recreation

The proposed action would require designation of an additional security zone adjacent to the new pier and trestle. This additional zone is shown on Figure I-8. Within this additional zone, private boating and fishing would be prohibited. However, use of Compton Creek Channel would not be restricted. The need to relocate the approach to the Compton Creek Channel due to the expansion of the security zone around the new pier is discussed in Chapter III.

As indicated in Chapter II, Section C, large amounts of the dredge material will be composed primarily of sand. Such material is excellent for use as beach nourishment and/or stabilization. The potential exists for use of this material for beach nourishment at Sandy Hook unit of Gateway National Recreation Area and Bayside communities faced with beach erosion. This method of dredge material disposal would enhance beach recreational use in Monmouth County.

To meet recreation needs of personnel assigned to NWS Earle, several projects identified in Chapter I involve construction of recreation facilities in the Waterfront Area. These include construction of an addition to the gymnasium, and a bowling alley. A wide range of facilities for exercise, athletics and recreation are also available for naval personnel at the Main Station and Ft. Monmouth. Planned recreation facilities would significantly limit the extent to which AOE crews use public facilities in the surrounding Bay communities.

j. Cultural Resources

No significant historical or archaeological sites would be affected at NWS Earle, the site for the ship fuel replenishment system or in the offshore area. An archaeological survey of the land acquisition site has been conducted as part of this study (see Appendix H for details) and reveals no evidence of historic or archaeological resources of significance. In addition, this study and a review of known locations of shipwrecks of the New Jersey coast (Krotee and Krotee, 1965) indicate that no historic or cultural resources would be impacted by the proposed offshore actions of dredging and pier and trestle construction.

k. Transportation

The proposed relocation of AOEs would not significantly increase traffic on roads serving NWS Earle. As with all major roads in Monmouth County, traffic on Routes 34 and 36 is heaviest during the summer, as visitors from New York and northern New Jersey travel to the coastal resort areas. The Sandy Hook unit of the Gateway National Recreation Area is a major summer attraction which directly affects traffic volumes along Route 36 in northern Monmouth County. Traffic volumes on Route 36 in the vicinity of NWS Earle vary from 15,000 to 20,000 AADT.

Under the proposed action, there would be an increase of about 300 automobiles at the Waterfront Area. This is based on Navy estimates for additional parking required to meet AOE homeporting requirements. Approximately 100 additional daily parking spaces would be available. Two hundred additional spaces in secured parking lots would be available while the ships are on assignment.

At present, 200 parking spaces are available at the NWS Earle waterfront. Of these, 100 are daily spaces and 100 are in secured lots. Accordingly, the amount of parking spaces available would increase by 150 percent. It is unlikely that actual traffic will increase to this extent as most personnel are reluctant to leave their cars in the secured lots. Rather, they are likely to leave their cars with dependents. This projection is borne out by experience with existing and largely unused secured parking for the AEs.

At the present time, the Navy is exploring alternatives to improving the traffic safety at crossings of the government road and railroad. The use of automated gates (activated by approaching cross traffic) or installation of speed-control road bumps are being considered as additions to the stop signs which presently exist. Implementation of such alternatives and the fact that homeporting of the AOEs is not expected to generate a significant increase in traffic along the government road, indicates that the proposed action would not significantly impact traffic safety hazards.

Navy personnel tend to use the government owned Normandy Road as the most direct means of reaching housing areas at Ft. Monmouth and NWS Earle. It is expected that use of Normandy Road will continue under the proposed action. Therefore, no major impact on traffic along Route 36 is expected.

No major impact on traffic along Route 34 serving the Main Station is expected to result, since traffic generated would be primarily to and from the Waterfront Area. Some additional rail, truck and automobile traffic would occur on Normandy Road, but the effect of this is expected to be slight.

1. Public Utility Systems

All public utility systems, including water, sanitary sewerage, electrical, and solid waste disposal presently have sufficient design capacity to handle the additional demand induced by the proposed action. Demand (usage) would increase only slightly over and above present levels. The Navy will negotiate contractual agreements with the appropriate companies to insure that additional demand will be met. Most of the increased population generated by the proposed action would be occupying existing housing. Therefore, they are not expected to create significant additional loads on public utility systems.

m. Other Community Services

The proposed action is not expected to have a significant impact on public health and safety services in Monmouth County. In addition to medical facilities at the NWS Earle Main Station, military personnel assigned to the Station would have full access to facilities located at Ft. Monmouth. Security at NWS Earle is provided by military police and marines assigned to the Station. Military security measures in force at Ft. Monmouth would provide for the safety of Navy personnel living at the base.

In addition to fire protection facilities presently located or planned at NWS Earle, the Station has mutual agreements (understandings) with 95 percent of the fire companies located in Monmouth County. While no contractural agreement has been signed, it is mutually understood that local departments as well as those at NWS Earle, would come to the aid of the other in time of emergency. The local companies are composed primarily of voluntary personnel.

CHAPTER V

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Chapter V (Continued)

V. ALTERNATIVES TO THE PROPOSED ACTION

A. INTRODUCTION

The alternatives to the proposed action are discussed into three major categories:

- o no action;
- o alternative approaches for implementing the proposed actions at NWS Earle; and
- o alternative sites for AOE homeporting and for constructing two additional Vessel Support Systems (VSS).

B. NO ACTION

B.1 AOE Homeporting

Under the no action alternative, the two AOEs would remain in their existing homeport at NS Norfolk, Virginia.

The Explosive Safety Quantity Distance (ESQD) arc for the two AOEs encumbers approximately 1800 acres of NS Norfolk. This area contains an estimated 500 structures and several thousand people, none of whom have any direct relationship with the explosive handling operations associated with the AOEs. It is this violation of the Navy's explosive safety criteria which has led to the proposed action. The waiver which permits current fully loaded homeporting at NS Norfolk extends to 1980. In the absence of a plan to homeport the two AOEs elsewhere, it is expected that the AOEs would have to be homeported at NS Norfolk in an unloaded condition. This means that the AOEs would have to homeport at NS Norfolk without explosives cargo. To accomplish this, on return from an operation, the AOE would have to proceed to Craney Island and offload cargo fuel in quantities sufficient to bring the ship's draft to less than 35 feet. It would then have to pass through the Chesapeake Bay Bridge-Tunnel twice and proceed to NWS Yorktown to offload its ammunition cargo. Then, it can homeport at NS Norfolk. This procedure would be reversed prior to rejoining the Fleet. The trip is delineated in Figure I-6.

When considered in terms of a round trip (returning from the Fleet to rejoining the Fleet), this operation has several adverse impacts:

- It can add about ten days to the AOEs ability to achieve a readiness status. Normally, an AOE is expected to be ready to join the Fleet on 24-hour notice;

- It can increase the cost of a single ammunition and fuel handling cycle by about $2 million;

- It results in double handling of hazardous explosive cargo; and

- It can involve ten passages of the Chesapeake Bay Bridge-Tunnel. This increases the exposure of AOEs to other ships in the heavily trafficked main channels of Chesapeake Bay.

While the no action alternative eliminates explosive safety hazards at NS Norfolk, it significantly increases the hazards associated with explosive handling and channel traffic. In addition, fleet readiness is significantly reduced and operational costs are significantly increased.

This alternative has some advantages when compared with homeporting at NWS Earle:

- The AOE homeport would be closer to Fleet facilities and operations;

- AOE crew relocation would be unnecessary;

- Existing shore service facilities could be used;

- No capital costs would be necessary;

- No dredging, dredge disposal and their related environmental effects would occur;

- No construction of the ship fuel replenishment system would occur in the coastal zone; and

- No tax loss would occur related to the land acquisition of the site for the ship fuel replenishment system.

The advantages are offset by the increased explosive handling and navigational hazards, the decrease in AOE readiness capability and the increase in operational costs.

B.2 Vessel Support Systems (VSS)

As indicated in Chapter I, the Joint Chiefs of Staff (JCS) have determined that 12 VSS are required on the east coast. In addition, the Navy has immediate and long range plans for Military Ocean Terminal Kings Bay (MOTKI), Georgia. MOTKI has been approved and is being developed as the relocation site for the Fleet Ballistic Missile Submarine Squadron (FBMS) presently based in Rota, Spain. In addition, The Navy has tentative plans to support the larger class of submarines, when they are approved, with ashore refit facilities.

The use of such ashore facilities at MOTKI in the future would not be compatible with VSS operations at MOTKI. Thus, plans for the 12 VSS on the east coast must include provision for the replacement of the present U.S. Army VSS capability that would be lost at MOTKI in the event that ashore based FBMS support proceeds at MOTKI. A joint Army-Navy study (May, 1977) determined that the best solution to the requirement for 12 VSS on the east coast and the future need for ashore support of the FBM base planned at MOTKI would be to have six VSS at NWS Earle and six VSS at Military Ocean Terminal Sunny Point (MOTSU), North Carolina. At present, three VSS are located at NWS Earle and four at

MOTSU. One additional VSS is planned for construction at NWS Earle and two more are planned for construction at MOTSU under a separate action. The two additional VSS proposed for NWS Earle would bring the total to the required 12.

The no action alternative would mean that the plans to attain the 12 VSS as required by the JCS would fall short. The VSS capability (including planned and ongoing construction at MOTSU and NWS Earle) in the immediate future would be 11 (4 at NWS Earle, 6 at MOTSU and 1 at Army VSS at MOTKI). In addition to falling short of the required 12 VSS, the Navy could not meet its obligation to the Army to replace the VSS capability at MOTKI. Under this circumstance, the Army could reclaim the VSS capacity at MOTKI. This would prevent the Navy from implementing its plans for ashore support for FBMS squadrons at MOTKI and would be inconsistent with prospective national defense requirements.

The advantage of the no action alternative for VSS would be that the costs and related impacts of the construction of the in-transit holding facilities and the pier and trestle would be eliminated.

C. ALTERNATIVES FOR IMPLEMENTING PROPOSED ACTION AT NWS EARLE

The alternative approaches considered for implementing the proposed action at NWS Earle include:

- Alternative sites and pipeline routes for the ship fuel replenishment system;
- Fully-loaded AOEs - Use of existing fuel storage tanks;
- Partially-loaded AOEs - Use of existing fueling stations;
- Offshore fuel replenishment system;
- Use of local fuel barges;
- Dredge material disposal alternatives; and
- Military housing alternative.

C.1 Alternative Sites for Ship Fuel Replenishment System

NWS Earle and the area surrounding it were examined to identify alternative sites for the ship fuel replenishment system (pipeline and fuel storage facilities). All existing NWS Earle lands were eliminated because areas where sufficient space existed for the facility fell within explosive safety distance zones. The construction of fuel storage tanks within these zones requires underground storage. This doubles the cost of the ship fuel replenishment system without completely eliminating safety hazards. Underground storage could also increase the potential for direct leakage of fuel into ground-water resources.

The search for sites in the area surrounding NWS Earle focussed on industrially zoned vacant lands in reasonable proximity to the NWS Earle waterfront. Of the areas presently zoned "Light Industry" and "Industrial Park" in Middle town Township, only two potential alternative sites were identified. Their location is shown in Figure V-1. The characteristics of these alternatives and the proposed action are summarized in Table V-1.

The first alternative site (#2 in Figure V-1) is located at the corner of Route 35 and Normandy Road. It contains 80.2 acres and is three miles from the NWS Earle piers. The Normandy Road corridor could be used as a right-of-way for the pipelines. The additional cost for construction of the ship fuel replenishment system on this site of $1.7 million is related to the additional pipeline.

A wide diversity of habitats are present on site: pasture, residential area, mature hardwood forest, old fields, shrub, a small cattail swamp, and a wooded floodplain. McClees Creek flows through the southern portion of the site. It is not listed as a trout stream by the State of New Jersey.

Of the areas free of human habitation, the pasture areas are ecologically the least valuable habitats on site and provide adequate area for fuel storage tanks.

TABLE V-1

COMPARISON OF ALTERNATIVE SITES FOR SHIP FUEL REPLENISHMENT SYSTEM

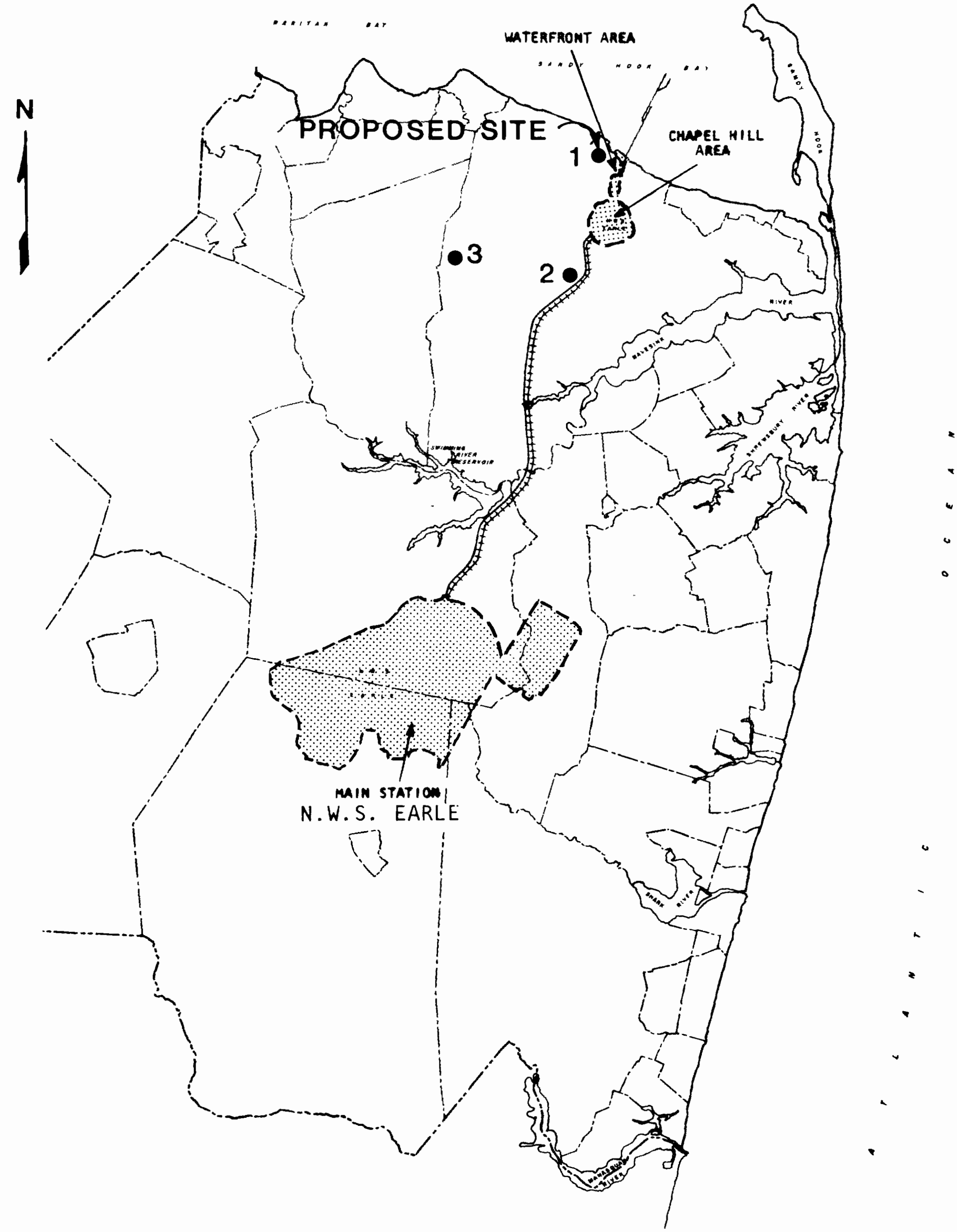
		NATURAL SETTING						ESTIMATED PIPELINE CONSTRUCTION COST			
Site Location[a]	Characteristic Land Uses	Habitat In Proposed Construction Areas	Unique Habitats[c] Near Storage Area and/or Crossed By Pipeline	Acres	Assessed Value	Assessed Value Per Acre	No. of Owners	Approx.[b] Length of Pipeline to Pier (miles)	16" Pipe	Two 10" Pipes	Total
Proposed Acquisition (1)	Predominantly vacant open space/wetlands. Airstrip and Hangar located on site. Zoned (M-2) light industry.	Old Field	Salt Marsh Wetland crossed by pipeline	309	$689,400	$ 2,115	1	.5	$ 132,000	$ 158,400	$ 290,400
Corner Route 35 Normandy Road (Government Rd.) (2)	Mixed urban area located along road-way. Primary vacant land. Zoned (M-1) light industry.	Pasture	No unique areas will be crossed by pipeline. Wetland and stream within designated storage area but at some distance	80.2	$485,500	$ 10,542	10	3	$ 792,000	$ 950,400	$1,742,400
Corner Holland Rd. & Laurel Ave. & N.Y. & Long Branch Railroad (3)	Primary vacant/ open space, sur-rounded by residential areas. Zoned (M-3) indus-trial park zone.	Pasture or Orchard	No unique areas will be crossed by pipeline. Wetland and stream within designated area of storage facility but at some distance.	123.8	$665,400	$ 5,375	13	6	$1,584,000	$1,900,800	$3,484,800

[a]Keyed to Figure V-1.

[b]Approximate length of pipeline is length derived from using existing street and utility right-of-way for pipeline path.

[c]Unique habitats crossed by pipeline assumes that pipeline will be constructed along existing streets and utility right-of-ways.

Source: Township of Middletown, Assessors Office, 1977



ALTERNATIVE SITES FOR SHIP FUEL REPLENISHMENT SYSTEM

FIGURE V-1

The second alternative site (#3 in Figure V-1) is located at the intersection of Holland Road, Laurel Avenue and the New York and Long Branch Railroad. It contains 123.8 acres and is 6 miles from the NWS Earle piers. Some existing corridors could be used for the pipeline right-of-way but no direct route exists. The estimated additional cost for construction of the ship fuel replenishment system is $3.4 million due to the extended pipeline.

The primary vegetation on this site is orchard. Other habitats on site include pasture and small forested areas along streams, and along the northern and western edge of the site. Mahora's Creek flows through the western side of the site. It is not listed as a trout stream by the State of New Jersey. Intermediate forest covers its floodplain.

The pasture or orchard provides a site of adequate size for fuel storage tank construction. Orchards usually provide stressed habitats because of cultivation and pesticide use.

Although industrial uses are permitted, no significant industrial development has occurred on either alternative site. Residential areas adjoin both sites. Fuel storage would be incompatible with these areas.

In comparison with the two alternative sites, the site proposed for the ship fuel replenishment system has been highly disturbed by landfill activities, construction of two airstrips and sewage treatment facilities. Construction of the fuel storage tanks on the land presently devoted to the airstrip would be more in keeping with surrounding land uses.

Habitats to be displaced on the alternative sites by the proposed fuel storage are of comparable ecological value. However, the proposed site is located nearest to wetlands which could be contaminated if a spill occurred. In addition, the pipeline must cross wetlands to reach the piers. However, these disadvantages of the proposed site are partially offset by the substantially greater pipeline length required for the alternative sites. Pipeline length is directly related to increased disturbance due to earth moving during construction, corridor maintenance, and possibility of a spill. The impacts on the wetland from the pipeline would be partially mitigated by use of an elevated construction scheme.

Aside from the fixed costs associated with the project, costs for pipeline construction would vary considerably, being proportional to length of the line and right-of-way acquisition. As shown in Table V-1, construction costs for one 16-inch and two 10-inch diameter pipelines range from six to twelve times the cost for development on the proposed site. These cost estimates assume that the pipelines would be located within existing rights-of-way, e.g., railroads, highways, utilities, etc. Selection of a site other than the one proposed for acquisition would result in increased project costs and could increase the time required to assemble property.

a. Alternative Pipeline Route for Ship Fuel Replenishment System

Under the proposed action, the pipeline from the fuel replenishment system (Figure I-8) would cross wetlands associated with Ware Creek. As an alternative to this route, the proposed pipeline could be set underground and follow a route along existing street and rail rights-of-way. The alternate pipeline route would travel westward from the fuel replenishment storage facilities to Main Street in Belford, run south to the Central Jersey Railroad spur, and follow the rail line along Route 36 and on out to the Waterfront Area at NWS Earle.

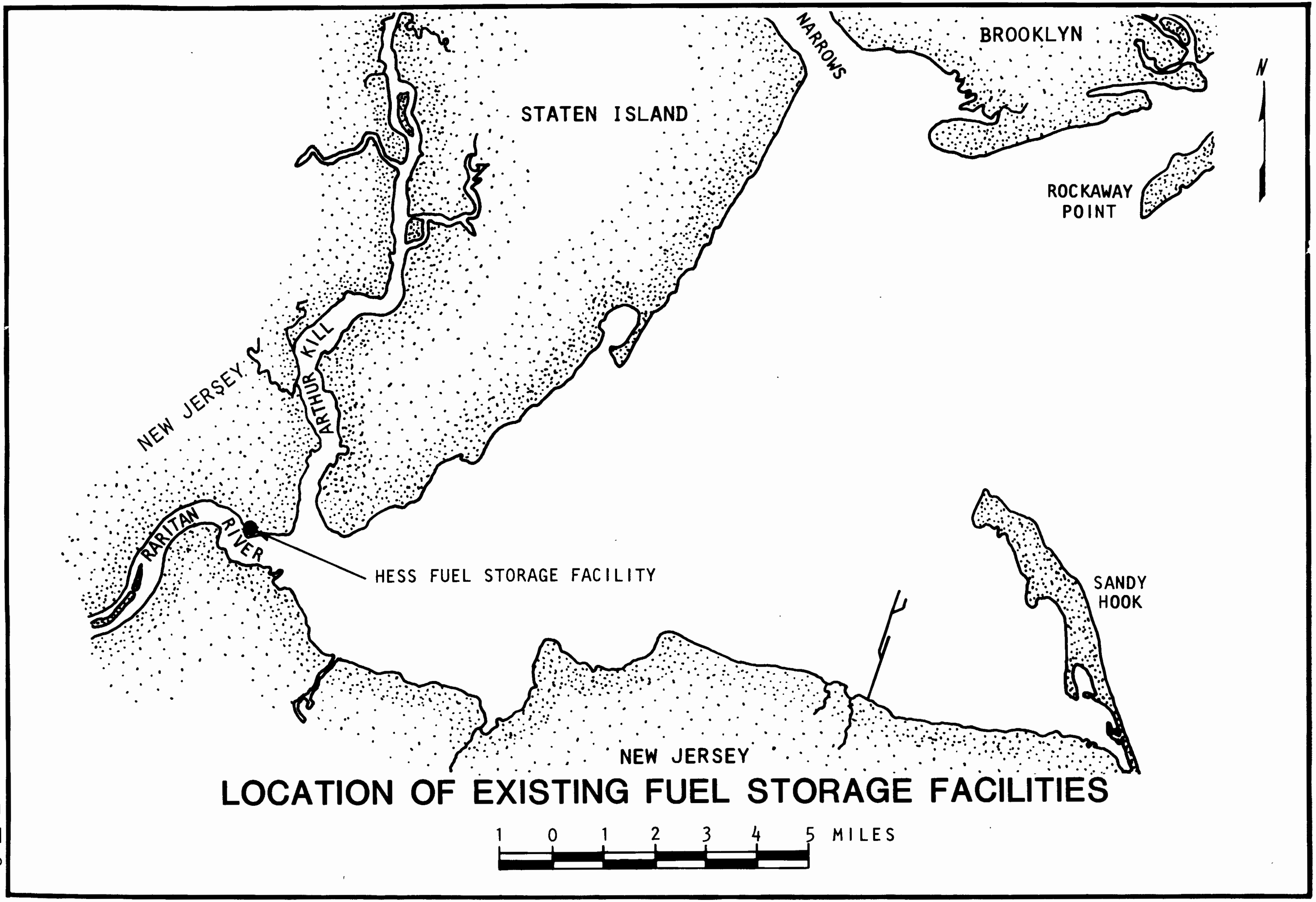
The estimated additional cost for constructing the pipeline for the ship fuel replenishment system along this corridor is estimated to be $1.6 million.

As proposed, this alternative pipeline corridor would not have a significant impact on vegetative habits, since existing right-of-way corridors are proposed to be used. However, considerable distribution of human activities would occur over the short term due to the placement of the pipeline beneath existing roadways. This alternative route would also be included in the 100-year flood plain (Figure II.C-4). However, burial of the pipeline would mitigate any flooding impacts for this area. Selection of a pipeline route using existing rights-of-way for the majority of the distance traversed would increase security risks, since the areas would be outside of the military defense parameter. Selection of the alternate pipeline corridor, other than the one proposed, would result in a 450 percent increase in pipeline construction costs and could result in construction delays should use of existing rights-of-way prove to be infeasible or politically unacceptable.

C.2 Fully-Loaded AOEs -Use of Existing Fuel Storage Tanks

Existing fuel storage facilities (product terminals) located in the New York Harbor area were investigated to determine if they could meet Naval storage needs. The Amerada-Hess Corporation's refinery/storage facilities, located in Perth Amboy are the closest available with adequate capacity (Figure V-2). Located on site are 11 unheated liquid storage tanks, each with capacities ranging from 20,000 to 3,250,000 gallons. The Hess refinery, with a capacity of 70,000 barrels of crude oil per day, has been inoperative since November 1974. However, the storage tanks are currently in use.

Even if the Hess tanks were available they are located approximately 15 miles from the NWS Earle piers. Since AOEs cannot proceed to the Hess storage tanks due to restricted water depths (35 feet MLW), pipelines to the Earle piers would be required. The cost to construct the pipelines required is estimated at between $8.0 and $10.0 million. In addition to this cost, some payment would have to be made to Amerada-Hess for use or acquisition of the storage facilities. Construction of oily waste treatment facilities near the NWS Earle piers would also



LOCATION OF EXISTING FUEL STORAGE FACILITIES

FIGURE V-2

be required. The total cost would be comparable to the cost for development of the proposed site, immediately to the west of NWS Earle Waterfront Area.

Environmental and social impacts would be generated by this alternative. About 15 stream crossings would be required. While existing rights-of-way would be used wherever possible, short-term construction impacts would affect several local communities along the Bay shore.

A further disadvantage of this alternative is that it exposes an above ground pipeline to accident or sabotage for a length of 15 miles. Should the pipeline be buried to avoid this risk, the cost of this alternative would increase even more.

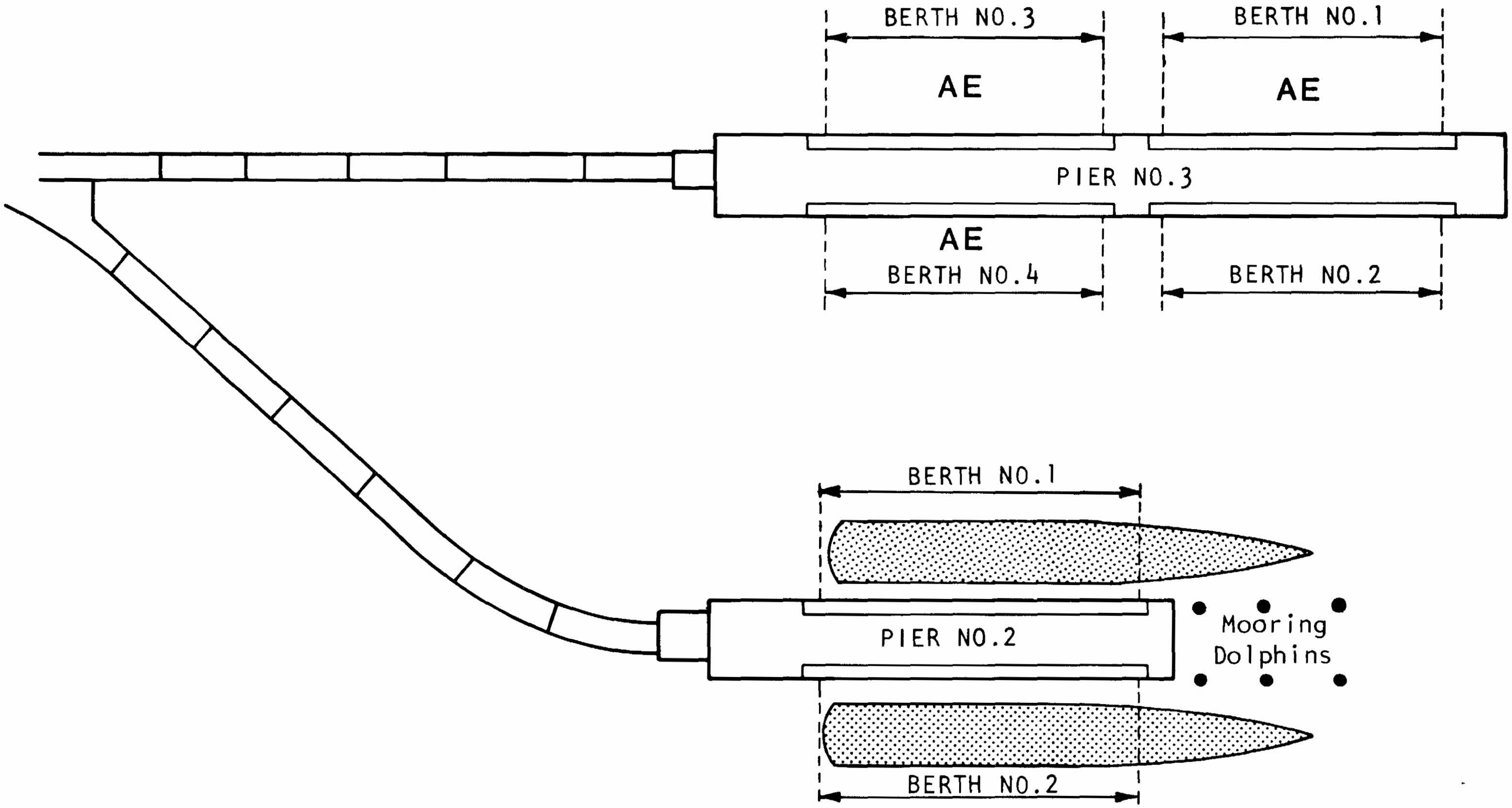
C.3 Fully-Loaded AOEs - Use of Existing Pier

It is possible to homeport two AOEs at NWS Earle using the existing piers. This alternative assumes that two additional VSS capability would be located elsewhere. In this alternative, a new pier would not be constructed at NWS Earle.

Berthing of two AOEs would be accomplished utilizing existing Pier 2. Both AOEs would be berthed at Pier 2 (Figure V-3). Mooring dolphins would be required at Pier 2. Berths 1, 3 and 4 at Pier 3 would be for AE berthing.

Insufficient explosive separation distance between ships would require an exemption/waiver to Navy regulations. It is noted, however, that when all ships (five) are in port, combined Net Explosive Weight (NEW) would not exceed the 10 million pound limit on Piers 2 and 3.

Dredging to -45 + 2 feet MLW under this alternative is limited to the following areas:



AOE BERTHING, PIERS 2 AND 3 NWS EARLE

300 0 300

SCALE IN FEET

FIGURE V-3

- Pier 2;
- The existing turning basin;
- The terminal channel; and
- The Sandy Hook Channel.

The total estimated volume of dredging required would be about 6.5 million cubic yards or 4.6 million cubic yards less than the proposed action. Dredging of new areas would not be required and no increase in the present security zone would occur. Strengthening of the north side of Pier 3 and the south side of Pier 2 to prevent undermining of piles during dredging would be required.

Since fueling is permitted at ammunition handling piers, the construction of the ship fuel replenishment system would be included in this alternative. This alternative would impact operations at the NWS Earle pier during instances when five vessels (two AOEs, three AEs) are in port simultaneously. When this occurs, only one berth would remain operational for ordnance downloading/loading of other ships.

This alternative is not characterized by the increase in vulnerability and decrease in readiness of AOEs during the initiation of a national emergency that characterizes the NWS Earle partially-loaded alternative. Costs for construction at NWS Earle would be considerably reduced.

C.4 Partially-Loaded AOEs -Use of Existing East Coast Fueling Station

Naval fueling stations are located at Craney Island, Virginia and Melville, Rhode Island (Figure I-4). The fueling Station at Melville, Rhode Island has only -35 feet MLW at the pier, and would not be able to accommodate a fully-loaded AOE. Therefore, the Melville Station would not be available for fueling without additional dredging. The AOEs can be homeported at NWS Earle and use the existing Navy fueling station located at Craney Island, Virginia. This would permit the AOEs to reduce the ship's draft to less than 35 feet for homeporting at NWS Earle without a fuel cargo.

Under this alternative, the AOEs would use the following operational procedures:

- Upon returning from the Fleet, the AOEs would proceed to Craney Island to offload fuel, as necessary, to reduce the ship's draft to less than 35 feet.

- The AOEs would then proceed to NWS Earle to homeport.

- Upon deployment, the AOEs would proceed to Craney Island to take on cargo fuel and proceed to the assigned mission. (The travel time to Craney Island is approximately twenty hours.)

This alternative would reduce the project dredging depth from -45 + 2 feet to -36 feet MLW and eliminate the need for the fuel replenishment system. The change in the project depth would reduce the materials to be dredged from 11.1 million cubic yards to 3.9 million cubic yards. This alternative would lessen environmental impacts and lower costs. Specifically:

- the amount of dredging would be reduced;

- the impact of removing the site for the ship fuel replenishment system from the local tax base would be avoided;

- the impact on the wetlands caused by the pipeline construction would be avoided;

- the potential for an oil spill at NWS Earle would be significantly reduced; and

- the project costs would be reduced by $36.2 million.

It should be noted, however, that the impact of dredging is not lessened in direct proportion to the reduction of the quantity of materials to be dredged. This is because the contaminated surface materials to be dredged are not reduced in the same proportion as the quantity of material to be dredged. This is to say, that much of the same surface area must be dredged.

The major disadvantage of this alternative is that the AOEs cannot deploy directly to the Fleet in the event of a national emergency. They would first have to proceed to Craney Island to take on fuel. This would substantially increase the vulnerability of the AOEs in the event of a national emergency. It would also increase the time, cost and energy required for the AOEs to reach the Fleet.

C.5 Offshore Fuel Replenishment System

This alternative to the proposed fuel replenishment system would consist of the following elements:

- a 4-6 million gallon capacity American Bureau of Shipping (ABS) approved fuel barge to be moored in the vicinity of the present piers; and

- a second fleet mooring to be installed beyond Sandy Hook in 45 feet of water.

AOE operations would be as follows:

- The AOE, loaded with only 40 percent of its fuel capacity (but otherwise fully loaded) proceeds to the new offshore mooring.

- A station tug takes the 4-6 million gallon barge along side and secures the barge to the moor.

Hoses and auxiliary pumping equipment on the barge would push fuel to the AOE.

The advantage of this alternative would be that dredging to -45 + 2 feet MLW and the resulting impacts on the estuarine and ocean system as well as the high costs associated with dredging would be reduced. It is estimated that this alternative can be implemented for about $10 million.

Disadvantages of this approach are that AOE operations are not based securely in protected waters. The potential for weather-related and/or marine traffic-related accidents or restrictions are significantly increased over the onshore ship fuel replenishment system. The areas off Sandy Hook are within the major marine traffic lanes to and from New York Harbor, and moorings in this area would increase navigational hazards. AOE responses to contingencies cannot be limited by such unfavorable risks. In addition, transfer operations in such offshore moorings, even during moderate weather, increase the potential for oil spills. Spills in this region would readily be transported to the adjacent nearshore areas of the beaches of the Sandy Hook unit of the Gateway National Recreation Area with the potential of causing significant impacts on this system.

Thus, the advantages of this alternative are outweighed by the disadvantages.

C.6 Use of Local Fuel Barges

This alternative to the ship fuel replenishment system would require the procurement of fuel supplies from available commercial sources in the metropolitan New York-New Jersey region. Tanker barges would supply AOEs at the new pier area. The advantage of this alternative is that the impacts and costs of construction and operation of the ship fuel replenishment system are eliminated. Disadvantages associated with this alternative are that 1) Navy AOE fuel supplies would be subject to the limitations and uncertanties of commercial supply (shortages, weather limitations, etc.). 2) Transfer operations involving fuel barges would increase the potential for oil spills.

C.7 Dredged Material Disposal Alternatives

The proposed action calls for the disposal of the 7.29 million cubic yards of fine grained dredged material at the existing dredged material disposal site in the Bight Apex. It is intended, if feasible, to utilize an additional 3.2 million cubic yards of sandy dredge materials, for constructive purposes such as beach nourishment and construction fill material. At the present time, the USACOE, New York District, is conducting an extensive study of dredged material disposal alternatives. The consensus of opinion at a recent workshop conducted by USACOE as part of this study was that for the short-term (next four years or so), continued ocean disposal at the present site is the most acceptable alternative (COE, 1977).

The viability of various alternatives depends largely on the nature of the dredged material. Three different types of dredge material can be distinguished: (1) coarse-grained clean sands; (2) fine-grained uncontaminated dredged materials; and (3) fine-grained contaminated dredged materials.

In general, it is difficult to distinguish between these three classes of dredged material for a particular project and to dredge them separately. However, it is considered feasible to segregate and distinguish these categories in the proposed Navy project as follows:

- Clean sands and gravels (Sandy Hook Channel).
- Uncontaminated fine-grained materials (sediment at depth in Sandy Hook Bay.
- Contaminated fine-grained materials (upper few feet of muddy areas in Sandy Hook Bay).

Contaminated materials may be acceptable for ocean disposal depending on the nature and degree of contamination and their impact on water quality and biologic systems as measured by ocean disposal testing procedures (EPA/COE, 1977).

The alternatives which have been considered for these three types of dredged material are presented in Table V-2. Short-term alternatives are those which are considered to be available within the next few years. The long-term alternatives are not considered to be available within the time frame of the proposed action.

a. Clean Coarse-Grained Material

Clean coarse-grained material should be considered as a resource to be used. The various alternatives listed for this material are generally preferable to ocean disposal and would be utilized if feasible.

1. Beach Nourishment - Approximately 3 million cubic yards of the proposed dredged material has the potential for use as beach nourishment. The National Park Service (NPS) is presently studying alternative schemes for addressing the beach nourishment of the seriously eroding southern segments of the Sandy Hook Unit.

It is estimated that 1.0 to 1.5 million cubic yards of material is necessary to reestablish the Gateway beaches and up to 400,000 cubic yards to maintain the beach (Dravo/Van Houghton, 1977). Materials dredged from the Sandy Hook Channel could be supplied to NPS for use in the beach nourishment program. Materials would be stockpiled at the northern tip of the park.

The NPS is considering the use of trucks, rail cars or pipeline transport of dredged materials to the southern beaches. Transport by barge and

TABLE V-2
ALTERNATIVES TO OCEAN DISPOSAL OF DREDGED MATERIAL

	DREDGE MATERIAL DISPOSAL TYPE		
Alternatives	Clean Coarse-Grained	Contaminated Fine-Grained	Uncontaminated Fine-Grained
Short-Term	Beach Nourishment	Placement in Submarine Borrow Pits	Enhancement of the Environment
	Construction Fill	Sanitary Landfill	Sanitary Landfill Cover
	Construction Aggregate	Contained Upland Sites	Submarine Borrow Pits
	Capping of Contaminated Dredge Material		Construction Fill
	Enhancement of the Environment		Contained Upland Sites
Long-Term	Contained Upland Disposal	Offshore and Inland Waterway Islands	Inland Waterway Islands
	Inland Waterway Islands	Detoxification Treatment	

Source: Adapted from USACOE, 1977a.

direct pumping of material onto beaches is feasible when conditions are favorable for direct nourishment.

Additionally, chronic erosion locations within the Bay may be suitable receiving areas for clean coarse-grained material. Loft Beach in Raritan Bay has been eroded to within close proximity to the landfill, increasing the threat to degradation of the Bay water quality. Protective beach fill in this area would help maintain water quality in this part of the Bay.

Thus, the alternative of resource utilization of the clean coarse-grained materials as beach nourishment is considered as a viable alternative to ocean disposal and would be utilized, if feasible.

2. Construction Fill - In addition to being used as a beach nourishment, the clean coarse-grained materials would be suitable as construction fill material. Within the next several years, a number of large-scale construction projects are planned which would require considerable fill. Major projects include: 1) the West Side Highway, approximately 10 million cubic yards of pierhead filling; 2) Liberty Island, 6 million cubic yards for park development along the Hudson River; 3) Hartz Mountain, new plant construction in New Jersey requiring 0.5 million cubic yards and 4) New Jersey Turnpike Interchange with Rt. 81, south of Newark Airport, requiring 1.5 million cubic yards.

3. Construction Aggregate - The clean sand and gravel components of the Navy project would also be suitable for use as construction aggregate. The feasibility of this alternative depends on the availability and distance to a market source during the proposed dredging period.

4. Capping of Contaminated Material - Portions of the 3.2 million cubic yards of clean sand and gravel dredged material could also be utilized as a capping to the contaminated fine-grained materials proposed for disposal at the designated dredge disposal site. Proper management of the dredge and disposal

program could ensure that sufficient quantities of the clean materials from Sandy Hook Channel are dredged last and used to cap previously disposed and contaminated materials at the disposal site. This would mitigate adverse impacts related to the direct exposure of the contaminated materials to benthic communities. It would also 1) reduce the chemical interchanges available between the bottom waters and the dredge contaminants; 2) decrease the susceptibility of the fine material to subsequent remobilization by storm currents and waves since the more stable sandy bottom materials would cap the muddy sediments.

The time frame for the proposed disposal operation would occur after 1981, the year that ocean dumping of sewage sludge at the nearby sludge disposal site will cease in response to Congressional action. Consideration of site restoration and revitalization of the sludge site may include the possibility of capping the bottom with clean fill material (coarse or fine-grained). Evaluations by EPA would determine the feasibility of such a course of action and whether coarse-grained or fine-grained fill would be preferable. At any rate, the volumes of suitable material available from the proposed Navy dredging project could be utilized for this purpose.

b. Uncontaminated Fine-Grained Materials

1. Borrow Pits (in Lower Bay or New York Bight) - A workshop conducted by USACOE, New York District, identified the use of borrow pits as a possible alternative for disposal of uncontaminated fine-grained materials. These borrow pits are located adjacent to the Ambrose Channel in the Lower Bay where sand is mined for construction fill and aggregate. Other borrow areas occur off Coney Island where sand has been borrowed for use in beach nourishment projects. This alternative would use these depressions to dispose of clean fine-grained materials. Clean sand material comparable to the natural adjacent areas could also be used to cap the filled borrow pits.

The advantage of this alternative is that it would lessen the volume of material to be disposed at the Mud Dump Site. The borrow pits have already been disturbed and would eventually be returned to their natural physical configuration with respect to depth and sediment texture.

However, since the areas are characterized by swift currents, the potential exists for causing impact on the adjacent coastal water quality from turbidity due to dumping. Individual sites would have to be evaluated with respect to this and the effects of sediment resuspension during fill operations.

The economic parameters controlling the market for the borrow materials vary with time. The site which is presently an unattractive deposit may become an exploitable resource in the near future due to changing market conditions. Thus, unless these borrow areas are truly abandoned and not just temporarily unattractive economically, their use as disposal areas could result in the elimination of future resources. Thus, this alternative to ocean disposal for the fine-grained uncontaminated materials may not be acceptable.

2. Agricultural Enhancement - The terrestrial environment may be enhanced by creative uses of fine-grained uncontaminated sediments such as agricultural enhancement or landscape restoration. The use of the clean fine-grained material for restoring and enhancing the construction-impacted sandy soil areas of the Main Station may prove a viable alternative to ocean disposal for some of this material. Transportation could be provided by government rail lines from the pier to the Main Station. However, such utilization of rail facilities may interfere with Earle operations. Care would have to be taken to insure that contaminated upper levels of dredge material are not included. This selective dredging, and the transport, would add slightly to the cost of the project. In addition, the salt concentration within the material would require washing and rehandling operations to ensure proper use for landscape restoration, thus increasing costs. This alternative would be suitable for only a portion of the total volume of clean fine-grained materials to be dredged.

c. Contaminated Fine-Grained Material

A maximum of 7.29 million cubic yards of fine grained material is proposed for ocean disposal Approximately one million cubic yards of this is contaminated. Alternatives to ocean disposal of this material within the project time frame include disposal in upland sanitary landfill or in containment sites and submarine borrow pits. The problems associated with submarine borrow alternatives as discussed above are further compounded by application to contaminated materials.

1. Upland Disposal - The New York District, U.S. Army Corps of Engineers is presently preparing an evaluation of alternatives to open waters disposal. This study includes a survey of available upland disposal sites in this region (Mitre Corp. November, 1978, unpublished draft). Upland disposal may be open or diked and utilize barren areas for disposal sites such as quarries, mines or borrow pits. It is estimated that an upland site of at least 500 acres, with a disposal height of 10 feet, would be required for the 7.29 million cubic yards of muddy dredge materials. A review of U.S.G.S. land use series map for this area (Newark sheet) indicates that no barren areas of suitable size are present in Monmouth County. The closest available barren land site of suitable size is located in South Amboy, Middlesex County. The site is about 843 acres and is bounded on the west by the Raritan River, on the east by the Garden State Parkway and on the south by Parlin Road. This site is the location of a former sand and quarry operation and contains small patches of scrub vegetation and bottom land deciduous forest. Residential development occurs along the eastern boundary of the site. The site is located within a recharge zone of a local aquifer and thus has the potential for ground-water contamination. Cost to develop this site for upland disposal, including land acquisition, development, equipment, pipelines and transfer facilities and site closure and restoration are estimated at about $17 to $49 million (Mitre Corp., November, 1978 unpublished draft). Barge transportation costs are increased over disposal at the ocean diposal site by about $875,000. In addition, operational costs are estimated at about a million dollars per year. This does not

include hidden costs that may be related to the need to drege to provide barge access to the site.

Croplands and pasture land also represent potential sites for upland disposal. Suitable size areas of cropland and pasture land are available in southern Holmdel and northern Colts Neck townships. However, several disadvantages are associated with this alternative. These areas are underlain by the Red Bank Sand aquifer and thus would pose a threat to contamination of ground-water. In addition, the surface drainage for this area, empties into the Swimming River Reservoir which serves as a major source of drinking water for the region. High capital costs would also be associated with development of a site in this area. For example, for a 655 acre site of agricultural land, located east of Colts Neck and west of the Government Railroad, it is estimated that capital costs for development would be between $16 to $44 million. In addition, it is estimated that farm revenue lost annually from five farms (Row crops and pasturing of cattle) would be $144,000 (Mitre Corp. November, 1978, unpublished draft). As above, operational costs are estimated at about one million dollars per year. Somewhat offsetting these costs, barge transportation costs would be lower than for ocean disposal by about $4.8 million.

Suitable size barren areas are not present within NWS Earle boundaries for upland disposal. About eighty percent of the Station is covered with forested areas. Significant environmental losses would be incurred in the utilization of such areas for development of an upland disposal site. Habitats for wildlife in these mature systems would be lost in addition to the related advantages that they provide such as, control of erosion, water purification, conservation of nutrients, mediation of runoff, temperature and wind fluctuations, oxygen and food and wood products (Odum, 1971). The potential for surface and ground-water contamination (into the Kirkwood or Vincentown Formation) would also exist for this area. In addition, development costs would be very high, comparable to those cited above for the Colts Neck agricultural site.

Disposal on wetlands is not considered a viable alternative due to losses and related impacts of displacing these sensitive and productive areas. In addition, review of USGS Land Use Maps, indicate that sites of suitable size are not available in Monmouth County.

In general, land disposal presents a number of problems. The disposal of the materials may tend to release heavy metals through leachate formation. Oxidation releases sulphuric acid with the effect of further leaching of metals. The presence of salt within dredged materials presents a potential threat to vegetated areas. The use of holding treatment facilities may be required. The drainage from such areas poses a threat to surface and ground-water resources. As a result, the chance for contamination of the food web by vegetation uptake is increased. In general, land disposal is unfavorable for contaminated materials since it brings the contaminants closer to man. In addition, the effects of exposure to low level contaminants over a long-term are not known. This alternative to ocean disposal is considered neither feasible nor environmentally sound.

2. Capping of Contaminated Deposits — As discussed above for clean sands and gravels, capping of contaminated deposits (dredge material or sewage sludge) is also a viable alternative for the fine-grained uncontaminated materials.

C.8 Military Housing Alternative

Housing accommodations at NWS Earle include bachelor quarters and barracks (207 spaces) and 65 family housing units. As discussed in Chapter I, under the proposed action, military personnel assigned to NWS Earle as a result of the AOE relocations are expected to have their housing requirements met by the Army; through use of housing available at Ft. Monmouth. However, as discussed in Chapter IV, should the Army be unable to accommodate Naval housing requirements, the possibility exists that military personnel would have to seek housing through the private sector. As a third alternative, the Navy is currently investigating the possibility of meeting its housing needs at NWS Earle through construction of new military housing at a site to be determined. This alternative would be the subject of a separate environmental impact assessment, should it become necessary.

Under this alternative, housing for military personnel assigned to NWS Earle would be constructed in sufficient quantity to meet the requirements of the Navy.

If this alternative were implemented, Naval personnel currently living at Ft. Monmouth could be relocated to this new housing. In addition, Naval personnel assigned to NWS Earle under the proposed action would not be required to be housed at Ft. Monmouth, or seek housing through the private sector.

Impacts associated with this alternative would mainly result from construction activities. In general, major short-term impacts associated with housing construction stem primarily from site preparation activities:

- Removal of vegetative habitat,
- Soil exposure creating potential for erosion and sedimentation. This, in turn, can affect aquatic and terrestrial ecosystems in the following manner:
- Sediments introduced to downstream watercourses can increase water turbidity; thereby reducing the photosynthetic activity of aquatic plants.
- Eroded sediments transport, store and act as catalytic agents for pollutants.
- Fugitive dust can settle on adjacent vegetation, watercourses and human habitation causing decreased productivity and annoyance.
- Increases in sound levels throughout construction phase.
- Degradation of air quality due primarily to release of fugitive dust.

In contrast to these negative physical impacts, housing development would have a beneficial, although temporary, impact on the contract construction industry in Monmouth County. Upon completion of the project, traffic and demand for public services would increase.

D. ALTERNATIVE SITES FOR AOE HOMEPORTING AND TWO VESSEL SUPPORT SYSTEMS (VSS)

D.1 Siting Considerations

a. Vessel Support System (VSS)

A joint Army and Navy study (May, 1977) evaluated the existing capability and potential for VSS to accommodate the required 12 VSS on the east coast. The options considered and their costs are listed in Table V-3.

Option A is the lowest cost option ($30.6 million) and includes two VSS at MOTKI. Option A is consistent with proposed plans to locate two squadrons of FBM submarines at MOTKI to be serviced by tender rather than by shore-based facilities. As discussed above in the section on the VSS no-action alternative, the two VSS at MOTKI (one existing and one potential) are not consistent with prospective national defense plans regarding development of FBM submarines and their required ashore refit facilities at MOTKI.

The Navy facilities that were examined to replace this capability at MOTKI were NWS Charleston, NWS Yorktown and NWS Earle, with the two VSS at Earle representing the proposed action. NWS Charleston and NWS Yorktown each have sufficient land available for the in-transit holding yards for only one VSS. The six VSS proposed for MOTSU represents the maximum potential development at that facility. Thus, the one potential VSS at NWS Charleston and the one at NWS Yorktown together represent a possible alternative to the two additional VSS proposed at NWS Earle.

TABLE V-3
VSS AMMUNITION OUTLOADING OPTIONS - EAST COAST

	REQUIRED TERMINAL DEVELOPMENT					COST OF DEVELOPMENT ($ MILLION)					
OPTION	MOTSU	MOTKI	EARLE	CHARLESTON	YORKTOWN	MOTSU	MOTKI	EARLE	CHARLESTON	YORKTOWN	TOTAL COST
A	6	2	4	—	—	$22.5	$3.4	$4.7	—	—	$30.6
B	6	—	4	1	1	22.5	—	4.7	$10.9	$10.9	49.0
C	6	—	6	—	—	22.5	—	53.8	—	—	76.3

Source: Army-Navy Ad Hoc Committee to Develop/Validate East Coast Ammunition Outload Capability, May, 1977

However, use of existing outloading capability at NWS Yorktown for VSS operations would shut down normal operations at the Station at a time when increased demand could be expected. Accordingly, the use of these two stations together to attain the two additional VSS required, is not considered to be a practical alternative.

b. AOE Homeporting

Basic requirements for an AOE homeport include the following:

- Explosives handling capability;
- Fuel replenishment capability;
- Deep water (depth greater than 45 feet MLW)
- Shore support facilities; and
- Safe explosive environment (large vacant areas).

At present, only three Naval Weapons Stations exist on the east coast. These stations are located at Charleston, South Carolina; Yorktown, Virginia; and Colts Neck, New Jersey (NWS Earle). None of these Naval Weapons Stations have fuel replenishment systems suitable for the AOE cargo fuel needs. Suitable fuel replenishment facilities are located at Craney Island, Virginia, Charleston, South Carolina (at the main Naval Station), and Jacksonville, Florida (Figure I-7).

Because deep water areas attract waterfront development from marine related industry, existing deep water and a safe explosive environment tend to be mutually exclusive. The AOEs need support services such as supply, administrative, repair, and maintenance; utilities; and crew-dependent housing and recreational facilities. These services are most readily available at existing Naval Stations. However, the Naval Stations have large numbers of personnel who are in close proximity to the piers who are not associated with explosive handling operations. The use of such facilities would violate explosive safety criteria by exposing these personnel to the hazards associated with explosive handling.

This study has identified no east coast site which meets all of the AOE homeporting requirements. The three existing Naval Weapons Stations come closest to meeting AOE homeporting requirements. They each have explosive handling capability, relatively deep water nearby, and some shore support facilities.

Accordingly, the guidance from the Chief of Naval Operations (CNO) for the site selection and feasibility study conducted by the Navy for AOE homeporting, indicate that candidate homeport should be an existing Naval Weapons Station where a safe explosive environment can be reasonably established. Based on these considerations, Charleston and Yorktown Naval Weapons Stations were considered as alternative AOE homeporting sites. After review of these alternatives, the Craney Island dredge material disposal site was considered as an alternative since it might provide a safe homeport environment permitting use of existing facilities at NS Norfolk, the Craney Island Refueling Depot and NWS Yorktown.

A detailed description and evaluation of this alternative is provided in Appendix K. However, the USACOE has decided to extend the capacity of the disposal area beyond 1979 by increasing the height within the inner dike. This is expected to extend the life of the disposal area until about 1989. Thus, it would not be available within the time frame for implementation of the proposed action and therefore is not considered a viable alternative.

D.2 NWS Charleston, South Carolina-AOE Homeport Alternative

NWS Charleston is located on the west side of the Cooper River about 20 miles from the Atlantic Ocean and 13 miles north of Charleston. The city of Charleston, situated on a peninsula formed at the confluence of the Ashley and Cooper Rivers, is the center of this region (Figure V-4).

a. Existing Installation Facilities

NWS Charleston comprises 550 structures, mostly of permanent construction. The POLARIS Missile Facility, Atlantic (POMFLANT), a tenant of the NWS, is located north of South Carolina Highway 29 on the west bank of the Back River. There are 228 permanent-type buildings at POMFLANT.

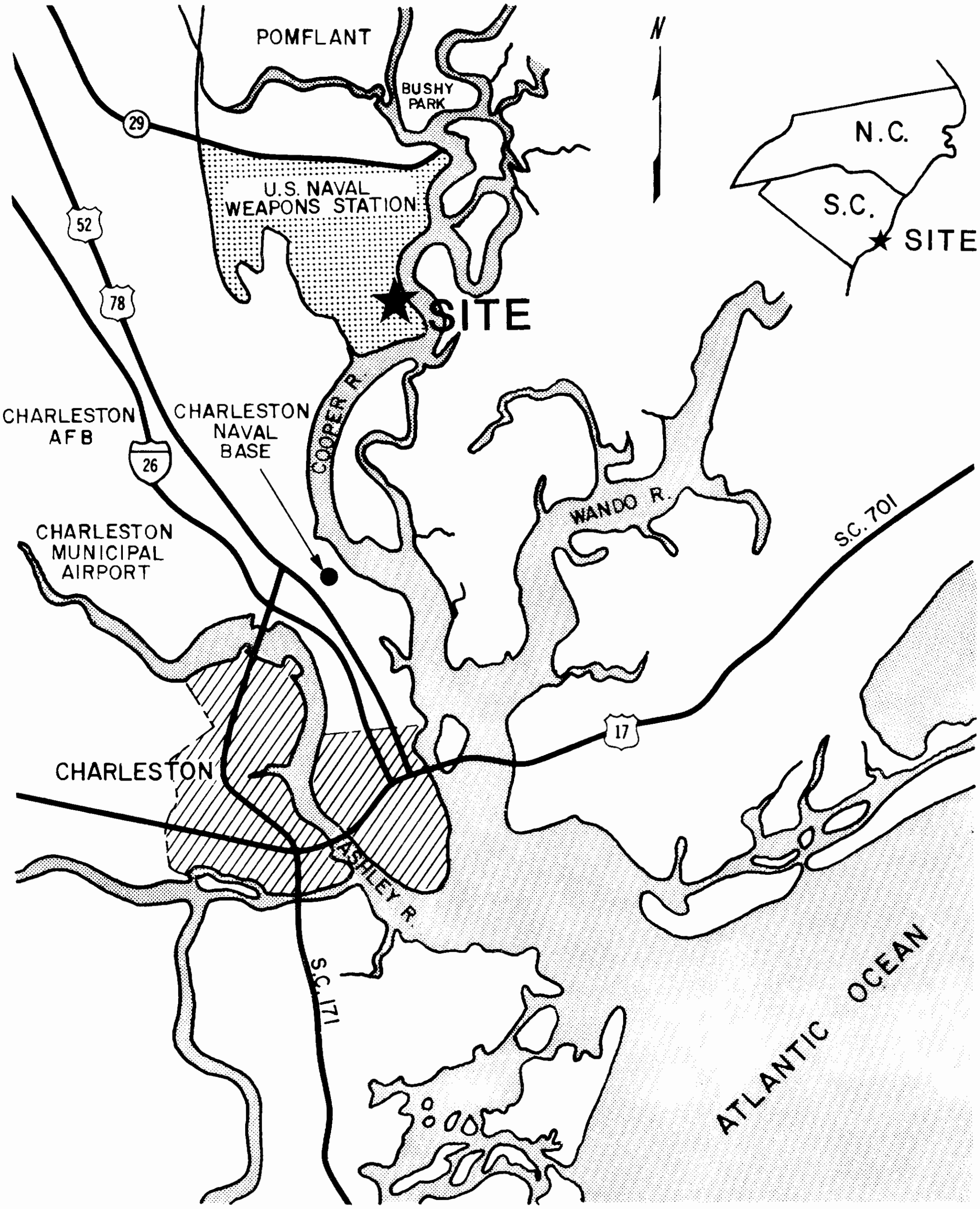
The Station is bordered on the west by pulpwood forest lands; to the north by pulpwood forest lands, tidal marshlands, and the Back River; to the east by tidal marshlands and the Cooper River; and to the south by tidal marshlands, the port of Charleston, industrial facilities, Charleston Navy Base, and residential housing. A fueling station capable of handling AOEs is located south of NWS Charleston.

The mission of NWS Charleston is to provide material support for assigned weapons and weapons systems and to perform additional tasks as directed by Commander, Naval Sea Systems Command.

Total land acreage at the Station is approximately 16,900 acres. Of this acreage, the Navy owns 15,927 acres, and 973 acres are ingranted.

b. Physical Environment

At the Charleston site, substantial dredging is currently needed to maintain the 35-foot channel. The Cooper River rediversion project of the Army Corps of Engineers is expected to reduce the rate of shoaling after 1981 by reducing the flow in the river by a factor of five.



REGIONAL LOCATION MAP: NWS CHARLESTON, SOUTH CAROLINA

1 ½ 0 1 2 3
MILES

FIGURE V-4

The Cooper River water quality in the area of the proposed facility is generally poor with bathing and shellfishing prohibited. Surrounding bodies of water are generally of higher quality but cannot be used as water supplies or for bathing. The sediments of the Cooper River are classified as polluted due to high organic and heavy metal content. (U.S. Department of the Navy, 1977b)

c. Biological Environment

The aquatic biological systems in the Cooper River near the proposed site can be considered improverished; however, there are annual runs of fish for spawning in the River. South of the site, marine fishes predominate and Charleston Harbor is considered a productive area for fish.

The terrestrial environment of the site is somewhat unique in that it contains representatives of almost all of the natural community types occurring in the coastal plain. These include salt/brackish marshes, freshwater marshes, ponds, swamps, open fields, hardwood forests, and pine forests. This wide range of habitat supports a wide variety of wildlife. Enhancement of wildlife resources has been actively encouraged through a fish and wildlife management program.

There have been many reports of rare or endangered animal species on the site, many of which have been unconfirmed (U.S. Department of the Navy, 1977b). Even if the unconfirmed reports are disregarded, the Station still has a high density of rare or endangered animal species within its boundaries.

d. Man-Made Environment

The area containing the proposed site is considered the fastest growing area in South Carolina in terms of key socioeconomic indicators. The government is the chief employer in the Charleston area, with the Navy the main government employer. The Port of Charleston is contributing to this growth by moving rapidly ahead as the busiest container port on the South Atlantic Coast.

e. AOE Homeporting Requirements

The channel depths within Charleston Harbor and Cooper River are at 37 feet (locally to 40 feet) and are not sufficient to allow homeporting of AOEs with full fuel cargo at NWS Charleston without extensive dredging. It is estimated that approximately 17 to 18 million cubic yards of sediments would have to be dredged from the 20 mile length of channel.

The existing piers (Wharf A, Pier B, and Pier C) would not be capable of berthing the two AOEs and a new pier would be required. Wharf A is a marginal wharf, approximately 1,100 feet long by 75 feet wide. It is used primarily for loading/offloading of POSEIDON/TRIDENT missiles. It is occasionally used for loading/offloading of conventional ammunition to and from surface vessels. Wharf A has one portal crane with 45 gross ton capacity, rail service, and electrical power for hotel services for two submarines. Wharf A is sited for an explosives quantity limit of 1.0 million pounds NEW.

Pier B is a finger pier, approximately 750 feet long by 60 feet wide. It serves as the homeport facility for two AEs, the USS SANTA BARBARA and the USS MOUNT BAKER. Pier B is the Station's primary facility for loading/offloading of conventional ammunition to and from surface vessels. This pier has one portal crane, 35 gross ton capacity, rail service, and complete hotel services (cold iron). Pier B is sited for an explosives quantity limit of 4.5 million pounds NEW, except when ammunition handling is in progress at Wharf A. During such times the limit is downgraded to 3.0 million pounds NEW.

Pier C is an approachway, approximately 600 feet long, to a berthing platform for Mediterranean mooring of a submarine tender, presently the USS HUNLEY. This pier also provides mooring space for a limited number of smaller craft. Pier C is sited for an explosives quantity limit of 1.7 million pounds NEW, but it has no explosive handling capability.

Ammunition outloading and submarine tender operations are being conducted concurrently at Piers B and C respectively. Only Pier B has an explosive limit adequate for two AOEs, and it is currently used as an AE homeport.

Sufficient safe separation distance does not exist for the siting of the new pier in the waterfront areas between Wharf A and Pier B. Locations within this waterfront area would require a waiver from safety criteria or operational restrictions. A site with a safe separation distance north of Wharf A would locate the AOE pier such that all the structural components of NWS Charleston would be encumbered by the ESQD arc of the berthed AOEs. This northern location is thus unacceptable, for it would require the relocation of all the encumbered structures.

In spite of the safe separation problem, the only feasible site for the new pier would be between Wharf A and Pier B. It would be about 900 feet long and would extend a considerable distance into the river channel, which is narrow in this area.

f. Impacts of AOE Homeporting

The NWS Charleston alternative results in a number of serious adverse impacts compared with the proposed site at NWS Earle. The most significant potential adverse impact on the environment is from dredging and disposal of 17 to 18 million cubic yards of material. Bottom sediments within the Cooper River are fine-grained and contaminated. It is expected that this degree of channel deepening will cause further upstream penetration of salt water wedge in the River, thus generating changes in the average annual temperature and salinity of the River. Dredging operations would result in water quality impacts such as increases in toxic contaminants, turbidity and depressed dissolved oxygen levels due to suspended, oxygen demanding sediments. These effects would be difficult to control due to the substantial currents present in the River. Dredging would impact benthic biota by smothering and habitat removal. It is possible that dredging could destroy Indian archaeological sites within the vicinity of NWS Charleston.

Dredged material disposal in the Cooper River area consists of contained upland disposal in sites along the River. Placement in such areas poses a significant threat to water quality. Sediment water overflows or breachings would result in release of heavy metals and other contaminants. The limited assimilation and capacity of these disposal areas and the large volume to be disposed of would result in extensive impacts on terrestrial fauna and flora habitats. The brackish water runoff from these disposal areas may have adverse affects on the freshwater marshes.

Construction operations related to the new pier may block the existing channel due to its length. This would require a major dredging into the sensitive marshy east bank areas of the River to relocate the present channel while construc-tion proceeds on the pier. It is expected that this requirement would result in a 3 to 4 year construction-time for the waterfront projects.

In addition to initial dredging impacts, maintenance dredging may be a significant problem. Maintenance dredging in Charleston Harbor has increased substantially since 1972. Studies by the U.S. Army Corps of Engineers, Charleston District (January, 1975), have indicated that the siltation can be reduced by implementation of the proposed Cooper River Rediversion Project scheduled for completion in 1981. Much of the base flow of the Cooper River will be rediverted to the Santee River. Excessive maintenance dredging can be avoided only if this project is successful.

Construction of the new AOE pier would require a waiver from the required safe separation distance for Pier B and/or Wharf A. If a safety waiver is not granted, operational restrictions on the use of the AOE pier and/or Pier B and Wharf A would be required. The ESQD arc for two AOEs (3.5 million NEW) for this site would encumber approximately 22 structures on the Station near the administrative area and relocation of these facilities would be required.

The proposed site at NWS Charleston presents additional significant problems with respect to safety considerations. The Department of Defense Safety Board has indicated concern over locating additional waterfront explosive handling facilities in this congested area. Ships using this portion of the Cooper River include traffic to Bushy Industrial Park upstream from NWS Charleston. The industrial park includes: the Verona Dyestuffs Plant, the General Dynamics liquid natural gas container facility, the South Carolina Electric and Gas Power Plant and the AMOCO pier. These ships, with their hazardous cargo, increase the potential for accidents along this narrow channel. An additional waiver for encumberance of a navigational channel would also be required at this site.

An advantage of NWS Charleston is that it is closer to most areas of AOE deployment. This advantage is partially offset by the location of the Station some 20 miles from the open ocean. This increases the time required for initiation of deployment during a national emergency.

Another advantage of NWS Charleston is availability of an existing refueling depot in the vicinity of the Station. However, this cost saving is balanced by the very high development costs, estimated at $145 to $175 million, largely related to the tremendous volume of dredging required.

D.3 NWS Yorktown, Virginia-AOE Homeport Alternative

NWS Yorktown is located on the Virginia Peninsula, which is 25 miles in length and eight to ten miles in width. The Station is situated approximately 80 highway miles from Richmond, the capital of Virginia, and 180 miles from Washington, D.C., as shown in Figure I-7. The Peninsula, lying between the James and the York Rivers, extends into Hampton Roads (the confluence of the James, York, Elizabeth, and Nansemond Rivers). At Old Point Comfort, the Hampton Roads broadens to form the mouth of the Chesapeake Bay. NWS Yorktown is approximately 38 nautical miles from the Atlantic Ocean (Figure V-5).

The Peninsula may be reached via Interstate 64, U.S. Routes 17 and 60, and Virginia Routes 143 and 238. These routes lead through one of the most historic areas in the United States - the renowned triangle formed by Williamsburg, Jamestown, and Yorktown (Figure V-5). At the Peninsula's end is Newport News, known for its shipbuilding and port facilities. Newport News is also the eastern terminus of the Cheasapeake and Ohio Railroad. Adjoining Newport News is the City of Hampton. Established in 1610, Hampton is the oldest English-speaking settlement in continuous existence in America today.

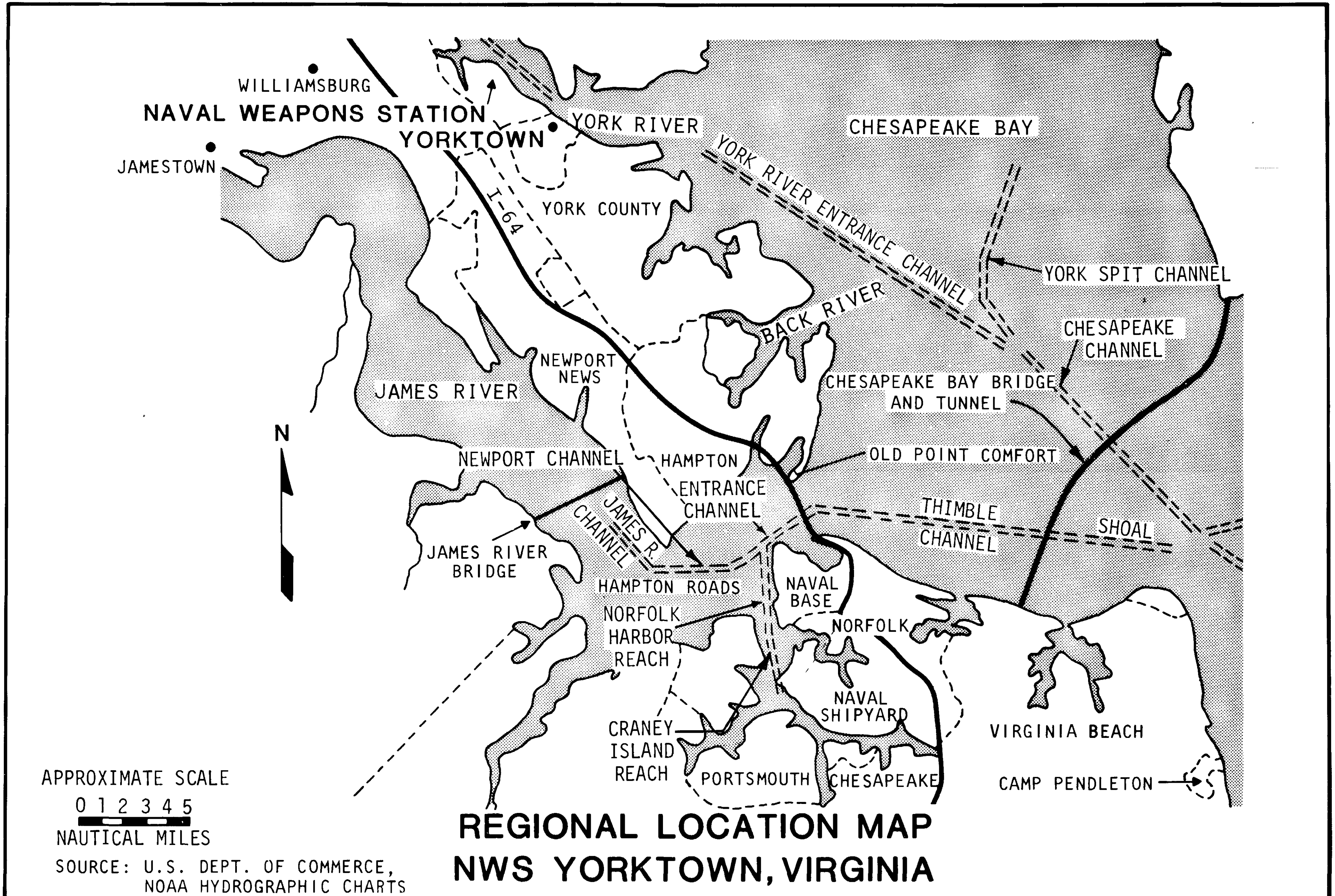
The central portion of the Peninsula is sparsely settled and retains much of its colonial appearance. Williamsburg, Jamestown, Yorktown, and NWS Yorktown form a major portion of the central Peninsula. Further west, the Peninsula broadens into even more sparsely settled agrarian land.

The Naval Weapons Station is located on over 10,500 acres adjacent to the York River near the town of Yorktown (Figure V-6). It is bounded on the west by the U.S. Naval Supply Center's Cheatham Annex, on the north by the Colonial Parkway, and on the south by Interstate 64. The small town of Lackey and private agricultural land adjoin the northeast Station boundary.

a. Existing Facilities

NWS Yorktown is a major logistic support base for units of the U.S. Atlantic Fleet operating in the Norfolk/Hampton Roads area. Its mission is to receive, segregate, store and issue (RSS&I) and renovate ammunition including bombs, mines, torpedoes, and other underwater ordnance. In response to development and introduction into the Fleet of guided missiles and other modern weapons, the Station's mission has expanded to include servicing, assembly, testing, repair, refurbishment and retrofit, and other military personnel training for this more complex inventory. NWS Yorktown also has a certified tactical weapons capability. In addition, NWS Yorktown has an explosive development mission for research

FIGURE V-5



REGIONAL LOCATION MAP
NWS YORKTOWN, VIRGINIA

and developmental studies, pilot production and testing facilities, technical engineering consultation, and testing and fabrication services for other Government agencies and allies.

NWS Yorktown has one 2250-foot pier parallel to the shore with a railroad trestle connecting each end to the shore. The upstream trestle has a lift span to permit use of the enclosed basin for small craft and barge operations. The outboard channel/pierside depth is 36 feet. One-thousand, two-hundred and fifty (1,250) feet of the pier is about 94 feet wide and is provided with three railroad tracks. The remaining 1,000 feet downstream is 42 feet wide. There are 22 barge berths on the inboard pier faces. The pier currently has an explosive limit of 700,000 pounds NEW and a waiver is in effect to permit the 2.25 million pounds NEW when operationally necessary. The 6,550 foot explosive safety arc for 2.25 million pounds NEW (NAVSEA OP-5, 1977) encumbers a narrow strip of land and the Colonial National Historical Parkway which comprises the Colonial National Historical Park under the control of the Interior Department. The arc also encumbers a number of older base structures built before the current ESQD criteria were published and a small segment of the Married Officers Quarters (MOQ) area. Projects for relocation of all the encumbered habitable buildings have been submitted for inclusion in the CNO-sponsored Naval Explosives Safety Improvement Program (NESIP) and are being programmed into the Military Construction Program on a continuing basis.

b. Physical Environment

NWS Yorktown is located in an area with slightly rolling hills; elevations vary from 5 to 80 feet above sea level with occasional steep slopes occurring at the river banks. The rolling terrain forms natural watershed areas, controlling and channelizing surface drainage. The soil varies from sand to clay with several inches of friable wood and leaf mold in wooded areas. Marshy wetlands occur frequently along the banks of the area's many lakes and tidal inlets.

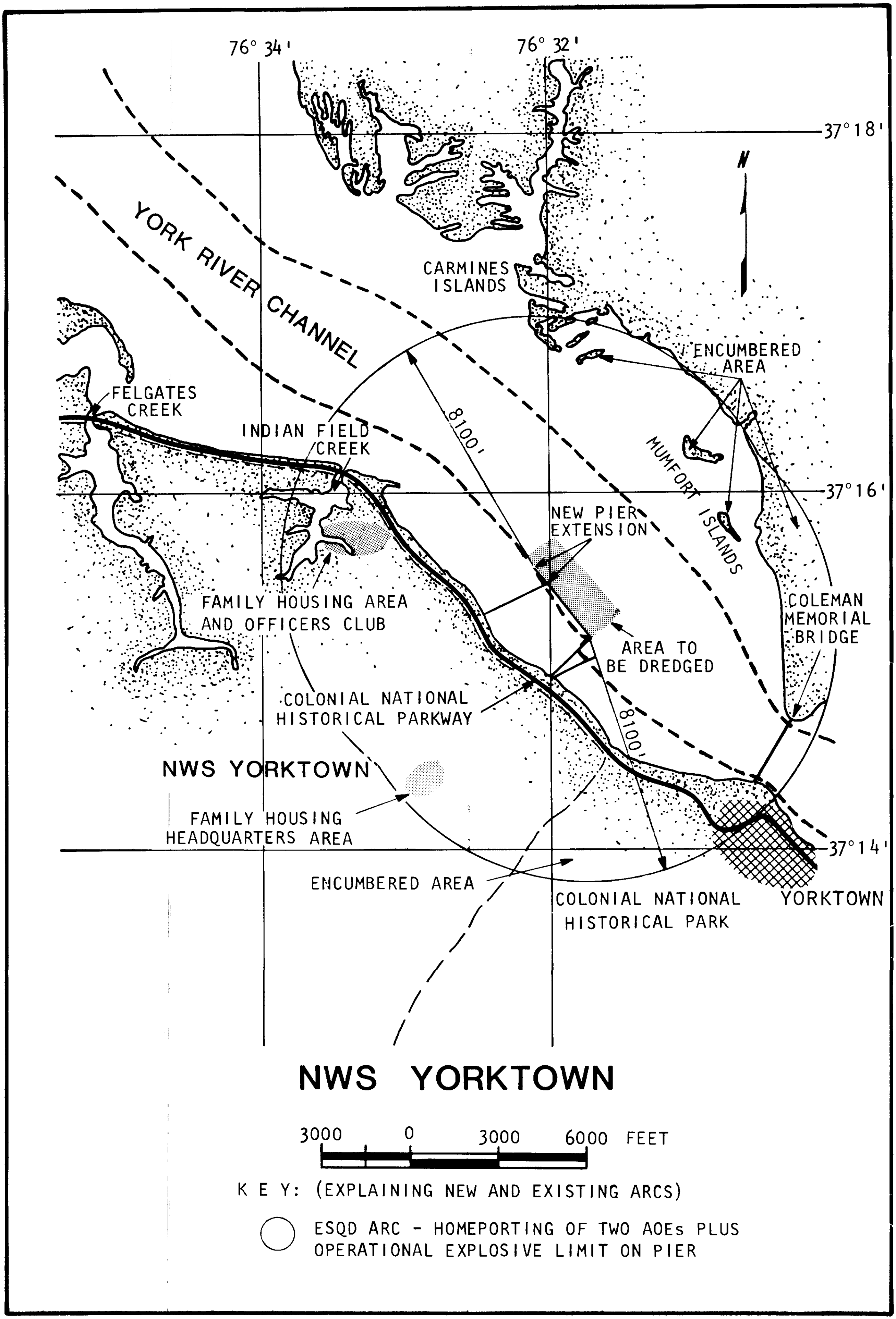

76° 34'
76° 32'
37° 18'
37° 16'
37° 14'
N
YORK RIVER CHANNEL
CARMINES ISLANDS
ENCUMBERED AREA
FELGATES CREEK
INDIAN FIELD CREEK
8100'
MUMFORT ISLANDS
NEW PIER EXTENSION
FAMILY HOUSING AREA AND OFFICERS CLUB
COLEMAN MEMORIAL BRIDGE
AREA TO BE DREDGED
COLONIAL NATIONAL HISTORICAL PARKWAY
8100'
NWS YORKTOWN
FAMILY HOUSING HEADQUARTERS AREA
ENCUMBERED AREA
COLONIAL NATIONAL HISTORICAL PARK
YORKTOWN
NWS YORKTOWN
3000 0 3000 6000 FEET
KEY: (EXPLAINING NEW AND EXISTING ARCS)
ESQD ARC - HOMEPORTING OF TWO AOEs PLUS OPERATIONAL EXPLOSIVE LIMIT ON PIER

FIGURE V-6

The area's largest and most vital environmental component is the York River. The York River is formed at the confluence of the Pamunkey and Mattaponi Rivers and extends for approximately 30 miles. The River averages two miles in width but narrows to half a mile at Gloucester, just before emptying into the Chesapeake Bay.

Access to the open sea (see Figure V-5) is through the York River Channel which ranges in depth from 45 to 80 feet for about 15 miles to the York River Entrance Channel. This Channel is maintained to a 37-foot depth for a width of 750 feet and continues 11 miles to the Chesapeake Channel. The Chesapeake Channel is a natural depression with depths of about 45 feet and a minimum width of 2,400 feet for 132 miles to the Cape Henry Channel. The Cape Henry Channel is one mile long, 42 feet deep, and 900 feet wide. Cape Henry Channel is the final channel leading to the Atlantic Ocean. The distance from Cape Henry Channel to the 20 fathom curve is approximately 80 miles; to the 100 fathom curve, approximately 105 miles.

The approach channel coincides with the Atlantic Intracoastal Waterway in the Chesapeake Channel reach. One bridge spans the 40-mile long channel to the open sea (passage is over the tunnel portion of the Chesapeake Bay Bridge-Tunnel). This bridge, the George P. Coleman Memorial Bridge, extends from Yorktown to Gloucester Point (Figure V-6). It has twin spans with a vertical clearance of 60 feet and a horizontal clearance between spans of 450 feet. For taller vessels, the two spans can be swung open.

The NWS Yorktown site has a physical environment which has been somewhat modified by the existing facilities. Surface soils near the developed waterfront area have been altered by construction. The approach channel is largely natural, but some dredging is required to maintain the 37-foot depth. The waters of the York River at this point are tidal, with denser saline water on the bottom and relatively fresh water on the top. The quality of water in the York

River is generally good and oysters are harvested south of the site. Several streams in the immediate vicinity of the site are experiencing water quality problems, primarily in terms of high bacteria counts.

c. Biological Environment

The aquatic systems associated with the river include only organisms which can tolerate relatively high salinity levels. Numerous landlocked lakes and ponds and river-connected tidal creeks which are fresh water also exist in the area. All these aquatic systems can generally be termed productive. Much of the land within NWS Yorktown is maintained in a fairly natural state.

d. Man-Made Environment

The area is growing in terms of population, income, employment, and other socioeconomic indicators. The Federal government has traditionally been the most important economic concern in the area. Much of this activity, as well as business in the private sector, is centered around the harbor at Newport News and Hampton Roads. This is one of the finest harbors in the world, and in terms of U.S. activity, is second only to the port of New York.

e. Fully-Loaded AOEs-Homeporting Requirements

In order to homeport two AOEs at NWS Yorktown fully-loaded, the following actions must be taken (Figure V-6):

- construct a 1250-foot pier extension with explosive handling capacity;
- dredge 14.0 million cubic yards at the pier extension, the York River entrance Channel and the Cape Henry Channel;
- construct utilities to support the AOEs while they are homeported;

- construct additional magazines for explosive storage;
- construct additional on-shore support facilities;
- acquire all privately owned non-federal land which falls within the explosive safety distance arc; and
- relocate all military family housing units and private residential and commercial structures which are encumbered by the explosive safety distance arc.

It is assumed that AOE refueling can be accomplished at the Craney Island fuel depot.

Relocation of AOE crews is probably unnecessary as the Norfolk area is within commuting distance of NWS Yorktown. However, the distance is far enough so that the crews may gradually self-relocate to the Yorktown area.

f. Impacts of AOE Homeporting - Fully-Loaded

This alternative could have a significant affect on ordnance operations on the piers when both AOEs are in port. The pier at NWS Yorktown currently has a safe explosive limit of 700,000 pounds NEW and a waivered limit of 2.25 million pounds NEW. Each AOE carries 1.75 million pounds NEW, hence, when both ships are in port simultaneously, ordnance handling would exceed allowable NEW. Unless a waiver is granted, NWS Yorktown would not be able to provide service to other ships while both AOEs are in port.

In order to allow the homeporting of two fully-loaded AOEs while maintaining the normal pier operational explosives capacity, the waivered allowable NEW (2.25 million pounds) would have to be increased to 4.2 million pounds

NEW (1.75 million pounds x 2 AOEs + 0.7 million pounds existing pier limit). Existing safety criteria require an 8100 foot explosive safety arc for habitable building based on 4.2 million pounds NEW (NAVSEA OP-5, 1977). When taken from both ends of the pier (including the proposed extension) this arc (see Figure V-6) would encumber:

- all Navy family housing units in the Indian Creek and Headquarters areas of the base proper;

- the base officers club and numerous other navy structures and facilities;

- approximately 485 acres of federally controlled land involving the Colonial National Historical Park and Parkway;

- approximately 585 acres of private agricultural, commercial and residential lands including the Mumford Islands, Carmines Islands, a portion of Yorktown proper, an area along the western shoreline of Gloucester Point, and an area bordering the base on the northeast near Yorktown. Approximately 140 structures would also be encumbered in these non-federal areas; and

Another alternative at NWS Yorktown would be to restrict AOE berthing to one ship at a time or reduce the amount of explosives permitted aboard the AOEs while homeporting. This approach would allow for a smaller ESQD arc, lesser encumbered areas and lower cost. However, it would have a significant impact on scheduling, fleet economies and strategic considerations. Under these circumstances, NWS Yorktown would not be able to carry out its principal mission. The cost of homeporting AOEs in fully-loaded configuration, including acquisition of encumbered non-federal lands and relocation/replacement of private structures, is estimated to be at least $145 million.

One of the disadvantages of NWS Yorktown is that the pier facility is located at the edge of the York River Channel. Under the latest DOD Safety Criteria for Ammunition and Explosives Handling (NAVSEA OP-5, 1977), a distance of 4860 feet based on 4.2 million pounds NEW would be required for separation of explosive ordinance ships or barges and a main river channel, public highway or passenger railroad. As the existing pier is at the edge of the York River Channel, a waiver/exemption from this criteria would be required. Similarly, waivers will have to be continued for the already encumbered Colonial National Historical Parkway (see Figure V-6).

Another disadvantage of NWS Yorktown is that destruction of the Coleman Memorial Bridge (either by accident or sabotage) downstream from the Station would isolate the pier facilities from the Fleet and/or prevent the homeported AOEs from getting to sea.

As discussed in Chapter IV, Section B.3, the navigational hazards and the potential for accidents resulting in oil spills would be significantly increased for this alternative. Such spills would have a greater overall impact on the local environment within the York River and Chesapeake Bay than at NWS Earle.

Dredging in the pier area could affect commercial fishing operations which occur from the mouth of the York River to about ten miles upstream.

However, the presence of the oyster drill, Urosalpinx cinerea, in the area below the Coleman Bridge, and the presence of the oyster disease MSX in the high salinity areas below the Coleman Bridge and in the area immediately above the Cheatham Annex, has severely limited oyster production in this area since 1960. Leased bottoms in the creeks and tributaries to the lower York River yielded an estimated harvest of less than 1,000 bushels per year since 1960 (Haven and Bendall, 1974). In addition, the possibility of bacterial pollution has resulted in many of these small creeks being classed as restricted. The area adjacent to the proposed dredge site has been classed as "restricted for harvest of shellfish" by the Virginia

Bureau of Shellfish Sanitation. Molluscs may not be harvested in restricted areas without first obtaining a permit from the Virginia Marine Resources Commission.

Dredging in the York River Entrance Channel may also affect shellfishing in oyster lease areas which are located immediately west of the channel for a distance of about four nautical miles.

Dredging between the mid-March to October spawning periods could change water quality in a manner that would seriously impact on the oyster populations. Chemical analyses of York River sediments indicate that they are contaminated. Short-term effects from removal of macrobenthic organisms, severe turbidity, increases in dissolved mercury, BOD and available nitrogen during dredging could be expected (NWS Yorktown, Va., 1976).

The NWS Yorktown site alternative does not offer a readily available disposal site for the large volumes of material that would be dredged. It is probable that various contained upland disposal sites would be utilized with resulting increased impacts on water quality and terrestrial biological systems. An on-station disposal site for material dredged from around the existing piers has been identified. This on-station site may be sufficient to handle the dredging requirements for at least the pier extension portions of the required dredging. Discussions with the Corps of Engineers indicated that the Craney Island disposal area is limited, under state law, to dredged material taken from Hampton Roads Harbor.

Additionally, several British naval artifacts and relics resulting from the Yorktown - Gloucester Point campaign of 1781 have been recovered from the waters of the York River. The potential occurrence of other objects having archaeological significance could present an obstacle to dredging in the York River.

g. Partially-Loaded AOEs

Under this alternative, upon return to port, AOEs would have to reduce their cargo fuel at Craney Island prior to proceeding to NWS Yorktown, thus passing across the Chesapeake Bay Bridge-Tunnel system four times. Berthing facilities required and operations waivers would otherwise be the same as for the fully-loaded AOEs.

The major advantage of this alternative is the limited amount of dredging that would be required. Dredging of only approximately 0.5 million cubic yards would be required for areas around the existing wharf and the proposed pier extension. Impacts to the aquatic systems and overall costs would be significantly reduced. An advantage of the Yorktown partially-loaded AOE alternative is that travel time from Yorktown to Craney Island is approximately six hours, compared with a 20-hour trip from NWS Earle. In addition, Yorktown is better located for service to the Fleet since no northern activity provides homeport berths to any surface combat vessels serviced by AOEs. The waivers from Safety Criteria cited above for AOEs berthed at NWS Yorktown also would apply to this alternative. In addition, military readiness would be decreased and vulnerability increased by the requirement to travel to Craney Island and load fuel prior to initiating deployment to open water during a national emergency. In addition, the difficulties of being located behind the Coleman Memorial Bridge would apply to this alternative. Costs for the alternative to homeport partially-loaded AOEs are about $20 million.

D.4 Comparison of Proposed Action with Major Alternatives

a. Definition of Major Alternatives

In addition to the proposed action, eight major alternatives were identified for comparative analysis. In addition to the No-Actions, these alternatives consist of combinations of two VSS alternatives;

- o two VSS at NWS Earle and
- o two VSS MOTKI

and three AOE alternative sites;

- o NWS Earle,
- o NWS Charleston, and
- o NWS Yorktown

In addition to the fully-loaded AOE configuration at the AOE sites, one partially-loaded AOE alternative was considered at Yorktown and two at NWS Earle (using existing piers and using the new pier and trestle).

Alternatives considered but not included in this summary include combinations related to:

- o Two VSS at NWS Yorktown
- o Two VSS at NWS Charleston
- o One VSS at NWS Yorktown and one VSS at NWS Charleston
- o Combination of one VSS at NWS Yorktown or NWS Charleston with one VSS at NWS Earle or MOTKI

Alternatives involving two VSS at NWS Yorktown or two VSS at NWS Charleston are considered impractical due to the insufficient land required for two VSS. Combinations involving one VSS at either NWS Yorktown or NWS Charleston are considered infeasible due to explosive handling limitations. Ammunition outloading for VSS operations would preclude other activities by these weapon stations in support of fleet operations.

In addition, alternatives considered but not included in this discussion are such combinations as AOE homeporting at NWS Charleston and NWS Yorktown coupled with two VSS at NWS Earle. These alternatives simply compound the adverse impacts associated with AOE homeporting at these stations with the adverse impacts of two VSS at NWS Earle with no advantage over other alternatives considered.

The alternatives of AOE homeporting at NWS Charleston without a full fuel cargo is omitted as the costs and impacts of implementation are similar to the fully-loaded alternatives. The No-Action-AOE homeporting fully-loaded at NS Norfolk was omitted because this would not be allowed due to exceedance of explosive safety waivers.

After taking these considerations into account, six major alternatives to the proposed action were identified. The following is a brief outline of the characteristics of the proposed action and the six major alternatives:

Proposed Action - AOE homeporting, fully-loaded and two VSS at NWS Earle:

- New pier and trestle
- New ship fuel replenishment system
- Extensive dredging

1) AOE homeporting, partially-loaded and two VSS at NWS Earle:

   - New pier and trestle
   - Existing ship fuel replenishment system
   - Moderate dredging

2) AOE homeporting, fully-loaded at NWS Earle and two VSS at MOTKI:

   - Existing piers
   - New ship fuel replenishment system
   - Moderate dredging

3) AOE homeporting, fully-loaded at NWS Charleston and two VSS at MOTKI:

- New pier
- Existing fuel replenishment system at Charleston Naval Station
- Extensive dredging

4) AOE homeporting, fully-loaded at NWS Yorktown and two VSS at MOTKI:

- New pier extension
- Existing fuel replenishment system at Craney Island
- Extensive dredging.

5) AOE homeporting, partially-loaded at NWS Yorktown and two VSS at MOTKI:

- New pier extension
- Existing fuel replenishment system at Craney Island
- Minimum dredging.

6) No Action - AOE homeporting partially-loaded at NS Norfolk and retention of one VSS at MOTKI:

- Existing pier
- Existing fuel replenishment system
- No dredging

b. Comparative Evaluation

The comparative evaluation of the proposed action and the alternatives is provided in Tables V-4 and V-5. In Table V-4 each alternative is ranked with respect to impact criteria related to safety (explosive and navigational), impacts on the natural environment (dredge-related and other impacts associated with other component actions), and impacts on the man-made environment. The ranking of alternatives ranges from 1 (worst alternative with respect to the criteria; i.e. highest impact) to 10 (best alternative; i.e. lowest impact).

Safety considerations considered two criteria; 1) whether or not additional safety waivers would be needed or not, and 2) navigational hazards. The ranking of navigational hazards were related to the distance of harbor sailing, the density of traffic movements and the presence of special hazards, such as the number of passages through the Chesapeake Bay Bridge-Tunnel complex. As discussed in Section IV-B-3, the proposed action offers significant improvement in navigational safety over the No-Action and to a lesser extent (due to fewer required trips) for the NWS Yorktown alternative. The narrow and active navigational channels near NWS Charleston are an additional negative aspect of this alternative. Based on these considerations, the proposed action and Alternative 1, fully-loaded AOEs at NWS Earle (Existing Piers) are ranked the best with regard to navigational safety, the No-Action is ranked the worst. The next lowest ranked alternative is the partially-loaded at NWS Earle. NWS Yorktown and NWS Charleston are ranked above these due to the lower levels of traffic compared to the other areas.

Socio-economic rankings reflect variations in impacts associated with AOE crew relocation, impacts associated with land acquisition, (due to related actions (ship fuel replenishment site at NWS Earle) or due to encumberance by ESQD arch) and impacts to recreation (security zone for pier and trestle). Some alternatives have no relocation-related impacts. However, even where relocation occurs, impacts are considered non-significant. Alternatives at NWS Yorktown are

TABLE V-4

COMPARATIVE ENVIRONMENTAL IMPACTS EVALUATION OF PROPOSED ACTION AND ALTERNATIVES

	Impacts on Man-Made Environment			Impacts On The Natural Environment									
	Safety		Other Impacts	Related to Dredging						Other Impacts			
Criteria	Explosive Waivers Needed	Navigation Hazards	Socio-Economic	Volume Dredged	Volume Contaminated	New Areas Dredged	Arch. & Biol. Impacts	Circulation Impacts	Availability of Disposal Sites	Pier & Trestle	Ship Fuel Replenishment System	In-Transit Holding Facilities	Total Weighted Impact Score = Ranking: (1-10) x wt. % (Best Possible Score 10.0)
Criteria Importance (weight %)	25%	20%	10%	5%	15%	2.5%	2.5%	2.5%	2.5%	5%	5%	5%	
Proposed Action	10[b]	10	4	4	9	1	10	10	10	2	1	1	7.625
Alternatives[a]													
1	10	4	8	8	9	1	10	10	10	2	10	1	7.275
2	1	10	6	7	10	10	10	10	10	10	1	2	6.35
3	1	7	6	1	1	10	1	1	1	1	10	2	3.425
4	1	6	1	3	4	10	1	10	1	2	10	1	3.50
5	1	6	1	10	10	10	10	10	10	2	10	1	4.20
6	10	1	10	10	10	10	10	10	10	10	10	10	8.20

NOTES:

[a]1 - Partially-loaded AOEs, NWS Earle, 2 VSS NWS Earle;
2 - Fully-loaded AOEs, NWS Earle (Existing Piers) 2 VSS MOTKI
3 - Fully-loaded AOEs, NWS Charleston, 2 VSS MOTKI;
4 - Fully loaded AOEs, NWS Yorktown, 2 VSS MOTKI
5 - Partially-loaded AOEs, NWS Yorktown, 2 VSS MOTKI;
6 - No Action, Partially-loaded AOEs, Norfolk NS, 2 VSS MOTKI

[b]Numbers indicate relative ranking of each criteria ranging from least favorable (1) to most favorable (10).

TABLE V-5

COMPARATIVE SUMMARY OF ENVIRONMENTAL IMPACTS, COSTS AND MILITARY CONSIDERATIONS FOR ALTERNATIVES AND PROPOSED ACTION

Alternative (#)[b]	Environmental Impacts: Relative[a] Ranking	Environmental Impacts: Impact[b] Score	Military Considerations: Precludes Ashore FBMS Option At MOKTI	Military Considerations: State Of Military Readiness	Costs: Development $ Millions	Costs: Operational
No Action Partially-loaded AOEs Norfolk NS 2 VSS, MOTKI(6)	1	8.20	Yes	Very Low	0	Very High
Proposed Action						
Fully-loaded AOEs, NWS Earl 2 VSS, NWS Earle	2	7.62	No	Very High	140-160	Low
Partially-loaded AOEs, NWS Earle 2 VSS, NWS Earle(1)	3	7.27	No	Very Low	115-125	Moderate
Fully-loaded AOEs, (Existing Pier) NWS Earle 2 VSS, MOTKI(2)	4	6.35	Yes	Moderate	50-70	Low
Partially-loaded AOEs, NWS Yorktown 2 VSS, MOTKI (5)	5	4.20	Yes	Low	25-30	Low-Moderate
Fully-loaded AOEs, NWS Yorktown 2 VSS, MOTKI (4)	6	3.50	Yes	Low	140-170	Low-Moderate
Fully-loaded AOEs, NWS Charleston 2 VSS, MOTKI (3)	7	3.42	Yes	Moderate	145-175	Low-Moderate

Note:

[a]Ranking based on weighted impact score (1 = lowest impact, 9 = highest impact).

[b]From Table V-4

ranked the lowest due to the impacts associated with acquisition associated with ESQD arch.

The ranking of alternatives with respect to dredging impacts considered both the total volume to be dredged, (highest for Charleston alternative) and the estimated volume of contaminated materials to be dredged. Also considered were the presence of sensitive areas such as oyster beds and archaeological resources, impacts on circulation and availability of and impacts associated with disposal areas for the volumes to be dredged.

Other impacts all associated with the construction and operation of the pier and trestle, the ship fuel replenishment system and in-transit holding facilities. These were ranked with respect to whether or not these actions are required by the alternative. For the pier and trestle, NWS Charleston is ranked 1 (the worst) since it would require channel modifications and significant impacts on adjacent marshy wetlands. Where no impact will occur due to non-inclusion of the projects, the alternatives were ranked 10. Comparable impacts are expected for the remaining alternatives (ranked 2). Impacts associated with the in-transit holding facilities are ranked 1 for those alternatives where 2 VSS are to be added to NWS Earle and ranked two for those alternatives where MOTKI would attain two VSS; since one VSS already exists at MOTKI and construction impacts would be associated with providing only one additional VSS.

Each criteria has been assigned a relative importance weighting expressed as a relative percentage. The weights reflect the relative significance of the potential impacts presented. The overall weighted impact score for each alternative is determined by adding the products of the rankings (1-10) for each criteria and the assigned relative percent weight. The overall weighted scores are provided in Table V-4. Higher scores indicate preferable alternatives (lower impacts). Table V-5 presents a summary ranking (from 1 to 9) of the weighted impact scores derived from Table V-4 together with military and cost considerations for comparison. Military considerations include a ranking of military readiness as well as consideration of whether the ashore FBMS option at MOTKI would be precluded. Military readiness rankings are based on logistic considerations of distance to open water, travel requirements necessary to obtain fuel or ammunition supplies and other considerations such as vulnerability to isolation from mission (Coleman Bridge at Yorktown) and disruption or restriction of station operations.

From this comparison, it can be seen that although the no-action alternative is ranked No. 1 (8.20 score) on environmental considerations alone, and has no development costs, it offers the lowest state of military readiness, precludes the future ashore option at MOTKI and would have a very high operational cost. The proposed action is ranked No. 2 (7.62) environmentally, provides a very high state of military readiness and does not preclude the future ashore option at MOTKI. However, it does have high development costs. It also has low operational costs. The partially-loaded AOE alternative at NWS Earle would also allow for the future ashore option at MOTKI. However, it is slightly less favorable environmentally (ranked No. 3 - 7.27), and offers a very low state of military readiness at only slightly reduced development costs and moderate operating costs. The fully-loaded AOE (Existing Piers) at NWS Earle/2 VSS MOTKI is ranked in the middle environmentally (No. 4 - 6.35) at moderate costs. However, the future ashore option at MOTKI would be precluded and impacts are higher than for the proposed action and it offers only a moderate state of military readiness. The partially-loaded Yorktown/MOTKI alternative is the lowest development cost with the exception of the No-Action alternative. However, it precludes the future MOTKI option, has a low state of military readiness and is ranked No. 5 environmentally (4.20). The fully-loaded Yorktown/MOTKI and Charleston/MOTKI are the worst alternatives, combining low environmental ranking (No. 6 and 7, respectively) high costs, preclusion of the future ashore option at MOTKI and only low (Yorktown) and moderate (Charleston) states of military readiness.

This comparative summary suggests that considering impacts, military considerations and costs, the proposed action is preferred to the alternatives.

CHAPTER VI

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VI. PROBABLE ADVERSE IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSED ACTION BE IMPLEMENTED

A. TERRESTRIAL ENVIRONMENT

Unavoidable adverse impacts on the terrestrial environment would arise from the clearing of 313 acres of land and construction of facilities for the proposed action. Of the 313 acres, 280 acres are woodlands and the balance are old fields and grass. In addition, potential adverse impacts could occur from the operation of the ship fuel replenishment system. Five sets of adverse impacts have been identified:

- loss of terrestrial habitats;
- risk of an oil spill affecting wetlands or water resources;
- increase in impervious areas slightly affecting water flows;
- slight increases in air pollution; and
- short-term construction-related impacts, including soil erosion and sedimentation, acid runoff, destruction of small amounts of wetlands, and noise.

Of these five sets of adverse impacts, only the first could not be mitigated. The only sites available for in-transit holding yards are wooded tracts on NWS Earle property. The effect of the other four sets of impacts could be substantially reduced by following established practices, guidelines and procedures outlined below:

1. Removal of Vegetation

- Natural vegetation should be removed to the least extent possible.
- Revegetate denuded areas as soon as possible.
- Construction activities should take place during the fall, when most animals are not breeding or raising their young.

2. Runoff

- Quantity - All projects should be designed for maximum infiltration and retention of surface water runoff. This could be accomplished by the use of swales, retention basins or the reduction of surface drainage in swamp areas to make use of their natural retention capacity.

- Projects located in currently developed areas should make use of overland flow (grassed ditches and/or swales) to the greatest extent practical.

- Quality - Paved areas should be cleaned periodically to prevent the accumulation of dirt and dust. In addition to large size particles, the smaller fractions, which account for much of the pollutant load, should also be removed.

3. Oil Spills

- NAVFAC guidelines on the design of dispension of liquid fuels should be strictly adhered to (Design Manual - Liquid Fueling and Dispensing Facilities, NAVFAC, DM-22, 1972).

- Contingency plans for the rapid containment of spills should be formulated.

- An effective method for temporarily sealing tidal creeks from the Bay should be developed.

4. Air Quality

- To mitigate the air quality impacts of increased traffic in and around NWS Earle, it is suggested that a mass transportation and car pool program be established for Station personnel.

- Power should be made available for the ship's lighting, heating, pumps, refrigeration, ventilation, etc. as expeditiously as possible to reduce emissions during berthing.

- To reduce the discharge of hydrocarbons the control methods described by the USEPA (1975) should be followed. These include regular maintenance, painting of storage tanks, watering, optimum scheduling of tank turnovers and the application of vapor recovery systems.

Short-term construction impacts could be minimized by following good environmental construction practices as outlined below:

1. Soil Erosion and Sedimentation

- Whenever feasible, natural vegetation should be retained and protected.

- The extent of the disturbed area and the duration of its exposure should be minimized as much as possible.

- Temporary seeding, mulching or other soil stabilization measures should be used to protect distrubed areas.

- Drainage facilities should be provided to accommodate increased runoff.

- Water runoff should be minimized and retained on-site wherever possible.

- Sediment should be retained on-site.

- Diversions, sediment basins, and similar structures should be installed prior to disturbance.

- The standards set forth in Soil Erosion and Sediment Control in New Jersey, prepared by the New Jersey State Soil Conservation District, should be adhered to.

2. Acid Soils

- Grading should be such that a minimum area of acid formation is exposed.

- All exposed material should be covered with one foot of non-acid soil suitable for plant growth, plus six inches of topsoil.

- Brooks and ditches near exposed acid soils should be surfaced with trap rock or other suitable materials to prevent flowing water from contacting the acid material.

3. Destruction of Salt Marsh Vegetation

- Number of men and machines in the marsh should be minimized.

4. Noise

- The installation of improved intake and exhaust mufflers on internal combustion engines should be specified.

- Replace internal combustion engine equipment with electric equipment, whenever possible.

- Enclose machinery with noise attenuating housing.

- Use commercially available quieted equipment (such as air compressors, pavement breakers, crawler tractors, etc.).

- Construct temporary barriers when activity is near noise sensitive areas.

5. Air Quality

- Watering of all exposed soils is suggested during construction activity to minimize dust emissions. Water is most often utilized as a dust-suppression technique because it is relatively inexpensive and generally effective. It can be effective (i.e., a 50 percent reduction), however, only if watering is performed at least twice daily (USEPA, 1975).

B. ESTUARINE ENVIRONMENT

Unavoidable adverse impacts would result from initial and maintenance dredging operations and pier construction. In addition, potential adverse impacts could occur from explosive hazards and oil spills during AOE homeporting or oil tanker resupply of the fuel storage tanks. Five sets of adverse impacts have been identified:

- removal of marine organisms and habitats, particularly benthic organisms, sediment habitats and fish eggs and larvae;

- short-term increases in suspended sediments and turbidity affecting marine biota in a local area;

- short-term changes in water quality, particularly releases of trace metals, organic compounds and nutrients;

- risk of an accident associated with the handling of explosives; and

- risk of an oil spill affecting marine biota and waterfowl.

Some of these adverse impacts could be mitigated. If dredging operations are conducted only during September through February, then the effect on fish eggs and larvae could be substantially reduced. The area affected by increased turbidity could be limited by use of a floating silt curtain or screen. Explosive hazards could be minimized by adherence to Coast Guard safety requirements. The effects of an oil spill could be minimized by implementation of the Navy's oil spill prevention and containment plans.

C. OCEAN DISPOSAL SITE ENVIRONMENT

Unavoidable adverse impacts would result from disposal of dredged material at the ocean disposal site. These adverse impacts include:

- burial of benthic organisms, fish eggs, and larvae;

- short-term depletion of oxygen resulting in possible local anoxic conditions; and

- increase in water pollution, including release of metals, organic compounds and nutrients, which may affect marine biota.

The last two impacts are associated with only the fine grained contaminated dredge material (about one million cubic yards).

The dredge material disposal site is already highly stressed. Release of metals and organic compounds from disposal of this material may result in long-term accumulations in the food chain.

Mitigating measures for this potential contamination include the possibility of capping the contaminated materials with the uncontaminated portions of the material to be dredged. Cumulative impacts from the Navy dredging project include the decrease of the capacity of the present site and reduction in its life span by about six percent. This could be mitigated by alternate use of the uncontaminated fine grained materials, perhaps as a capping of the adjacent sewage sludge site in the Bight Apex, after its closure in 1981.

D. MAN-MADE ENVIRONMENT

Unavoidable adverse impacts would result from relocation of AOE crews and their dependents and acquisition of land for the ship fuel replenishment system. Adverse impacts could result from AOE homeporting and tanker resupply of fuel storage tanks. These adverse impacts include:

- increase in population;
- loss of a small amount of property taxes;
- preemption of 309 acres of land from private industrial development;
- prohibition of fishing and boating in a small additional area of Raritan Bay adjacent to the new pier;

- relocation of the approach to Compton Creek Channel;

- additional traffic to and from the NWS Waterfront Area;

- risk of accident due to explosive handling;

- risk of an oil spill affecting Bay recreation activities; and

- risk of fire hazard from operation of the ship fuel replenishment system.

Some of these adverse impacts could be mitigated. Impacts due to population increase could be mitigated by use of existing military housing and community facilities at NWS Earle and Ft. Monmouth and providing residential services on board the AOEs while they are homeported. Loss of property taxes could be avoided by the Navy's entering into a long-term lease for the property required for the ship fuel replenishment system. Additional vehicular traffic could be reduced by encouraging use of buses and car pools. Explosive handling risks could be minimized by establishing a safe distance from the piers to the nearest inhabited building not associated with explosive handling. The risk of an oil spill could be reduced by the implementation of the Navy's oil spill prevention and containment plans. The risk of fire could be reduced by adherence to safety design with regard to tank separation distance, installation of fixed foam protection systems and the presence of manned fire-fighting equipment at the storage tank site. Also, adherence to safe operational procedures would help mitigate this hazard.

CHAPTER VII

VII. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Most of the adverse impacts present local short-term uses of the environment. These include impacts on the terrestrial environment due to construction of onshore support facilities, impacts on the estuarine environment due to initial and maintenance dredging activities, and impacts on the ocean environment due to disposal of dredged materials. These short-term impacts largely affect chemical or biological systems in the three environments, particularly water quality and aquatic organisms. Once construction operations are completed, the chemical and biological systems tend to return to background levels.

The effect of the proposed action on energy consumption in comparison with AOE homeporting at NS Norfolk depends on the geographic area for AOE deployment. If the deployment area is the Carribean Sea, then there would be a long-term increase in energy consumption. If the deployment area is the Mediterranean Sea, then there would be no significant increase in energy consumption. If the deployment area is the North Sea, then there would be a decrease in energy consumption.

Dedication of 640 acres of land to support facilities for the proposed action would be a significant long-term use of the environment. This would include the destruction of 280 acres of woodlands and related habitats.

These uses of the environment would be necessary to achieve a safe, efficient environment for AOE homeporting and two additional VSS operations. The proposed action at NWS Earle would permit the two AOEs to homeport in a high state of military readiness and to comply with military explosive safety requirements. It would also minimize the exposure of the AOEs to other harbor ship traffic. Further, the proposed action would permit use of pier facilities by the

AOEs during peacetime and VSS operations during a national emergency. Otherwise, separate facilities for VSS operations would have to be constructed and maintained elsewhere.

The proposed action would enhance the long-term use of the physical environment in four ways. First, because AOEs have less exposure to harbor ship traffic, the proposed action would reduce the overall risk of an oil spill in sensitive estuarine waters. Second, the proposed action would preserve virtually all the wetlands on the site proposed for the ship fuel replenishment system. An industrial or marina use of the site could threaten these wetlands. Third, the new pier would create a new habitat for marine organisms. Fourth, some of the dredged material could be used as beach nourishment, particularly for heavily eroded areas of the Sandy Hook unit of the Gateway National Recreation Area and some could be used as a capping of contaminated bottom areas at the dredge or sewage disposal sites.

Overall, the uses of the physical environment would permit long-term improvements in explosive safety and national defense readiness, reduce the risk of impacts from oil spills, preserve wetlands, create a new estuarine habitat and provide materials for beach nourishment. In addition, the proposed action would stimulate the economy of Monmouth County because of new construction jobs and the multiplier effect of AOE crew salaries.

CHAPTER VIII

VIII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable commitments of resources resulting from the proposed action may be considered to be:

- destruction of 280 acres of woodlands for the construction of support facilities;
- destruction of benthic organisms, sediment habitats and fish eggs and larvae during initial and maintenance dredging and pier construction; and
- development costs of about $150 million.

The dedication of land for support facilities would require the destruction of 280 acres of woodlands and the preemption of 309 acres from private industrial or marina use. Some long-term reduction in property taxes to Middletown Township would also occur. Once the Navy no longer needed these facilities, the land could be available for other purposes. However, while the Navy is using these lands, other uses would be precluded.

The destruction of benthic organisms, sediment habitats and fish eggs and larvae would be irreversible. However, the effects are expected to be short-term. Most of the areas to be dredged are already maintained as channels. Further, after dredging operations and pier construction are completed, the areas affected would evenutally be repopulated.

Development costs of $150 million must be irretrievably committed. The money allocated for development of this project could not be used for other purposes.

CHAPTER IX

IX. CONSIDERATIONS THAT OFFSET ADVERSE ENVIRONMENTAL EFFECTS

Improved safety and national defense considerations would offset the adverse environmental impacts. First, the proposed action would permit AOEs to homeport in compliance with the Navy's explosive safety regulations. Currently, several thousand people at NS Norfolk, not associated with explosive handling, are exposed to the dangers of an accidental explosion. The proposed action would eliminate this condition.

Second, the AOEs would be exposed to much less harbor ship traffic if they homeport at NWS Earle. There is less traffic in Sandy Hook Bay than Chesapeake Bay. Under the proposed action, multiple trips across the Chesapeake Bay Bridge-Tunnel would be eliminated. This reduced exposure to ship traffic would diminish the risk of collison with other ships. Navigation safety would be improved and the risk of a serious oil spill minimized by the proposed action.

Third, the proposed action would integrate all the facilities needed for AOE homeporting. This means that the AOEs could homeport fully-loaded with oil and explosives and steam directly to open water in the event of a national emergency. The proposed action would eliminate inefficient homeporting operations. In addition, the proposed action would permit efficient sharing of pier facilities by AOE and VSS operations.

Fourth, the proposed action would permit the FBMS ashore option to be implemented at MOTKI. Relocation of VSS capability from MOTKI is a prerequisite for this prospective national defense action.

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GLOSSARY

GLOSSARY

AE	Auxiliary Explosive ship
ANOXIC	Permanent damage
AOE	Auxiliary Oil and Explosive Ship
Aquatic	Growing, living in, or frequenting water
Aquicludes	Confining beds
Aquifer	(artesian = confined, phreatic = water table) a water-bearing statum of permeable rock sand or gravel
AQMP	Air quality maintenance program
AQCR	Air quality control region
Ballast	Water used in the storage tanks when it is not carrying fuel to ensure stability
Bathymetry	The measurement of depths of water in oceans, seas, or lakes
Benthos	Organisms that live on or in the bottom of bodies of (benthic) water; relating to the bottom of a body of water
BEQ	Bachelor Enlisted Quarters
Bioindicators	Sessile benthic invertebrates
Biomass	The amount of living matter (as in a unit area or volume of habitat)
Biota	Plants or animals
BOD	Biological Oxygen Demand
BOQ	Bachelor Officers Quarters
cfs	Cubic feet per second
CINCLANTFLT	Commander-in-Chief Atlantic Fleet
CNO	Chief of Naval Operations

CO	Commanding Officer
COMNAVSEASYSCOM	Commander of Naval Sea Systems Command
COMSURFLANT	Commander of Naval Surface Force, Atlantic Fleet
Containment Berms	Dikes
CONUS	Continental United States
DDD	(DDT breakdown product)
Deciduous	Plants which shed leaves seasonally or at a certain stage of development in the life cycle
DEIS	Draft Environmental Impact Statement
Demography	Vital statistics of population, such as births, deaths, age, sex, race and migration patterns
Detritus	Particles of partially decayed organic matter
DFM	Marine Diesel Fuel
DOD	Department of Defense
Ebb	Return of the tide to the sea
Ectocrines	Hormones
ECCB	Explosive component checkout building
Ecosystem	The complex of a community and its environment functioning as an ecological unit in nature
Effluent	Liquid waste material discharged into the environment
Emerita	A rapid-burrowing organism which migrates
Endangered Species	A species whose overall survival or whose survival in a particular region or locality is in jeopardy
Entrainment	To draw and transport by the flow of a fluid
ESQD	Explosive safety quantity distances arcs

Estuary	A semi-enclosed coastal body of water with free connection to open sea
Eutrophic	Rich in dissolved nutrients and seasonally deficient in oxygen
Evapotranspiration	Loss of water from the soil both by evaporation and by transpiration from the plants growing thereon
Fauna	Animals or animal life
FBM	Fleet ballistic missile
Fetch Favor	In the direction of prevailing winds
FDA	Food and Drug Administration
Flora	Plants or plant life
Fluvial	Produced by stream action
Glauconite sands	Sand composed of significant proportion of the mineral glouconite
gdp	Gallons per day
Gyre	To move in a circle or spiral
Habitat	The place or type of site where a plant or animal naturally or normally lives and grows
HHW	Higher high water
Hindcasting	Use of past meteorlogical data to predict future wave characteristics
Holoplankton	Zooplankton which spend their entire life cycle in the water column
Impermeable	Resistant of fluid (water) penetration
In situ	(in place)
In-Transit Holding Facilities	Railroad sidings area and a truck parking area for temporary holding of explosives awaiting loading for VSS.

Invertebrate	Not possessing a spinal column; relating to invertebrate animals
JCP&L	Jersey Central Power and Light Company
JCS	Joint chiefs of staff
JP-5	Kerosene-based jet fuel that is primarily used for naval aircraft
K	Risk factor
Knolls	A small round hill
kV	Kilovolt - electrical unit of potential difference equal to 1000 volts
kVA	Kilovolt-amphere - unit of apparent power in an alternating-current circuit, equal to 1000 volt-ampheres
Leachate	Water that has filtered down through soil
Littoral drift	Material moved by waves and currents in the near-shore region within the breaker zone
LLW	Lower low water
MACFC	Middle Atlantic Coastal Fisheries Center
MAFC	Middle Atlantic Fisheries Center
Macro fauna	Organisms larger than 1 mm
Macroinvertebrate	Invertebrates which are visible with the unaided eye, such as crabs, shrimp, and worms
Magazines	A place where supplies or ammunitiions are stored
Meio fauna	Organisms that will pass through the 100 u sieve. Organisms near the base of the benthic food chain and immobile and generally indicative of the environment in which they are found.
Meroplankton	Zooplankton which spend only a portion of their life cycle as plankton
MESA	Marine Eco-system Analysis, a program of the National Atmospheric and Oceanic Administration

MGD	Million gallons a day
Milking action	Accelerates the seaward movement of freshened water along the south shore of the estuary
MLW	Mean low water
MOQ	Military officers quarters
MOTKI	Military Ocean Terminal, Kings Bay
MOTSU	Military Ocean Terminal, Sunny Point
msl	Mean sea level
NAVFAC	Naval Facilities Engineeing Command
NAVSEA	Naval Sea Systems
NEW	Net explosive weight
NJDEP	New Jersey Department of Environmental Protection
NOAA	National Oceanographic and Atmospheric Administration
Non-attainment Area	Relating to an air pollutant, an area is shown by monitored data or by air quality dispersion modeling to exceed the ambient air quality standard
NOS	National Ocean Survey of NOAA
NPS	National Park Service
Nutrients	Substances which provide nourishment for living organisms
NWHC	(Naval Weapons Handling Center) Performs the function of design and engineering for the packaging, handling, stowage and transportation of Naval weapons
NWS	Naval Weapons Station
Oil Spill Containment Facilities	Allows emergency response to oil spills and will protect the boats and equipment when not in use
PCB	Polychlorinated bi-phenyl
Pelagic	Water portions of the ocean

Photic Zone	Upper Zone in the ocean where light penetrates
Photosynthesis	Conversion of chemical compounds with the aid of light
Phytoplankton	Minute plant life in a body of water
Plankton	Minute floating or weakly swimming animal and plant life in a body of water
POMFLANT	Polaris Missile Facility Atlantic, Charleston, S.C.
ppm	parts per million
psi	pounds per square inch
Redox Potential	Chemical oxidation and reduction potential (Eh)
Relict	Remnant of a former period
Scraps	A steep slope
Settling Tanks	Used to store and process oil from ballast tanks, tank strippings, bilge water, contaminated fuel and other oily waters
SHL	Sandy Hook Laboratory (NOAA)
Shoal	A sandbar or sand bank where the water depth is 6 fathoms or less
Species	A group of individuals having common attributes and designated by a common name
STORET	EPA - Computer listing of water quality monitoring data
SUNY-SB	State University of New York at Stony Brook
Terrestrial	Living on or growing from the land
TOC	Total Organic Carbon
Trout Maintenance Waters	Waters that either support trout throughout the year, or have a potential to do so
Turbidity	Muddy appearance of water created by suspended particles

TW-1	Classification of tidal waters body
Tychoplankton	Zooplankton which are accidentally swept off the bottom
Vales	Small valleys
Vertebrates	Possessing a segmented spinal column; pertaining to vertebrates
VSS	Vessel support systems - the capability to load breakbulk freighters with military supplies during a national emergency
Zooplankton	Minute animal life in a body of water

APPENDICES

APPENDIX A

PLANTS RECORDED DURING SITE SURVEY OF WATERFRONT AREA

Common Name	Scientific Name
	Herbaceous Plants
Common Yarrow	*Achillea millefolium*
Onion	*Allium* sp.
Common Ragweed	*Ambrosia artemisiifolia*
Blue-stem	*Andropogon scoparius*
Broom-sedge	*Andropogon virginicus*
Wormwood	*Artemisia* sp.
Aster	*Aster* sp.
Orach	*Atriplex* sp.
Common Thistle	*Cirsium* sp.
Horseweed	*Conyza canadensis*
Salt-grass	*Distichlis spicata*
Fleabane	*Erigeron* sp.
Catfoot	*Gnaphalium obtusifolium*
Grass	*Graminal* sp.
Lettuce	*Lactuca* sp.
Pepper-grass	*Lipidium virginicum*
Wood-sorrel	*Oxalis* sp.
Switch-grass	*Panicum virgatum*
Common Reed	*Phragmites communis*
Poke-weed	*Phytolacea americana*
Climbing False Buckwheat	*Polygonum scandens*
Bramble	*Rubus* sp.
Foxtail	*Setaria glauca*
Bittersweet	*Solanum dulcamara*
Goldenrod	*Solidago* sp.
Grass-leaved Goldenrod	*Solidago graminifolia*
Sweet Goldenrod	*Solidago odora*
Seaside Goldenrod	*Solidago sempervirens*
Smooth Cord-grass	*Spartina alterniflora*
Salt Hay	*Spartina patens*
Common Cat-tail	*Typha latifolia*

Woody Plants

Sea-myrtle	*Baccharis halimifolia*
Marsh-elder	*Iva fructescens*
Japanese Honeysuckle	*Lonicera japonica*
Bayberry	*Myrica pensylvanica*
Cottonwood	*Populus deltoides*
Wing-rib Sumac	*Rhus copallina*
Staghorn Sumac	*Rhus typhina*
Black Locust	*Robinia pseudo-acacia*
Willow	*Salix* sp.

Source: Dames & Moore, 1977. Field Plant Studies conducted in Waterfront Area of NWS Earle.

APPENDIX B

VEGETATION AND WILDLIFE RECORDED DURING SITE SURVEY OF MAIN STATION

B-1 VEGETATION

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
	(TREES, SHRUBS AND VINES)			
Acer rubrum	Red Maple	X	X	X
Ailanthus altissima	Tree of Heaven			X
Ascyrum hyperioides	St. Andrew's Cross	X		
Betula sp.	Birch	X		
Betula lutea	Yellow Birch			X
Betula nigra	River Birch	X		
Betula populifolia	Gray Birch		X	X
Carya tomentosa	Mockernut		X	
Chamaecyparis thyoides	White Cedar			X
Clethra alnifolia	Sweet Pepper-bush	X	X	X
Diospyros virginiana	Persimmon		X	
Fagus grandifolia	Beech		X	X
Fraxinus sp.	Ash	X	X	X
Gaultheria procumbens	Wintergreen	X	X	
Gaylussacia frondosa	Tall Huckleberry	X	X	X
Ilex laevigata	Smooth Winterberry Holly	X	X	
Ilex opaca	American Holly	X	X	X
Juniperus virginiana	Red Cedar	X	X	
Kalmia angustifolia	Sheep-laurel	X	X	
Kalmia latifolia	Mountain Laurel		X	X
Liquidambar styraciflua	Sweet Gum		X	X
Lionicera japonica	Japanese Honeysuckle	X		
Magnolia virginiana	Sweetbay Magnolia	X		X
Myrica asplenifolia	Sweet Fern	X	X	
Myrica pensylvanica	Bayberry	X		
Nyssa sylvatica	Black Gum	X	X	X
Parthenocissus quinquefolia	Virginia Creeper	X	X	X
Pinus rigida	Pitch Pine	X	X	
Pinus strobus	White Pine		X	X
Prunus serotina	Black Cherry	X	X	X
Pyrus arbutifolia	Red Chokeberry	X		
Quercus alba	White Oak	X	X	X
Quercus borealis	Northern Red Oak	X	X	
Quercus coccinea	Scartlet Oak	X	X	X

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
Quercus falcata	Spanish Oak	X	X	
Quercus marilandica	Black-jack Oak	X	X	
Quercus prinus	Chestnut Oak	X		
Quercus stellata	Post Oak		X	
Quercus velutina	Black Oak	X	X	
Rhododendron sp.	Laurel	X		X
Rhus copallinum	Winged Sumac	X	X	
Rhus radicans	Poison Ivy	X		
Robinia pseudoacacia	Black Locust	X	X	
Rosa sp.	Rose		X	X
Rubus sp.	Bramble	X	X	
Sassafras albidum	Sassafras	X	X	
Smilax bon-nox	Greenbrier		X	X
Smilax glauca	Greenbrier	X	X	X
Smilax rotundifolia	Common Greenbrier	X	X	X
Spiraea tomentosa	Hardhack	X		
Vaccinium sp.	Blueberry	X	X	X
Viburnum dentatum	Southern Arrow-wood		X	
Vitus aestivalis	Summer Grape		X	
Vitus labrusca	Fox Grape	X		
	(HERBACEOUS PLANTS)			
Achillea millefolium	Common Yarrow	X		
Allium vineale	Field Garlic	X		
Andropogon virginicus	Broomsedge	X	X	X
Antennaria plantaginifolia	Everlasting	X		
Asclerpias sp.	Milkweed	X	X	X
Athyrium filix-femina	Lady Fern	X		
Barbarea vulgaris	Winter Cress	X		
Bromus sp.	Brome Grass	X		
Carex spp.	Sedges	X	X	X
Chimaphila maculata	Spotted Wintergreen		X	
Chrysanthemum leucanthemum	Ox-eye Daisy	X		
Cirsium sp.	Thistle	X		
Dactylis glomerata	Orchard Grass	X		
Galium aparine	Bedstraw	X		
Hieracium pratense	King Devil	X	X	
Hypochaeris radicata	Cat's-ear	X		
Juncus sp.	Rush			X
Lepidium campestre	Field Cress	X		

APPENDIX B (Continued)

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
Lespedeza sp.	Bush Clover	X		
Linaria canadensis	Blue Toadflax	X		
Mitchella repens	Partridge-berry			X
Onoclea sensibilis	Sensitive Fern	X	X	X
Osmunda cinnamomea	Cinnamon Fern	X	X	X
Osmunda regalis	Royal Fern			X
Oxalis stricta	Yellow Wood-sorrel	X		
Panicum spp.	Panic Grass	X	X	
Penstemon digitalis	Beard-tongue	X		
Phragmites communis	Reed	X	X	
Plantago lanceolata	English Plantain	X		
Plantago virginica	Plantain	X		
Pteridium aquilinum	Bracken Fern	X	X	
Rumex acetosella	Red Sorrel	X		
Rumex crispus	Sour Dock	X		
Sisyrinchium albidum	Blue-eyed Grass	X		
Symplocarpus foetidus	Skunk Cabbage	X		X
Thelypteris simulata	Massachusetts Fern	X		X
Tragopogon pratense	Goat's Beard	X		
Trientalis borealis	Star Flower		X	
Trifolium dubium	Hop Clover	X		
Verbascum thapsus	Mullein	X		
Woodwardia areolata	Netted Chain Fern			X

B-2 WILDLIFE

(AMPHIBIANS)

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
Bufo woodhousei fowleri	Fowler's Toad		X	
Rana catesbeiana	Bullfrog		X	
Rana claitans melanto	Greenfrog	X		

(REPTILES)

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
Chelydra s. serpentina	Common Snapping Turtle	X	X	
Clemmys guttata carolina	Spotted Turtle	X		
Terrapene carolina	Eastern Box Turtle			X
Coluber constrictor constrictor	Northern Black Racer			X

APPENDIX B (Continued)

Scientific Name	Common Name	Rail Holding Yard	Truck Holding Yard	Inert Rail Holding Yard
	(BIRDS)			
Coragyps artratus	Black Vulture	X		
Colinus virginanus	Bobwhite	X		
Colaptes auratus	Yellow-shafted Flicker		X	
Tyrannus tyrannus	Eastern Kingbird	X		
Cyanocitta cristata	Blue Jay	X	X	
Corvus brachyrhynchos	Common Crow	X	X	
Mimus polyglottos	Mockingbird	X		X
Dumetella carolinensis	Catbird		X	
Sturnus vulgaris	Starling	X		
Sturnella magna	Eastern Meadowlark	X		
Quiscalus quiscula	Common Grackle		X	
Molothrus ater	Brown Headed Cowbid		X	
Pipilo erythrophthalmus	Rufous-sided Towhee	X		
	(MAMMALS)			
Marmoto monax	Woodchuck		X	
Tamias striatus	Eastern Chipmunk		X	X
Peromyscus leucopus	White-footed Mouse		X	
Ondatra zibetha	Muskrat	X		
Sylvilagus floridanus	Eastern Cottontail	X	X	X
Odocoileus virginianus	White-tailed Deer	X	X	X

APPENDIX C

WILDLIFE OF POTENTIAL OCCURRENCE AT NWS EARLE

C.1 - BIRDS

Common Name	Scientific Name	Occurrence[a]
	Loons	
Common Loon	*Gavia immer*	CW
Arctic Loon	*Gavia arctica*	RW
Red-throated Loon	*Gavia stellata*	CW
	Grebes	
Red-necked Grebe	*Podiceps grisegena*	UW
Horned Grebe	*Podiceps auritus*	CW
Eared Grebe	*Podiceps nigricollis*	OW
Western Grebe	*Aechmophorus occidentalis*	RW
Pied-billed Grebe	*Podilymbus podiceps*	CW
	Shearwaters, Fulmars and Petrels	
Cory's Shearwater	*Puffinus diomedea*	PT
Greater Shearwater	*Puffinus gravis*	PT
Sooty Shearwater	*Puffinus griseus*	PT
Audubon's Shearwater	*Puffinus lherminieri*	PT
	Storm Petrels	
Leach's Storm-petrel	*Oceanodroma leucorhoa*	PT
Wilson's Storm-petrel	*Oceanites oceanicus*	PS
	Pelicans	
Brown Pelican	*Pelecanus occidentalis*	RT
	Boobies and Gannets	
Gannet	*Morus bassanus*	PW
	Cormorants	
Great Cormorant	*Phalacrocorax carbo*	CW
Double-crested Cormorant	*Phalacrocorax auritus*	CW

C-1 - BIRDS (Continued)

Common Name	Scientific Name	Occurrence[a]
	Herons and Bitterns	
Great Blue Heron	Ardea herodias	CY
Green Heron	Butorides virescens	CS
Little Blue Heron	Florida caerulea	CT
Cattle Egret	Bubulcus ibis	UT
Great Egret	Casmerodius albus	CS
Snowy Egret	Egretta thula	CS
Louisiana Heron	Hydranassa tricolor	OT
Black-crowned Night Heron	Nycticorax nycticorax	CY
Yellow-crowned Night Heron	Nyctanassa violacea	US
Least Bittern	Ixobrychus exilis	RS
American Bittern	Botaurus lentiginosus	UY
	Ibises and Spoonbills	
Glossy Ibis	Plegadis falcinellus	UT
	Swans, Geese, and Ducks	
Mute Swan	Cygnus olor	CY
Whistling Swan	Olor columbianus	UW
Canada Goose	Branta canadensis	CW
Brant	Branta bernicia	CW
White-fronted Goose	Anser albifrons	RW
Blue Goose	Chen caerulescens	UW
Snow Goose	Chen hyperborea	UW
Mallard	Anas platyrhynchos	AY
Black Duck	Anas rubripes	AY
Gadwall	Anas strepera	CW
Pintail	Anas acuta	CW
Green-winged Teal	Anas crecca	CW
Blue-winged Teal	Anas discors	CS
European Wigeon	Anas penelope	UW
American Wigeon	Anas americana	AW
Northern Shoveler	Anas clypeata	UW
Wood Duck	Aix sponsa	CS
Redhead	Aythya americana	UW
Ring-necked Duck	Aythya collaris	CW
Canvasback	Aythya valisineria	AW
Greater Scaup	Aythya marila	AW
Lesser Scaup	Aythya affinis	AW
Common Goldeneye	Bucephala clangula	CW

C-1 - BIRDS (Continued)

Common Name	Scientific Name	Occurrence[a]
	Swans, Geese and Ducks - Continued	
Barrow's Goldeneye	Bucephala islandica	RW
Bufflehead	Bucephala albeola	CW
Oldsquaw	Clangula hyemalis	CW
Harlequin Duck	Histrionicus histrionicus	OW
Common Eider	Somateria mollissima	OW
King Eider	Somateria spectabilis	OW
White-winged Scoter	Melanitta deglandi	CW
Surf Scoter	Melanitta perspicillata	CW
Common Scoter	Oidemia nigra	CW
Ruddy Duck	Oxyura jamaicensis	CW
Hooded Merganser	Lophodytes cucullatus	UW
Common Merganser	Mergus merganser	CW
Red-breasted Merganser	Mergus serrator	CW
	American Vultures	
Turkey Vulture	Cathartes aura	CS
Black Vulture	Coragyps atratus	RT
	Kites, Hawks, Eagles, and Harriers	
Goshawk	Accipiter gentilis	OW
Sharp-shinned Hawk	Accipiter striatus	UY
Cooper's Hawk	Accipiter cooperii	UY
Red-tailed Hawk	Buteo jamaicensis	CY
Red-shouldered Hawk	Buteo lineatus	UT
Broad-winged Hawk	Buteo platypterus	CS
Rough-legged Hawk	Buteo lagopus	OW
Bald Eagle	Haliaeetus leucocephalus	UT
Marsh Hawk	Circus cyaneus	CY
	Ospreys	
Osprey	Pandion haliaetus	CS
	Caracaras and Falcons	
Peregrine Falcon	Falco peregrinus	UT
Merlin	Falco columbarius	UT
American Kestrel	Falco sparverius	CY
	Grouse and Ptarmigan	
Ruffed Grouse	Bonasa umbellus	UY

Common Name	Scientific Name	Occurrence[a]
	Quail, Pheasants, and Partridge	
Bobwhite	Colinus virginianus	CY
Ring-necked Pheasant	Phasianus colchicus	CY
	Rails, Gallinules, and Coots	
King Rail	Rallus elegans	UY
Clapper Rail	Rallus longirostris	CY
Sora	Porzana carolina	US
Black Rail	Laterallus jamaicensis	RS
Purple Gallinule	Porphyrula martinica	RT
Common Gallinule	Gallinula chloropus	CT
American Coot	Fulica americana	AW
	Oystercatchers	
American Oystercatcher	Haematopus palliatus	RT
	Plovers, Turnstones, and Surfbirds	
Semipalmated Plover	Charadrius semipalmatus	CT
Piping Plover	Charadrius melodus	US
Wilson's Plover	Charadrius wilsonia	RT
Killdeer	Charadrius vociferus	CY
American Golden Plover	Pluvialis dominica	VT
Black-bellied Plover	Pluvialis squatarola	CT
	Woodcock, Snipe, and Sandpipers	
Ruddy Turnstone	Arenaria interpres	CT
American Woodcock	Philohela minor	CS
Common Snipe	Capella gallinago	CT
Whimbrel	Numenius phaeopus	UT
Upland Sandpiper	Bartramia longicauda	UT
Spotted Sandpiper	Actitis macularia	CS
Solitary Sandpiper	Tringa solitaria	CT
Greater Yellowlegs	Tringa melanoleuca	AT
Lesser Yellowlegs	Tringa flavipes	CT
Willet	Catoptrophorus semipalmatus	UT
Red Knot	Calidris canutus	CT
Purple Sandpiper	Calidris maritima	UW
Pectoral Sandpiper	Calidris melanotos	CT
White-rumped Sandpiper	Calidris fuscicollis	UT
Baird's Sandpiper	Calidris bairdii	OT
Least Sandpiper	Calidris minutilla	CT
Dunlin	Calidris alpina	CT
Semipalmated Sandpiper	Calidris pusilla	AT

Common Name	Scientific Name	Occurrence[a]
	Woodcocks, Snipe and Sandpipers - Continued	
Western Sandpiper	*Calidris mauri*	UT
Sanderling	*Calidris alba*	AW
Short-billed Dowitcher	*Limnodromus griseus*	CT
Long-billed Dowitcher	*Limnodromus scolopaceus*	OT
Stilt Sandpiper	*Micropalama himantopus*	UT
Buff-breasted Sandpiper	*Tryngites subruficollis*	RT
Marbled Godwit	*Limosa fedoa*	OT
Hudsonian Godwit	*Limosa haemastica*	RT
Ruff	*Philomachus pugnax*	RT
	Avocets and Stilts	
American Avocet	*Recurvirostra americana*	RT
Black-necked Stilt	*Himantopus mexicanus*	RT
	Phalaropes	
Red Phalarope	*Phalaropus fulicarius*	PT
Northern Phalarope	*Lobipes lobatus*	PT
	Jaegers and Skuas	
Pomarine Jaeger	*Stercorarius pomarinus*	PT
Rarasitic Jaeger	*Stercorarius parasiticus*	PT
Long-tailed Jaeger	*Stercorarius longicaudus*	PT
	Gulls and Terns	
Glaucous Gull	*Larus hyperboreus*	UW
Iceland Gull	*Larus glaucoides*	UW
Great Black-backed Gull	*Larus marinus*	AY
Lesser Black-backed Gull	*Larus fuscus*	RT
Herring Gull	*Larus argentatus*	AY
Ring-billed Gull	*Larus delawarensis*	CW
Black-headed Gull	*Larus ridibundus*	UW
Laughing Gull	*Larus atricilla*	AS
Bonaparte's Gull	*Larus philadelphia*	AW
Little Gull	*Larus minutus*	OW
Ivory Gull	*Pagophila eburnea*	RW
Black-legged Kittiwake	*Rissa tridactyia*	UW
Sabine's Gull	*Xema sabini*	RT
Forster's Tern	*Sterna forsteri*	CT
Common Tern	*Sterna hirundo*	AS
Roseate Tern	*Sterna dougallii*	UT
Bridled Tern	*Stern anaethetus*	RT
Least Tern	*Sterna albifrons*	CS

Common Name	Scientific Name	Occurrence[a]
	Gulls and Terns - Continued	
Royal Tern	Thalasseus maximus	CT
Caspian Tern	Hydroprogne caspia	UT
Black Tern	Chlidonias niger	CT
	Skimmers	
Black Skimmer	Rynchops niger	US
	Auks, Murres, and Puffins	
Razorbill	Alca otrda	OW
Common Murre	Uria aalge	RW
Thick-billed Murre	Uria lomvia	OW
Dovekie	Alle alle	UW
Black Guillemot	Cepphus grylle	RW
Common Puffin	Fratercula arctica	RW
	Pigeons and Doves	
Mourning Dove	Zenaida macroura	AY
	Cuckoos, Roadrunners, and Anis	
Yellow-billed Cuckoo	Coccyzus americanus	CS
Black-billed Cuckoo	Coccyzus erythropthalmus	CS
	Barn Owls	
Barn Owl	Tyto alba	UY
	Typical Owls	
Screech Owl	Otus asio	CY
Great Horned Owl	Bubo virginianus	CY
Snowy Owl	Nyctea scandiaca	OW
Barred Owl	Strix varia	UY
Long-eared Owl	Asio otus	UW
Short-eared Owl	Asio flammeus	UW
Saw-whet Owl	Aegolius acadicus	UW
	Goatsuckers	
Chuck-will's-widow	Caprimulgus carolinensis	RS
Whip-poor-will	Caprimulgus vociferus	CS
Common Nighthawk	Chordeiles minor	US

C.1 - BIRDS (Continued)

Common Name	Scientific Name	Occurrence[a]
	Swifts	
Chimney Swift	*Chaetura pelagica*	AS
	Hummingbirds	
Ruby-throated Hummingbird	*Archilochus colubris*	CS
	Kingfishers	
Belted Kingfisher	*Megaceryle alcyon*	CY
	Woodpeckers, Flickers, and Sapsuckers	
Common Flicker	*Colaptes auratus*	CY
Pileated Woodpecker	*Dryocopus pileatus*	RT
Red-bellied Woodpecker	*Centurus carolinus*	UW
Red-headed Woodpecker	*Melanerpes erythrocephalus*	UT
Yellow-bellied Sapsucker	*Sphyrapicus varius*	CT
Hairy Woodpecker	*Dendrocopos villosus*	CY
Downy Woodpecker	*Dendrocopos pubescens*	CY
	Tyrant Flycatchers	
Eastern Kingbird	*Tyrannus tyrannus*	CS
Western Kingbird	*Tyrannus verticalis*	OT
Great Crested Flycatcher	*Myiarchus crinitus*	CS
Eastern Phoebe	*Sayornis phoebe*	CS
Yellow-bellied Flycatcher	*Empidonax flaviventris*	RT
Acadian Flycatcher	*Empidonax virescens*	US
Alder Flycatcher	*Empidonax traillii*	US
Least Flycatcher	*Empidonax minimus*	CS
Eastern Wood Pewee	*Contopus virens*	CS
Olive-sided Flycatcher	*Nuttallornis borealis*	UT
	Larks	
Horned Lark	*Eremophila alpestris*	CY
	Swallows	
Tree Swallow	*Iridoprocne bicolor*	AS
Bank Swallow	*Riparia riparia*	US
Rough-winged Swallow	*Stelgidopteryx ruficollis*	CS
Barn Swallow	*Hirundo rustica*	AS
Cliff Swallow	*Petrochelidon pyrrhonota*	UT
Purple Martin	*Progne subis*	CS

Common Name	Scientific Name	Occurrence[a]
	Jays, Magpies, and Crows	
Blue Jay	Cyanocitta cristata	AY
Common Raven	Corvus corax	RW
Common Crow	Corvus brachyrhynchos	AY
Fish Crow	Corvus ossifragus	CS
	Chickadees, Titmice, Verdins, and Bushtits	
Black-capped Chickadee	Parus atricapillus	UW
Carolina Chickadee	Parus carolinensis	AY
Tufted Titmouse	Parus bicolor	CY
	Nuthatches	
White-breasted Nuthatch	Sitta carolinensis	CY
Red-breasted Nuthatch	Sitta canadensis	UW
	Creepers	
Brown Creeper	Certhia familiaris	CW
	Wrens	
House Wren	Troglodytes aedon	CS
Winter Wren	Troglodytes troglodytes	UW
Carolina Wren	Thryothorus ludovicianus	CY
Long-billed Marsh Wren	Telmatodytes palustris	CS
Short-billed Marsh Wren	Cistothorus platensis	RS
	Mockingbirds and Thrashers	
Mockingbird	Mimus polyglottos	CY
Gray Catbird	Dumetella carolinensis	AS
Brown Thrasher	Toxostoma rufum	CS
	Thrushes, Solitaires, and Bluebirds	
American Robin	Turdus migratorius	AY
Wood Thrush	Hylocichla mustelina	CS
Hermit Thrush	Catharus guttatus	CT
Swainson's Thrush	Catharus ustulatus	CT
Gray-cheeked Thrush	Catharus minimus	CT
Veery	Catharus fuscescens	CT
Eastern Bluebird	Sialia sialis	US

Common Name	Scientific Name	Occurrence[a]
	Arctic Warblers, Kinglets, and Gnatcatchers	
Blue-gray Gnatcatcher	*Polioptila caerulea*	CS
Golden-crowned Kinglet	*Regulus satrapa*	AW
Ruby-crowned Kinglet	*Regulus calendula*	CT
	Wagtails and Pipits	
Water Pipit	*Anthus spinoletta*	UW
	Waxwings	
Cedar Waxwing	*Bombycilla cedrorum*	CY
	Shrikes	
Northern Shrike	*Lanius excubitor*	RW
Loggerhead Shrike	*Lanius ludovicianus*	OW
	Starlings	
Starling	*Sturnus vulgaris*	AY
	Vireos	
White-eyed Vireo	*Vireo griseus*	CS
Yellow-throated Vireo	*Vireo flavifrons*	CS
Solitary Vireo	*Vireo solitarius*	CT
Red-eyed Vireo	*Vireo olivaceus*	AS
Philadelphia Vireo	*Vireo philadelphicus*	OT
Warbling Vireo	*Vireo gilvus*	UT
	Wood Warblers	
Black-and-white Warbler	*Mniotilta varia*	CT
Prothonotary Warbler	*Protonotaria citrea*	UT
Worm-eating Warbler	*Helmitheros vermivorus*	UT
Golden-winged Warbler	*Vermivora chrysoptera*	OT
Blue-winged Warbler	*Vermivora pinus*	CS
Lawrence's Warbler	*Vermivora lawrencei*	RT
Tennessee Warbler	*Vermivora peregrina*	CT
Orange-crowned Warbler	*Vermivora celata*	UW
Nashville Warbler	*Vermivora ruricapilla*	CT
Northern Parula	*Parula americana*	CT
Yellow Warbler	*Dendroica petechia*	CS
Magnolia Warbler	*Dendroica magnolia*	CT
Cape May Warbler	*Dendroica trigrina*	CT

Common Name	Scientific Name	Occurrence[a]
	Wood Warblers - Continued	
Black-throated Blue Warbler	Dendroica caerulescens	CT
Yellow-rumped Warbler	Dendroica coronata	AW
Black-throated Green Warbler	Dendroica virens	CT
Cerulean Warbler	Dendroica cerulea	OT
Blackburnian Warbler	Dendroica fusca	CT
Yellow-throated Warbler	Dendroica dominica	RT
Chestnut-sided Warbler	Dendroica pensylvanica	CT
Bay-breasted Warbler	Dendroica castanea	CT
Blackpoll Warbler	Dendroica striata	CT
Pine Warbler	Dendroica pinus	CS
Kirtland's Warbler	Dendroica kirtlandii	RT
Prairie Warbler	Dendroica discolor	CS
Palm Warbler	Dendroica palmarum	CT
Ovenbird	Seiurus aurocapillus	CS
Northern Waterthrush	Seiurus noveboracensis	CT
Louisiana Waterthrush	Seiurus motacilla	CT
Kentucky Warbler	Oporornis formosus	UT
Connecticut Warbler	Oporornis agilis	UT
Mourning Warbler	Oporornis philadelphia	UT
Common Yellowthroat	Geothlypis trichas	CS
Yellow-breasted Chat	Icteria virens	US
Hooded Warbler	Wilsonia citrina	US
Wilson's Warbler	Wilsonia pusilla	CT
Canada Warbler	Wilsonia canadensis	CT
American Redstart	Setophaga ruticilla	CS
	Weaver Finches	
House Sparrow	Passer domesticus	AY
	Meadowlarks, Blackbirds, and Orioles	
Bobolink	Dolichonyx oryzivorus	UT
Eastern Meadowlark	Sturnella magna	CY
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	RT
Red-winged Blackbird	Agelaius phoeniceus	AY
Orchard Oriole	Icterus spurius	US
Northern Oriole	Icterus galbula	CS
Rusty Blackbird	Euphagus carolinus	CW
Boat-tailed Grackle	Cassidix major	RT
Common Grackle	Quiscalus quiscula	AY
Brown-headed Cowbird	Molothrus ater	AY

C.1 - BIRDS (Continued)

Common Name	Scientific Name	Occurrence[a]
	Tanagers	
Western Tanager	*Piranga ludoviciana*	RT
Scarlet Tanager	*Piranga olivacea*	CS
Summer Tanager	*Piranga rubra*	RT
	Grosbeaks, Sparrows, Finches, and Buntings	
Cardinal	*Cardinalis cardinalis*	AY
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	CT
Black-headed Grosbeak	*Pheucticus melanocephalus*	RW
Blue Grosbeak	*Guiraca caerulea*	RT
Indigo Bunting	*Passerina cyanea*	CS
Dickcissel	*Spiza americana*	UW
Evening Grosbeak	*Hesperiphona vespertina*	CW
Purple Finch	*Carpodacus purpureus*	CW
House Finch	*Carpodacus mexicanus*	CY
Pine Grosbeak	*Pinicola enculeator*	RW
Common Redpoll	*Acanthis flammea*	OW
Pine Siskin	*Spinus pinus*	UW
American Goldfinch	*Spinus tristis*	AY
Red Crossbill	*Loxia curvirostra*	OW
White-winged Crossbill	*Loxia elucoptera*	OW
Rufous-sided Towhee	*Pipilo erythrophthalmus*	AS
Ipswich Sparrow	*Passerculus princeps*	UW
Savannah Sparrow	*Passerculus sandwichensis*	CW
Grasshopper Sparrow	*Ammodramus savannarum*	CS
Henslow's Sparrow	*Ammodramus henslowii*	US
Sharp-tailed Sparrow	*Ammospiza caudacuta*	CS
Seaside Sparrow	*Ammospiza maritima*	CS
Vesper Sparrow	*Pooecetes gramineus*	US
Lark Sparrow	*Chondestes grammacus*	OW
Dark-eyed Junco	*Junco hyemalis*	AW
Oregon Junco	*Junco oreganus*	OW
Tree Sparrow	*Spizella arborea*	CW
Chipping Sparrow	*Spizella passerina*	AS
Clay-colored Sparrow	*Spizella pallida*	OT
Field Sparrow	*Spizella pusilla*	CY
Harris's Sparrow	*Zonotrichia querula*	RT
White-crowned Sparrow	*Zonotrichia leucophrys*	UT
White-throated Sparrow	*Zonotrichia albicollis*	AW
Fox Sparrow	*Passerella iliaca*	CW
Lincoln's Sparrow	*Melospiza lincolnii*	UT
Swamp Sparrow	*Melospiza georgiana*	CY
Song Sparrow	*Melospiza melodia*	AY
Lapland Longspur	*Calcarius lapponicus*	OW
Snow Bunting	*Plectrophenax nivalis*	UW

SOURCE: Sandford, W.F., Feb. 20, 1969. Monmouth County's 331 Bird Species. The Daily Register.

Sandford, W.F., Feb. 27, 1969. Make it 332 Bird Species. The Daily Register.

[a]NOTE: A = Abundant; C = Common; U = Uncommon; O = Occasional; R = Rare; P = Pelagic; Y = Year-round; S = Summer; W = Winter; T = Transient.

C.2 - MAMMALS

Common Name	Scientific Name
Pouched Mammals	
Opossum	Didelphis marsupialus
Insect Eaters	
Masked Shrew	Sorex cinereus
Smoky Shrew	Sorex fumeus
Least Shrew	Cryptotis parva
Eastern Mole	Scalopus aquaticus
Star-nosed Mole	Condylura cristata
Bats	
Keen Myotis	Myotis keeni
Little Brown Myotis	Myotis lucifugus
Small-footed Myotis	Myotis subulatus
Silver-haired Bat	Lasionycteris noctwagans
Eastern Pipistrel	Pipistrellus subflavus
Red Bat	Lasiurus borealis
Hoary Bat	Lasiurus cinereus
Big Brown Bat	Eptesicus fuscus
Hares and Rabbits	
Eastern Cottontail	Sylvilagus floridanus
New England Cottontail	Sylvilagus transitionalis
Rodents	
Eastern Chipmunk	Tamias striatus
Woodchuck	Marmota monax
Eastern Gray Squirrel	Sciurus carolinensis
Red Squirrel	Tamiasciurus hudsonicus
Southern Flying Squirrel	Glaucomys volans
Beaver	Castor canadensis
Rice Rat	Oryzomys palustris
White-footed Mouse	Peromyscus leucopus
Boreal Redback Vole	Clethrionomys gapperi
Meadow Vole	Microtus pennsylvanicus
Pine Vole	Pitymys pinetorum
Muskrat	Ondatra zibethicus
Southern Bog Lemming	Synaptomys cooperi
Norway Rat	Rattus norvegicus
House Mouse	Mus musculus
Meadow Jumping Mouse	Zapus hudsonius

C.2 - MAMMALS

Common Name	Scientific Name
Flesh Eaters	
Red Fox	Vulpes fluva
Gray Fox	Urocyon cinereoargenteus
Raccoon	Procyon lotor
Long-tailed Weasel	Mustela frenata
Mink	Mustela vison
Striped Skunk	Mephitis mephitis
River Otter	Lutra canadensis
Even-Toed Hoofed Mammals	
White-tailed Deer	Odocoileus virginianus

SOURCE: Burt, W.H. and R.P. Grossenheider, 1964. A Field Guide to the Mammals. Houghton Mifflin Company: Boston. 284 p.

C.3 - REPTILES

Common Name	Scientific Name
Turtles	
Common Snapping Turtle	*Chelydra s. serpentina*
Eastern Painted Turtle	*Chrysemys p. picta*
Spotted Turtle	*Clemmys guttata*
Wood Turtle	*Clemmys insculpta*
Bog Turtle	*Clemmys muhlenbergi*
Eastern Mud Turtle	*Kinosternon s. subrubrum*
Red-bellied Turtle	*Pseudemys rubriventris*
Stinkpot	*Sternothaerus odoratus*
Eastern Box Turtle	*Terrapene c. carolina*
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*
Lizards	
Five-lined Skink	*Eumeces fasciatus*
Ground Skink	*Lygosoma laterale*
Northern Fence Lizard	*Sceloporus undulatus hyacinthus*
Snakes	
Eastern Worm Snake	*Carphophis a. amoenus*
Scarlet Snake	*Cemophora coccinea*
Northern Black Racer	*Coluber c. constrictor*
Timber Rattlesnake	*Crotalus h. horridus*
Northern Ringneck Snake	*Diadophis punctatus edwardsi*
Corn Snake	*Elaphe g. guttata*
Black Rat Snake	*Elaphe o. obsoleta*
Eastern Earth Snake	*Haldea v. valeriae*
Eastern Hognose Snake	*Heterodon platyrhinos*
Eastern Milk Snake	*Lampropeltis doliata triangulum*
Eastern Kingsnake	*Lampropeltis g. getulus*
Northern Water Snake	*Natrix s. sipedon*
Rough Green Snake	*Opheodrys aestivus*
Northern Pine Snake	*Pituophis m. melanoleucus*
Northern Brown Snake	*Storeria d. dekayi*
Northern Red-bellied Snake	*Storeria o. occipitomaculata*
Eastern Ribbon Snake	*Thamnophis s. sauritus*
Eastern Garter Snake	*Thamnophis s. sirtalis*

SOURCE: Conant, R., 1958. A Field Guide to Reptiles and Amphibians. Houghton Mifflin Company: Boston. 366 p.

C.4 - AMPHIBIANS

Common Name	Scientific Name
Salamanders	
Eastern Tiger Salamander	*Ambystoma t. tigrinum*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Four-toed Salamander	*Hemidactylium scutatum*
Red-backed Salamander	*Plethodon c. cinereus*
Northern Two-lined Salamander	*Eurycea b. bislineata*
Northern Dusky Salamander	*Desmognathus f. fuscus*
Red-spotted Newt	*Diemictylus v. viridescens*
Northern Red Salamander	*Pseudotriton r. rubra*
Eastern Mud Salamander	*Pseudotriton m. montanus*
Frogs and Toads	
Northern Cricket Frog	*Acris c. crepitans*
Fowler's Toad	*Bufo woodhousei fowleri*
Pine Barrens Treefrog	*Hyla andersoni*
Northern Spring Peeper	*Hyla c. crucifer*
Eastern Gray Treefrog	*Hyla v. versicolor*
New Jersey Chorus Frog	*Pseudacris triseriata kalmi*
Bullfrog	*Rana catesbeiana*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*
Southern Leopard Frog	*Rana pipiens sphenocephala*
Carpenter Frog	*Rana virgatipes*
Wood Frog	*Rana sylvatica*
Eastern Spadefoot	*Scaphiopus holbrooki*

SOURCE: Conant, R., 1958. A Field Guide to Reptiles and Amphibians. Houghton Mifflin Company: Boston. 366 p.

APPENDIX D

CLIMATOLOGY

A. STORMS

The major storms affecting the area are cyclones of non-tropical origin (extratropical cyclones), thunderstorms and tropical storms. The probability of tornadoes striking the area is very low.

A.1 Cyclones of Non-Tropical Origin

The area is affected by extratropical storms throughout the year. These storms occur most frequently during the winter season, when from six to nine such storms per month can be expected. During mid-summer, only about three to six such storms are experienced.

The intensity of the extratropical storms depends on the path of the storm and the resulting pressure gradient across the region. Winds are usually strongest near the storm center; hence, storm centers tracking closest to NWS Earle are likely to produce the strongest winds. However, well-developed storms may produce strong winds over a vast area, especially when encountering a strong high pressure ridge. Under these conditions, affected areas may experience prolonged periods (one to three days) of strong wind conditions. The maximum monthly sustained winds historically occurring at most locations can be attributed to extratropical storm influences.

Table D-1 shows the prevailing direction and fastest mile wind data for John F. Kennedy Airport, New York. This table indicates that a typical strong storm has a maximum sustained speed of 40-50 miles per hour; however, such storms can reach a speed of 70 miles per hour and more. These wind speed

TABLE D-1

WIND DATA (MPH) AT JOHN F. KENNEDY INTERNATIONAL AIRPORT

	Mean Speed (1959-1973)	Fastest Mile Speed (1964-1973)	Fastest Mile Direction (1964-1973)
January	13.4	52	W
February	14.1	46	WSW
March	13.9	44	W
April	13.2	44	W
May	12.0	44	SSE
June	11.0	32	WSW
July	10.7	37	NNW
August	10.4	46	WNW
September	10.7	40	WNW
October	11.3	39	W
November	12.5	44	NE
December	12.9	46	ENE
Annual	12.2	52	W

SOURCE: U.S. Department of Commerce, 1973.

estimates are generally less than those for most other coastal areas of the United States.

A.2 Thunderstorms

The most frequently occurring form of severe weather affecting the area is the thunderstorm. The New Jersey coastal area experiences from 20 to 35 such storms per year - more than any other coastal region at the same latitude on the earth. These storms occur either as air mass thunderstorms resulting from unstable atmospheric conditions or in conjunction with frontal systems. Air mass thunderstorms occur mostly during the summer months within unstable tropical air. Thunderstorms occurring with fronts can occur at any time and are usually more widespread and severe than the more localized air mass thunderstorms. Table D-2 shows the mean number of days in which thunderstorms have occurred at selected locations.

A.3 Tropical Storms

Intense tropical storms have seldom affected the New Jersey-Long Island coastal area. This is due in part to the "natural" tendency for tropical storms to follow the clockwise flow around the Bermuda High pressure center which acts as a steering mechanism. Other steering influences such as upper air flow will usually contribute to guiding the tropical storms away from the coast at these latitudes. Another factor is the relatively sheltered nature of the New Jersey coastline against the likelihood of a direct strike from a tropical storm. Table D-3 shows the number of tropical storms reaching the New Jersey coastal area during the 85 year period 1886-1970.

The highest reported winds at Blue Hills Observatory, Massachusetts, during the hurricane of September, 1938 were 139 mph; the lowest central pressure observed was 27.86 inches.

TABLE D-2

MEAN NUMBER OF DAYS WITH THUNDERSTORMS AT SELECTED LOCATIONS*

Months of Records	John F. Kennedy, N.Y. (15)	La Guardia, N.Y.[a] (12)
January	#	0
February	#	0
March	1	1
April	2	2
May	3	4
June	4	6
July	5	7
August	4	6
September	2	3
October	1	1
November	#	1
December	#	0
Annual	22	31

Notes:

*No data observed on Staten Island or Sandy Hook.

[a]Data found in official Floyd Bennett records.

#Less than 0.5 days.

SOURCE: U.S. Department of Commerce, 1973.
U.S. Air Force, 1970.

TABLE D-3

NUMBER OF TROPICAL STORMS AFFECTING THE NEW JERSEY COASTAL AREA (1886-1970)

New Jersey Coast	Tropical Cyclones (>40 mph)	Hurricanes (>74 mph)	Great Hurricanes (>125 mph)
South	1	1	0
Central	1	0	0
North	1	1	0

SOURCE: Simpson, R.H. and M.B. Lawrence, 1971.

A.4 Tornadoes

Tornadoes are the most devastating storms known to man and pose the greatest threat to life and structural damage. The approximate number of tornadoes occurring inside a 1^{o} latitude-longitude square over New Jersey during a 10-year period (1953-1962) was 6, or an average of 0.6 tornadoes per year. This agrees favorably with longer term tornado frequencies (1916-1955). The probability of a tornado striking within the study area is extremely small.

B. SEA BREEZE

Sea breezes occur due to differences in air density along coastal areas. Daytime heating occurs more rapidly over land than over water; similarly, nighttime reradiation occurs more rapidly over land areas. Hence, the more dense air will normally be over the water during the daytime and over land during nighttime hours. This results in a potential sea to land air flow during the daytime (especially afternoon hours) and a potential land to sea air flow at night.

Sea breezes are most pronounced during the summer months at the latitudes of the New Jersey coast, since this is the time of year when the largest differences between air densities over land and over water are observed. Day to day variations in the intensity of the sea breeze can be expected depending on the ambient temperatures, cloud cover (which restricts radiation), and existing air circulation. Also variations between locations can be significant depending on the coastal configuration, exposure and distance from the coast.

C. TEMPERATURE

Temperature data from John F. Kennedy International Airport are shown in Table D-4. Mean daily maximum temperatures generally range from the low to mid 80's (^{o}F) in the summer to the upper 30's (^{o}F) in the winter months. Mean daily lows range from the mid 60's (^{o}F) in July to the mid 20's (^{o}F) in January.

TABLE D-4

TEMPERATURE (^{o}F) FOR JOHN F KENNEDY INTERNATIONAL AIRPORT, NEW YORK

	Mean Daily Maximum (1941-1970)	Mean Daily Minimum (1941-1970)	Extreme Maximum (1961-1973)	Extreme Minimum (1961-1973)
January	38.0	24.8	64	0
February	39.1	25.2	65	-2
March	46.5	32.1	72	7
April	58.1	41.7	87	26
May	68.4	51.1	99	34
June	78.0	60.9	99	45
July	83.2	66.9	104	55
August	81.7	65.4	98	46
September	75.4	58.6	94	40
October	65.8	48.7	84	25
November	53.7	39.3	73	20
December	41.3	28.4	68	5
Annual	60.8	45.3	104	-2

SOURCE: U.S. Department of Commerce, 1973.

Extremes, as based on long-term data from surrounding stations have ranged from -15°F at Central Park, New York (February, 1934) to 105 (°F) at Newark, New Jersey (July, 1949). Temperatures equal or exceed 90°F during 10 days per year at John F. Kennedy International Airport; below freezing temperatures are normally experienced during 86 days per year at the same location. Temperatures below 0°F are experienced on an average of less than once per year.

D. PRECIPITATION

Table D-5 shows a summary of precipitation data for John F. Kennedy Airport, New York. This is a first order meteorological station where official hourly records are maintained.

Annual precipitation amounts generally range from the low 40's to the low 50's (inches); the summer months have experienced the greatest amounts of precipitation, but, as can be seen from the tables, the area has a remarkably even year-round distribution. Precipitation during the winter months is most often a steady type rain or snow as opposed to spring and summertime rains which are more apt to be showers.

Variations in monthly and annual precipitation amounts can be expected from year to year. For example, over a 26-year period, monthly precipitation amounts at John F. Kennedy Airport during June have ranged from a maximum of 6.70 inches in 1972 to a minimum of only a trace in 1949. During the same period, August totals ranged from a maximum of more than 17.0 inches in 1955 to a minimum of less than 0.5 in 1972. Unusually heavy 24-hour precipitation amounts have occurred along coastal locations. Tropical storms have accounted for most of the short-term heavy rainfall amounts especially during August through Ocotober.

E. FOG

Along the New York and New Jersey coasts, an average of 25 to 35 days of thick fog occur when the visibility is reduced to 1/4 mile or less. The greatest occurrence of fogs takes place during the winter and spring months (Figure D-1).

TABLE D-5

PRECIPITATION (INCHES) AT JOHN F. KENNEDY INTERNATIONAL AIRPORT, NEW YORK

	Normal Total	Maximum Monthly	Maximum 24-hour	Mean No. of Days With: Pcpn. $\geq$ .01"	Snow-Ice $\geq$ 1.0"
	(1941-1970)	(1948-1973)	(1948-1973)	(1959-1973)	(1959-1973)
January	2.69	5.77	1.60	10	2
February	3.05	5.48	2.87	10	2
March	3.77	7.93	2.27	12	1
April	3.59	6.98	2.12	11	#
May	3.54	6.14	2.88	11	0
June	2.98	6.70	2.23	10	0
July	4.04	8.48	3.21	9	0
August	4.30	17.41	6.59	8	0
September	3.31	9.60	5.83	7	0
October	2.76	6.41	3.42	7	0
November	3.90	9.51	4.09	11	#
December	3.60	6.16	2.05	11	1
Annual	41.53	17.41	6.59	118	7

# Indicates less than 0.5 days

SOURCE: U.S. Department of Commerce, 1973.

A distinct difference in the occurrences of fog between J. F. Kennedy International Airport and the Ambrose Lightship was observed along with a substantially greater incidence of prolonged occurrences.

The winter maximum fog (Figure D-1) is caused predominantly by rain from an upper level of relatively warm air from an upper level of relatively warm air falling into more stable and colder air. This increases the dew point of the colder air to the temperature required for condensation.

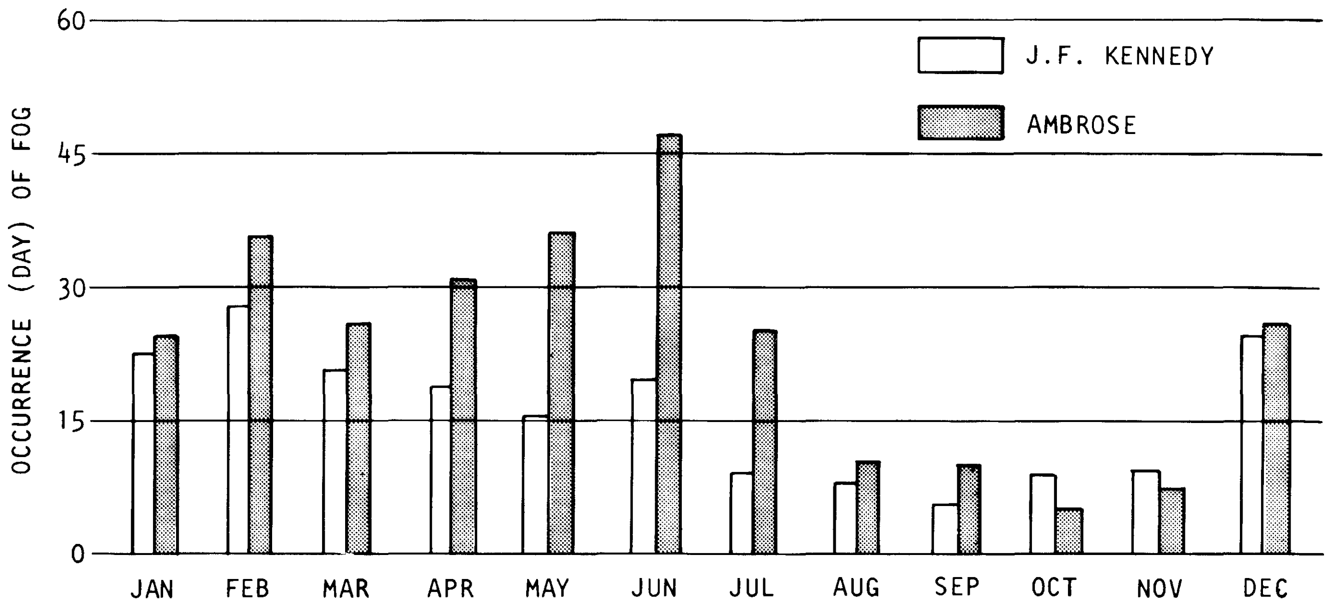
During the late spring and early summer, the sharpest contrast between air and coastal water is reached. A 53 percent greater hourly occurrence of fog was reported offshore than onshore during this time period when no precipitation occurred. Only during the fall do land stations have a greater frequency of fog than offshore sites, because the ocean cools much slower than land.

REFERENCES:

Simpson, R.H. and M.B. Lawrence, 1971, Atlantic Hurricane Frequencies Along The United States Coastline. NOAA Technical Memo NWS SR-58, Ft. Worth, Texas. U.S. Dept. of Commerce, NOAA, Southern Region.

U.S. Air Force, 1970, Environmental Technical Application Center, Air Weather Service.

U.S. Department of Commerce, 1973, NOAA, Local Climatological Data, Kennedy International Airport.



OCCURRENCE OF FOG AT J.F. KENNEDY INTERNATIONAL AIRPORT AND AMBROSE LIGHTSHIP

FIGURE D-1

APPENDIX E

METHODOLOGY FOR MEASURING AMBIENT NOISE LEVELS AND ASSESSING NOISE IMPACTS

E-1 MEASUREMENT METHODOLOGY

A. INTRODUCTION

The ambient sound survey was conducted during the period November 9 to 15, 1977. Sound level recordings were made on typical weekdays during morning (0700-1500), afternoon (1500-1800), evening (1800-2200) and nighttime (2200-0700) periods. The daytime periods from 0700-2200 hours and nighttime periods from 2200-0700 hours are used by the U.S. Environmental Protection Agency in its definition of day/night average sound level, L_{dn}. A description of the instrumentation and techniques used for acquisition and analysis of the ambient sound data is presented in this Appendix.

B. NOMENCLATURE

The range of sound pressures that can be heard by humans is very large. This range varies from two ten-thousand-millionths (2×10^{-10}) of an atmosphere for sound barely audible to humans to two thousandths (2×10^{-3}) of an atmosphere for sounds which are so loud as to be painful. The decibel notation system is used to present sound levels over this wide physical range. Essentially, the decibel system compresses this range to a workable range using logaithms. Sound level is defined as:

$$\text{Sound level in decibels (dB)} = 20 \text{ Log}_{10} \left(\frac{P}{P_o}\right)$$

where P_o is a reference sound pressure required for a minimum sensation of hearing, and P is the measured sound pressure.

Zero decibel is assigned to the minimum level and 140 decibels to sound which is painful. Thus a range of more than one million is expressed on a scale of zero to 140.

The human ear does not perceive sounds at low frequencies in the same manner as those at higher frequencies. Sounds at low frequency do not seem as loud as those of equal intensity at higher frequencies. The A-weighting network is provided in sound analysis systems to simulate the human ear. A-weighted sound levels are expressed in units of dBA. These levels in dBA are used by the engineer to evaluate hearing damage risk (OSHA) or community annoyance impact. These values are also used in federal, state and local noise ordinances.

Sound is not constant in time. Statistical analysis is used to describe the temporal distribution of sound and to compute single number descriptors for the time-varying sound. This report contains the following statistical A-weighted sound levels:

L_{90} - This is the sound level exceeded 90 percent of the time during the measurement period and is often used to present the "residual" sound level.

L_{50} - This is the sound level exceeded 50 percent of the time during the measurement period and is used to represent the "median" sound level.

L_{10} - This is the sound level exceeded 10 percent of the time during the measurement period and is often used to represent the "intrusive" sound level.

L_{eq} - This is the equivalent steady sound level which provides an equal amount of acoustic energy as the time-varying sound.

L_d - Average sound level, L_{eq}, for the daytime period (0700-2200) only.

L_n - Average sound level, L_{eq}, for the nighttime period (2200-0700) only.

L_{dn} - Average day/night sound level, defined as:

$$L_{dn} = 10 \, Log_{10} \left(\{15 \times 10^{L_d/10} + 9 \times 10^{(L_d+10)/10}\} /24\right)$$

Note: A 10 dB correction factor is added to the nighttime average sound level.

B. DATA ACQUISITION AND ANALYSIS

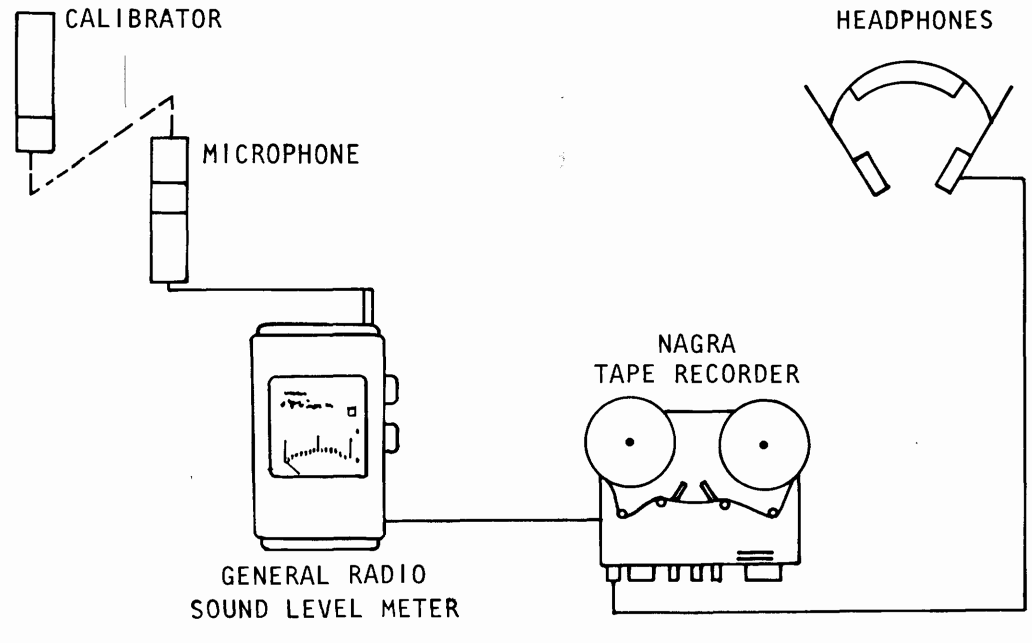
This section describes the instrumentation, data acquisition and analysis, used for the ambient sound survey conducted at the site.

The data acquisition system consisted of a Gen Rad omnidirectional one-inch electric condenser microphone with windscreen, a Gen Rad Type 1933 Sound Level Meter and Octave Band Analyzer, and a Nagra 4.2L single track magnetic tape recorder. The Gen Rad Type 1933 Sound Level Meter and Octave Band Analyzer were used as a linear amplifier and stem attenuator. Ambient sound was recorded on Scotch 177 magnetic tape. The data acquisition system is shown schematically in Figure D-1.

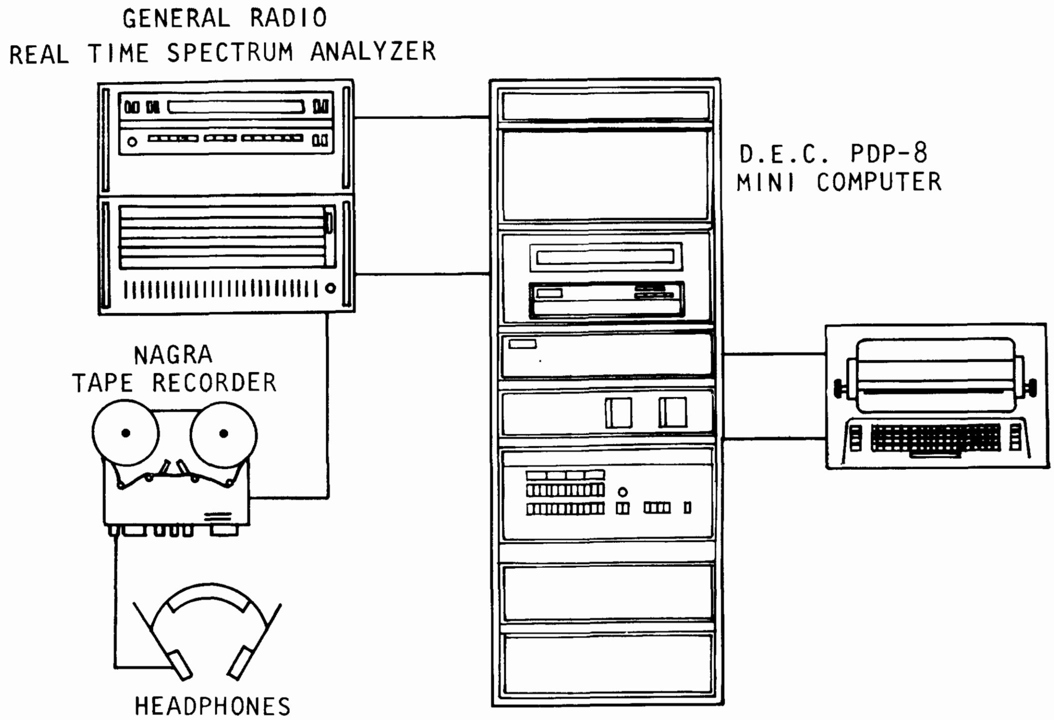
The above system was calibrated before each recording by means of a reference signal at 1000 Hertz of 114 dB generated by a Gen Rad Type 1562A Sound Level Calibrator.

The microphone was mounted on a tripod 1.2 meter above the ground surface and at least three meters from any sizeable sound reflecting surfaces in order to avoid the major interference with sound propagation. Most recordings of the background ambient sound were 20 minutes in length.

Meteorological parameters such as wet bulb and dry bulb temperature, and wind speed were noted during each recording period. If high relative humidity (over 90%) or excessive wind speed (over six meters per second) occurred during the measurement period, the recording session would have been terminated. The tape recorded data were returned to the acoustic laboratory at Dames & Moore for



DATA ACQUISITION SYSTEM



COMPUTER CONTROLLED DATA ANALYSIS SYSTEM

ACOUSTICAL DATA ACQUISITION AND ANALYSIS SYSTEMS

FIGURE E-1

analysis, using a Gen Rad Real-Time Analyzer and a Digital Equipment Corporation mini-computer shown schematically in Figure E-1.

During the recording sessions, any usual intrusions such as wind pop over the microphone or clipping due to overloads, were noted by the engineer monitoring the signal input to the tape. Such intrusions are not characteristic of the acoustic environment, and are deleted during the analysis phase. Each sample tape is used to obtain a cumulative distribution of A-weighted sound levels.

C. AMBIENT SOUND LEVELS

The detailed results of the ambient sound level survey conducted at the proposed project area during November 9 and 15, 1977, are contained in A-weighted sound level histograms indicating the number of times a particular sound level occurred during the measurement period, and the cumulative distribution of the A-weighted sound levels, indicating the percentage of time a sound level is exceeded. Also included are the L_{90}, L_{50}, L_{10}, and L_{eq} of the sound pressure levels at octave band center frequencies. These histograms are available in a Dames & Moore data file report.

E-2 IMPACT ASSESSMENT ANALYSIS

The energy average or equivalent sound level, L_{eq}, is used for sound level calculations. It is a time average of the sound energy emitted from the individual items of construction equipment such that:

$$L_{eq} = 10 \text{ Log } \frac{1}{T} \int_0^T (p(t)^2 / P_o^2)\, dt$$

where

P_o = reference pressure 20 microPascals

P = pressure

t = time

T = length of time under consideration

The average sound level, L_{eq}, is determined form the maximum A-weighted sound level measured at a prescribed distance from a source and from a "usage factor" which describes the fraction of the time that the equipment is in use in its noisiest mode.

From the preliminary construction schedule, equipment use schedule, construction equipment sound levels and construction equipment usage factors, the value of L_{eq} was obtained from:

$$L_{eq} = 10 \text{ Log} \sum_{i=1}^{k} (N_i F_i 10^{(L_{Pi}/10)})$$

where

L_P	=	maximum A-weighted sound level at 15 meters (50 feet)
F	=	this equipment usage factor
N	=	the number of equipment units used
i	=	the i^{th} item
k	=	the total number of items

The daytime (or nighttime) equivalent sound level, L_d, is an (energy) average sound level. To compute L_d (or L_n), construction site or project operation sound, L_{eq}, must be added to the daytime (or nighttime) background ambient sound level, L_{do}, on an energy basis and averaged.

$$L_d = 10 \text{ Log} \{ \frac{1}{15} (n \times 10^{L_{eq}/10} + 15 \times 10^{L_{do}/10}) \}$$

where n is the number of hours per day the source emits noise.

In a similar manner, construction or operation noise for a portion of a week, month, or year may be averaged. The number of days/week, weeks/month, or months/year the source emits noise must be known. For example, if the source emits noise only 5 days per week for 8 hours per day, then:

$$L_d = 10 \text{ Log}\{ (\frac{1}{7 \times 15}) (8 \times 5 \times 10^{L_{eq}/10} + 7 \times 15 \times 10^{L_{do}/10}) \}$$

A similar computation is accomplished for the nighttime equivalent sound level, L_n. The average daytime and nighttime sound levels are then averaged on an energy basis, L_{dn}. The nighttime sound level is weighted by 10 decibels to account for the increased environmental sensitivity to nighttime sound.

APPENDIX F

SUMMARY OF FIELD AND LABORATORY PROCEDURES AND DATA FOR ESTUARINE/MARINE SURVEYS

A. FIELD PROGRAMS

A.1 General

In order to supplement existing physical, chemical and biological data for the proposed project dredging area, two field sampling programs were conducted in October, 1977. The first survey consisted of surficial sediment sampling along Sandy Hook Channel and the proposed terminal channel and basin. This survey was conducted to determine the distribution of sediments in the project area in order to plan and design the detailed sampling program of the second survey. In addition, water was collected from the dredge material disposal site.

The second survey involved a number of programs: (1) the collection of project area sediment and reference sediment for conducting chemical and bacteriological analyses and bioassays on the materials to be dredged; (2) a benthic sampling program for the project; (3) a scraping survey of organisms inhabiting pilings of the NWS Earle pier; and, (4) a current meter survey.

An additional one-day field sampling survey was conducted in January, 1978 to recollect project area and reference sediment for a re-test of a portion of the solid phase bioassay. Samples were collected at the same stations as in the October survey. The initial test results were discarded because test organisms in the reference controls exceeded the 10 percent mortality limit for valid results outlined by the EPA-COE manual for conducting bioassays (July, 1977).

In July, 1978, a fourth field survey was undertaken to collect project area and reference sediment to reflect a change in the proposed dredging project, which eliminated dredging at the existing pier. This material was used to conduct a bioassay on the dredge material stations identified in Figure F-2.

A.2 Sediment Sampling

a. Surficial Sediments

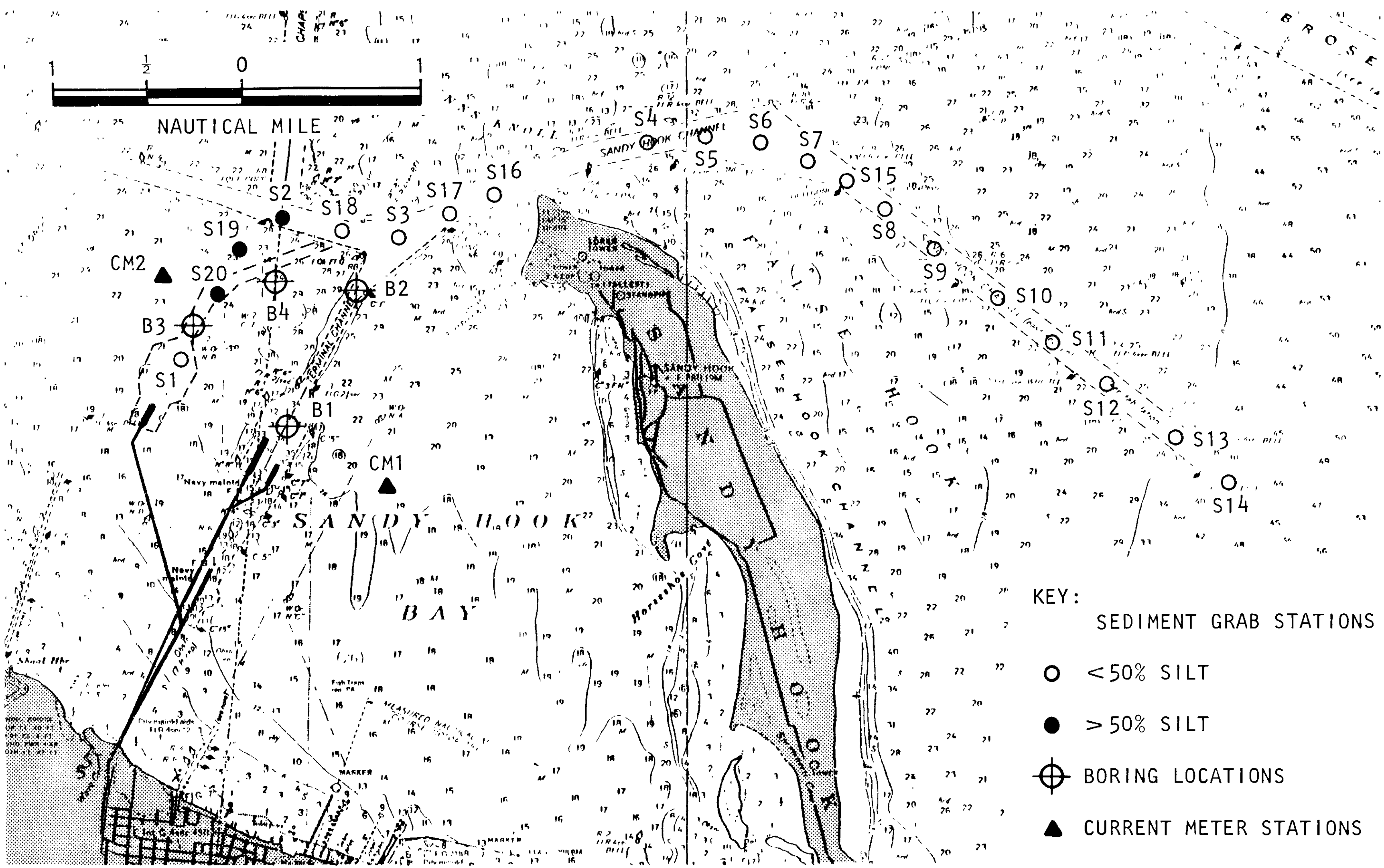
Twenty surficial sediment samples were taken along Sandy Hook Channel and on the area of the proposed terminal basin during the first survey. A Ponar grab sampler was used to obtain the sediment samples from a 45-foot fishing vessel. Sediments were examined and described in the field and representative samples were retained in glass containers for laboratory particle size analysis. Sample locations are shown on Figure F-1. Table F-1 presents the depth, location and description of the sediment samples.

Positioning of sediment grab stations was by visually sighting on navigational aids (landmarks) using a sextant or hand bearing compass. Station locations were then plotted on a 1:40,000 scale NOAA nautical chart of New York Harbor. In the existing navigable channels, samples were taken along the channel center line.

b. Subsurface Borings

Four borings were completed to the project dredging depth (-45+2 feet elevation MLW) in the mud-dominated area of Sandy Hook Bay. The borings were located in the existing Terminal Basin and Channel and in the area of the proposed terminal basin and channel. The locations of the borings are shown on Figure F-1.

Continuous sampling was conducted using a rotary wash rig mounted on a 60 x 20 foot barge anchored in place using bow and stern spuds. In each boring, four-inch casing was jetted to the top of each successive sampling interval and flushed to ensure a clean, open hole.



LOCATION OF SEDIMENT SAMPLES, BORINGS AND CURRENT METER STATIONS

FIGURE F-1

<u>TABLE F-1</u>

SURFICIAL SEDIMENT SAMPLES

Grab Sample No.	Water Depth (feet)	Location Latitude (North)	Location Longitude (West)	Sediment Description
1	20	40°27'50"	74°03'38"	Dark gray to gray green, organic silty fine to very fine sand with trace shell fragments.
2	39	40°28'35"	74°02'56"	Dark gray to olive green, organic silty fine to medium sand with trace shell fragments.
3	39	40°28'24"	74°02'11"	Gray brown, medium to fine sand with abundant shell fragments and occasional silty lumps.
4	43	40°29'00"	74°00'23"	Poorly sorted, clean, medium to coarse sand with coarse sand and trace fine gravel and shell fragments.
5	41	40°29"02"	73°59'50"	Yellow brown, poorly sorted, medium to very coarse sand with trace gravel and shell fragments.
6	42	40°29'01"	73°59'26"	Yellow brown, shelly medium to coarse sand.
7	38	40°28'52"	73°59'08"	Yellow brown, poorly sorted fine to very coarse sand with gravel and shells
8	40	40°28'40"	73°58'38"	Poorly sorted, shelly medium to very coarse sand with occasional lumps of clayey silt and very fine sand.
9	39	40°28'24"	73°58'13"	Yellow brown, medium to coarse sand with trace fine and coarse sand and gravel - with shells.
10	40	40°28'08"	73°57'45"	Yellow brown, well sorted, medium sand with trace very coarse sand, fine gravel and occasional shell fragments.
11	40	40°27'53"	73°57'23"	Yellow brown, clean medium to coarse sand.
12	39	40°27'39"	73°56'56"	Gray brown, medium sand with trace coarse sand and shell fragments.
13	40	40°27'23"	73°56'30"	Gray to olive green, silty fine to medium sand with fine shell fragments common.
14	39	40°27'02"	73°55'56"	Grayish brown, poorly sorted, fine to very coarse sand with trace fine gravel

TABLE F-1 (Continued)

Grab Sample No.	Water Depth (feet)	Location Latitude (North)	Location Longitude (West)	Sediment Description
15	39	40°28'46"	73°58'51"	Poorly sorted, fine to very coarse sand and fine to medium gravel with abundant shell fragments.
16	57	40°28'43"	74°01'20"	Yellow brown, medium to coarse sand with trace very coarse sand and gravel - with shells.
17	37	40°28'34"	74°01'40"	Yellow brown, clean medium to coarse sand with abundant shells and shell fragments.
18	39	40°28'31"	74°02'34"	Dark gray to gray brown, silty fine to very fine sand.
19	22	40°28'23"	74°03'13"	Dark gray to black organic silty very fine sand.
20	22	40°28'09"	74°03'23"	Dark gray to light brown organic silty very fine sand.
Boring Number				
B1-1	37	40°27'31"	74°02'51"	Black, very soft organic silt with trace of clay.
B2-1	36	40°28'11"	74°02'22"	Dark gray, to black soft silty fine sand with trace of shell fragments.
B3-1	25	40°28'22"	74°02'54"	Black very soft organic silt and very fine sand.
B4-2	22	40°28'06"	74°03'32"	Black very soft organic silt and very fine sand with shells and shell fragments.

NOTES: Sediment grab samples were taken on October 18, 1977.
Borings 1 and 2 were collected on October 27, 1977.
Borings 3 and 4 were collected on October 28, 1977.

A special sampler was assembled for this boring program. It involved a 2-1/2 inch I.D., 3-1/4 inch O.D., Dames & Moore type U sampler fitter with a 25-inch long split barrel and polystyrene barrel liners. The sampler and sample liners were cleaned and decontaminated in accordance with U.S. Army Corps of Engineers approved procedures (EPA/COE, 1977), so that select samples could be used for chemical and bioassay or bacteriological analysis. The sampler was disassembled and cleaned between samples and new liners were used to ensure uncontaminated sample retrieval.

Normally the sampler was allowed to sink into the soft subsurface sediments under its own weight or it was driven by the impact of a 300-pound hammer dropping 30 inches to obtain the desired 2.5- to 3-foot sample. In a few cases when sample retrieval was not possible using the Dames & Moore sampler, a standard 1-3/8 I.D., 2-inch O.D., split spoon sampler was used.

As each sample was retrieved, it was immediately extruded, photographed and logged. A representative sample was stored for reference or further analysis. Samples requiring special care for chemical, bioassay or bacteriological analysis, were handled with decontaminated tools and gloves, placed in sterile glass containers and kept on ice until delivery to the laboratory for analysis.

During sampling, water depth and tide levels were monitored continuously to ensure correct elevation determinations. Water depths were measured from the drilling barge using a lead line. Tide levels were recorded from a tide staff maintained by the NOAA National Ocean Survey at the Sandy Hook Coast Guard station.

Accurate positioning of the borings was established using an electronic Mini-Ranger Positioning System located aboard the survey/support vessel. Coordinates of the borings are presented in Table F-2.

TABLE F-2

LOCATION COORDINATES OF BORINGS, CURRENT METER STATIONS AND REFERENCE STATIONS

Location Name	New Jersey State Plane Coordinates (feet) (north)	(east)	Nautical Chart Mercator Projection Coordinates Latitude (N)	Longitude (W)
Boring 1	592682	2172317	40°27'31"	74°02'51"
Boring 2	596684	2174516	40°28'11"	74°02'22"
Boring 3	597781	2172020	40°28'22"	74°02'54"
Boring 4	596063	2169075	40°28'06"	74°03'32"
Current Meter 1	590548	2175311	40°27'10"	74°02'12"
Current Meter 2	597050	2168184	40°28'15"	74°03'44"
Positioning Sta. 1	597082.18	2180322.86	40°28'14.64"	74°01'6.82"
Positioning Sta. 2	593379.15	2183804.95	40°27'37.79"	74°00'22.13"

Location coordinates determined using a Mini-Ranger electronic positioning system and a computer data processing. Positioning reference stations were established on Sandy Hook using conventional surveying techniques.

c. Sediment Samples Taken for Chemical, Elutriate, Bioassay and Bacteriological Analysis

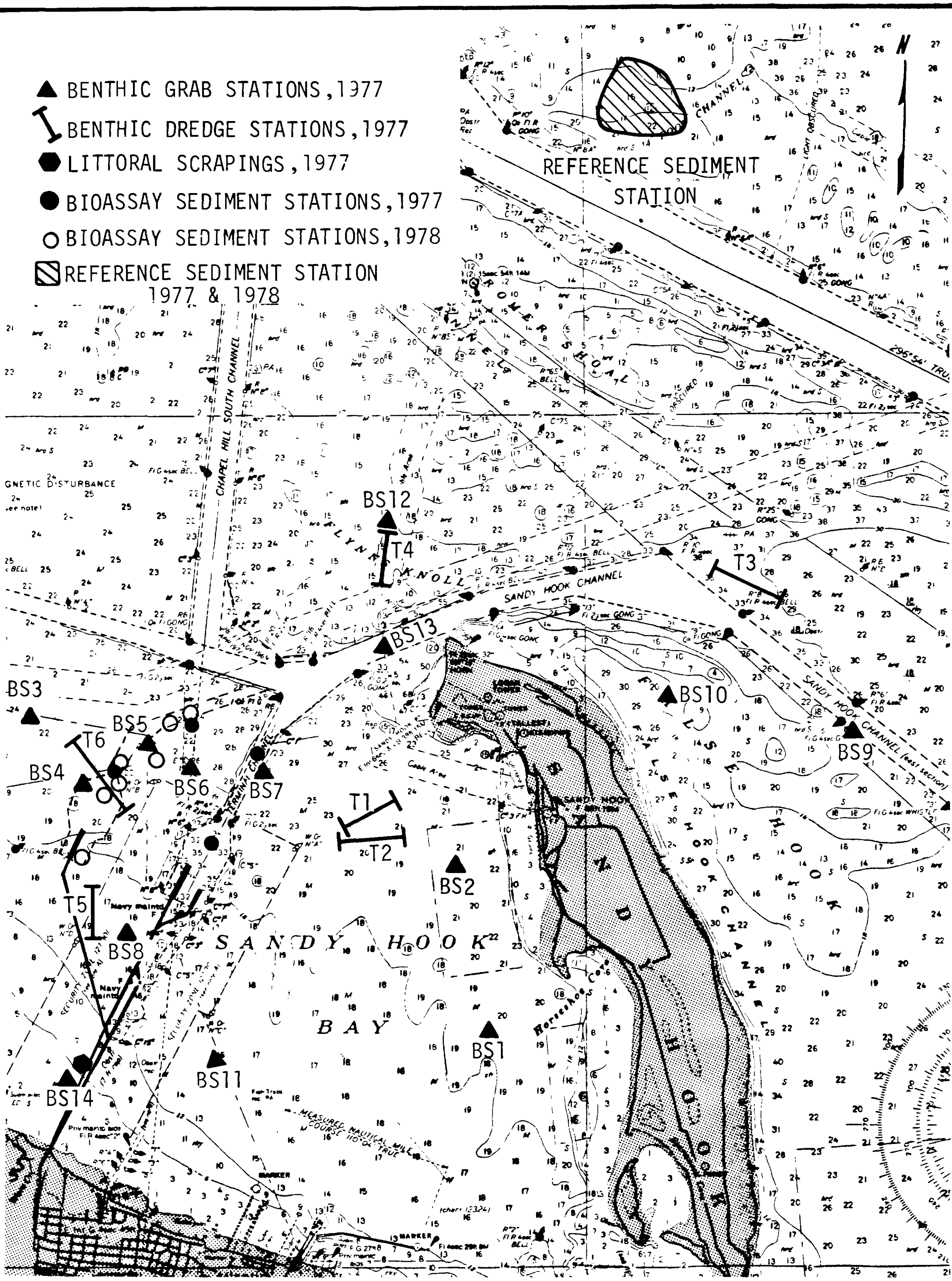
Based on the surficial sediment distribution established during the first survey, predominantly sandy sediments were eliminated from further testing under EPA/COE (1977) criteria. Subsequent sediment sampling was, therefore, concentrated in the muddy area where dredging is proposed.

Samples for bulk chemical and elutriate analysis were formed by combining sediments taken at elevation -47 feet MLW in subsurface borings. Two composite sediment samples were used for bulk chemical analysis. Composite #1 was composed of only material from boring 2, since no material was collected at -47 feet elevation in boring 1. Composite #2 was composed of samples taken in borings 3 and 4. A single composite sample of sediment from bulk chemical composites #1 and #2 was used for the elutriate analysis.

Sediments were collected in field survey No. 4 using a Ponar grab sampler at seven locations near the proposed turning basin and terminal channel (Figure F-2). For the earlier surveys, large representative samples of muddy dredge material were collected using a Ponar grab sampler at locations in the vicinity of the four subsurface borings in the existing and proposed terminal channels and basins (Figure F-2).

Forty and fifty-five gallon composite samples of the dredge material for field surveys Nos. 2 and 4, respectively were used for the bioassay analyses. Two composite bacteriological samples were formed by combining surficial sediments collected in the vicinity of borings 1 and 2 and borings 3 and 4 respectively.

Reference sediment required for bioassay analyses was collected from an area east of Ambrose Channel in the vicinity of East Bank (Figure F-2). This location was recommended by the U.S. Army Corps of Engineers, New York District (personal communication, 1977). A total of 15 and 50 gallons of reference sediment was collected for field surveys 2 and 4 respectively. For survey No. 2,



LOCATION OF BIOLOGICAL SAMPLES

1 ½ 0 1 2 3

NAUTICAL MILES

FIGURE F-2

approximately half was collected using a Ponar grab sampler from a drifting survey vessel. The remaining amount was collected by a scuba diver. In the fourth survey the total 50 gallons was collected with the Ponar grab from an anchored vessel.

Sample collection and preservation for bioassay, bacteriological, chemical and elutriate analysis were performed as specified in the "Implementation Manual for Ecological Evaluation of Proposed Discharge of Dredged Material Into Ocean Waters", EPA/COE, 1977. Samples were stored on ice until tested. Thermometer readings were taken periodically to insure that the temperature remained between 2^{o}-4^{o}C.

Positioning for dredge material sample stations and borings was provided by an electronic positioning system as described above. Positioning in the reference sediment area and on field survey No. 4 was accomplished visually using techniques described above. The location coordinates of sediment stations for chemical, elutriate, bioassay and bacteriological analyses is listed in Table F-3.

A.3 Dredge Material Disposal Site Water Samples

Eighteen liters of water were collected for chemical analysis at the dredge material disposal site (Mud Dump) in the Atlantic Ocean on October 12, 1977. The water was collected using a 6.1 liter alpha bottle at the surface, mid-depth and bottom in 90 feet of water. Six liters from each level were combined in a single composite sample and stored in a decontaminated glass carboy and kept at 2-4^{o}C until tested.

Positioning at the dump site was accomplished using visual techniques discussed in Section A.2 of this Appendix. Coordinates of the water sample status are listed in Table F-3.

TABLE F-3

SAMPLE STATION LOCATIONS
(Bactereological, Bioassay and Reference Samples)

Station[a] Name	Location Coordinates Latitude (N)	Longitude (W)	Positioning[b] Method
BBS 1	40°27'35"	74°02'47"	MR
BBS 2	40°28'07"	74°02'24"	MR
BBS 3	40°28'51"	74°02'53"	MR
BBS 4	40°28'05"	74°03'33"	MR
REF	40°26'13"	74°03'54"	HBC
DSW	40°23'18"	73°50'42"	HBC
D 1 & 2	40°28'15"	74°03'02"	HBC
D 3 & 4	40°28'10"	74°03'16"	HBC
D 5 & 6	40°28'02"	74°03'18"	HBC
D 7 & 8	40°27'59"	74°03'29"	HBC
D 9 & 10	40°27'52"	74°03'31"	HBC
D 11 & 12	40°27'59"	74°03'36"	HBC
D 13 & 14	40°27'30"	74°03'50"	HBC
REF	40°32'53"	73°59'28"	HBC

[a]BBS = Sediment station for bioassy and bacteriological analyses.
REF = Reference sediment station
DSW = Dredge site water sample station

[b]MR = Electronic Mini-Ranger system
HBC = Visual positioning using hand bearing compass

A.4 Biological Sampling

a. Benthic Grab Samples

A Ponar grab sampler was used to obtain samples of surficial sediments for benthic analysis. Single grabs were taken at the fourteen grab stations identified on Figure F-2. Sediment samples were sieved onboard the survey vessel using a 1.0 mm screen (U.S. Standard Sieve No. 30) and the residue was preserved in a 10 percent formalin solution.

Benthic grab station locations are listed on Table F-4 along with respective methods of positioning.

b. Benthic Dredge Sample

A biological dredge was used to index abundance of benthic macroinvertibrates. The dredge had a metal frame (mouth size 46 cm x 26 cm) with a cloth net (2.5 cm mesh). The dredge was towed at six stations for either 5 or 10 minutes. Tow stations are shown on Figure F-2. Each catch was sorted immediately for larger organisms. Representative numbers of the remaining organisms were fixed in 10 percent formalin and returned to the laboratory for identification.

c. Pile Scrapings

Littoral fouling organisms were scraped from a wooden piling at the NWS Earle Pier in Sandy Hook Bay. Scraping were collected by a scuba diver at surface, mid-depth and one foot above bottom. Organisms were placed in glass jars and returned to the laboratory for sorting.

The location of the pile scraping is shown on Figure F-2. The coordinates and method of positioning are given in Table F-4.

TABLE F-4

LOCATION OF BIOLOGICAL STATIONS

Sample[a] Name	Location Coordinates Latitude (N)	Longitude (W)	Positioning[b] Method
BS-1	40°26'24"	74°00'46"	M.R.
BS-2	40°27'20"	74°00'59"	M.R.
BS-3	40°28'21"	74°04'05"	M.R.
BS-4	40°27'52"	74°03'52"	M.R.
BS-5	40°28'07"	74°03'16"	M.R.
BS-6	40°28'00"	74°02'59"	M.R.
BS-7	40°27'55"	74°02'33"	M.R.
BS-8	40°26'49"	74°03'41"	H.B.C.
BS-9	40°28'11"	73°57'49"	H.B.C.
BS-10	40°28'24"	73°59'16"	H.B.C.
BS-11	40°26'12"	74°02'42"	M.R.
BS-12	40°29'19"	74°01'29"	H.B.C.
BS-13	40°28'42"	74°01'24"	H.B.C.
BS-14	40°26'10"	74°03'52"	M.R.
LS	40°26'13"	74°03'54"	M.R.

Note:

[a]BS = Benthic grab station
LS = Littoral scrape

[b]MR = Electronic Mini-Ranger system
HBC = Visual positioning using hand bearing compass

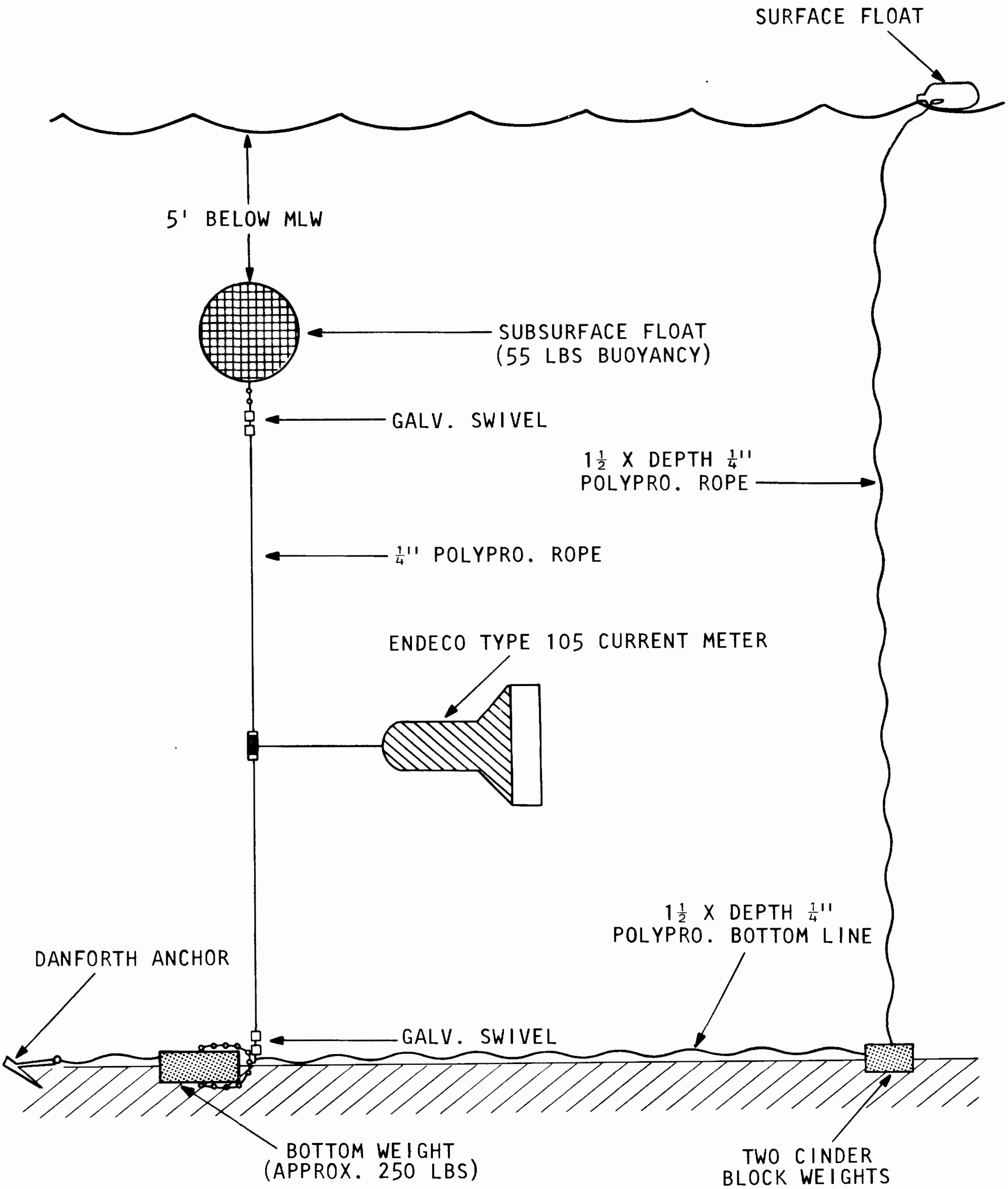
A.5 Current Measurements

Two current meters were deployed from a survey vessel in Sandy Hook Bay. Current meter No. 1 was placed east of the NWS Earle pier at a depth of nine feet below MLW and current meter No. 2 was placed northwest of the pier, 11 feet below MLW (Figure F-1). Positioning for deployment and retrieval of the meters was provided using an electronic Mini-Range Positioning System aboard the survey vessel. Final position coordinates for the two current meters are provided in Table F-2.

Endeco (Environmental Devices Corporation) Type 105 Tethered Current Meters (TCM) were used in this study. The Type 105 TCM is a battery-powered, neutrally-buoyant, shrouded impeller meter designed to measure water current speed and direction. It integrates motor revolutions over a 30 minute time interval for a full scale current speed of 3.5 knots and employs a mechanical magnetic compass to reference magnetic north. Both current speed and direction are recorded on 16 mm film cassettes.

During field deployment, the instrument was attached by a scuba diver at the end of five-foot nylon tether that is secured to a taut mooring line (Figure F-3). The resilient tether design and the neutral buoyancy of the instrument allow the meter to align itself into the flow. Trim weights were used for pitch, roll and buoyancy control.

Spot check current readings were made from the drilling barge during boring programs using a Bendix Q-9 Savonius Current meter with deck readout. This data compared favorably with the continuous Endeco meter data.



CURRENT METER MOORING SYSTEM

FIGURE F-3

B. LABORATORY PROCEDURES

B.1 Sediment Analyses

a. Surficial and Subsurface Sediment Size Analysis

Grain size analysis was performed on 19 of the 20 surficial sediment grab samples using standard procedures of Folk (1968). Grain Size Analysis was also conducted on representative surficial samples from each of the four subsurface borings and on a representative sample of a subsurface clayey layer from Boring 3. Sediment size classification was based on the Wentworth Grain Size Scale (Table F-5).

b. Chemical and Bacteriological Analyses

All sediment bulk chemistry, elutriate and bacteriological analyses were performed in accordance with EPA approved procedures.

The bulk chemical analysis was performed on the sediment without prior preparation. Bulk chemical composite #1 arrived in the laboratory as a single boring sample, thus requiring no preparation. Bulk chemistry composite #2 arrived in the laboratory as 3 samples. These three samples were composited using equal weights of each sample.

The sample for the Elutriate analysis was prepared by mixing equal parts of composite 1 and composite 2 with laboratory prepared salt water in a ratio of 1 part sediment to 4 parts water. The mixture was made up in thoroughly cleaned 1 liter polypropylene bottles. The bottles were tightly capped and placed on a shaker for 30 minutes at 100 oscillations per minute. The mixture was then allowed to settle for 1 hour and the liquid was decanted. The liquid was then centrifuged and filtered through a 0.45 micron filter.

TABLE F-5

WENTWORTH GRAIN SIZE SCALE

U.S. Standard Sieve Mesh #	Grain Size (millimeters)	Wentworth Size Class	
		Boulder	
Used	> 256		
Wire		Cobble	
Squares	16		Gravel
		Pebble	
5	4		
		Granule	
10	2.00		
		Very Coarse Sand	
18	1.00		
		Coarse Sand	
35	0.50		
		Medium Sand	
60	0.25		Sand
		Fine Sand	
120	0.125		
		Very Fine Sand	
230	0.0625		
		Coarse Silt	
	0.031		
Analysis		Medium Silt	
	0.0156		
by		Fine Silt	Mud
	0.0078		
Hydrometer		Very Fine Silt	
	< 0.0039		
		Clay	

SOURCE: Adapted from Folk, 1968.

c. Bioassay Analysis

Liquid, suspended particulate, and solid phase bioassays were performed in accordance with procedures approved by EPA/COE, 1977. A brief description of procedures for each phase follows:

1. Liquid Phase Bioassay - The Liquid Phase for the Bioassay test was prepared by mixing sediment and sea water in a 1:4 ratio. This mixture was then placed on a shaker at about 100 oscillation per minute for thirty minutes. The mixture was then allowed to settle for 1 hour. The liquid was then decanted off the top of the mixture. Finally the liquid was centrifuged and filtered through a 0.45 micron filter.

The bioassays were performed in a temperature controlled room at 20°C. Three replicates were used at all dilutions. The temperature, pH, salinity and dissolved oxygen were taken at the start and finish of each bioassay.

Ten organisms were exposed to each dilution of the liquid phase for a period of 96 hours. The deaths which occurred were recorded at 0, 4, 8, 24, 48, 72 and 96 hours. Any dead organisms were removed from the test containers. The organisms used in the bioassay were Menidia menidia (a common baitfish), Mysidopsis bigelowi (a mysid shrimp) and Skeletonema costatum (a microscopic algae). The mysid shrimp Mysidopsis bahia was used in each phase during the second bioassay test conducted in July, 1978.

2. Suspended Particulate Phase Bioassay - The suspended particulate phase for the bioassay was prepared by mixing sediment and sea water in a 1:4 ratio. The mixture was then placed on a shaker at about 100 oscillations per minute for thirty minutes. The mixture was then allowed to settle for one hour. The liquid portion was decanted off and used as the suspended particulate phase for the bioassay.

The bioassays were performed in a temperature controlled room at 20°C. Three replicates were used at all dilutions. The temperature, pH, Salinity and dissolved oxygen were taken at the start and finish of each test.

Ten organisms were exposed to each dilution of the suspended particulate phase for a period of 96 hours. The deaths which occurred were recorded at 0, 4, 8, 24, 48, 72 and 96 hours. Any dead organisms were removed from the test containers.

The organisms used in the bioassay were *Menidia menidia* (a common baitfish), *Mysidopsis bigelowi* (a mysid shrimp) and *Skeletonema costatum* (a microscopic algae).

The dilutions used in the bioassay are as follows:

Percent Liquid Phase	Percent Salt Water
10	90
50	50
100	0

3. Solid Phase Bioassay - The solid phase bioassay utilizes the bottom sediment without treatment. Five replicates of the sediment and the blank are used in the test.

The preparation of the aquaria involved placing a layer of reference sediment 30 mm thick on the bottom of the aquarium. Seventy-five percent of the seawater in the tank was changed 1 hour after the addition of the sediment. The animals were then introduced to the tanks and allowed to acclimate for 48 hours. The salt water in the tanks was changed at 48 hour intervals throughout the testing period. After 48 hours, the dredged sediment was added to the test tanks to form a 15 mm layer above the reference a sediment. The test was allowed to continue for 10 days.

The organisms used in the solid phase bioassay were Mercenaria, Mydisopsis bigelowi, and Nereis nereis.

B.2 Disposal Site Water Analysis

Chemical analysis of water from the dredge material disposal site was performed in accordance with approved EPA procedures.

B.3 Biological Laboratory Analyses

Benthic grab and dredge sample and littoral scrap microinvertebrates and fish were sorted, counted and identified by a qualified marine biologist in accordance with "Standard Method" (APHJA, 1971). Individual organisms from each sample were enumerated and identified to the lowest possible taxonomic level.

B.4 Current Data Processing

After the two current meters were returned, the film cassettes were developed and analyzed by the manufacturer using computer processing.

C. DATA RESULTS

C.1 Sediment Analysis Results

a. Grain Size Analyses

Results of grain size analyses of grab and boring samples are presented in Table F-6 and cumulative size frequency plots are presented in Figure F-4. Detailed logs of borings are presented in Figures F-5 and F-6.

TABLE F-6

GRAIN SIZE ANALYSIS RESULTS

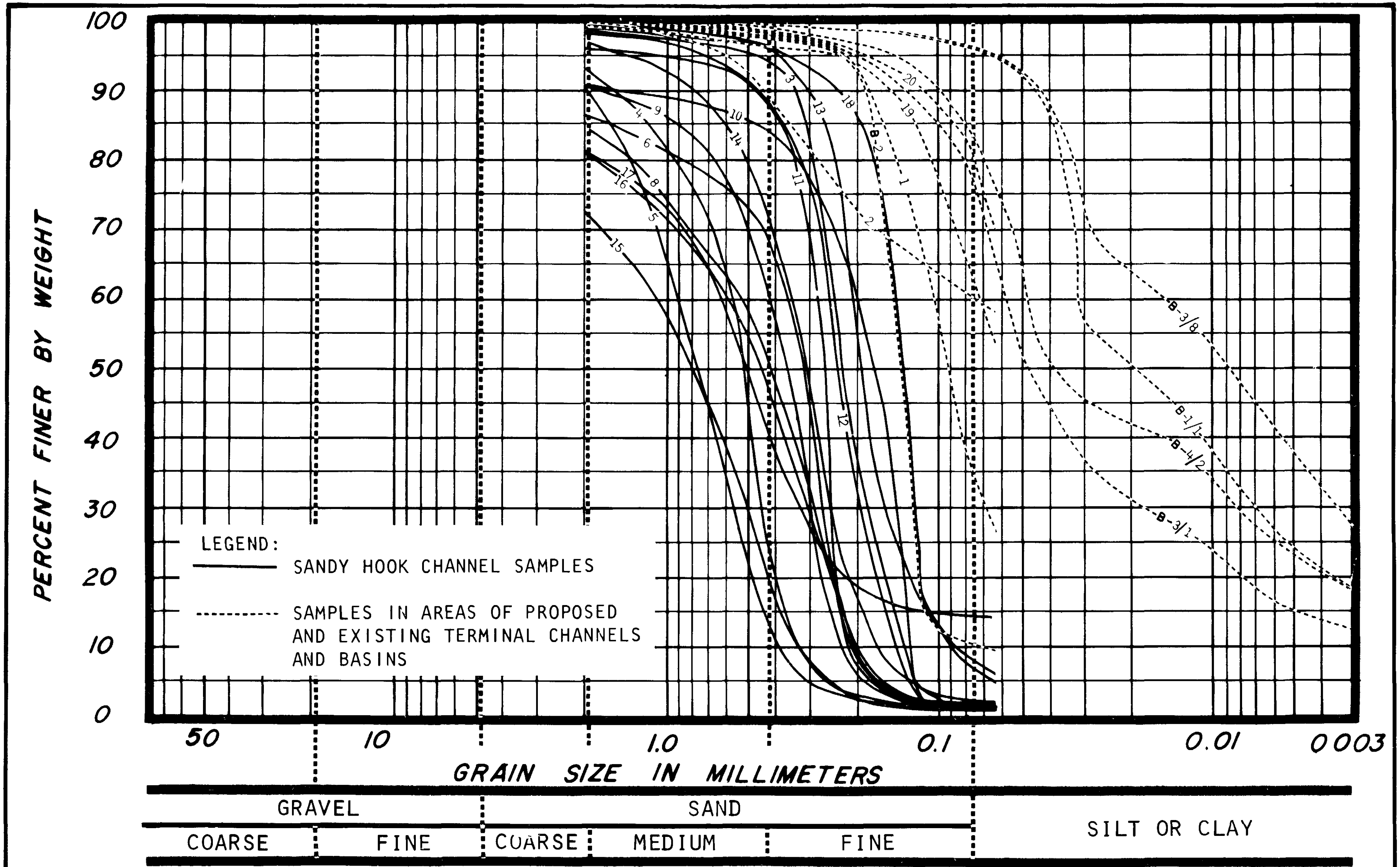
Grab Sample #	Median (mm)	Gravel and Shells	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	% Mud
		Size Fractions (% by weight)						
1	0.088	0.41	0.86	0.66	0.88	26.62	43.52	27.05
2	M	0.82	1.87	5.34	14.91	11.37	7.70	57.99
3	0.23	1.34	0.95	1.30	35.46	56.25	3.21	1.49
4	0.51	6.53	11.80	32.65	45.19	2.65	0.16	1.12
5	0.82	8.87	24.82	42.79	20.38	0.91	0.09	2.15
6	0.37	13.84	3.55	8.01	54.12	18.33	0.38	1.78
7	—	Sample washed out not considered representative						
8	0.50	15.42	15.69	18.35	28.89	6.66	0.54	14.45
9	0.37	9.88	3.38	14.56	57.20	13.43	0.17	1.38
10	0.40	9.14	4.61	12.85	58.15	13.51	0.34	1.40
11	0.33	0.11	0.44	6.10	74.03	18.35	0.17	0.80
12	0.23	3.50	1.42	2.81	32.83	56.76	1.26	1.41
13	0.20	0.15	0.21	0.85	17.50	64.19	11.09	6.01
14	0.33	2.69	3.83	13.11	51.55	24.66	1.70	2.45
15	0.79	26.93	15.01	26.23	26.54	4.34	0.21	0.75
16	0.45	18.61	9.43	16.09	41.25	13.20	0.66	0.75
17	0.40	19.49	6.26	14.40	41.28	16.90	0.79	0.87
18	0.21	1.05	0.87	0.66	6.01	69.81	16.55	5.05
19	0.06	0.40	1.39	1.26	0.87	11.42	30.18	54.47
20	M	0.39	1.34	0.80	0.55	4.95	21.24	70.74

M = median in mud range (less than 0.06 mm)

TABEL F-6 (Continued)

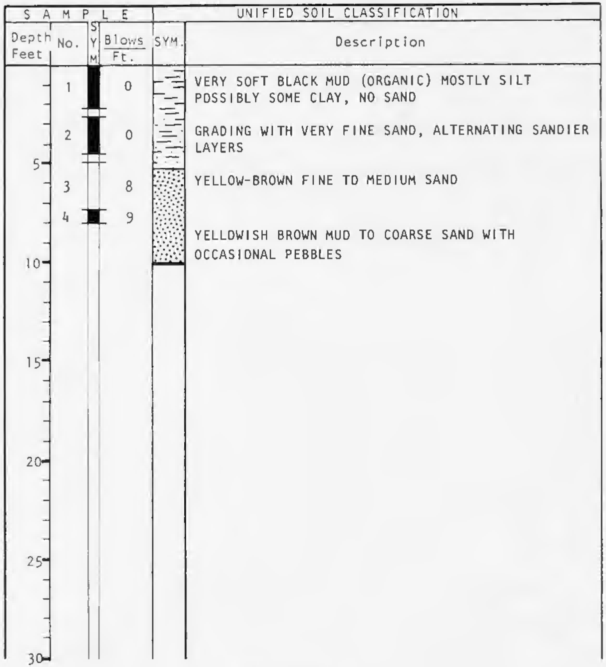
Boring Sample	Median (mm)	Size Fractions (% by weight) Gravel and Shells	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	% Mud
Boring 1 Sample 1	0.02	0.0	0.0	0.15	0.17	0.91	3.07	95.70
Boring 2 Sample 1	0.18	0.0	0.08	0.09	3.15	79.29	7.44	9.94
Boring 3 Sample 1	0.05	0.0	1.16	0.94	0.74	8.94	20.89	67.33
Boring 3 Sample 8	0.006	0.0	0.12	0.19	0.27	0.66	2.39	96.39
Boring 4 Sample 2	0.036	0.0	1.0	0.71	0.60	3.82	16.37	77.51

Notes: For detailed sediment size classification refer to Wentworth Grain Size Scale in Table F-5.

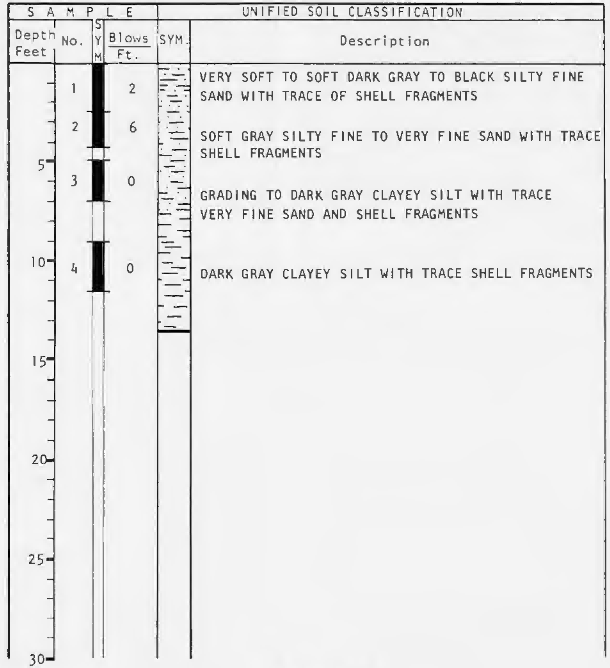


PARTICLE SIZE DISTRIBUTIONS: PROJECT DREDGE MATERIALS

FIGURE F-4



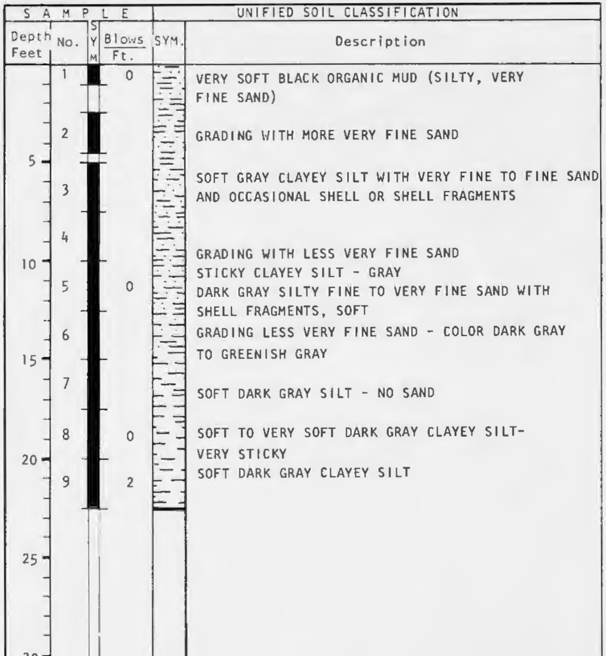
BORING 1



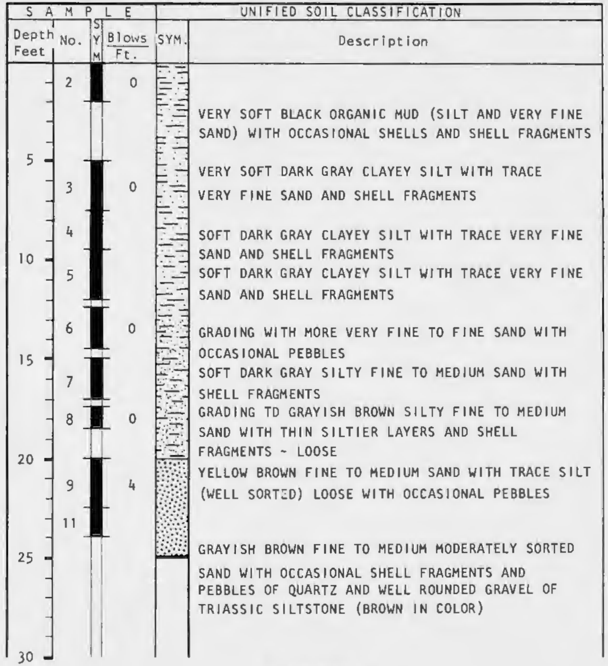
BORING 2

LOG OF BORINGS 1 AND 2

FIGURE F-5



BORING 3



BORING 4

LOG OF BORINGS 3 AND 4

b. Chemical Testing Data Results

Laboratory results for sediment bulk chemistry, and elutriate analysis are presented in Tables F-7 and F-8. In addition, Table F-9 presents quality control results run during lab testing.

c. Bioassay Results

Results of the liquid bioassay are presented in Tables F-10 and F-11. Suspended particulate bioassay results are presented in Tables F-12 and F-13. Solid phase bioassay results are presented in Table F-14.

Salinity, temperature, dissolved oxygen and pH were monitored during liquid and suspended phase for Mysidopsis bigelowi and Menidia menidia. Data is presented in Tables F-15 and F-16.

d. Bacteriological Results

Laboratory results for bacteriological analysis of surficial sediments are presented below:

	Composite 1	Composite 2
Total Coliform	9,300 MPN	430,000 MPN
Fecal Coliform	90 MPN	430 MPN
Streptococcus	24,000 MPN	240,000 MPN
Salonella	Negative	Negative
Staphylococcus	8/gram	16/grm

C.2 Disposal Site Water Chemistry Results

Laboratory results from disposal site water chemistry are presented on Table F-17.

TABLE F-7

RESULTS OF SEDIMENT BULK CHEMICAL ANALYSIS

BULK CHEMISTRY - COMPOSITE 1

		A	B	C
Total Organic Carbon	mg/gm	7,100	6,550	6,800
Volatile Solids	mg/gm	30.0	31.6	31.3
Oil & Grease	mg/gm	8.6	13.0	10.2
Total Phosphate	mg/kg	5.48	4.76	5.21
Ortho-Phosphate	mg/kg	3.27	3.34	3.71
Phenols	mg/kg	0.324	0.211	0.284
Nitrate	mg/kg	0.278	0.258	0.263
Nitrite	mg/kg	0.160	0.143	0.164
Ammonia	mg/kg	0.229	0.331	0.273
Organic Nitrogen	mg/kg	0.042	0.044	0.056
COD	mg/kg	41,589	36,607	39,413
PCB	ppb	< 0.1	< 0.1	< 0.1
DDT	ppb	< 0.1	< 0.1	< 0.1
Mercury	mg/kg	0.051	0.048	0.052
Lead	mg/gm	0.0005	0.0033	0.0001
Zinc	mg/gm	0.0013	0.0010	0.0007
Copper	mg/gm	0.0003	0.0004	0.0004
Chromium	mg/gm	0.0006	0.0004	0.0007
Cadmium	mg/gm	0.0001	0.0001	0.0001
Sulfide	mg/gm	0.001	0.001	0.001
Cyanide	mg/kg	0.0024	0.0024	0.0026
Flouride	mg/kg	0.152	0.161	0.158

TABLE F-7 (Continued)

BULK CHEMISTRY - COMPOSITE 2

		A	B	C
Total Organic Carbon	mg/kg	6,000	6,200	—
Volatile Solids	mg/gm	27.5	25.1	26.7
Oil & Grease	mg/gm	3.2	30.3	28.7
Total Phosphate	mg/kg	5.8	5.43	5.72
Ortho-Phosphate	mg/kg	4.31	4.17	3.78
Phenols	mg/kg	0.573	0.139	0.371
Nitrate	mg/kg	0.616	0.684	0.597
Nitrite	mg/kg	0.635	0.642	0.627
Ammonia	mg/kg	0.0285	0.041	0.037
Organic Nitrogen	mg/kg	0.175	0.143	0.139
COD	mg/kg	28,819	29.414	28.672
PCB	ppb	< 0.1	< 0.1	< 0.1
DDT	ppb	< 0.1	< 0.1	< 0.1
Mercury	mg/kg	0.026	0.031	0.028
Lead	mg/gm	0.0001	0.0003	0.0002
Zinc	mg/gm	0.0011	0.0015	0.0011
Copper	mg/gm	0.0002	0.0005	0.0003
Chromium	mg/gm	0.0005	0.0007	0.0004
Cadmium	mg/gm	<0.001	< 0.001	< 0.001
Sulfide	mg/gm	<0.001	< 0.001	< 0.001
Cyanide	mg/kg	0.0019	0.0017	0.0021
Flouride	mg/kg	0.193	0.204	0.195

SOURCE: Pedneault Assoc., December 1977.

TABLE F-8

RESULTS OF SEDIMENT ELUTRIATE ANALYSIS

ELUTRIATE ANALYSIS

		A	B	C	D	E	F
Total Organic Carbon	mg/l	250	260	300	—	—	—
Volatile Solids	mg/l	178.5	184.3	172.4	1,162	1,241	1,187
Oil & Grease	mg/l	0.4	0.7	0.6	54.9	53.8	54.6
Total Phosphate	mg/l	0.76	0.69	0.74	0.49	0.46	0.47
Ortho-Phosphate	mg/l	0.44	0.47	0.43	0.18	0.18	0.17
Phenols	mg/l	0.004	0.003	0.004	0.001	< 0.001	0.001
Nitrate	mg/l	0.04	0.04	0.06	<0.01	<0.01	<0.01
Nitrite	mg/l	0.007	0.008	0.005	0.003	0.002	0.003
Ammonia	mg/l	0.116	0.131	0.124	0.74	0.71	0.73
Organic Nitrogen	mg/l	0.125	0.112	0.129	0.83	0.81	0.82
COD	mg/l	18,080	19,420	15,148	72	70	72
PCB	μg/l	< 0.1	< 0.1	< 0.1	< 1	< 1	< 1
DDT	μg/l	< 0.1	< 0.1	< 0.1	< 1	< 1	< 1
Mercury	mg/l	0.003	0.001	0.004	<0.001	<0.001	<0.001
Lead	mg/l	0.01	0.009	0.013	<0.001	<0.001	<0.001
Zinc	mg/l	0.0058	0.0063	0.0047	<0.001	<0.001	<0.001
Copper	mg/l	0.004	0.007	0.003	<0.001	<0.001	<0.001
Chromium	mg/l	0.0008	0.010	0.0009	<0.001	<0.001	<0.001

TABLE F-8 (Continued)

RESULTS OF SEDIMENT ELUTRIATE ANALYSIS

ELUTRIATE ANALYSIS

		A	B	C	D	E	F
Cadmium	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sulfide	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cyanide	mg/l	0.020	0.028	0.031	<0.001	<0.001	<0.001
Flouride	mg/l	3.4	3.1	3.7	< 0.2	< 0.2	< 0.2

SOURCE: Pedneault Assoc., December 1977 (ABC); August 1978 (DEF)

TABLE F-9

RESULTS OF QUALITY CONTROL SAMPLES

Parameter	Quality Control Concentration of Spiked Sample (mg/l)	Concentration Recovered (mg/l)
Oil & Grease	50	49.6
Total Phosphate	5.0	5.0
Ortho-Phosphate	5.0	5.0
Phenols	0.5	0.51
Nitrate	0.1	0.1
Nitrite	0.5	0.497
Ammonia	0.1	0.1
Organic Nitrogen	0.1	0.09
Mercury	0.001	0.001
Lead	0.01	0.01
Zinc	0.01	0.01
Copper	0.01	0.01
Chromium	0.01	0.01
Cadmium	0.01	0.01
Sulfide	0.01	0.01
Cyanide	0.01	0.01
Flouride	0.1	0.1

SOURCE: Pedneault Assoc., December 1977.

TABLE F-10

LIQUID PHASE BIOASSAY RESULTS

Mysidopsis bigelowi[a]

Exposure Condition	Replicate	Time of Observation (hrs) - Number of Survivors						
		0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Mysidopsis bahia[b]

Exposure Condition	Replicate	0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-10 (Continued)

LIQUID PHASE BIOASSAY RESULTS

Menidia menidia[a]

Exposure Condition	Replicate	0	4	8	24	48	72	96
		Time of Observation (hrs) - Number of Survivors						
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	9
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	29
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Menidia menidia[b]

Exposure Condition	Replicate	0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-11

LIQUID PHASE BIOASSAY RESULTS

Skeletonema costatum[a]

Cell Counts at 96 Hours

Dilution		Cells Per ml	Percent of Blank
Blank	A	4,610	—
	B	5,230	—
	C	4,870	—
10%	A	3,790	77.3
	B	3,910	79.7
	C	3,860	78.7
50%	A	3,570	72.8
	B	3,310	67.5
	C	3,280	66.9
100%	A	2,990	61.0
	B	3,020	61.6
	C	2,930	60.0

Skeletonema costatum[b]

Dilution		Cells Per ml	Percent of Blank
Blank	A	355,000	—
	B	348,000	—
	C	362,000	—
10%	A	340,000	95.8
	B	342,000	96.3
	C	336,000	94.6
50%	A	41,000	11.5
	B	39,000	11.0
	C	43,000	12.1
100%	A	2,100	0.6
	B	1,900	0.5
	C	2,200	0.6

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-12

SUSPENDED PARTICULATE PHASE BIOASSAY RESULTS

Mysidopsis bigelowi[a]

Exposure Condition	Replicate	0	4	8	24	48	72	96
		Time of Observation (hrs) - Number of Survivors						
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Mysidopsis bahia[b]

Exposure Condition	Replicate	0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-12 (Continued)

SUSPENDED PARTICULATE PHASE BIOASSAY RESULTS

Menidia menidia[a]

Exposure Condition	Replicate	Time of Observation (hrs) - Number of Survivors						
		0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	29
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Menidia menidia[b]

Exposure Condition	Replicate	0	4	8	24	48	72	96
Culture Water Control	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
100% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
50% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30
10% Test Medium	1	10	10	10	10	10	10	10
	2	10	10	10	10	10	10	10
	3	10	10	10	10	10	10	10
		30	30	30	30	30	30	30

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-13

SUSPENDED PARTICULATE PHASE BIOASSAY RESULTS

Skeletonema costatum[a]

Cell Counts at 96 Hours

Dilution		Cells Per ml	Percent of Blank
10%	A	3,810	77.7
	B	3,770	76.9
	C	3,820	77.9
50%	A	3,040	62.0
	B	3,150	64.2
	C	3,070	62.6
100%	A	2,140	43.6
	B	2,260	46.1
	C	2,210	45.1
		Skeletonema costatum[b]	
10%	A	335,000	94.4
	B	342,000	96.3
	C	336,000	94.6
50%	A	10,000	2.8
	B	11,000	3.1
	C	9,600	2.7
100%	A	2,000	0.6
	B	3,600	1.0
	C	3,500	1.0

Source: Pedneault Assoc., a December, 1977; b August, 1978.

TABLE F-14

SOLID PHASE BIOASSAY RESULTS

Mysidopsis bigelowi[a]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment Blank	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100

Mysidopsis bahia[b]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment Blank	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100

Source: Pedneault Assoc., [a]December, 1977, February, 1978; [b]August, 1978.

TABLE F-14 (Continued)

Nereis nereis[c]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	19	95
	5	20	20	100
		100	99	99
Dredged Material	1	20	20	100
	2	20	19	95
	3	20	20	100
	4	20	20	100
	5	20	19	95
		100	98	98

Nereis nereis[b]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment Blank	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	99

Source: Pedneault Assoc., [a]December, 1977; [c]February, 1978; [b]August, 1978.

TABLE F-14 (Continued)

Mercenaria mercenaria[a]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100

Mercenaria mercenaria[b]

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment Blank	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	100	100
Dredged Material	1	20	20	100
	2	20	19	95
	3	20	20	100
	4	20	20	100
	5	20	20	100
		100	99	99

Source: Pedneault Assoc., [a]December, 1977; [c]February, 1978; [b]August, 1978.

TABLE F-15

AQUARIA PARAMETERS MONITORED DURING LIQUID AND SUSPENDED PARTICULATE PHASES FOR *Menidia menidia*

Start (0) hrs.

		Salinity (^{o}/oo)		Temperature (^{o}C)		Dissolved Oxygen (mg/l)		pH	
		(L)	(SP)	(L)	(SP)	(L)	(SP)	(L)	(SP)
Blank	A	26.6	26.9	20	20	7.2	5.5	8.10	8.00
	B	26.0	27.6	20	20	7.0	5.7	8.05	7.80
	C	25.5	27.6	20	20	7.2	5.8	8.05	7.85
10%	A	26.3	26.9	20	20	7.3	5.1	8.15	7.90
	B	26.7	27.1	20	20	7.4	5.4	8.10	7.85
	C	26.5	26.9	20	20	7.4	5.3	8.15	7.80
50%	A	26.5	26.3	20.5	21	8.3	4.5	8.15	7.85
	B	26.5	26.2	20	21	7.9	4.8	8.15	7.80
	C	26.9	26.4	20	21	7.8	4.7	8.20	7.80
100%	A	27.1	25.4	21	21	6.1	4.1	8.25	7.70
	B	27.3	25.7	20.5	21	6.8	4.4	8.20	7.75
	C	26.7	25.8	21	21	6.9	4.5	8.25	7.75
End (96) hrs.									
Blank	A	25.8	27.4	20	20	5.2	5.0	8.10	7.90
	B	26.0	27.6	20	20	5.1	5.3	8.10	7.85
	C	25.5	27.6	20	20	5.4	5.4	8.10	7.90
10%	A	26.3	26.9	20	20	5.4	4.7	8.20	7.95
	B	26.7	27.1	20	20	5.6	4.9	8.15	7.90
	C	26.5	26.9	20	20	5.7	5.0	8.20	7.85
50%	A	26.5	26.3	20	20	6.6	4.1	8.25	7.90
	B	26.8	26.2	20	20	6.7	4.5	8.20	7.85
	C	26.9	26.4	20	20	6.3	4.4	8.20	7.85
100%	A	27.1	25.4	20	20	5.1	3.8	8.30	7.75
	B	27.3	25.7	20	20	4.9	4.1	8.30	7.80
	C	26.7	25.8	20	20	5.6	4.2	8.25	7.80

L = Liquid Phase
SP = Suspended Particulate Phase

Source: Pedneault Assoc., December, 1977.

TABLE F-15 (Continued)

Start (0) hrs.

		Salinity (^{o}/oo) (L)	(SP)	Temperature (^oC) (L)	(SP)	Dissolved Oxygen (mg/l) (L)	(SP)	pH (L)	(SP)
Blank	A	24.6	24.6	18.0	18.0	6.1	6.1	7.6	7.6
	B	24.6	24.7	18.0	18.0	6.2	6.2	7.7	7.7
	C	24.7	24.6	18.5	18.0	6.2	6.2	7.6	7.6
10%	A	22.3	22.3	18.0	18.0	6.9	6.1	8.3	8.2
	B	22.4	22.4	18.0	18.0	6.4	6.1	8.3	8.1
	C	22.6	22.4	18.0	18.0	6.5	6.0	8.4	8.1
50%	A	24.2	24.1	18.0	18.0	6.3	6.0	8.2	8.2
	B	23.9	22.2	18.5	18.5	6.2	6.2	8.1	8.3
	C	24.1	22.2	18.5	18.0	6.3	6.1	8.3	8.3
100%	A	24.9	25.7	18.0	18.0	6.2	6.1	8.2	8.3
	B	25.0	25.6	18.0	18.0	6.2	6.2	8.3	8.2
	C	24.9	25.7	18.0	18.0	6.1	6.1	8.3	8.3

End (96) hrs.

		Salinity (^{o}/oo) (L)	(SP)	Temperature (^oC) (L)	(SP)	Dissolved Oxygen (mg/l) (L)	(SP)	pH (L)	(SP)
Blank	A	24.6	24.6	18.0	18.5	4.8	4.8	7.7	7.6
	B	24.6	24.7	18.0	18.0	4.9	5.0	7.6	7.7
	C	24.7	24.6	18.0	18.0	4.9	5.1	7.7	7.7
10%	A	22.3	22.3	18.5	18.5	6.5	5.2	8.3	8.2
	B	22.4	22.4	18.5	18.0	6.3	5.5	8.2	8.3
	C	24.1	24.2	18.0	18.0	4.3	4.0	8.2	8.1
50%	A	24.2	24.1	18.0	18.0	4.4	4.0	8.3	8.2
	B	23.9	24.2	18.0	18.0	4.2	4.2	8.2	8.3
	C	22.6	22.4	18.5	18.5	6.3	5.1	8.2	8.3
100%	A	24.9	25.7	18.0	18.5	4.0	3.1	8.4	8.3
	B	25.0	25.6	18.5	18.0	3.9	3.3	8.3	8.2
	C	24.9	25.7	18.0	18.5	3.7	3.4	8.3	8.3

L = Liquid Phase
SP = Suspended Particulate Phase

Source: Pedneault Assoc., August, 1978.

TABLE F-16

AQUARIA PARAMETERS MONITORED DURING LIQUID AND SUSPENDED PARTICULATE PHASES FOR *Mysidopsis bigelowi*

Start (0) hrs.

		Salinity ($^{o}/oo$)		Temperature (^{o}C)		Dissolved Oxygen (mg/l)		pH	
		(L)	(SP)	(L)	(SP)	(L)	(SP)	(L)	(SP)
Blank	A	26.6	26.9	20	20	7.2	5.5	8.10	8.00
	B	27.1	27.4	20	20	7.0	5.7	8.10	8.00
	C	26.8	27.1	20	20	7.1	5.4	8.10	7.95
10%	A	26.8	26.9	20.5	20.5	8.0	5.0	8.15	7.95
	B	26.4	26.9	20.5	20.5	7.6	5.1	8.20	7.95
	C	26.9	27.0	20.5	20	7.5	5.1	8.15	7.95
50%	A	27.2	26.7	20.5	20.5	7.4	4.6	8.20	7.90
	B	27.0	26.8	20.5	20.5	7.5	4.7	8.20	7.95
	C	27.3	26.5	20.5	20.5	7.4	4.5	8.20	7.90
100%	A	27.5	26.1	21	21	7.3	4.5	8.25	7.85
	B	27.4	26.0	20.5	20.5	7.3	4.6	8.20	7.90
	C	27.5	26.2	21	21	7.5	4.4	8.25	7.90

End (96) hrs.

		Salinity ($^{o}/oo$) (L)	Salinity (SP)	Temperature (L)	Temperature (SP)	Dissolved Oxygen (L)	Dissolved Oxygen (SP)	pH (L)	pH (SP)
Blank	A	26.6	26.9	20	20	7.1	5.3	8.10	8.05
	B	27.1	27.4	20	20	6.8	5.5	8.15	8.05
	C	26.8	27.1	20	20	6.9	5.3	8.10	8.00
10%	A	26.8	26.9	20	20	7.6	5.0	8.15	8.00
	B	26.4	26.9	20	20	7.2	5.0	8.20	8.00
	C	26.9	27.0	20	20	7.1	4.9	8.15	7.95
50%	A	27.2	26.7	20	20	7.0	4.2	8.15	7.95
	B	27.0	26.8	20	20	6.9	4.3	8.20	8.00
	C	27.3	26.5	20	20	6.9	4.2	8.20	8.00
100%	A	27.5	26.1	20	20	6.8	4.1	8.25	7.95
	B	27.4	26.0	20	20	6.7	4.2	8.30	7.90
	C	27.5	26.2	20	20	6.9	4.0	8.25	7.90

L = Liquid Phase
SP = Suspended Particulate Phase

Source: Pedneault Assoc., December, 1977.

TABLE F-16 (Continued)

Start (0) hrs.

		Salinity (^{o}/oo) (L)	Salinity (^{o}/oo) (SP)	Temperature (^{o}C) (L)	Temperature (^{o}C) (SP)	Dissolved Oxygen (mg/l) (L)	Dissolved Oxygen (mg/l) (SP)	pH (L)	pH (SP)
Blank	A	24.6	24.6	18.0	18.0	6.1	6.1	7.6	7.6
	B	24.6	24.7	18.0	18.0	6.2	6.2	7.7	7.7
	C	24.7	24.6	18.5	18.0	6.2	6.2	7.6	7.6
10%	A	22.3	22.3	18.0	18.0	6.9	6.1	8.3	8.2
	B	22.4	22.4	18.0	18.0	6.4	6.1	8.3	8.1
	C	22.6	22.4	18.0	18.0	6.5	6.0	8.4	8.1
50%	A	24.2	24.1	18.0	18.0	6.3	6.0	8.2	8.2
	B	23.9	22.4	18.5	18.5	6.2	6.2	8.1	8.3
	C	24.1	24.2	18.5	18.0	6.3	6.1	8.3	8.3
100%	A	24.9	25.7	18.0	18.0	6.2	6.1	8.2	8.3
	B	24.9	25.6	18.0	18.0	6.2	6.2	8.3	8.2
	C	25.0	25.7	18.0	18.0	6.1	6.1	8.3	8.3

End (96) hrs.

		Salinity (^{o}/oo) (L)	Salinity (^{o}/oo) (SP)	Temperature (^{o}C) (L)	Temperature (^{o}C) (SP)	Dissolved Oxygen (mg/l) (L)	Dissolved Oxygen (mg/l) (SP)	pH (L)	pH (SP)
Blank	A	24.6	24.6	18.0	18.5	4.8	4.8	7.7	7.6
	B	24.6	24.7	18.0	18.0	4.9	5.0	7.6	7.7
	C	24.7	24.6	18.0	18.0	4.9	5.1	7.7	7.7
10%	A	22.3	22.3	18.5	18.5	6.5	5.2	8.3	8.2
	B	22.4	22.4	18.5	18.0	6.3	5.5	8.2	8.3
	C	22.6	22.4	18.5	18.5	6.3	5.1	8.2	8.3
50%	A	24.2	24.1	18.0	18.0	4.4	4.0	8.3	8.2
	B	23.9	24.2	18.0	18.0	4.2	4.2	8.2	8.3
	C	24.1	24.2	18.5	18.0	4.3	4.0	8.2	8.1
100%	A	24.9	25.7	18.0	18.5	4.0	3.1	8.4	8.3
	B	24.9	25.6	18.5	18.0	3.9	3.3	8.3	8.2
	C	25.0	25.7	18.0	18.5	3.7	3.4	8.3	8.3

L = Liquid Phase
SP = Suspended Particulate Phase

Source: Pedneault Assoc., August, 1978.

TABLE E-17

RESULTS OF WATER CHEMISTRY OF DISPOSAL SITE WATER

Disposal Site Sea Water

Total Organic Carbon	0.05 mg/l
Volitile Solids	26,470 mg/l
Oil & Grease	2.8 mg/l
Total Phosphate	< 0.02 mg/l
Ortho Phosphate	< 0.02 mg/l
Phenols	< 0.002 mg/l
Nitrates	0.13 mg/l
Nitrites	0.038 mg/l
Ammonia	0.030 mg/l
Organic Nitrogen	< 0.002 mg/l
COD	2,612 mg/l
Mercury	< 0.001 mg/l
Lead	0.0065 mg/l
Zinc	0.0204 mg/l
Copper	0.006 mg/l
Chromium	0.0016 mg/l
Cadimum	0.0013 mg/l
Sulfide	< 0.01 mg/l
Cyanide	0.045 mg/l
Fluoride	1.04 mg/l
DDT	< 0.1 µg/l
PCB	< 0.1 µg/l

Source: Pedneault Assoc., December, 1977.

C.3 Biological Results

The results of field sampling with benthic grabs, littoral scrape and biological dredge tows are presented and discussed in Chapter II.C.

C.4 Current Meter Data

A complete listing of the current velocity and direction for both meters is contained in Table F-18. A progressive vector current plot is presented and discussed in Chapter II, Section C.4.

TABLE F-18

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: THUR, 27 OCT 1977

TIME	STATION Ø1 SPEED	STATION Ø1 DIR	STATION Ø2 SPEED	STATION Ø2 DIR
123Ø	Ø.ØØ	97	Ø.ØØ	94
13ØØ	Ø.35	77	Ø.69	95
133Ø	Ø.3Ø	33	Ø.64	89
14ØØ	Ø.53	9	Ø.44	84
143Ø	Ø.58	7	Ø.49	85
15ØØ	Ø.56	6	Ø.34	119
153Ø	Ø.68	7	Ø.22	178
16ØØ	Ø.68	7	Ø.3Ø	237
163Ø	Ø.7Ø	6	Ø.62	274
17ØØ	Ø.65	4	Ø.88	269
173Ø	Ø.46	5	Ø.93	264
18ØØ	Ø.42	67	Ø.89	257
183Ø	Ø.11	133	Ø.89	275
19ØØ	Ø.33	182	Ø.77	313
193Ø	Ø.35	198	Ø.61	313
2ØØØ	Ø.54	191	Ø.39	294
2Ø3Ø	Ø.54	179	Ø.19	249
21ØØ	Ø.63	175	Ø.24	22Ø
213Ø	Ø.67	17Ø	Ø.22	211
22ØØ	Ø.7Ø	164	Ø.Ø7	183
223Ø	Ø.58	149	Ø.3Ø	115
23ØØ	Ø.63	144	Ø.52	9Ø
233Ø	Ø.54	137	Ø.77	65

JULIAN DATE: 3Ø1 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: FRI. 28 OCT 1977

TIME	STATION Ø1 SPEED	STATION Ø1 DIR	STATION Ø2 SPEED	STATION Ø2 DIR
Ø	Ø.4Ø	115	Ø.69	66
3Ø	Ø.46	119	Ø.64	73
1ØØ	Ø.32	118	Ø.71	77
13Ø	Ø.25	11Ø	Ø.51	78
2ØØ	Ø.35	11	Ø.4Ø	1Ø3
23Ø	Ø.39	12	Ø.32	1Ø6
3ØØ	Ø.46	1Ø	Ø.27	115
33Ø	Ø.67	7	Ø.22	17Ø
4ØØ	Ø.32	336	Ø.34	255
43Ø	Ø.4Ø	334	Ø.62	278
5ØØ	Ø.42	339	Ø.99	279
53Ø	Ø.49	329	1.13	271
6ØØ	Ø.37	324	Ø.96	274
63Ø	Ø.26	241	Ø.76	297
7ØØ	Ø.33	242	Ø.66	3Ø2
73Ø	Ø.33	225	Ø.56	3Ø4
8ØØ	Ø.44	2Ø1	Ø.4Ø	3ØØ
83Ø	Ø.68	179	Ø.25	239
9ØØ	Ø.77	162	Ø.37	223
93Ø	Ø.84	165	Ø.27	145
1ØØØ	1.14	163	Ø.1Ø	95
1Ø3Ø	Ø.72	156	Ø.44	73
11ØØ	Ø.72	137	Ø.57	63
113Ø	Ø.58	144	Ø.71	58

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

12ØØ	Ø.56	134	Ø.96	64
123Ø	Ø.54	138	1.Ø6	81
13ØØ	Ø.51	126	Ø.83	85
133Ø	Ø.16	82	Ø.72	97
14ØØ	Ø.47	2Ø	Ø.66	1Ø1
143Ø	Ø.72	6	Ø.57	83
15ØØ	Ø.74	12	Ø.49	69
153Ø	Ø.7Ø	15	Ø.61	1Ø3
16ØØ	Ø.98	9	Ø.34	141
163Ø	Ø.75	11	Ø.3Ø	217
17ØØ	Ø.74	9	Ø.51	23Ø
173Ø	Ø.79	6	Ø.86	246
18ØØ	Ø.79	11	Ø.84	26Ø
183Ø	Ø.42	1Ø	Ø.77	269
19ØØ	Ø.23	194	Ø.54	266
193Ø	Ø.28	197	Ø.66	291
2ØØØ	Ø.51	217	Ø.57	31Ø
2Ø3Ø	Ø.44	2Ø7	Ø.44	339
21ØØ	Ø.6Ø	17Ø	Ø.27	342
213Ø	Ø.65	164	Ø.4Ø	16
22ØØ	Ø.79	171	Ø.29	27
223Ø	Ø.72	171	Ø.42	47
23ØØ	Ø.46	157	Ø.59	58
233Ø	Ø.54	143	Ø.72	7Ø

JULIAN DATE: 3Ø5 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: SAT, 29 OCT 1977

TIME	STATION Ø1 SPEED	STATION Ø1 DIR	STATION Ø2 SPEED	STATION Ø2 DIR
Ø	Ø,67	119	Ø,81	69
3Ø	Ø,61	14Ø	Ø,76	53
1ØØ	Ø,49	113	Ø,93	81
13Ø	Ø,58	112	Ø,81	82
2ØØ	Ø,42	9Ø	Ø,83	96
23Ø	Ø,44	81	Ø,64	98
3ØØ	Ø,44	54	Ø,66	1Ø3
33Ø	Ø,53	46	Ø,52	1Ø9
4ØØ	Ø,56	43	Ø,42	137
43Ø	Ø,7Ø	59	Ø,19	199
5ØØ	Ø,58	64	Ø,49	238
53Ø	Ø,67	35	Ø,81	252
6ØØ	Ø,3Ø	33	Ø,79	252
63Ø	Ø,33	1Ø	Ø,89	257
7ØØ	Ø,ØØ	27Ø	Ø,66	276
73Ø	Ø,23	25Ø	Ø,64	313
8ØØ	Ø,26	238	Ø,49	29Ø
83Ø	Ø,58	196	Ø,25	261
9ØØ	Ø,53	19Ø	Ø,34	243
93Ø	1,Ø5	169	Ø,29	228
1ØØØ	Ø,86	159	Ø,19	215
1Ø3Ø	1,Ø9	143	Ø,2Ø	116
11ØØ	1,12	151	Ø,37	1Ø6
113Ø	1,Ø9	151	Ø,52	111

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

1200	0.96	152	0.71	86
1230	0.75	141	0.74	76
1300	0.68	129	0.94	79
1330	0.58	115	0.81	100
1400	0.68	97	0.86	86
1430	0.60	89	0.83	95
1500	0.58	82	0.66	93
1530	0.46	66	0.72	94
1600	0.46	53	0.44	106
1630	0.47	58	0.25	124
1700	0.53	68	0.27	185
1730	0.51	61	0.30	225
1800	0.58	30	0.37	246
1830	0.37	20	0.44	252
1900	0.21	29	0.47	240
1930	0.18	24	0.52	266
2000	0.02	31	0.49	275
2030	0.18	169	0.54	284
2100	0.63	174	0.51	295
2130	0.82	174	0.62	321
2200	1.00	177	0.40	336
2230	0.93	182	0.35	332
2300	1.05	176	0.25	27
2330	0.96	175	0.59	48

JULIAN DATE: 304 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: SUN, 30 OCT 1977

	STATION 01		STATION 02	
TIME	SPEED	DIR	SPEED	DIR
0	0.93	162	0.52	70
30	0.72	137	0.84	70
100	0.68	128	0.76	87
130	0.65	94	0.91	77
200	0.63	97	0.61	86
230	0.54	108	0.72	90
300	0.51	125	0.74	89
330	0.33	87	0.71	87
400	0.37	47	0.59	97
430	0.54	42	0.40	112
500	0.56	43	0.20	141
530	0.63	54	0.30	223
600	0.61	57	0.59	258
630	0.53	40	0.77	257
700	0.30	16	0.74	263
730	0.14	24	0.69	261
800	0.12	160	0.72	275
830	0.33	187	0.57	321
900	0.26	179	0.45	321
930	0.49	169	0.27	269
1000	0.53	168	0.24	248
1030	0.72	175	0.40	247
1100	0.63	164	0.35	250
1130	0.67	161	0.19	278

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

1200	0.68	150	0.37	46
1230	0.68	139	0.54	62
1300	0.56	143	0.69	80
1330	0.51	129	0.93	81
1400	0.44	116	0.89	84
1430	0.58	94	0.81	82
1500	0.32	84	0.81	89
1530	0.30	84	0.83	99
1600	0.33	77	0.61	100
1630	0.26	48	0.56	114
1700	0.33	27	0.45	122
1730	0.42	11	0.25	163
1800	0.53	14	0.39	217
1830	0.47	20	0.59	257
1900	0.49	26	0.56	250
1930	0.47	28	0.72	267
2000	0.26	28	0.45	261
2030	0.21	71	0.67	286
2100	0.09	143	0.51	307
2130	0.23	144	0.74	321
2200	0.33	148	0.62	321
2230	0.37	162	0.62	346
2300	0.56	160	0.27	327
2330	0.56	161	0.24	288

JULIAN DATE: 303 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: MON. 31 OCT 1977

	STATION Ø1		STATION Ø2	
TIME	SPEED	DIR	SPEED	DIR
Ø	Ø.49	175	Ø.32	243
3Ø	Ø.7Ø	172	Ø.15	228
1ØØ	Ø.56	158	Ø.15	154
13Ø	Ø.61	144	Ø.47	77
2ØØ	Ø.65	138	Ø.45	69
23Ø	Ø.7Ø	123	Ø.86	62
3ØØ	Ø.42	1Ø8	Ø.84	86
33Ø	Ø.65	89	Ø.98	94
4ØØ	Ø.51	85	Ø.72	96
43Ø	Ø.28	76	Ø.52	114
5ØØ	Ø.33	79	Ø.24	135
53Ø	Ø.25	6Ø	Ø.27	188
6ØØ	Ø.32	44	Ø.29	226
63Ø	Ø.44	47	Ø.54	246
7ØØ	Ø.51	51	Ø.72	248
73Ø	Ø.4Ø	38	Ø.72	252
8ØØ	Ø.12	24	Ø.67	27Ø
83Ø	Ø.Ø9	189	Ø.72	269
9ØØ	Ø.16	196	Ø.44	284
93Ø	Ø.3Ø	194	Ø.42	321
1ØØØ	Ø.32	177	Ø.49	31Ø
1Ø3Ø	Ø.33	177	Ø.29	6Ø
11ØØ	Ø.56	154	Ø.Ø8	149
113Ø	Ø.72	145	Ø.17	156

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

1200	0,82	151	0,25	91
1230	0,96	144	0,44	56
1300	0,84	136	0,64	75
1330	0,68	124	0,86	75
1400	1,05	107	0,81	94
1430	0,58	102	1,01	89
1500	0,49	116	0,69	88
1530	0,60	110	0,83	93
1600	0,42	99	0,67	87
1630	0,37	90	0,71	91
1700	0,42	65	0,57	94
1730	0,42	53	0,44	114
1800	0,49	46	0,40	135
1830	0,40	37	0,15	224
1900	0,37	33	0,29	239
1930	0,30	32	0,51	247
2000	0,18	42	0,42	239
2030	0,16	104	0,54	245
2100	0,11	134	0,49	252
2130	0,21	163	0,30	261
2200	0,23	153	0,32	248
2230	0,33	175	0,34	279
2300	0,40	165	0,25	285
2330	0,42	168	0,10	303

JULIAN DATE: 302 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

TABLE F-18 (Continued)

RARITAN BAY CURRENT STUDY

PREPARED FOR DAMES & MOORE BY ENDECO

DATA DATE: TUES, 1 NOV 1977

TIME	STATION 01 SPEED	STATION 01 DIR	STATION 02 SPEED	STATION 02 DIR
0	0,58	166	0,12	62
30	0,61	169	0,12	76
100	0,72	172	0,17	90
130	0,68	165	0,40	96
200	0,44	164	0,47	84
230	0,35	132	0,56	83
300	0,39	107	0,57	77
330	0,39	105	0,64	88
400	0,37	110	0,47	93
430	0,40	105	0,49	98
500	0,39	103	0,35	111
530	0,40	94	0,29	129
600	0,35	72	0,13	161
630	0,37	47	0,22	212
700	0,28	43	0,34	245
730	0,19	23	0,44	250
800	0,04	289	0,61	247
830	0,11	186	0,54	252
900	0,23	186	0,62	264
930	0,39	200	0,61	269
1000	0,47	195	0,44	291
1030	0,47	179	0,56	331
1100	0,39	160	0,45	4
1130	0,60	149	0,10	73
1200	0,77	149	0,24	134
1230	0,74	151	0,29	94
1300	0,51	144	0,40	89

JULIAN DATE: 300 TIME: EDT SPEEDS IN FT/S DIRS ARE TRUE

REFERENCES

American Public Health Association, 1971. Standard Methods for the Examination of Waste and Wastewater.

Folk, R.L., 1968. Petrology and Sedimentary Rock, Hemphills, Austin, Texas, 169 p.

Folk, R.D., D. Gruber, and R. Wullschleger, 1975. Laboratory study of the release of pesticides and PCB materials to the water column during dredging and disposal operations. Dredged Material Research Program, Contract rep. D-75-6, U.S. Army Engineer Waterways Experimental Station, Vicksburg, Miss.

Pedneault Associates, December 1977. Report to Dames & Moore on Chemical, Bacteriologic and Bioassay analysis NWS Earle Dredge Project.

Pedneault Associates, February 1978. Report to Dames & Moore - Bioassay Re-test Solid Phase, *Nereis nereis*; NWS Earle Dredge Project.

Pedneault Associates, August 1978. Report to Dames & Moore - Chemical and Bioassay Analysis NWS Earle Dredge Project.

APPENDIX G

ESTUARINE SPECIES OF POTENTIAL OCCURRENCE IN SANDY HOOK BAY

G-1 PHYTOPLANKTON

Bacillariophyceae

Melosira varians Agarph[1]
M. borreri Greville[2]
Coscinodiscus excentricus Ehrenberg
Coscinodiscus radiatus Ehrenberg
Coscinodiscus concinnus W. Smith
Coscinodiscus centralis Ehrenberg
Coscinodiscus gigas Ehrenberg
Coscinodiscus sp.
Thalassiosira nordenskioldi Cleve
Thalassiosira gravida Cleve
Thalassiosira hyalina (Grun.)
Thalassiosira rotula Muenier
Thalassiosira sp.
Coscinosira polychorda Gran
Skeletonema costatum (Grev.) Cleve
Rhizosolenia alata Brightwell
Rhizosolenia fragilissima Bergon
Rhizosolenia setigera Brightwell
Rhizosolenia hebetata f. *semispina* (Hensen) Gran
Leptocylindrus danicus Cleve
Chaetoceros atlanticus Cleve
Chaetoceros danicus Cleve
Chaetoceros borealis Baily
Chaetoceros decipiens Cleve
Chaetoceros compressus Lauder
Chaetoceros didymus Ehrenberg

Bacillariophyceae (Continued)

Chaetoceros constrictus Gran

Chaetoceros affinis Lauder

Chaetoceros affinis v. Willei (Gran) Hustedt

Chaetoceros subsecundes (Gran) Hustedt

Chaetoceros holsaticus Schutt

Chaetoceros debilis Cleve

Chaetoceros sp.

Biddulphia granulata Roper

Triceratium favus Ehrenberg

Cerataulina bergonii Peragallo

Lithodesmium undulatum Ehrenberg

Eucampia zoodiacus Ehrenberg

Fragilaria crotonensis Kitton[1]

Fragilaria spp.

Asterionella japonica Cleve

Asterionella bleakerleyi Smith[2]

Synedra affinis v. faciculata (Kutzing) Gunow[2]

Thalassiothrix longissima Cleve and Grunow

Licomophora abbreviata Agardh

Achnanthes longpipes Agardh

Cocconeis scutellum Ehrenberg

Cocconeis spp.

Rhoicosphenia curvata (Kutzing) Grunow

Navicula cancellata Donk[2]

Navicula radiosa Kutzing

Navicula elegans W. Smith

Navicula spp.

Diploneis splendida (Greg.) Cleve

Pennularia spp.

Gyrosigma accuminatus (Kutzing) Rabenhorst[1/2]

Gyrosigma spp.

Bacillariophyceae (Continued)

Pleurosigma fasciola Ehrenberg

Pleurosigma spp.

Donkinia spp.

Amphora ovaris Kutzing[1]

Amphora lineolata Ehrenberg[1/2]

Cymbella spp.

Nitzschia seriata Cleve

Nitzschia lanceolata W. Smith[1/2]

Nitzschia closterium W. Smith

Nitzschia paradoxa (Gmelin) Grunow

Nitzschia spp.

Cymatopleura solea (Breb.) W. Smith[1]

Cymatopleura elliptica (Breb.) W. Smith[1]

Campylodiscus undulatus Greville

Cyanophyceae

Gomphosphaeria lucstris Chodat[1]

Agmenellum quadruplicatum (Menegh.) Brebsson[1]

Pandorina morum (O.F. Muller) Bory[1]

Scenedesmus armatus Chodat[1]

Ulothrix spp.[1]

Spirogyra spp.[1]

Closterium leileinni Kutzing[1]

Euglenophyta

Euglenoids[1/2]

Dinophyceae

Exuviella compressa (Stein) Ostenfeld

Exuviella spp.

Prorocentrum micans Ehrenberg

Amphidinium fusiforme Martin (?)

Gymnodinium rhombiodes Schutt

Nematodinium armatum (Dogiel) Kofoid and Swezy

Dinophysis acuta Ehrenberg

Dinophysis ovum Schutt

Glenodinium danicum Paulsen

Goniaulax spinifera (Clap. and Lachum.) Diessing

Goniaulax spp.

Peridiniopsis rotundata Lebour

Peridinium pellucidum (Bergh) Schutt

Peridinium cerasus Paulsen

Peridinium conicoides Paulsen

Peridinium trochoideum (Stein) Lemmermann

Peridinium elgans Cleve

Peridinium brevipes Paulsen

Ceratium bucephalum (Cleve) Cleve

Ceratium furca (Ehrenberg) Claparede and Lachmann

Ceratium fusus (Ehrenberg) Dujardin

Ceratium minutum Jorgensen

Ceratium tripos (O.F. Muller) Nitzsch

Ceratium macroseros (Ehrenberg) Van Heurck

NOTE:

[1]Freshwater species.

[2]Brackish-Water Species

SOURCE: Kawamura, T., 1966. Distribution of Phytoplankton Populations in Sandy Hook Bay and Adjacent Areas in Relation to Hydrographic Conditions in June 1962. Bureau of Sport Fisheries and Wildlife, Technical Paper 1, Washington, D.C.

APPENDIX G-2

ZOOPLANKTON

Protozoa

Tintinnopsis aperta
Tintinnopsis kofoidii
Tintinnopsis lindeni
Tintinnopsis musicola
Tintinnopsis sp.
Tintinnopsis tubulosa
Helicostomella fusiformis
Favella ehrenbergi
Ptychocylis obtusa
Rhabdonella sp.
Tintinnus rectus
Tintinnus turris
Lionotus fasciola
Loxophyllum rostratum
Dipleptus sp.
Acineta tuberosa

Coexentexata

Diparena strangulata
Phialacium longuida
Obelia sp.
Boceroides sp.

Aschelminuthes

Synchaeta littoralis

Chaetognatha

Sagitta elegans
Sagitta minima

Arthropoda

Euadne nordmanni
Euadne tergestina
. odon polyphenoides
Podon lenckarti
Calanus finmarchicus
Calanus minor
Paracalanus crassipostris

Arthropoda (Continued)

<u>Pseudocalanus</u> <u>minutus</u>
<u>Pseudodiaptomus</u> <u>coronatus</u>
<u>Centropages</u> <u>bradyl</u>
<u>Centropages</u> <u>hamatus</u>
<u>Centropages</u> <u>typicus</u>
<u>Labidoceia</u> <u>activa</u>
<u>Acartia</u> <u>tonsa</u>
<u>Acartia</u> <u>clausi</u>
<u>Temora</u> <u>longicornis</u>
<u>Temora</u> <u>turbinata</u>
<u>Eurytemora</u> <u>americana</u>
<u>Eurytemora</u> <u>affinis</u>
<u>Tortanus</u> <u>discaudata</u>
<u>Oithona</u> <u>similis</u>
<u>Oithona</u> <u>simplex</u>
<u>Oithona</u> <u>plumifera</u>
<u>Microsetella</u> <u>norvegica</u>
<u>Microsetella</u> <u>rosea</u>
<u>Evansula</u> <u>incerta</u>
<u>Harpacticus</u> spp.

Prochordata

<u>Oikopleura</u> <u>disica</u>
<u>Oikopleura</u> <u>longicauda</u>
<u>Oikopleura</u> sp.

SOURCE: Yamazi, I., 1966, Zooplankton Communities of the Navesink and Shrewsbury Rivers and Sandy Hook Bay, New Jersey, U.S. Bur. Sport Fish & Wildlife, Tech. Paper No. 2, pp 1-44.

APPENDIX G -3

BENTHOS

Porifera:

Cliona sp.
Microciona prolifera
unidentified sp.

Cnidaria (Coelenterata):

Hydrozoa:
Hydractinia echinata
Tubularia sp.
unidentified sp.

Anthozoa:
Certanthus sp.
Haliplanella luciae
Metridium senile
unidentified sp.

Platyhelminthes:

Tuberellaria:
unidentified sp.

Nemertea (Rhynchocoela):
Unidentified sp.

Annelida:

Oligochaeta:
unidentified sp.

Polychaeta:
Polynoidae:
Harmothoe extenuata
Harmothoe imbricata
Lepidonotus squamatus
Lepidonotus sublevis

Phyllodociadae:
Eteone heteropoda
Eteane lactea
Eteane sanguinea
Eulalia viridis

Eumida sanguinea
Paranaitis speciosa
Phyllodoce groenlandica

Hesionidae:
Podarke obscura

Syllidae:
Exogone dispar
Antolytus cornutus

Nereidae:
Nereis arenaceodentata
Nereis succinea
Nereis virens
Nereis pelagica

Nephtyidae:
Nephtys bucera
Nephtys incisa
Nephtys picta

Glyceridae:
Glycera americana
Clycera dibranchiata

Onuphidae:
Diopatra cuprea

Lumbrineridae:
Lumbrineris tenuis

Arabellidae:
Drilonereis longa

Orbiniidae:
Scolopolos fragilis
Scoloplos armiger

Spionidae:
Polydora lingni
Spio setosa
Spio filicornis
Spiophanes bambyx
Streblospio benedicti
Scolelepis squamata
Scolelepides viridis

Chaetopteridae:
Spiochaetopterus oculatus

Cirratulidae:
Dodecaceria coralii
Tharyx sp.

Flabelligeridae:
Pherusa affinis

Capitellidae:
Heteromastus filiformis
Capitellid A
Capitellid B

Sabellariidae:
Sabellaria vulgaris

Pectinariidae:
Pectinaria gouldii
Pectinaria hyperborea
Pectinaria sp.

Ampharetidae:
Asabellides oculata

Terebellidae:
Polycirrus eximius

Sabellidae:
Sabella microphthalma

Serpulidae:
Hydroides dianthus
Protula tubularia
unidentified sp.

Mollusca:

Gastropoda:

Prosobrachia:
Littorina littorea
Crepidula fornicata
Crepidula plana
Lunatia heros
Polinices duplicatus
Urosalpinx cinerea
Eupleura caudata

Prosobranchia (Continued)

Busycon canaliculatum
Busycon carica
Nassarius obsoletus
Nassarius tribittatus
Retusa canaliculata
Retusa obtusa
Pyramidella fusca
Odostomia trifida
Odostomia sp.
Mitrella lunata

Opisthobranchia:
Adalaria proxima
Doridella obscura

Bivalvia:

Protobranchia:
Nucula proxima
Yoldia limatula

Lamellibranchis:
Modiolus demissus
Mytilus edulis
Anonia simplex
Crassostrea virginica
Mercenaria mercenaria
Gemma gemma
Petricola pholadiformis
Tellina agilis
Macoma balthica
Ensis directus
Spisula solidissima
Mulinia lateralis
Mya arenaria
Astarte borealis

Arthropoda:

Crustacea:

Cirripedia:
Balanus crenatus
Balanus eburneus
Balanus improvisus

Isopoda:

<u>Cyathura</u> <u>polita</u>
<u>Edotea</u> <u>triloba</u>
<u>Edotea</u> <u>montosa</u>

Amphipoda:

Ampeliscidae:

<u>Ampelisca</u> sp.

Haustoriidae:

<u>Haustorius</u> sp.

Phoxocephalidae:

<u>Paraphoxus</u> <u>spinosus</u>
<u>Paraphoxus</u> <u>epistomus</u>

Stenothoidae:

<u>Stenothoe</u> <u>cypris</u>
<u>Stenothoe</u> <u>minuta</u>
<u>Stenothoe</u> sp.

Gammaridae:

<u>Carinogammarus</u> <u>mucronatus</u>
<u>Elasmopus</u> <u>laevis</u>

Corophiidae:

<u>Corophium</u> sp.
<u>Unciola</u> <u>serrata</u>

Ischyroceridae:

<u>Jassa</u> <u>marmorata</u>
<u>Jassa</u> <u>falceta</u>

Aoridae:

<u>Microdentopus</u> <u>gryllotalpa</u>

Unidentified sp.

Decapoda:

Carridea:

<u>Crangon</u> <u>septemspinosus</u>

Brachyura:

<u>Callinectes</u> <u>sapidus</u>
<u>Cancer</u> <u>irroratus</u>
<u>Carcinus</u> <u>maenas</u>
<u>Eurypanopeus</u> <u>depressus</u>
<u>Hexapanopeus</u> <u>angustifrons</u>

Brachyura (Continued)

Neopanope texana sayi
Panopeus herbsti
Rhithropanopeus harrissi
Libinia sp.
Ovalipis ocellatus

Anomura:
Pagurus longicarpus
Parurus pollicarus

Merostomata:
Limulus polyphemus

Ectoprocta:

Ctenostomata:
Alcyonidium polyoum
Amathia vidovici
Bowerbankia gracilis

Cheilostomata:
Bugula sp.
Canopeum reticulum
Electra hastingsae
Membranipora tenuis
Cryptosula pallasiana
Schizoporella unicornis

unidentified sp.

Echinodermata:

Asteroidea:
Asterias forbesi

Echinoidea:
Arbacia punctualata

Chordata:

Urochordata:
Molgula manhattensis

Tunicate:
Ascidiacea

Source: Dean, D. 1975, Raritan Bay Macrobenthos Survey, 1957-1960. NMFS Data Report 99.

McGrath, R.A., 1974. Benthic Macrofaunal Census of Raritan Bay: Preliminary results: Benthos of Raritan Bay. Paper NO24j Proceeding 3rd Symposium Hudson River Ecology, March 22-23, 1973.

U.S. Army Corps of Engineers, New York District, 1976a. Draft Environmental Statement: Staten Island, Fort Wadsworth to Arthur Kill Beach, Erosion Control and Hurricane Project, Richmond County, New York.

APPENDIX G-4

FISH

Common Name	Scientific Name	Occurrence*
Sand tiger	Odontaspis taurus	C
Sandbar sharks	Carcharhinus milberti	C
Smooth dogfish	Mustelus canis	C
Smooth hammerhead	Sphyrna zygaena	R
Spiny dogfish	Squalus acanthias	C
Clearnose skate	Raja eglanteria	C
Little skate	Raja erinacea	C
Barndoor skate	Raja laevis	C
Roughtail stingray	Dasyatis centroura	C
Smooth butterfly ray	Gymnura micrura	R
Bullnose ray	Myliobatis freminvillei	R
Cownnose ray	Rhinoptera bonasus	C
Shortnose sturgeon	Acipenser brevirostrum	C
Atlantic sturgeon	Acipenser oxyrhynchus	C
Ladyfish	Elops saurus	R
Tarpon	Megalops atlantica	R
American eel	Anguilla rostrata	A
Hickory shad	Alosa mediocris	C
Blueback herring	Alosa aestivalis	C
Alewife	Alosa pseudoharengus	C
American shad	Alosa sapidissima	C
Atlantic menhaden	Brevortia tyrannus	A
Atlantic herring	Clupes harengus harengus	R
Gizzard shad	Dorosoma cepedianum	R
Atlantic round herring	Etrumeus teres	R
Atlantic thread herring	Opisthonema oglinum	R
Striped anchovy	Anchoa hepsetus	A
Bay anchovy	Anchoa mitchilli	C
Rainbow trout	Salmo gairdneri	R
Brown trout	Salmo trutta	R
Inshore lizardfish	Synodus foetens	R
Oyster toadfish	Opsanus tau	C
Goosefish	Lophius americanus	C
Atlantic cod	Gadus morhua	R
Silver hake	Merluccius bilinearis	R
Atlantic tomcod	Microgadus tomcod	R
Red hake	Urophycis chuss	C
Spotted hake	Urophycis regius	C
Striped cusk-eel	Rissola marginata	R
Halfbeak	Hyporhamphus unifasciatus	C
Atlantic needlefish	Strongylura marina	C
Sheepshead minnow	Cyprinodon variegatus	C

Common Name	Scientific Name	Occurrence*
Mumichog	Fundulus heteroclitus	A
Striped killifish	Fundulus majalis	C
Rainwater killifish	Lucania parva	C
Atlantic silverside	Menidia menidia	A
Rough silverside	Membras martinica	C
Threespine stickleback	Gasterosteus aculeatus	C
Fourspine stickleback	Apeltes quadracus	R
Lined seahorse	Hippocampus erectus	R
Northern pipefish	Syngnathus fuscus	C
White perch	Morone americanus	C
Striped bass	Morone saxatilis	C
Black sea bass	Centropristes striata	C
Bluefish	Pomatomus saltatrix	A
Cobia	Rachycentron canadum	R
Sharksucker	Echeneis naucrates	R
African pompano	Alectis crinitus	R
Blue runner	Caranx crysos	C
Crevalle jack	Caranx hippos	C
Atlantic bumper	Chloroscombrus chrysurus	R
Bigeye scad	Selar crumenophthalmus	R
Lookdown	Selene vomer	R
Banded rudderfish	Seriola zonata	R
Florida pompany	Trachinotus carolinus	R
Permit	Trachinotus falcatus	R
Atlantic moonfish	Vomer setapinnis	C
Gray snapper	Lutjanus griseus	R
Tripletail	Lobotes surinamensis	R
Pigfish	Orthopristis chrysopterus	R
Pinfish	Lagodon rhomboides	R
Scup	Stenotomus chrysops	A
Silver perch	Bairdiella chrysura	C
Weakfish	Cynoscion regalis	C
Spot	Leiostromus xanthurus	R
Northern kingfish	Menticirrhus saxatilis	C
Atlantic croaker	Micropogon undulatus	R
Black drum	Pogonias cromis	C
Red drum	Sciaenops ocellata	R
Red goatfish	Mullus auratus	R
Bermuda chub	Kyphosus sectatrix	R
Atlantic spadefish	Chaetodipterus faber	R
Spotfin butterflyfish	Chaetodon ocellatus	R
Tautog	Tautoga onitis	C
Cunner	Tautogolabrus adspersus	C
White mullet	Mugil curema	R
Striped mullet	Mugil cephalus	C
Northern sennet	Sphyraena borealis	R

Common Name	Scientific Name	Occurrence*
Northern stargazer	Astroscopus guttatus	R
American sand lance	Ammodytes americanus	R
Naked goby	Gobiosoma bosci	R
Atlantic cutlassfish	Trichiurus lepturus	R
Atlantic bonito	Sarda sarda	R
Chub mackerel	Scomber japonicus	R
Atlantic mackerel	Scomber scombrus	C
Spanish mackerel	Scomberomorus maculatus	R
Harvestfish	Peprilus adepidotus	R
Butterfish	Peprilus triacanthus	C
Northern searobin	Prionotus carolinus	A
Striped searobin	Prionotus evolans	A
Grubby	Myoxocephalus aneneus	R
Longhorn sculpin	Myoxocephalus octodecemspinosus	C
Gulfstream flounder	Citharichthys arctifrons	R
Smallmouth flounder	Etropus microstromus	R
Summer flounder	Paralichtys dentatus	C
Fourspot flounder	Paralichthys oblongus	R
Windowpane	Scophthalmus aquosus	A
Winter flounder	Pseudopleuronectes americanus	A
Hogchoker	Trinectes maculatus	C
Orange filefish	Aluterus schoepfi	R
Planehead filefish	Monacanthus hispidus	R
Gray triggerfish	Balistes capriscus	R
Smooth puffer	Lagocephalus laevigatus	R
Northern puffer	Sphoeroides maculatus	C
Striped burrfish	Chilomycterus schoepfi	R
Ocean sunfish	Mola mola	R

*A = abundant
C = common
R = rare

SOURCE: Sandy Hook Marine Laboratory, 1971. Review of aquatic resources and hydrographic characteristics of Raritan, Lower New York, and Sandy Hook Bays. National Marine Fisheries Service, NOAA, Battelle Institute 61 p.

APPENDIX H

ARCHAEOLOGICAL AND HISTORICAL CULTURAL RESOURCES SURVEY
OF THE PROPOSED NAVAL FUEL FARM SITE
BELFORD, MONMOUTH COUNTY, NEW JERSEY

PREPARED BY:

Herbert C. Kraft

Archaeological Research Center

SETON HALL UNIVERSITY MUSEUM
SOUTH ORANGE, NEW JERSEY 07079

SUBMITTED TO:

DAMES AND MOORE

6 COMMERCE DRIVE

CRANFORD, NEW JERSEY 07016

Archaeological Research Center

SETON HALL UNIVERSITY MUSEUM
SOUTH ORANGE, NEW JERSEY 07079

Dec. 2, 1977

Dames and Moore
6 Commerce Drive
Cranford, New Jersey 07016

Gentlemen:

The project herein identified as the proposed site of the Naval Fuel Farm in Belford, Monmouth County, New Jersey, has been thoroughly investigated with respect to prehistoric and historic cultural resources. The entire area was walked, visually inspected, selectively excavated, augered and tested. Additionally, the investigators have researched the extant literature, and the early maps and documents pertinent to the area. Avocational archaeologists and local collectors were interviewed and local historians and historical societies were consulted.

No evidence of prehistoric aboriginal cultural materials or sites was encountered anywhere within the proposed area of study. Early reports show no prehistoric archaeological site in any proximity to the property being investigated (Map 2,3). Most local archaeologists agree that the known productive Indian sites are considerably removed from this lowland section of Belford. Consequently, there will be no direct or indirect threat to prehistoric archaeological sites.

From the historical perspective it is noted that the property does not now have, and never has had historic houses or sites. This fact has been verified through direct consultation with local historians. The State and National Registers of Historic Places list no sites within the area of concern, and there are no sites worthy of consideration to the National Register of Historic Places.

It is my judgment, and that of my historical advisers, that the requirements of the National Environmental Policy Act for the Preservation of Historical and Cultural Properties have been satisfied. There appears to be no direct or indirect effect upon any prehistoric or historic sites since, in fact, none exist here. Therefore, I recommend that no further archaeological or historical investigations need be made, and that the construction on this property need not be inhibited for archaeological or historical reasons.

Respectfully submitted,

Herbert C. Kraft

Herbert C. Kraft
Anthropology/Archaeology

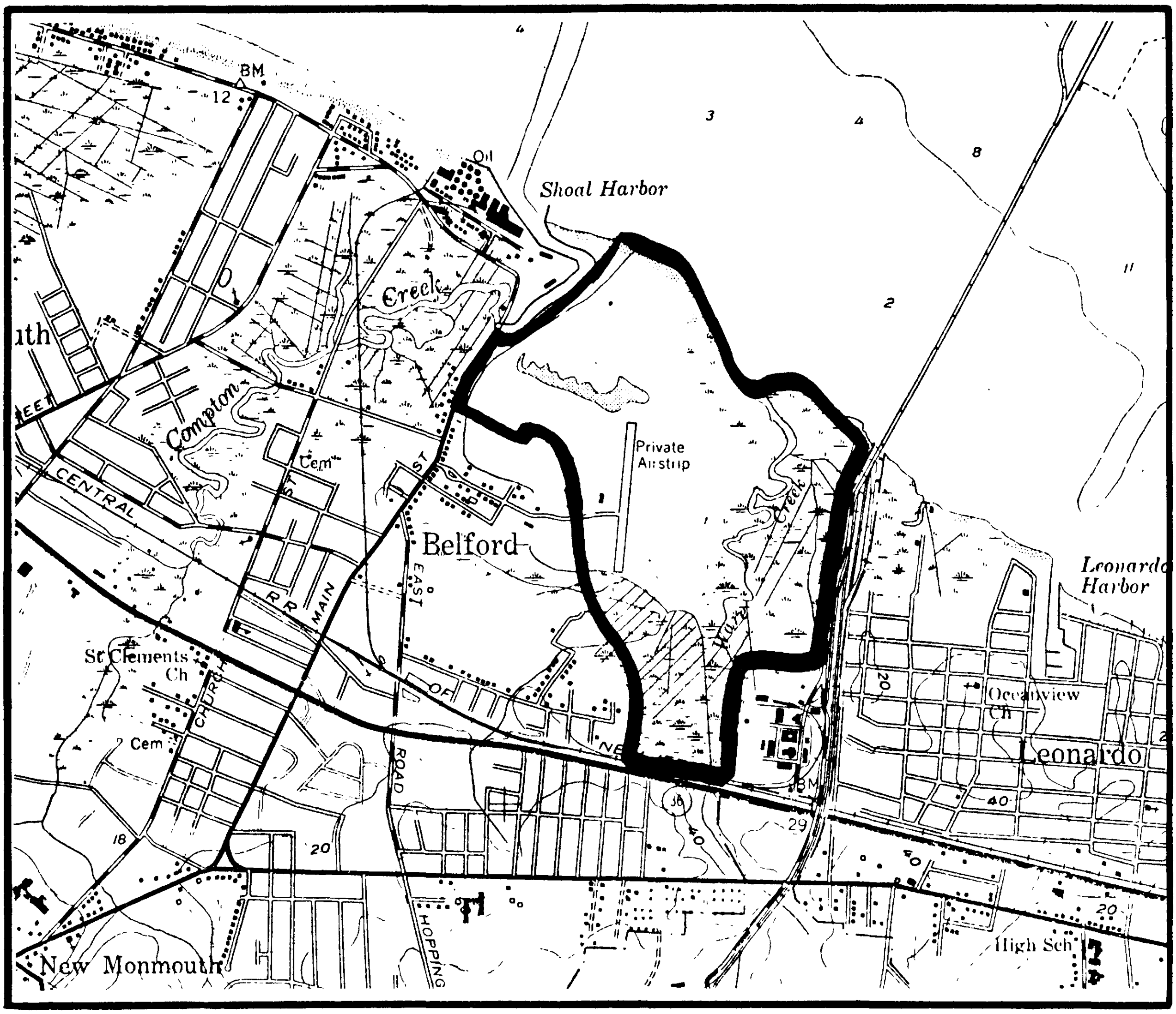
HCK:jk

Table of Contents

Introduction

The archaeological/historical study of the proposed site of the Navy Fuel Farm at the Bayshore area of Earle Depot is located north of Route 36 between Main Street and the U.S. Government Railroad with Sandy Hook Bay forming the northeastern perimeter.

In general, the area is a lowland swamp which has undergone extensive alterations. About ½ of the acreage has been filled and bulldozed, with drainage ditches, dirt roads, air strips and dredging operations adding to the modification.



Map 1: Detail of the U.S.G.S. map (Sandy Hook Quadrant) showing the Bayshore area of Earle Depot with respect to the surrounding communities of Belford and Leonardo. The area of study is outlined.

Location, Geography and General Environment

The site of the proposed Naval Fuel Farm, to be constructed north of the U.S. Naval Reservation (Earle Ammunition Depot), is located in the northeasternmost section of Belford Township, Monmouth County, New Jersey. The property is bounded on the west by Main Street and Compton Creek, and on the north by Sandy Hook Bay. The tracks of the U.S. Government Railroad forms the easternmost terminus, and U.S. Highway Route 36 serves as the southernmost boundary. The geographical coordinates are between 74° 4' 30" and 74° 5' 20" west longitude and 40° 25' 00" and 40° 26' 00" north latitude.

The study area lies entirely within the Outer Coastal Plain physiographic province of New Jersey. This shore area consists of sedimentary deposits of Tertiary formation with overlying patches of sand and gravel that date to interglacial times. The present soils of the Coastal Plain vary considerably in their admixture of clays, silts, sands and gravels, but the lower land elevations are more or less unconsolidated (Robichaud and Buell 1973:45). Freehold-Collington undifferentiated soils are the dominant series in this region, and are characterized as deep, well drained materials with small amounts of glauconite present (Ibid: and Jablonski, personal communication).

The property under study ranges from 40 feet above sea level at New Jersey Route 36 to sea level at the northernmost confrontation with Sandy Hook Bay.

Almost the entire project area is covered by coastal marsh. Reed grass is the dominant form of vegetation, accompanied in parts by salt-marsh cordgrass, salt-meadow grass and a few isolated patches of smaller and thicker successional weeds. Only a small portion of the study area consists of deciduous forest; this is just north of Route 35 on slightly elevated land. Oak, red maple, elm and birch are among the more common species while sassafras, spice bush, and sumac are less frequently encountered. Underbrush in this forest is sparse and consists mostly of grasses and a heavy cover of forest duff.

The land has been exceedingly disturbed by garbage disposal, airport, and railroad construction and by public road and building development. The area is subject to severe flooding, as for example in 1959 when hurricane winds lashed the bay, carrying water and small crafts across Route 36. It is also noted that silt and sand has been pumped from the shore front and streams beds and redeposited on the eroding beaches.

Preliminary Assessment

In our original proposal and research design (submitted September 14, 1977) it was noted that almost nothing was known concerning the prehistory of this region, and that no archaeological sites had been recorded by the Indian Sites Survey or other agencies. Certain observations concerning the historic aborigines of this general region are contained in the writings of

Juet (1609) and in the early land transactions involving Governor Nicolls and the original settlers about 1664. The prehistory is less well known, because no scientific, archaeological excavations have ever been carried out on any Indian sites along the Raritan Bay or in the Atlantic Highlands. While it is common knowledge that many prehistoric Indian sites have been surface collected and sometimes even excavated by Indian relic collectors and inexperienced amateurs, none have ever been reported in the archaeological literature. The loss of such sites is the more lamentable because whatever information they might have been able to contribute is now also lost.

From the historic perspective, it was noted that no structures exist in the area of concern and no historic events occurred here. There is, therefore, nothing on either the State or National Registers of Historic Places. Before the area was used for garbage disposal and fill, the land was, and in parts still is, a coastal wetland. Such land would have been uncondusive for prehistoric or historic settlement, but would have been exploited for its faunal and floral resources.

Method of Investigation

Library and Archival Research:

The maps and documents provided by the firm of Dames and Moore (Map 1) defined the study area. The U.S.G.S. maps (Sandy Hook Quadrangle) as well as the N.J.G.S. Map 29, and certain soil maps were inspected for additional details.

The information concerning possible prehistoric sites was gleaned primarily from the works of such early investigators as Alanson Skinner and Max Schrabisch (1913), the Indian Sites Survey of the Division of Professional and Service Projects of the Work Projects Administration (Cross 1941), through an examination of the records of prehistoric sites registered with the Bureau of Archaeology, New Jersey State Museum, Trenton; at the Archaeological Research Center, Seton Hall University, and through personal contact with local collectors familiar with the area. The latter included Mr. William Watkins of 57 Main Street, Keyport, New Jersey and Peggie Leifeste of 95 Broad Street, Matawn, John Cavallo, 407 Sunset Avenue, Asbury Park and Ralph Phillips, 100 Brandywine East, Brielle.

The history of the area was ascertained by interviewing Miss Gertrude and Mr John Neidlinger of 57 Concord Avenue, Leonardo both of whom are associated with the Shoal Harbor Marine Museum, and from library research in the following institutions: the New Jersey Collection of the Newark Public Library, the New Jersey Historical Society, Newark; the Freehold Branch of the Monmouth County Public Library, Freehold; the New Jersey Room of the Elizabeth Public Library, Elizabeth; and the Archaeological Research Center Library, Seton Hall University, South Orange. Additional information was obtained from local residents.

The "Pedestrian" or Stage I Archaeological/Historical Survey:

The field reconnaissance was undertaken by a team of 5 persons experienced in archaeological investigations. Upwards of 128 manhours were devoted to a careful, visual inspection of the proposed site. All exposed surfaces, earthen embankments, dredged areas, bulldozer cuts, exposed beaches and stream channels were visually scrutinized for signs of prehistoric cultural manifestations such as charcoal, fire-cracked rock, pottery sherds, flint debitage and, of course artifacts like arrowheads, axes or celts. Test excavations, shovel probes and subsurface auger testing was conducted in random locations throughout the site and in areas believed to have possible archaeological potential. Test squares were dug to a depth of from 2 feet to 4 feet depending upon soil conditions. A gasoline driven 8" mechanical screw auger with a 6 foot screw extension was extensively employed to recover soils from beneath the garbage dump, and to probe the subsoils in the areas between the test excavations.

As a result of our visual examination, test excavations, auger probes and shovel troweling of the stream banks, we can safely say that no prehistoric or historic occupation occurred here because absolutely no cultural evidence was encountered. We paid special attention to the creeks because mastodon bones were reportedly found here in former times. We, however, did not find any such evidence. Our negative determination concerning historic and prehistoric settlement in this area were verified by maps, documents and personal interviews.

For additional information concerning the investigative methods we regularly employ in our cultural resources surveys, please see Appendix I, pp. i - iv.

Prehistory:

It is not known when early man first began to settle in the area around Sandy Hook Bay. At the time when Paleo-Indians first came into this region 10,000+ years ago, the sea coast was nearly a hundred miles further east, and the geographical configuration of New Jersey was far different from what it is today. Seven to ten thousand years ago much of the continental shelf was exposed and Ware Creek and other streams drained into the lakes and lagoons far to the east (Kraft 1977:4; Edwards and Emery 1977:253-254; see also map 4,5). In view of this changing geographical condition, it is not surprising that so few fluted points and Paleo-Indian artifacts attributable to early man have been found along the eastern coast of New Jersey (Kraft 1976). However, the Port Mobil site in southwestern Staten Island attests to the fact that early hunters and gatherers were in the area (Kraft 1977:1-19). In the millenia following the glacial retreat, large game animals such as mammoth, mastodon, muskox and possibly even walrus were living on the exposed coastal plain. The remains of such animals are constantly being dredged up,and their ocean-floor resting places have been plotted (Whitmore et al 1967; Kraft 1973:60; Edwards and Merrill 1977:-1).

As the glacier continued to melt, it gushed forth torrents of water that caused the ocean levels to rise throughout the world. They continue to rise even to this day (John Kraft 1977:35-69), and the inexorable flow and force continue to erode away and modify the coastal configurations (Moss 1964:104-105). Leonardo and Belford Township, and the more easterly coastal areas have doubtless changed innumerable times in the past and will continue to do so in the future.

Such changes had their impact upon the environment and upon the aboriginal adaptation at various times in the past. It is reasonable to suppose that great middens, composed of clams, oysters, scallops and other kinds of shell, and perhaps fish, sea bird, and sea mammal remains, may have existed not only on the existing banks of Sandy Hook Bay, but all along the coastal shelf. Most of these shell middens sites have been destroyed by the rising waters and some may have been destroyed by human agencies such as farmers who in formers years carted such shells far inland and then plowed them into the soils to "sweeten" the earth.

It is to be expected that Indians camped near Leonardo and Belford to gather shellfish and fish, marsh birds and local mammals, and to gather edible and useful plants. Few of these sites are extant, but we have been informed by Mr. Neidlinger that such sites did at one time exist on the higher ground in the area immediately south of Route 36. No one is known to have found any archaeological artifacts in the area of study and we were likewise unsuccessful in our own pedestrian and subsurface examinations.

An observation in Robert Juet's Journal of 1609 is one of the few eye-witness accounts we have concerning the aborigines who lived here at the time of European contact. Juet, an officer aboard Henry Hudson's ship, the "Half Moon" wrote:

> ...*this day (September 4, 1609) the people of the Countrey came aboard of us, seemingly very glad of our coming, and brought green tobacco...they go in Deere skins loose, weel dressed... they desire cloathes, and are very civill. They have great stores of Maiz or Indian Wheate, whereof they make good bread. The country is full or great and tall oakes...(Juet 1959:28).*

Although this reference probably relates to Sandy Hook, it might as well describe the aboriginal situation in the area of study. The account of Penelope Stout (ca. 1620) also pertains to the area (Barber and Howe 1865: 259). Besides these there are, regrettably no early accounts or documents relating to the Indians who formerly inhabited the coastal region of present-day Leonardo and Belfords townships.

Several shell middens had been reported along the coast of Raritan Bay at Keyport, Cliffwood, and Matawan (Skinner 1913:45-47). More than a century ago, Samuel Lockwood (1864:371) reported an immense shell deposit near Keyport in which "pottery, stone knives, axes, arrowheads and many other implements were discovered". Charles Rau (1884:370-379) made similar observations concerning shell heaps at Keyport near Comaskonck Point. Today, most of these sites are gone; victims of seashore resort development and rising water levels.

It is very doubtful that the area would have been used for any purpose other than food procurement since it is composed primarily of coastal marshland. Extant reports and surveys by the Indian Sites Survey (Cross 1941) and by such early investigators as Alanson Skinner (1913) indicate a total absence of habitation sites along the coast south from Raritan Bay. Recent site surveys and previous Cultural Resource Surveys in the northern Monmouth areas revealed no new prehistoric sites (see maps 2 and 3).

Mr. Neidlinger, a well informed Leonardo resident advised this writer that mastadon remains had been found in and around Ware Creek by a, now deceased, Mr Horn. These remains, consisting of knuckle and toe bones, ribs and leg bones, were disseminated upon Mr. Horn's death. It is not now known where these palaeontological remains might be, nor the precise location of their alleged discovery. We search for remnants of such extinct pachyderms, but found none.

History:

The area of Belford, between Compton Creek and Ware Creek, has always been mapped as a marshland or wetlands area, and except for the very extensive garbage dump around and north of the airstrip, it remains so today. In the late 18th and early 19th centuries, Ware Creek was used for limited transportation and trade, but little development occurred in this region prior to its acquisition by the U.S. Government in this century.

The land under review was purchased by the U.S. Navy in 1943 as part of an 8,400 acre tract of land which stretched south from Sandy Hook Bay to just north of High Point Chapel approximately two miles inland. The property was acquired for the purpose of erecting an ammunition depot in which to store and ship the equipment needed for the Naval units operating out of New York at the time (Wilson 1964:999). A double track railroad was built from the Earle Ammunition Depot to Leonardo, where a two mile long deep-water pier was constructed. The completed ammunition reservation was named in honor of Admiral Ralph Earle, Chief of the Navy's Bureau of Ordinance in W.W. II (Ibid).

Except for the railroad and certain military installations near Route 36, the area has experienced no building construction; however much of the low-lying marshland has been filled and elevated by decades of municipal garbage disposal. This refuse-filled section constitutes about one half of the total project area. Two government owned airstrip and a local sewerage treatment plant ncw occupies a large portion of this filled section. Dredging operations have also added to the disturbance of the land. Following the hurricane of 1959, an enormous amount of off beach sand was dredged from the bay and distributed along the eroding beachline. Today dredging operations are under way in Compton's Creek inlet. Here the U.S. Army Corps of Engineers is simultaneously deepening the channel and ejecting the removed silt and sand over the stream banks. Parenthetically, it is noted that the 1959 hurricane which contributed to the devastation of this seashore area, completely inundated the land up to and beyond Route 36 (see map 11).

Although Belford is a part of the greater Middletown area, it was peripheral to the development of this very historic community regarded by some as "the oldest settlement in New Jersey" (Salter 1890:355).

Archaeological/Historical Investigation

It has been noted that the area under study was at one time a tidal marshland (Maps 7, 8). Most of this area has been seriously altered by natural forces such as hurricanes and erosion, and by the numerous kinds of human construction and destruction already adumbrated (p. 8). Today, it would appear, that only the land immediately bordering Ware Creek has escaped total change.

To enable us more systematically to examine the area proposed for the construction of the Naval Fuel Farm, and to facilitate our record keeping, we divided the land into three artbitrary segments, using natural or artificial land marks. These three sections are as follows: Section I comprises the land-filled area in the northwestern part of the property which is characterized by the garbage dumping. Section II consists of the land immediately bordering Ware Creek and the remaining areas of tidal marsh. Section III consists of the relatively small areas near Route 36 which is somewhat elevated and covered with deciduous forest.

Section I: Map 12, Figs. 1 - 13.

Section I is located in the northwest portion of the area of study. It is the site of a garbage disposal operation stretching from Sandy Hook Bay to the small Belford community, and from Main Street to Ware Creek.

This filled-in area is the proposed site of the Navy Fuel Farm and is presently the site of two airstrips, a hanger, sewerage treatment plant and numerous dirt roads; all of which have been built on the garbage heaps. Today, this area is overgrown with marsh vegetation and successional weeds and trees. The soils deposited over the garbage consist predominantly of sand with small pebbles. Some of the property is owned by the U.S. Naval Earle Ammunitions Depot, and permission to inspect and test excavate in this region was readily granted.

The view of the land between Shoal Harbor and Ware Creek where most of the garbage had been dumped looked, deceptively, as if it were dotted with hillocks or low mounds. However, out test excavations and auger probes into these features revealed concentrations of refuse overlain by soil covers. The perimeters of some of these garbage areas revealed an accumulation of from 10 to 30 feet of compacted refuse (Figs. 1, 2, 9, 12, 13).

From areas around the perimeter of the garbage dump it was apparent that the subsoils were water logged and would not have supported aboriginal or historic habitations. Nonetheless, we carefully investigated all exposed banks and land surfaces in order to ascertain whether or not the area might contain deposits of historic debris or evidence of earlier industries. Nothing of the kind was observed.

An irregular depression in the midst of the dump is presently being filled with a black muck dredged out of Shoal Harbor. It was impossible to test this area and the land bordering Compton Creek-Shoal Harbor because of the sludge laden silt being discharged from the suction dredge (Fig. 4).

The presence of deeply piled garbage in an otherwise swampy area, together with our negative field observations and absence of data on maps spanning nearly two centuries caused us to conclude that this area (Section I) was totally devoid of any cultural manifestations.

Section II: Map 12, Figs. 14 - 16.

Section II is located for the most part, east of Ware Creek up to the U.S. Navy Earle Depot Railroad. The southernmost portion of this section extends west to the edge of the Belford community. This region is characterized as low, swampy marshland. As an estuary of Sandy Hook Bay, Ware Creek constitutes a fresh water-saltwater marsh ecosystem. Reed grass is prominent along the waterways while cordgrass, salt marsh grass, and various swamp sedges are also present. In general, the terrain is flat and the soils consists of fine grained sands mixed with clay. Subsurface testing was difficult due to the wetness of the soils and heavy ground cover. Visual inspection was likewise hindered by the dense vegetation. Where possible, subsurface tests were taken (Map 12), and the eroded stream banks, exposed coastal areas, and dredging operations were minutely examined for evidence of cultural remains.

It is unlikely that any Indian sites would have existed in this low-lying area. The wetlands, now somewhat altered by the hurricane of 1959, would doubtless have been exploited for food and useful plant materials, but campsites would have been situated on the higher bluffs some distance to the south in the vicinity of present Route 36.

Although aboriginal artifacts have not been discovered here at any time, it has been stated that mastodon bones were recovered by Mr. Horn, now deceased (Personal communication with Mr. John Neidlinger). It has already been stated (p. 8) that these palaeontological specimens were neither reposited nor documented and it cannot now be determined whether the alleged finds represented one or more such extinct proboscidians. In studies of such remains conducted by the author and others, it has been determined that the formerly exposed continental shelf with its spruce, pine and fir cover supported numerous mastodon and mammoth 10,000 to 12,000 years ago (Kraft 1973, 1977, 1977a; Edwards and Merrill 1977; Whitmore et al 1967). Nearly 50 such mastodon remains have also been found in various parts of the New Jersey mainland as well.(see maps 4,5).

We could find no mastodon remains in our intensive search. Surely, some vestiges may yet remain; however, it is also likely that the previous finds may have represented a single mastodon which would now be incomplete even if found. It is equally likely that the garbage dump and/or the devastation occasioned by the hurricane of 1959 may have submerged such remains.

Since, in fact, Ware Creek comes under the CAFRA regulations it will doubtless receive some measure of protection, as also will the immediately adjacent lands; hence this estuarine environment with its possible mastodon remains may provide future evidence of extinct fauna.

Our field survey and library research concerning this segment together with numerous interviews with local historians and archaeologists were disappointingly unproductive. We therefore conclude that the marsh area bordering Ware Creek is without archaeological merit and there is nothing worthy of recommendation for the National Register of Historic Places.

Section III: Map 12, Figs. 17,18.

Section III is located north of Route 36 and comprises a small forested portion of land between the Belford community and the Earle Naval Base. This area extends north following the declining contour of the land, and passes through an area of dense underbrush, until it enters the marsh area of Section II.

This small field has never been known as an area for the collection of prehistoric Indian artifacts or as an historic region. This fact is apparent both from the maps and the literature and from interviews with local collectors and historians.

Mindful of the fact that small prehistoric sites do occur on the knolls and terraces overlooking marshlands and small creeks, we decided to check the area as thoroughly as possible. Our visual survey included an examination of the exposed railroad embankments nearby, and the eroded stream banks and foot paths, as well as the soils contined in the root clusters of overturned trees. Our subsurface survey included three 5' x 5' test squares and numerour 8" mechanical auger probes and shovel tests. (Map12). Additionally, a 10" x 10" by 4' deep excavation was encountered in this area. This was carefully searched for prehistoric cultural remains or foundation ruins. In no instance did we find any evidence whatever of prehistoric or historic occupation or industry. There were no postmolds or other features, no fire-cracked rocks or debitage, no artifacts of any kind. The area appears to be completely devoid of cultural remains.

Conclusions and Recommendations

The extant archaeological literature references no prehistoric archaeological sites in the vicinity of the proposed Naval Fuel Farm in Belford, New Jersey. (Skinner and Schrabisch: 1913; Cross 1941 and others). Interviews with local residents and avocational archaeologists (see P. 27) failed to produce information or evidence concerning of a single aboriginal Indian site in or near the area of study. Historic sites such as the old Spy House also known as the Whitlock-Seabrook Homestead and Shoal Harbor Marine House Museum,(now the Middletown Historical Society headquarters) is sufficiently remote from the area of concern and will suffer no adverse affect (map 10).

The proposed site of the Navy Fuel Farm has undergone substantial modification as a result of bulldozer cuts and grading, railroad and airport construction, house development, and general use as a garbage dump. It has also suffered hurricane damage in the past and has had, and is now having sludge, silt and off-shore sediments pumped over the land surfaces. Visual examination of exposed surfaces, eroded gullies, root clusters of upturned trees and other bulldozer cuts indicated no evidence of historic or prehistoric cultural materials. Ten 5' x 5' test squares, innumerable 8" auger borings, as well as shovel probes failed to produce evidence of prehistoric or historic cultural remains of any kind. Moreover, there appear to be no historically important shipwrecks in the bay north of the proposed site. It is,therefore, conluded that the proposed construction site of the Naval Fuel Farm is totally devoid of historic or prehistoric cultural resources, and neither the area or any of the houses and structures in the immediate vicinity are worthy of consideration for the State or National Registers of Historic Places. No adverse impact is foreseen and we recommend that no further archaeological or historical work need be undertaken here.

Note Concerning the Disposition of Specimens and Documents

All artifacts recovered in this or any other archaeological/historical surveys conducted by us in the course of an Environmental Impact Study, as well as the complete field notes, photographs and negatives, and at least one copy of the final report, will be kept in the permanent collections of the Archaeological Research Center at Seton Hall University. It is noted, however, that no prehistoric or historic artifacts were recovered in the survey of the Naval Fuel Farm in Belford, hence, none are preserved.

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Maps

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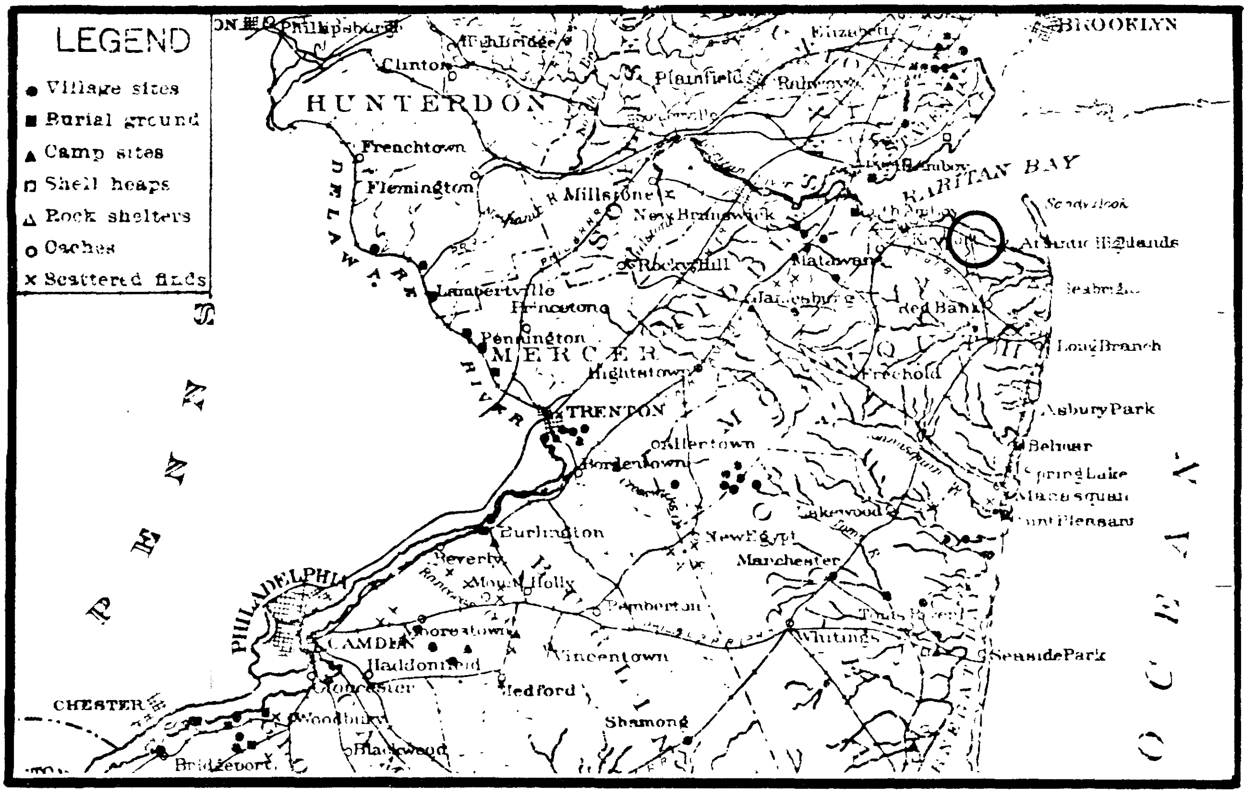
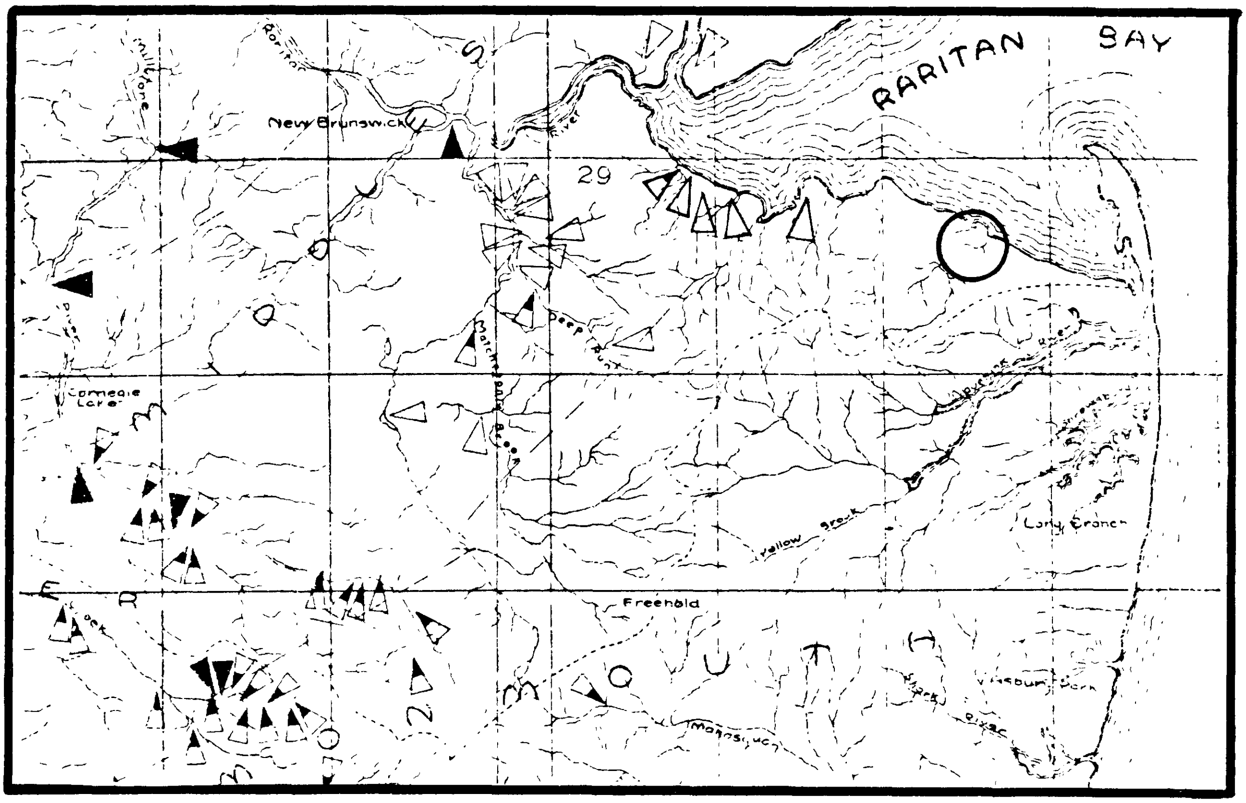
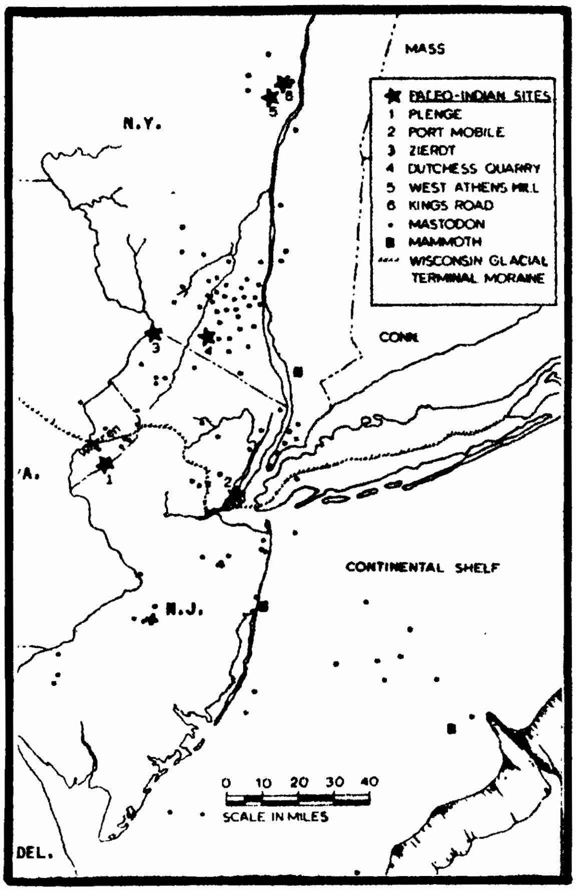


Map 2. Detail of the Skinner and Schrabisch map (1913) shwoing the distribution of archaeological sites. Note absence of sites in study area.

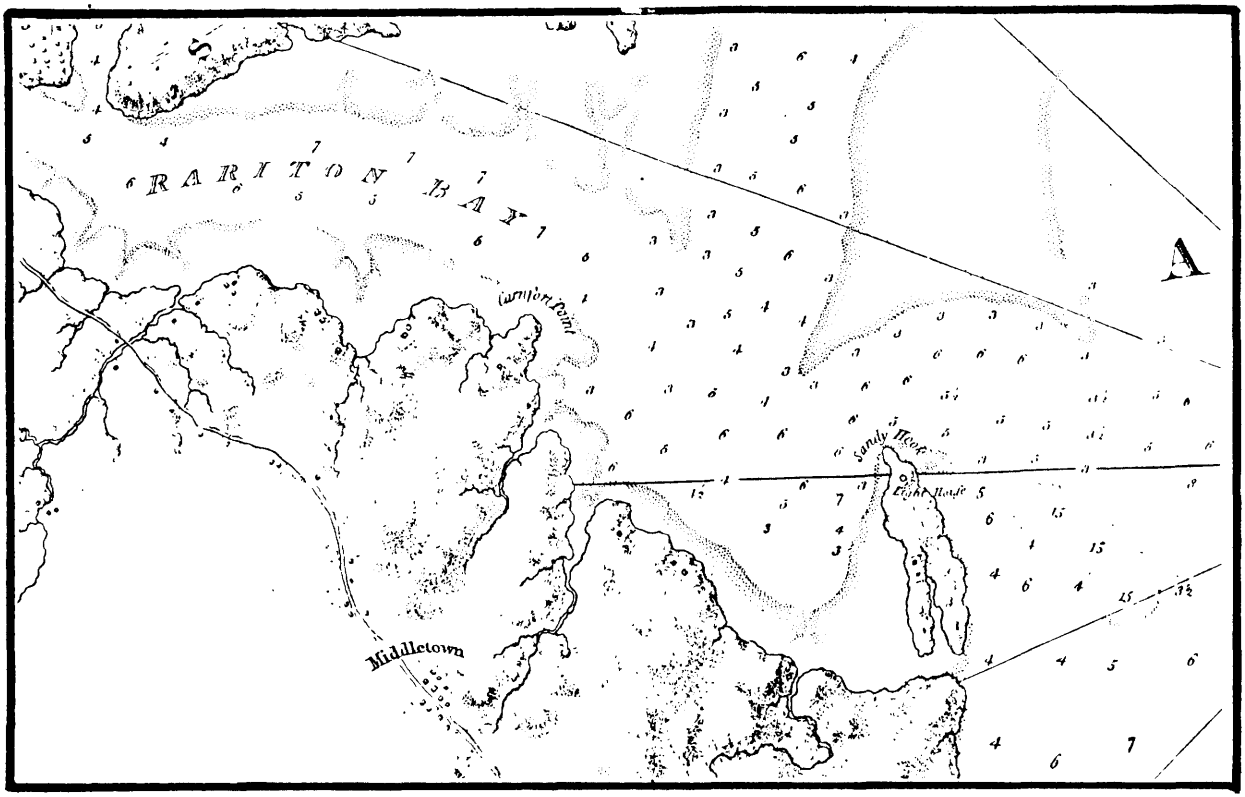


Map 3. Detail of the Indian Sites Survey map (Cross 1941) showing absence of recorded sites in the area of study. ▶ = sites surveyed by Indian Sites Survey, ▷ = sites surveyed by others.

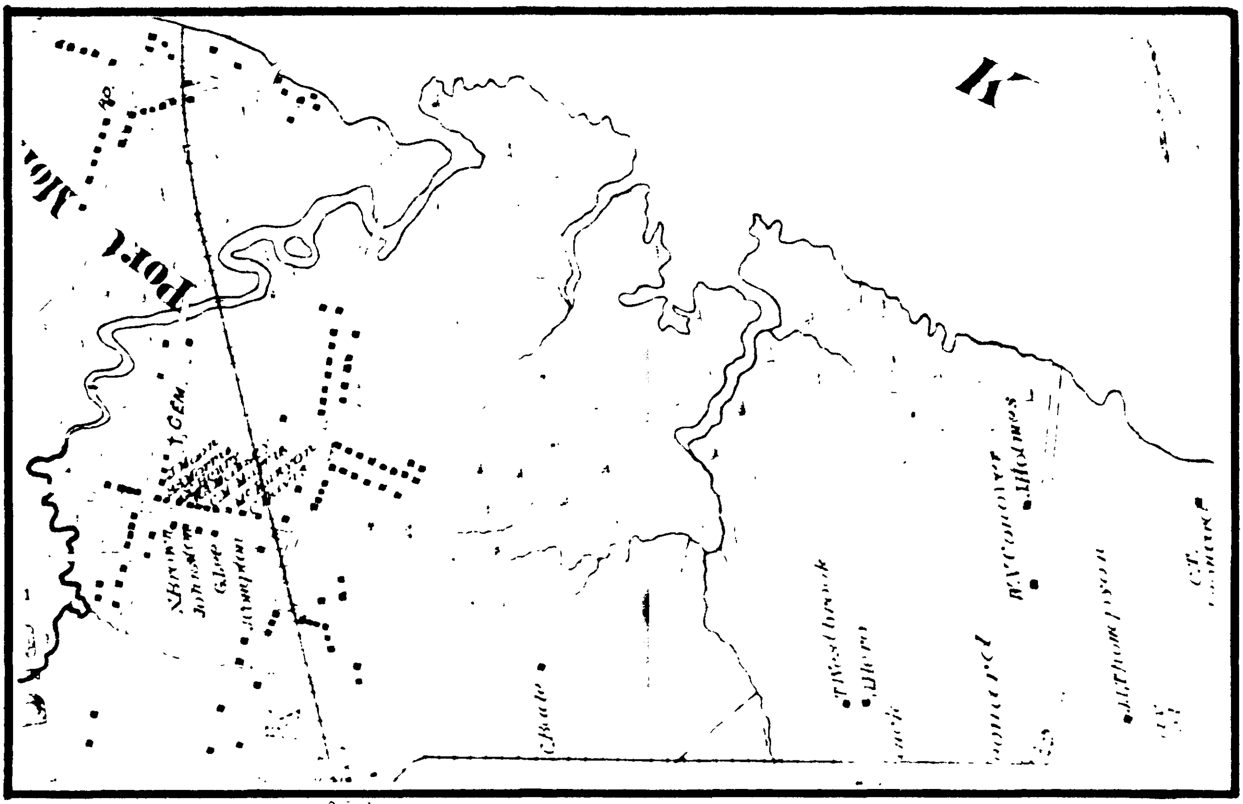


Map 4. Reported distribution of mammoth and mastodon remains in New Jersey and on the continental shelf. From Kraft (1977: 270; 1977a: 3).

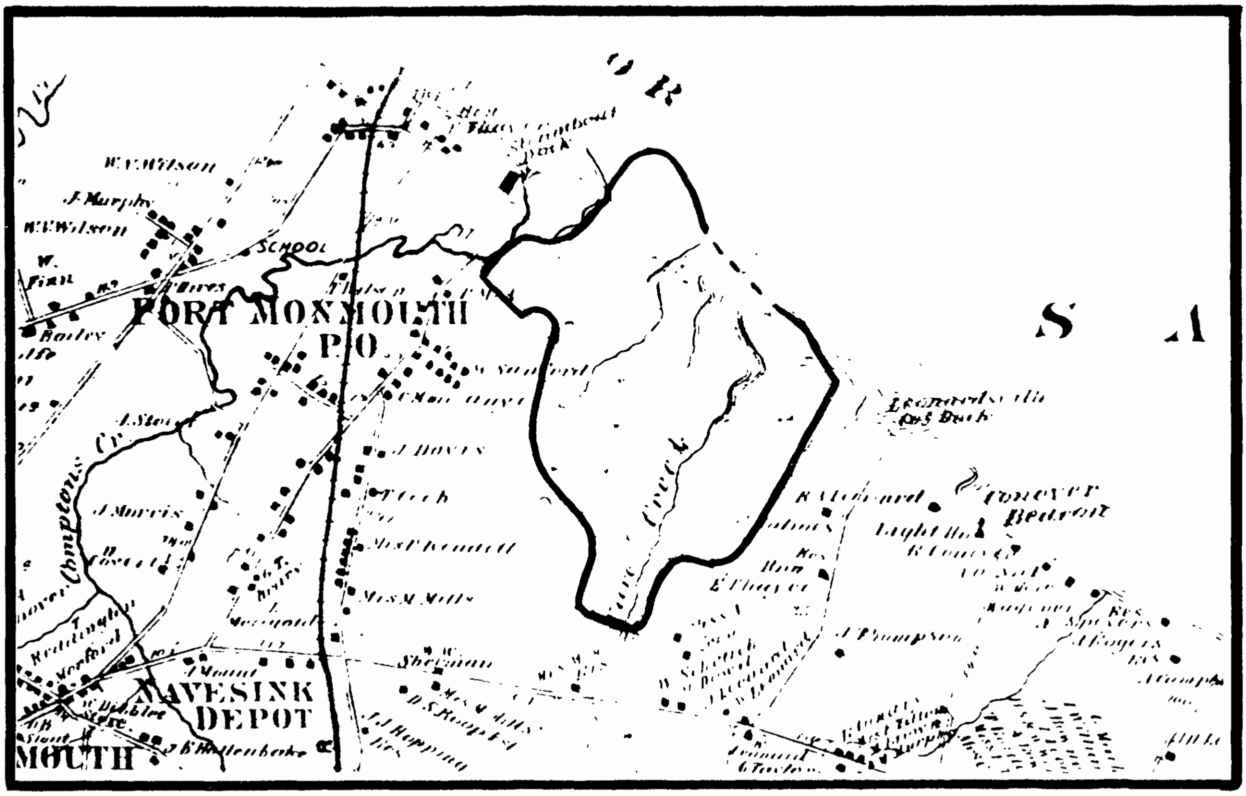
Map 5. (below). The land area of the Middle Atlantic Bight as it might have appeared during the period 12,000 to 10,000 years ago. From Edwards and Emery (1977: 253). The area of study i.e. the Naval Fuel Farm, is circled.



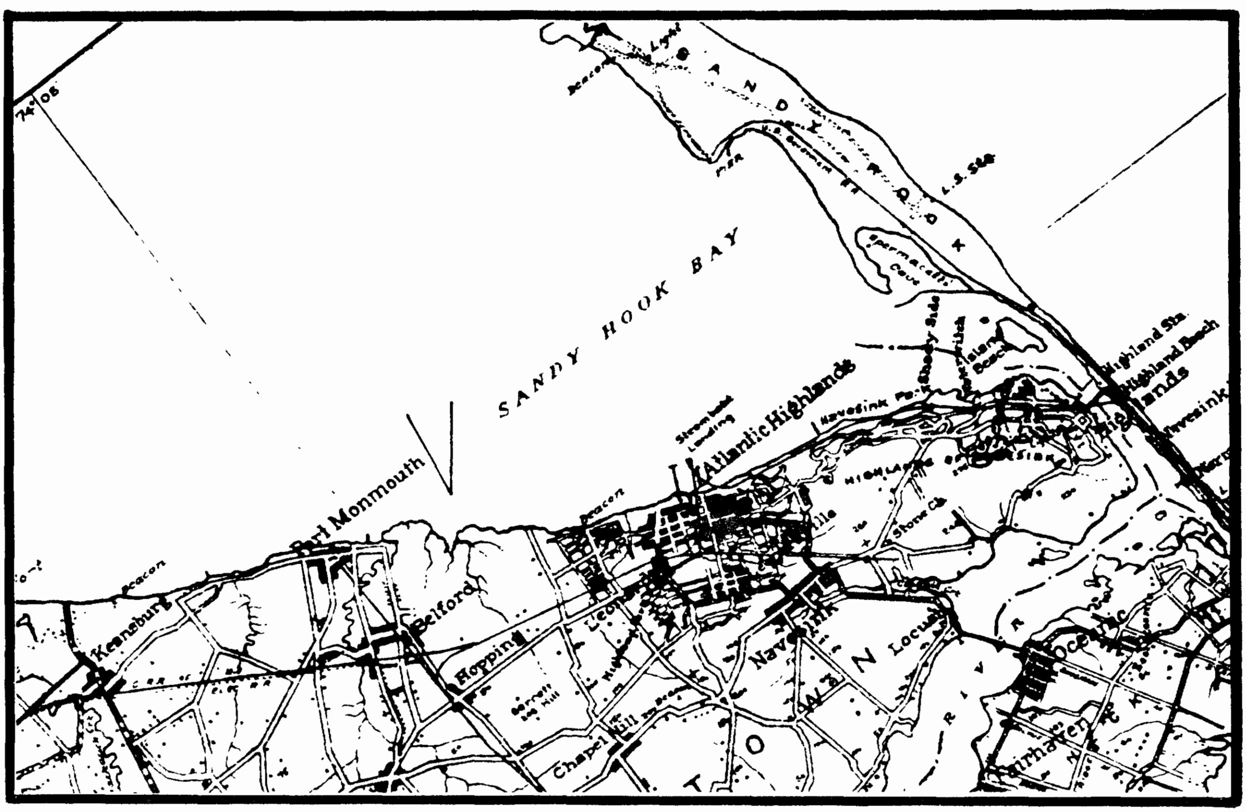
Map 6. Detail of the 1776 map drawn by J.F.W.Des Borres Esq., showing the area of study as it was at that time.



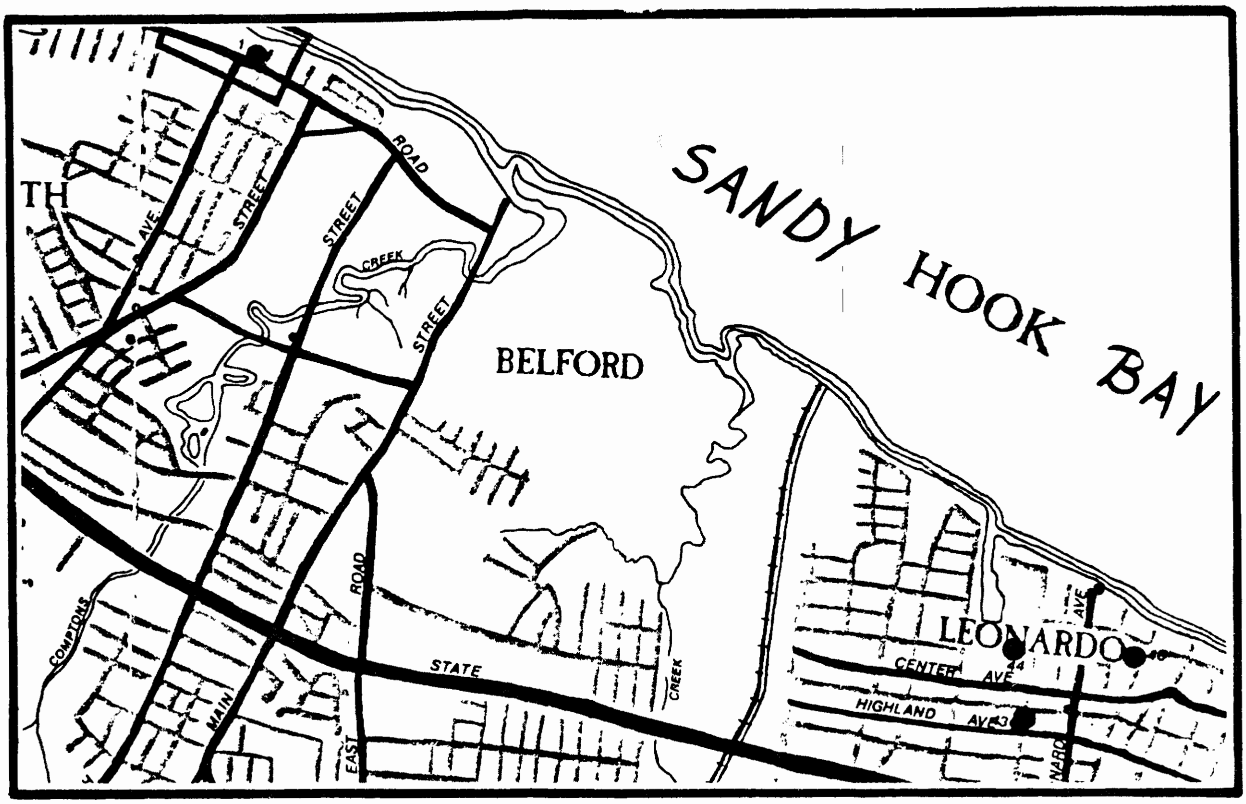
Map 7. Detail of the 1871 Wolverton Atlas of Monmouth County, N.J. showing the project area as a total marshland.



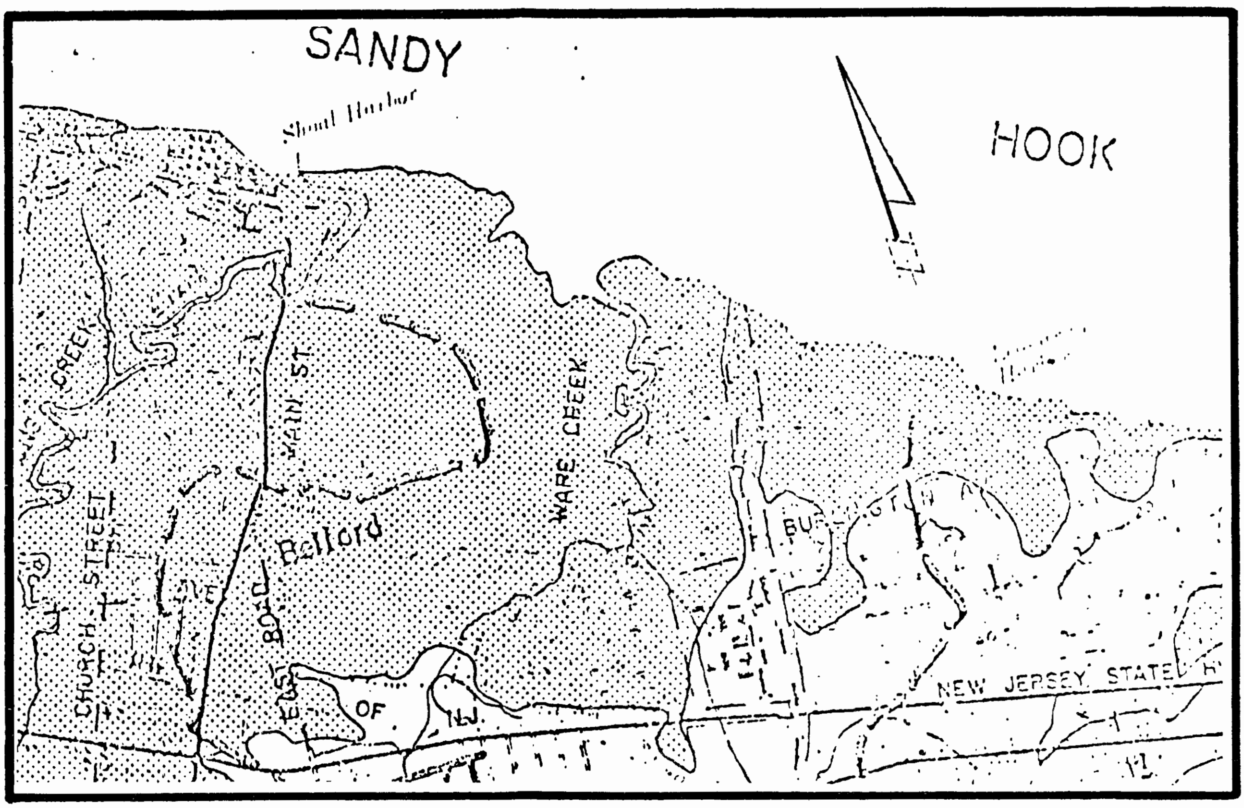
Map 8. Detail of the general area as shown in the Beers Atlas of 1873. The project area has been outlined.



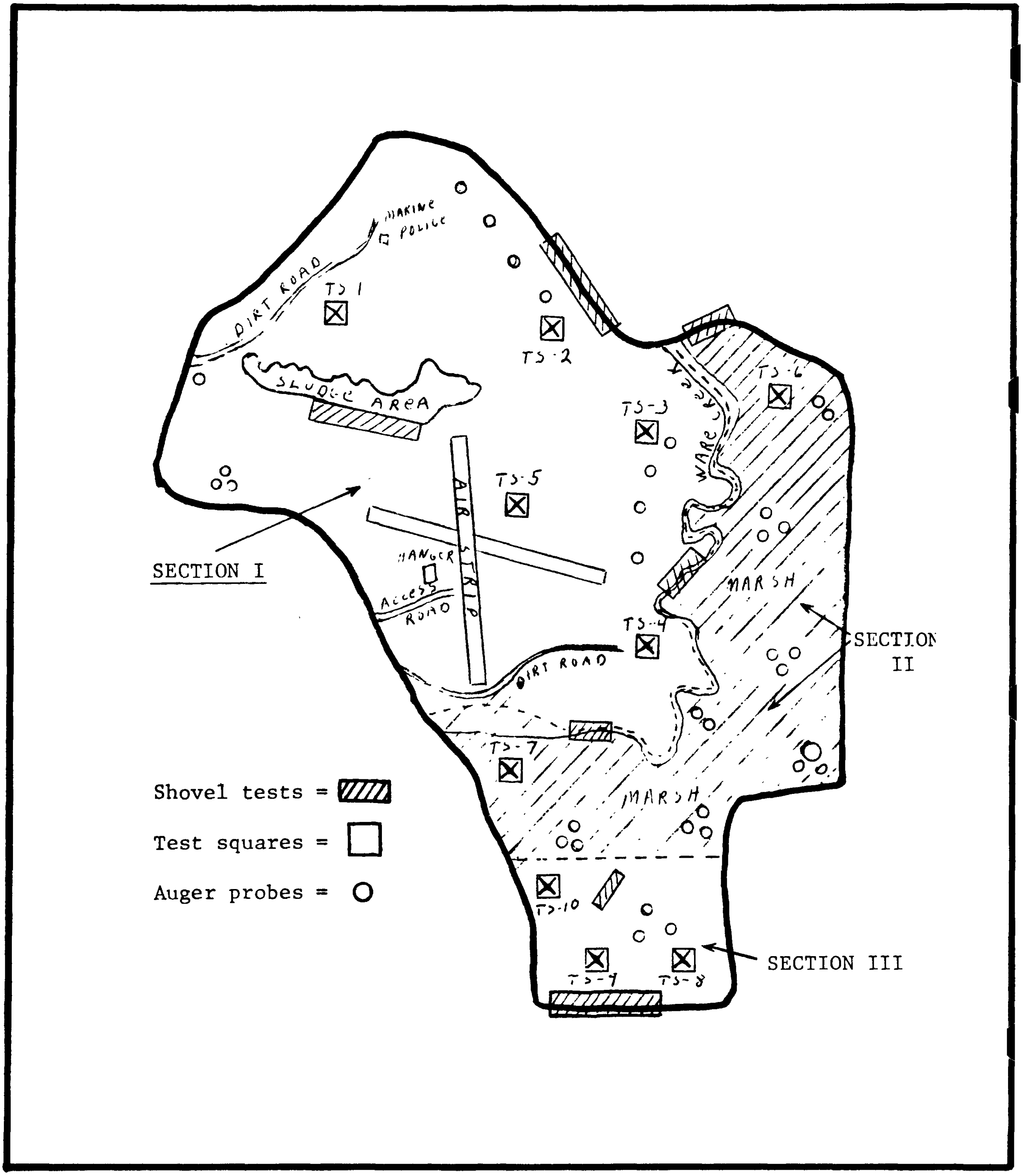
Map. 9. Detail of the Westgard Atlas of the State of New Jersey, compiled in 1905, depicting the Sandy Hook Area. The area of study is shown.



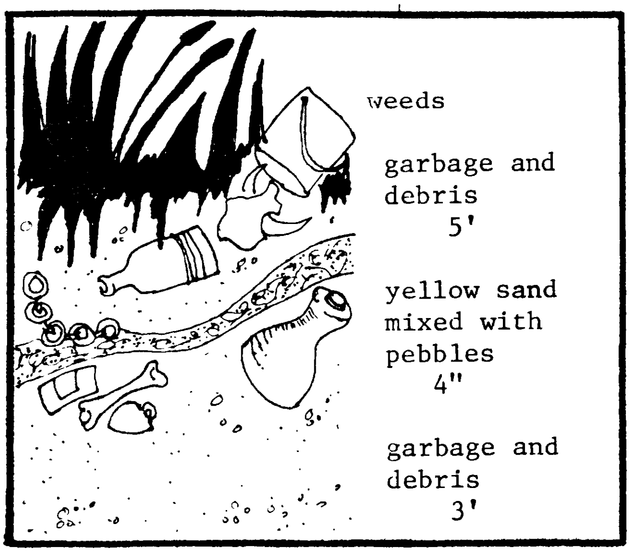
Map 10. Detail from the Middletown Bicentennia map showing the historic sites and structures. Note that no historic site is closer than 3/4 mile.



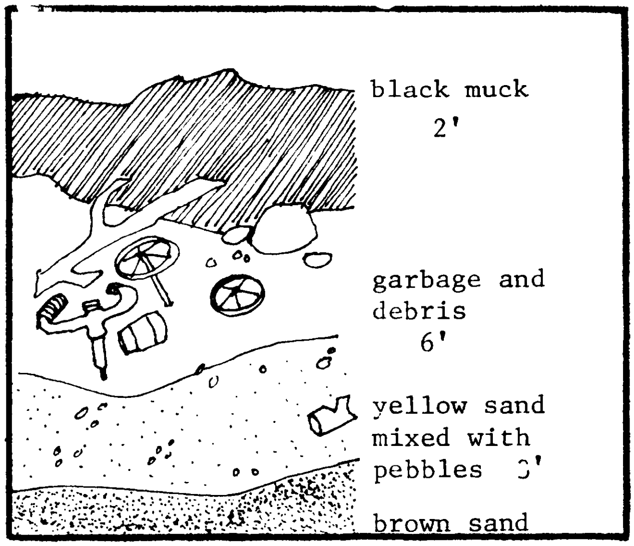
Map. 11. Map of the Master Plan study, Middletown Township Planning Board (June 1977) showing the area subject to flooding (shaded).



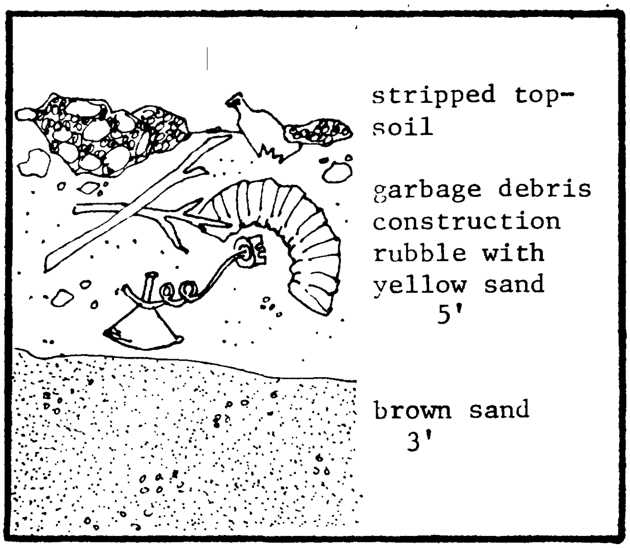
Map 12. Project map showing the area of study and the arbitrary divisions employed to facilitate our study. Compare with maps 1 or 8.



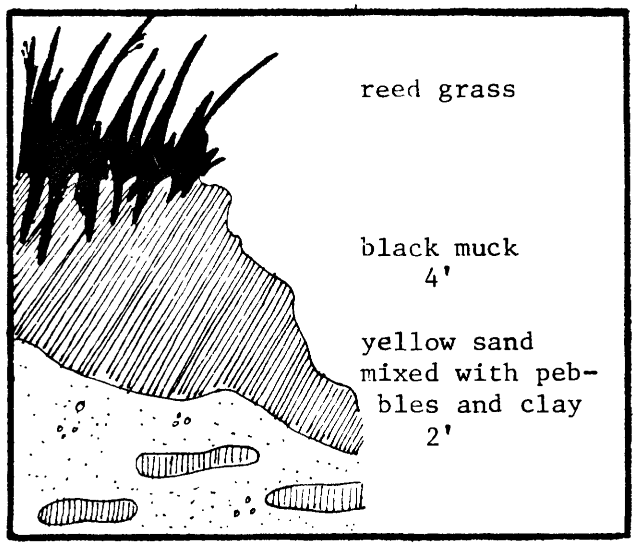
Strat.1: Test Square 1, taken near Shoal Harbor.



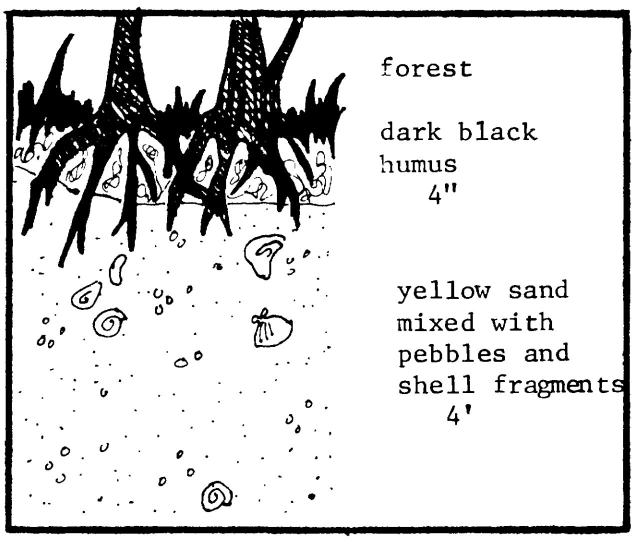
Strat.2: Test Square 2, taken 200 feet south of the bayshore.



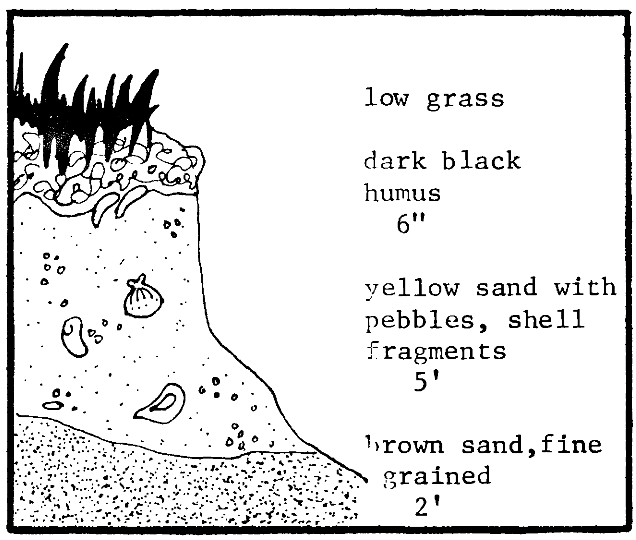
Strat.3: Test Square 4, taken near edge of land fill region.



Strat.4: Test Square 6, taken along the east bank of Ware Creek.



Strat.5: Test Square 8, taken near Route 36.



Strat.6: Shovel scrapes taken from previous excavations near Route 36.

Fig.1: General view of a dirt road constructed over the garbage debris.

Fig.2: Construction debris piled up near the airstrip; Section I.

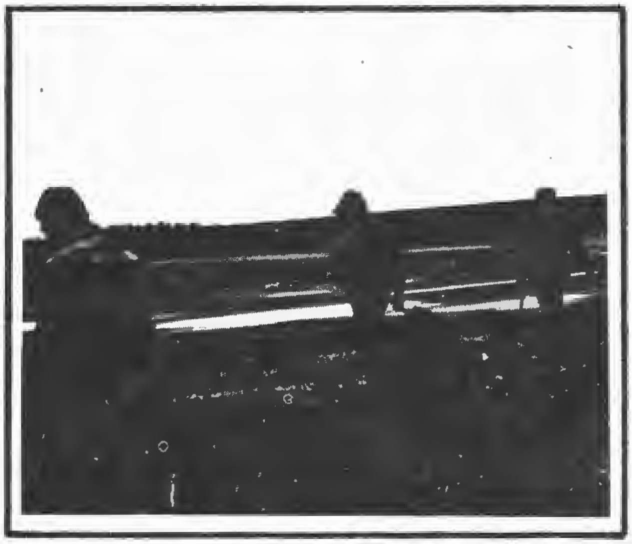


Fig.3: Surface examination near the airstrip; Section I.

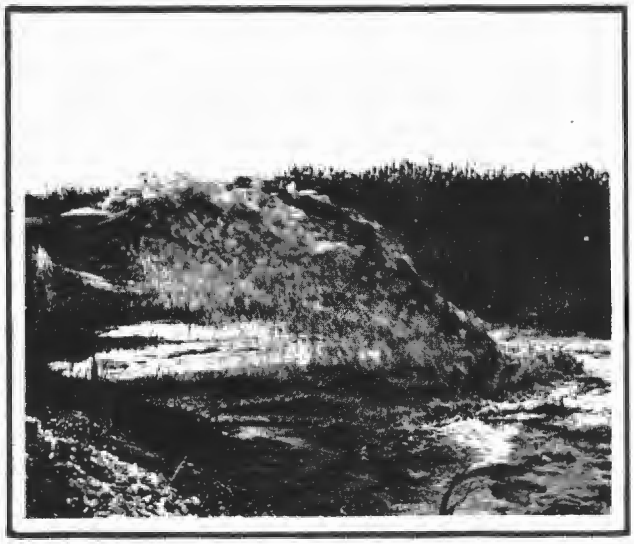


Fig.4: View of sludge being pumped from Shoal Harbor onto study area.

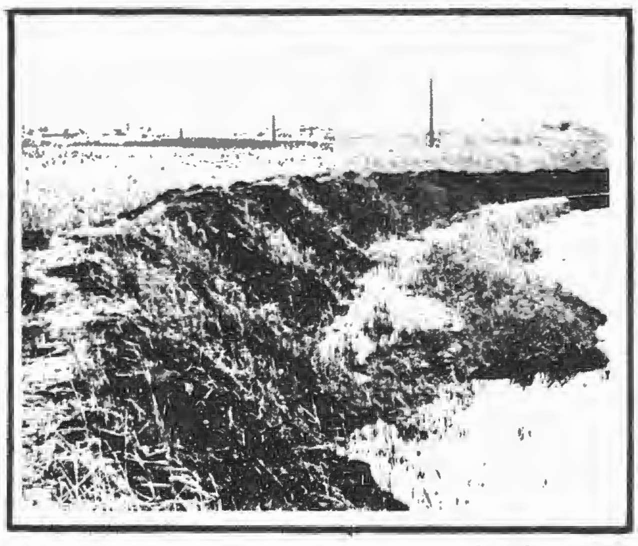


Fig.5: View of earth mounds which contain the sludge brought up by recent dredging.

Fig.6: View of test excavation #4, in Section I.

Fig.7: Examination of the shore line along Sandy Hook Bay.

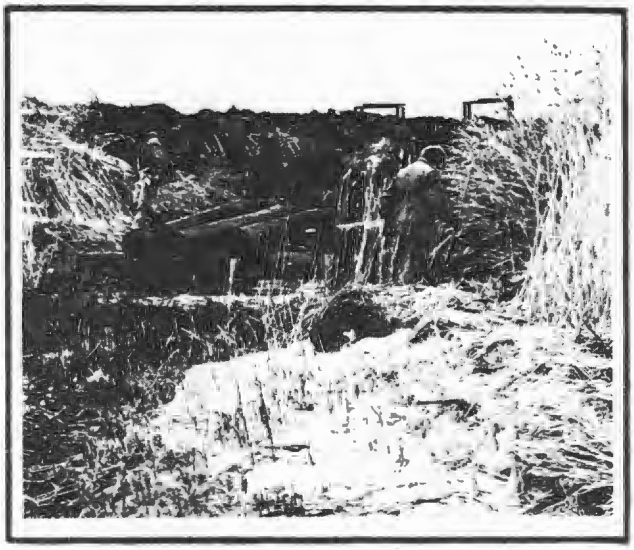


Fig.8: Examination of the bulldozed embankments along the shore area.

Fig.9: Subsurface testing of the bulldozed area along the bay.

Fig.10: Mapping and shovel testing of the sludge area in Section I.

Fig.11: Surface examination of the sludge area along the beach front; Section I.

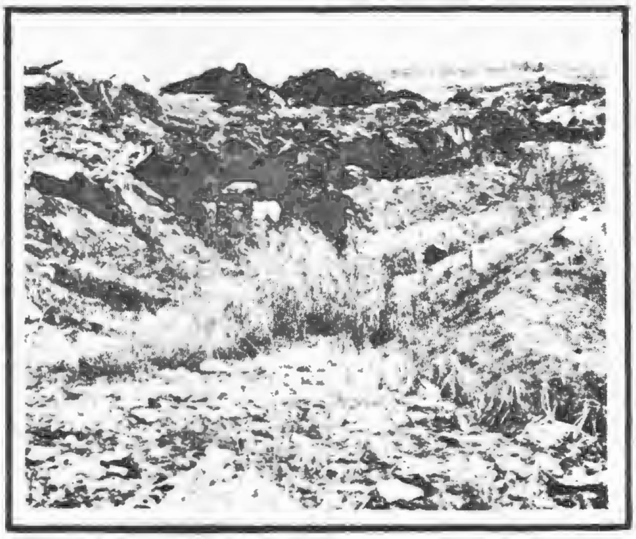


Fig.12: General view of the garbage area, showing the extent of the fill.

Fig.13: Surface examination of Section I. View of buried garbage.

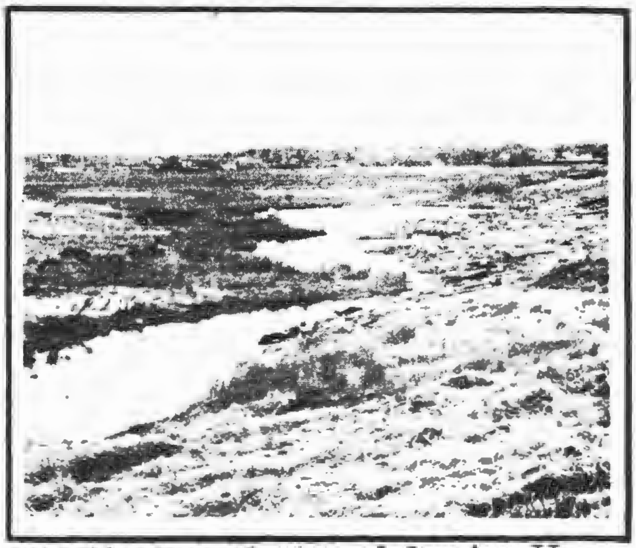


Fig.14: General view of Section II, showing the tidal marsh; fill area is to the right.

Fig.15: View of Ware Creek as it appears today.

Fig.16: Subsurface probing in marsh area; Section II.

Fig.17: Examination of stream embankment in Section III.

Fig.18: Subsurface examination of a previous excavation in Section III.

Participating Members of the Archaeological/Historical Survey Team

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Clerical and Graphics: Joan E. Kraft: Attended Archaeological Field School and has ten seasons of archaeological field experience including more than 30 Cultural Resources Surveys.

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Miss Gertrude Neidlinger and Mr. John Neidlinger, 57 Concrod Avenue, Leonardo, New Jersey. Local historians and officers of the Shoal Harbor Marine Museum, Belford, New Jerse.

Mr. C.F. Jablonski, Soil Conservation Service, Monmouth County, Freehold Office.

APPENDIX I

AIR QUALITY IMPACT ANALYSIS

A. CARBON MONOXIDE - INCREASED TRAFFIC ANALYSIS

The analysis of peak one-hour concentration of carbon monoxide resulting from the increase in vehicular flow at the Waterfront Area gate due to the proposed action is outlined below.

The time required to accomodate all vehicles wishing to use the gate is derived from the following expression:

$$T = V/C \tag{1}$$

where V is the volume of traffic passing through the gate (vehicles) and C is the maximum capacity of the gate (vehicles per hour). Substituting the appropriate values into the above expression (i.e., V = 200 vehicles and C = 2000) yields at T of 0.1 hour.

The following assumptions were made to determine whether the given operating parameters are capable of threatening the one-hour carbon monoxide air quality standard (35 ppm) in the vicinity of the auto-parks: (1) the lot's capacity is 200 vehicles, (2) access to the lot is made through one gate consisting of two lanes (five meters wide each) having the capacity of 1000 vehicles per hour, (3) the nearest reasonable receptor is 10 meters from the gate, and (4) the wind speed is one meter per second. The average one-hour concentration of carbon monoxide at the receptor is then determined by the following expression:

$$\chi_{1\text{-hour}} = (\chi_1 + \chi_2)\,T + \chi_{bgd} \tag{2}$$

where χ_1 and χ_2 are the component carbon monoxide concentrations at the receptor resulting from vehicles flowing through the gate's two lanes and χ_{bgd} refers to the background concentration level of carbon monoxide. These values are obtained by utilizing the appropriate relationships given by the EPA in the document "Interim Guidelines for the Review of the Impact of Indirect Sources of Ambient Air Quality," 1974, p. 65-67.

Substituting the appropriate values into the expression (2) above yields an average one-hour concentration at the receptor of 18.2 ppm, assuming the peak 1974 one-hour background concentration level of carbon monoxide is $\sim$ 13.1 ppm and 1974 automobile pollution controls are in effect. Since the source is scheduled to begin operation in some year other than 1974, peak carbon monoxide concentrations obtained by using the preceding procedures should be adjusted by the appropriate factor (given by the EPA) to correct the emissions rate over various years. If it is assumed that the auto-parks begin operation in the year 1979, the maximum one-hour concentration of carbon monoxide at the receptor may be 15.7 ppm.

B. OPERATION OF VESSELS

In order to assess the maximum possible concentration of air pollutants discharging during the hoteling of vessels, the mathematical dispersion modeling technique of Turner (1969) was used. The expression of the ground-level pollutant concentration along the plume centerline for sampling times of short duration (3-10 minutes) is:

$$\chi = \frac{Q}{\pi \sigma_y \sigma_z \bar{u}} \exp\left(-0.5(H_e/\sigma_2)^2\right) \qquad (3)$$

where:

χ = ground-level pollutant concentration, $\mu g/m^3$

Q = pollutant emission rate,

σ_y σ_z = standard deviations of plume concentration distribution in the horizontal and vertical directions, respectively, m

$\bar{u}$ = mean wind speed affecting the plume, m/s

He = effective plume height. Over relatively flat terrain it is the sum of the physical stack height (h) and the plume rise (ΔH) (m).

The rise of the plume from the vessel stack was computed according to Brigg's (1975) expression:

$$\Delta H = 2.4\left(\left(F/\bar{u}s\right)\right)^{1/3} \tag{4}$$

where:

Δ H = Plume rise, m

F = Buoyancy flux, m^4/sec^3

s = Restoring acceleration per unit vertical displacement for adiabatic motion in the atmosphere, sec^{-2}.

Pollutant emission rates for this study were obtained from values published by the EPA (1973).

The influence of mechanical turbulence around the vessel's superstructure can significantly alter the effective dispersion of the plume downwind. To account for the effect of aerodynamic downwash Turner suggests that the guassian plume model be modified by assuming binormal distributions of concentrations at the source. To estimate the concentration levels of pollutants for sampling times longer than a few minutes, Turner suggests that the best estimate apparently can be made from the following empirical relationship:

$$\chi_s = \chi_k (t_k/t_s)^P \tag{5}$$

where:

χ_s = the desired concentration estimate for the larger sampling period (t_s)

χ_k = the concentration estimate for the shorter sampling period (t_k)

p = factor having a value of ~ 0.2

The results of this analysis are presented in Table IV-9 of Chapter II and discussed in Section B.10.

C. TOTAL EMISSIONS - SHIP FUEL REPLENISHMENT SYSTEM

The following text documents the calculation of estimated hydrocarbon (HC) emissions which would result from the proposed ship fuel replenishment system. This analysis includes four 50,000 bbl tanks of marine diesel fuel, and two 50,000 bbl tanks of JP-5 jet fuel.

The methods recommended in the third edition of AP-42 (USEPA, 1973 and 1978) were used to calculate both the breathing and working losses from the tanks. The results given below apply to a fixed roof tank with a height and radius of 44.71 feet. The ambient temperature has been assumed to be $80^{\circ}F$; this temperature allows a conservative estimate to be used for vapor pressure (0.015 psia for diesel #2 and JP-5). A molecular weight of 130 was used for both fuels.

The breathing loss (L_B) for a fixed roof tank may be calculated from the following equation:

$$L_B = 2.21 \; 10^{-4} m \left[\frac{P}{14.7-P}\right]^{0.68} D^{1.73} \; H^{0.51} \; T^{0.50} \; F_P C K_c \qquad (6)$$

Table I-1 lists each variable in this equation, its description and value used in estimating the breathing loss for one 50,000 bbl tank. Using the values given in Table 1 the breathing loss for one 50,000 bbl tank is 5.658 tons/year, or a total of 33.95 tons/year for all six tanks (7.751 pounds/hour).

The working loss (L_W) is calculated from the following equation:

$$L_W = 2.40 \times 10^{-2} \ MP \ K_n \ K_c \tag{7}$$

where K_n is the turnover factor which is taken to be 1.0 (realistic based upon the number of turnovers in tank capacity per year) and the remaining variables retain the meaning and values given in Table I-1. On this basis the working loss was calculated to be 4.68 10^{-2} pounds/10^3 gal throughput. The total throughput of DFM and JP-5, based on monthly AOE receipts is estimated at 1.08 x 10^6 bbls or 45.4 x 10^6 gals per year. For this throughput, the total working loss, Lw, would be 1.06 tons per year of HC.

Hydrocarbon emissions from in berth AOEs were calculated using AP-42 emission factors. A conservative emission factor of 33 pounds per day (considering that base power is supplied to in-berth AOEs) and a residing of one AOE per year (also conservative). AOE in-berth HC emission is thus estimated to be 6.02 tons per year (1.374 pounds /hour). The hydrocarbon emissions due to traffic generated by the proposed changes to the NWS Earle were conservatively estimated by assuming a 20-mile round trip per day for 365 days for a total of 300 vehicles (maximum parking lot capacity). The emission factor used is a conservative volume of 6.9 grams per mile, representing a vehicle built in 1974 and operating in 1980; see supplement 8 of AP-42). The total yearly hydrocarbon emission is thus estimated to be 16.64 tons per year.

Thus total hydrocarbon emission resutling from the proposed action would be 57.67 tons per year:

TABLE I-1

Description of Variables Required to Calculate Breathing Loss
From a 50,000 BBL Tank

Symbol	Definition	Value Used	Degree of Conservatism
m	Molecluar weight	130	realistic
P	vapor pressure	0.015 psia	conservative (assumes ambient temperature of 80°F)
D	Tank Diameter	89.42 ft.	realistic
H	Average vapor space height	44.71 ft.	conservative (assumes that tank is almost empty on average)
ΔT	average ambient temperature change from day to night	20°F	realistic
F_p	paint factor	1.58	conservative (medium gray tank in poor condition)
C	adjustment factor for small tanks	1.0	realistic
K_c	crude oil factor	1.0	realistic

Ship Fuel Replenishment System	Tons per Year
Breathing Loss (L_B)	33.95
Working Loss (L_W)	1.06
AOEs In-Berth	6.02
Automobiles	16.64
Total	57.67

In addition, nitrogen oxide and carbon dioxide emissions are estimated at 7.24 tons and 199.7 tons per year, respectively using 3.0 gms per mile and 82.8 gms per mile emission factor for a 1974 car operating in 1980 (USEPA, 1978).

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APPENDIX J

OCEAN DISPOSAL OF DREDGED MATERIAL:

Geochemistry and Impacts of Heavy Metals

A. GEOCHEMISTRY

A.1 Geochemistry of Heavy Metals in Seawater

The impacts of potentially toxic metals such as copper, cadmium, chromium, lead, mercury and zinc during dredging and ocean disposal operations, are related to the physical, chemical and biological processes affecting metal cycling and removal.

Metal concentrations in seawater result from a balance between the rates at which metals are added to the ocean from the land and atmosphere, and the rates at which they are removed from the sea by incorporation into the sediments and uptake by biota, or by being returned to the atmosphere, e.g. in sea spray or as a volatile element (Hg). Unlike the major elements of sea water, metals are not conservative in sea water. This is partly because of their greater geochemical and biological reactivity, and partly because processes involving sorption and biological uptake of metals will produce a relatively greater effect since the metals occur at relatively low concentrations.

The chemical and physical form of a metal when introduced to sea water is important in determining the type and rate of removal. First, metals may occur in solution, and therefore, are readily available for various sorption processes and biotic uptake. Secondly, metals may be absorbed to the surfaces of suspended particulate matter and are subject to disorption and ion-exchange processes, which will mobilize the metals into the water column. These metals will consequently become readily available for various sorption processes and biotic uptake. Thirdly, metals may be associated with suspended organic material and metallic hydroxide precipitates or coatings on crystalline solids. These metals are less available to the water column since chemical changes; oxidative decomposition or reducing conditions, are required before they are released. Moreover, these particulates are subject to sedimentation processes whereby they are removed from the water column. Finally, metals may be held in lattice position within the minerals of suspended crystalline solids. These metals are generally assumed to be unavailable for mobilization to sea water and are rapidly lost from the water column by sedimentation processes.

A number of studies have reported that a large proportion of such metals as chromium, copper and lead introduced to the ocean from river runoff is associated with the suspended crystalline solids (Gibbs, 1973; Fitzgerald et al., 1973). However, a greater proportion of mercury appears to be associated with the organic component.

Little research has been done on the physical and chemical forms of metals introduced to sea water from sources other than river runoff, e.g. industrial and municipal effluents, atmospheric fallout and waste disposal. However, it is expected that a substantial portion of the metals occurs in the less-reactive organic phases and the non-reactive solid-phases. Moreover, the dissolved and colloidal metal species in these pollution sources become subject to various sorption processes, whereby the metals become associated with the suspended organic and inorganic particulate matter which sediment to the ocean floor. (It should be noted that desorption processes may become more significant, thereby resulting in increased concentrations of dissolved and colloidal species.)

Consequently, the geochemical balance of metals in the sea is controlled to a significant degree by sorption processes, such as co-precipitation, precipitation, organic complexation and adsorption and by the physical process of sedimentation. For example, Knauskopf (1956) reported that lead, copper, zinc, cadmium and other metals were undersaturated in sea water at equilibrium. The metals precipitated and existed in compounds of more abundant elements having similar ionic radius and charge, e.g. (Mn, Pb) O_2 for lead. When such substitution occurs, the trace metal will have an apparent solubility many times lower than if it existed as a pure compound.

The concentrations of metals in sediments is a function of several parameters: (1) grain size, i.e. the smaller the mean grain size, the larger the surface area available for surface adsorption; (2) minerology, i.e. the proportion of various minerals which affect adsorptive and desorptive, processes; (3) quantity of organic carbon, i.e. metal concentration increases with increase in total organic carbon; and (4) proximity to the source of the metal, e.g. elevated metal concentrations occur at or near dredge spoil and sewage sludge dumping sites (Carmody et al., 1973).

In addition, metal concentrations are affected by the chemical environment of the sediments, especially in terms of pH and redox potential. Since pH varies only slightly in the marine environment, redox potential is more important in regulating sorption-desorption processes.

In oxidizing environments, iron and manganese are removed from the water column especially in the formation of precipitates and ferro-mangenese nodules. Such metals as copper, lead, zinc and cadmium are strongly concentrated in these complexes by co-precipitation. In addition, adsorption processes involving iron and manganese hydrous oxide coating on particulate matter remove metals from sea water. However, an increase in redox potential may also result in the oxidative decomposition of organosulfur compounds of metals and subsequent dissolution of the metals in the aqueous phase.

Reducing (anoxic) conditions occur in regions where the bottom waters are dense and stagnant (during temperature stratification of waters), particularly if the productivity of the overlying surface waters is high. Anoxic waters commonly contain relatively high concentrations of iron and manganese which have sulfides that are comparatively soluble at neutral pH or higher. Other metals, e.g. copper, lead and zinc, have low-solubility sulfides and are therefore precipitated and thereby enriched in sediment. However, the dissolution of iron and manganese from the hydrous oxide phase into the overlying water may lead to the release of other adsorbed metals.

The resuspension of bottom muds (e.g. by storm activity) would favor the loss of metals by desorption through cation exchange or oxidation of organic matter. However, these dissolved species would then be subject to removal by suspended precipitates or to sulfide reprecipitation.

Only the upper few centimeters of sediment are able to exchange metals with the water column. Segar and Cantillo (1976) reported that the amount of copper and zinc in the water column of the New York Bight Apex is comparable to the amount in the upper one centimeter of sediment. Since the deposition rates in the Bight are generally low, and since some equilibrium exists between sediments and water, it was speculated that an appreciable fraction of copper and zinc and other metals added as dissolved contaminants must stay in solution until either taken up by organisms or physically transported out of the apex. It was estimated that these metals are removed from the apex only a little slower than the water column is flushed (approximately one week). Therefore, it was suggested that resuspension of sedimentary contaminants and transport of particulate material out of the apex must constitute a very efficient process.

A.2 Sediment Geochemical Processes

As in the water column, a metal can occur in a number of chemical and physical forms in bottom sediments. First, it may be present in the interstitial waters in dissolved or colloidal form. Secondly, metals may be sorbed to organic matter in the sediments. For example, humic substances have been found to be effective in the sorption of metals through chelation, cation exchange and surface adsorption (Rashid 1974; Nissenbaum and Swaine, 1976). Thirdly, metals may be sorbed to inorganic (mineral) constituents, e.g. adsorption and ion-exchange by such clay minerals as illite and montmorillonite (O'Connor and Kester, 1975; Hirst, 1962); and adsorption or co-precipitation in solid solution by hydrous oxides of iron, manganese and aluminum, including ferromanganese nodules (Murray, 1975; Stumm and Morgan, 1970). Metals may also be precipitated as insoluble sulfides and other compounds during reducing conditions. Finally, a large proportion of metals are combined structurally in the lattices of clay minerals (Hirst, 1962).

Interstitial waters are considerably enriched in metals compared to the overlying sea water (Presley et al, 1972; Lindberg and Harriss, 1974). This enrichment is principally due to the formation of soluble organic and polysulfide complexes with the metals, especially under reducing conditions. Other processes, such as desorption, ion-exchange and solution, can release metals into interstital waters.

Once a metal is released into interstitial water, upward migration can occur by two main mechanisms (Riley and Chester, 1971). First, an upward transfer of entrapped water will occur due to the compaction of sediments at depth. Secondly, ionic diffusion along a concentration gradient will occur from interstitial waters having higher metal concentrations to the overlying sea water. The extent to which metals are mobilized prior to migration is governed largely by the redox potential and pH of the environment.

A.3 Biotic Uptake

Biotic uptake is also a major factor controlling the geochemical balance of metals. Living cells are capable of taking up metals from solution against a concentration gradient as demonstrated by many marine organisms, which contain trace metals at concentrations as high as 10^6 times their sea water concentrations. The order of affinity of organisms for metals is species specific. For example, Bowen (1966) found the order of affinities for marine plankton and brown algae to be Zn Pb Cu Cd and Pb Zn Cu Cd, respectively. Pringle et al (1968) reported that the apparent affinities for trace metals among various molluscan species depend upon concentrations available in the environment, physiochemical properties of each element, organic ligands available for chelation, stability of metal-organic legands formed, and processes of transport and storage. The affinity of organisms for metals is also organ specific. For example, the concentration factors for cadmium in the shell, muscle and digestive gland of the scallop Pecten maximus have been found to be 10, 16,000 and 5 x 10^6, respectively (Riley and Chester, 1971).

When the organisms die, bacterial degradation returns metals to the water, perhaps initially in the form of organic complexes. Further decomposition of these complexes liberates ionic and colloidal species of the metals. Therefore, a general recycling of the metals occurs in the marine environment.

However, a net loss of metals does occur from the sea through biological activity, since resistant and incompletely decomposed parts of some organisms reach the sea floor and are incorporated into the sediments. Some bacterial decomposition of these organic materials occurs in the upper layers of the sediment resulting in the enrichment of the interstitial waters with metals. From these waters, the metals may return to the sea or be incorporated in the sediment, probably by adsorption or co-precipitation of the ferromanganese phases.

A.4 Summary

In conclusion, spatial and temporal variations occur in the metal levels of the three major compartments of the marine ecosystem, i.e. water, sediment and biota. For example, Harris (1976) reported that a maximum chromium to zinc ratio in the sediments of the New York Bight Apex occurred between late Spring and early Fall due to preferential adsorption of organic chromum chelates from solution by organic mud substrates or zinc uptake by phytoplankton or bacteria. The minimum annual chromium to zinc ratio was attributed to the dissolution of manganese and iron-hydroxides releasing adsorbed zinc and chromium, or the oxidation of the organosulfur compounds of the two metals at nearly equal rates. Therefore, it is evident that trace metals can be cycled and incorporated into the compartments by a number of mechanisms. The importance of each mechanism varies for each metal.

B. IMPACTS

B.1 Release of Heavy Metals During Dredge and Disposal Operations

During dredging and ocean disposal operations, of great concern is the exchange of metals between the sediments and the water column, with the subsequent effect on water quality and potential for uptake by the biota. The direction of metal migration depends greatly on the prevailing pH and redox conditions and the chemistry of both the sediment and water.

A number of studies have evaluated the direct and indirect effects of redox potential (Eh) and pH on the migration of metals to and from the water column during dredging and aquatic disposal of dredge materials (or during their simulation by the Elutriate Test). In general, the transport of reduced sediments to an oxygenated environment results in some release of trace metals. These releases are relatively small and temporary. For example, during experimental disposal of metal-contaminated dredge spoils in San Francisco Bay, short-term (of 1.5 hour duration) increases in dissolved cadmium, copper and lead concentrations (but not chromium, mercury or zinc) were observed in water samples collected from within the spoil plume (U.S. COE 1975 b). In certain instances, dredging activities apparently reduce the metal content of surface waters that contact the suspended sediments, since colloidal clay particles derived from the dredged sediments may absorb metals from the surrounding water (Gustafson, 1972).

In addition to changes in pH and redox potential, the physiochemical forms and species of the metals present in the sediments are important in determining the magnitude and direction of exchange of metals between the sediments and water column. Selective analytical procedures have been developed such that metals in sediments can be extracted from different phases as a function of the analytical procedure and the physiochemical nature of the specific metal. These metal phases include; (1) metals dissolved in interstitial water, (2) adsorbed on sediment material (exchangeable phase), (3) occluded or co-precipitated with iron and manganese hydrous oxides (easily and moderately reducible phases), (4) bound with organic matter and sulfides (organic and sulfide phase) and (5) bound in the crystalline mineral lattices (residual phase). Therefore, quantitative knowledge of the selective distribution of metals in dredged sediments can aid in determining the relative availability of these chemicals to the water column during dredging operations, their availability to biological communities, and their availability to enter into chemical reactions.

In general, as pH decreases, metal solubility increases. pH is not expected to be a factor in metal release during the dredging and disposal of the NAVFAC dredge sediments, since the pH of the waters at the dredging and disposal sites is high and similar.

Changes in redox potential are expected to have a more significant effect on metal exchange between the sediments and the water column. During dredging and disposal operations, the mixing of large quantities of oxygenated surface water with reduced sediments and interstitial water can potentially affect redox potential and subsequently the solubility of trace metals.

Chen et al (1976) reported that a sudden release of metal to sea water occurs during the first hour of sediment dispersion, followed by subsequent removal from solution, either gradually, as has often been found in reducing environments or immediately, as under slightly oxidizing environments. Under reducing conditions, trace metals are removed by precipitation as metal sulfides. Under oxidizing conditions, the metals in reduced sediments; (1) readsorb to the organic matter and to oxides of iron and manganese; or (2) precipitate, co-precipitate or form complex metal compounds. It was noted that the release of cadmium, copper, lead and zinc (in the ppb range) increases as the environment becomes more oxidizing. No significant release occurred for chromium and mercury.

Gambrell et al (1977) reported that, in general, a moderately low redox potential environment favors the relatively bioavailable soluble and exchangeable chemical forms of metals while sparingly soluble, oxidized compounds predominate at higher oxidation levels. Metal precipitation as insoluble sulfide occurs under strongly reducing conditions, while the formation of discrete metal oxides and hydroxides of low solubility or metal adsorption to colloidal iron and manganese oxides occurs under oxidizing conditions (with neutral and alkaline pH). Brannon et al (1976a) reported that the concentration of reduced iron in the interstitial water and exchangeable phases had a significant inhibiting effect upon the amount of trace metals released into an elutriate and it was anticipated that the same effect would occur in the water column during aquatic disposal of metal-contaminated dredge spoils.

Metal complexation with soluble and insoluble organic matter occurs at all levels of redox potential (Gambrell et al 1976). Chelate formation with soluble organic compounds may enhance heavy metal solubility to levels considerably greater than the concentration of soluble free ions. Conversely, complexation with insoluble organics is an important sink for many metals.

Brannon et al (1976 a) reported that the mobility of the more easily extracted phases, coupled with the immobility of metals in the moderately reducible phase and residual phase demonstrated that the physical-chemical form of bound metals was a greater factor than total metal concentrations in determining the mobility of metals into the standard elutriate. This is indicated by the fact that no relationship occurred between trace metal concentrations in the standard elutriate and the total sediment metal concentrations in the standard elutriate and the total sediment metal concentrations as well as the metal concentrations in the moderately reducible phase and the residual phase.

Metals in the interstitial water would be expected to be immediately mobile. High concentrations of metals can develop in the interstitial waters of sediments even rich in sulfides. It is believed that the formation of soluble metal organic complexes is responsible for the high metal levels even when sediments are in a reduced state and contained high levels of sulfides. However, when organic complexes migrate from an environment that is reducing into one that is oxidizing, the metals in the complexes will tend to precipitate. Exchangeable phase and easily reducible phase metals although not initially in solution in the sediments are subject to mobilization. Finally, metals associated with the organic and sulfide phase would be expected to be relatively immobile. However, metal sulfide oxidation and release of metals can occur. Sulfide oxidation can proceed rapidly when oxygen is present, but metals released into solution would be expected to be rapidly absorbed by sediment solid phases with high cation adsorption capacity.

Research carried out on the effects of pH and redox potential as well as the physiochemical nature of the metals in the sediments on the release of specific metals during dredging and aquatic disposal operations are summarized below:

a. Cadmium

Brannon et al (1976 a,b) reported no release of cadmium (above background levels) during elutriate tests. The highest cadmium levels in the sediments were in the organic and sulfide phase and the residual phase. Much lower concentrations were presented in the interstitial phase and the easily reducible phase.

Gambrell et al (1976) reported that redox potential and pH greatly influenced the levels of readily available cadmium. Therefore, a typically reduced dredged sediment when exposed to an oxidizing environment for a sufficiently long time may release much of its potential bioavailable cadmium. Segar and Cantillo (1976) reported that high cadmium concentrations, but no zinc or copper were generally observed in near bottom water at a station nearest to the designated dredge material disposal site. It was speculated that these high concentrations were caused by the disposal of dredged material.

b. Copper

Brannon et al (1976 b) reported that copper was not released in significant amounts into the elutriate. Copper occurred mainly in the residual phase and the organic and sulfide phase of sediments. Copper in the organic and sulfide phase increased in concentration as the total copper concentration of the sediment increased, suggesting that this phase acts as a sediment sink for copper. A high correlation between organic and sulfide phase copper and copper levels in the overlying water supports this theory.

Gambrell et al (1976) reported that changes in pH and redox potential result in little increase in readily bioavailable copper. Copper readily associates with the hydrous oxides precipitates of iron and manganese during oxidizing conditions.

c. Lead

Gambrell et al (1976) reported that changes in the sediment chemical environment had little effect on soluble lead. Redox potential had little influence on exchangeable lead levels. As in the case of copper, lead concentrations associated with precipitated hydrous oxides of iron and manganese increased with increase in oxidation level.

d. Mercury

Gambrell et al (1976) reported that soluble mercury was strongly influenced by pH and redox. The reducible mercury concentrations increased with increase in oxidation level, as was the case for copper and lead. Sediment organics, however, were the major regulating factor in reduced as well as oxidized environments. Mercury-organic chelate complexes may become less stable as the sediment material is oxidized.

e. Zinc

Brannon et al (1976 a,b) reported high concentrations of zinc in test elutriates, but suggested that this may be due to the release of zinc with dissolution of iron and manganese hydrous oxides during reducing conditions. When dissolved oxygen status is controlled, very little zinc release occurred (Lee et al 1976).

Gambrell et al (1976) reported that there was not a great release of zinc at any pH-redox potential combination. In general, zinc solubility decreased, as pH was increased. Under reducing conditions, insoluble zinc sulfide formation is predominant.

Brannon et al (1976 a,b) reported that the highest zinc levels occurred in the organic and sulfide phase and the interstitial water phase of sediments. (The concentration of zinc in the residual phase was not determined, but is expected to be high). The zinc concentration in the elutriate was correlated with easily reducible zinc and organic and sulfide zinc.

APPENDIX J

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APPENDIX K

CRANEY ISLAND, VIRGINIA-AOE HOMEPORT ALTERNATIVE

The Craney Island Naval Supply Center is located on the Elizabeth River approximately four to five miles southwest of the waterfront area of NS Norfolk (Figure V-7). Immediately adjacent and to the north of the fuel replenishment facilities at the Supply Center is a dredge material disposal area owned and operated by the U.S. Army Corps of Engineers.

This disposal area is surrounded by two levees; an outer levee at approxi mately +7 feet mean sea level (MSL) and an inner levee, approximately 1,000 feet inland, at approximately +17 feet MSL. The area (about 2,500 acres) is estimated to have a capacity of 125 million cubic yards of dredge materials. Under current rates of disposal, the site should reach capacity by 1979. The U.S. Army Corps of Engineers, (1975d) has decided to extend the project life of the area by raising the inner and outer levees to +17 feet MSL and +29 feet MSL respectively. This action would extend the life of the project to approximately 1989. At present this area contains no weapons handling or other facilities.

A. PHYSICAL ENVIRONMENT

This area is completely disturbed. It is located adjacent to the Elizabeth River and the Hampton Roads Harbor at the edge of the low-lying terrain of the Coastal Plain. Except for improved navigation channels, water depths of less than 20 feet fringe the Chesapeake Bay area.

The estuary system in this area is well mixed and shows evidence of slight pollution comparable to other areas of the Bay. However, heavy metal contamination (lead and zinc) shows some increase in the immediate vicinity of the disposal area. (USACOE, 1975d).

B. BIOLOGICAL ENVIRONMENT

The disposal area is a unique low level habitat to which tolerant birds, small mammals, plants and insects have become adapted.

Aquatic systems are slightly stressed, especially benthic communities which reflect bottom sediment contamination in these silty areas. (USACOE, 1975d).

C. MAN-MADE ENVIRONMENT

The regional aspects of the man-made environment are as outlined for NWS Yorktown. In the immediate vicinity of the Craney Island disposal area existing land use is not intense. Immediately adjacent to the fill area is U.S. Government property composed of the U.S. Naval Supply Center and an access strip which has become part of the Craney Island Project. A new U.S. Coast Guard facility is located south of the supply depot on Craney Creek. The fill area is isolated from most contiguous private development.

The closest neighborhood of Portsmouth to Craney Island is Merrifields. It lies to the south and west of the project and is one of 21 neighborhoods which Portsmouth has delineated for statistical and planning purposes in conjunction with its comprehensive planning process. To the east of Merrifields is West Norfolk. These two neighborhoods, lying between the proposed Western Freeway and the Federal property and water to the north, would be those most directly affected by the future use of Craney Island.

Although adjacent to one another, these areas have marked development differences. West Norfolk is primarily industrial. Merrifields is a low density, higher-income residential section. Density is approximately 1,100 persons per square mile, or two dwelling units per acre. The housing is relatively new, ranging in price from $15,000 to $50,000 and in excellent condition. However, one section known as Twin Pines, contains about 50 houses which are more than 75 years old. This section shows signs of dilapidation and deterioration. No industrial development, except for several neighborhood commercial facilities is present. River Shores subdivision, bordering Hampton Roads, is near the fill area and contains high quality single family homes. Churchland Junior High School and its adjoining recreation facilities serve an area population of somewhat under 2,500.

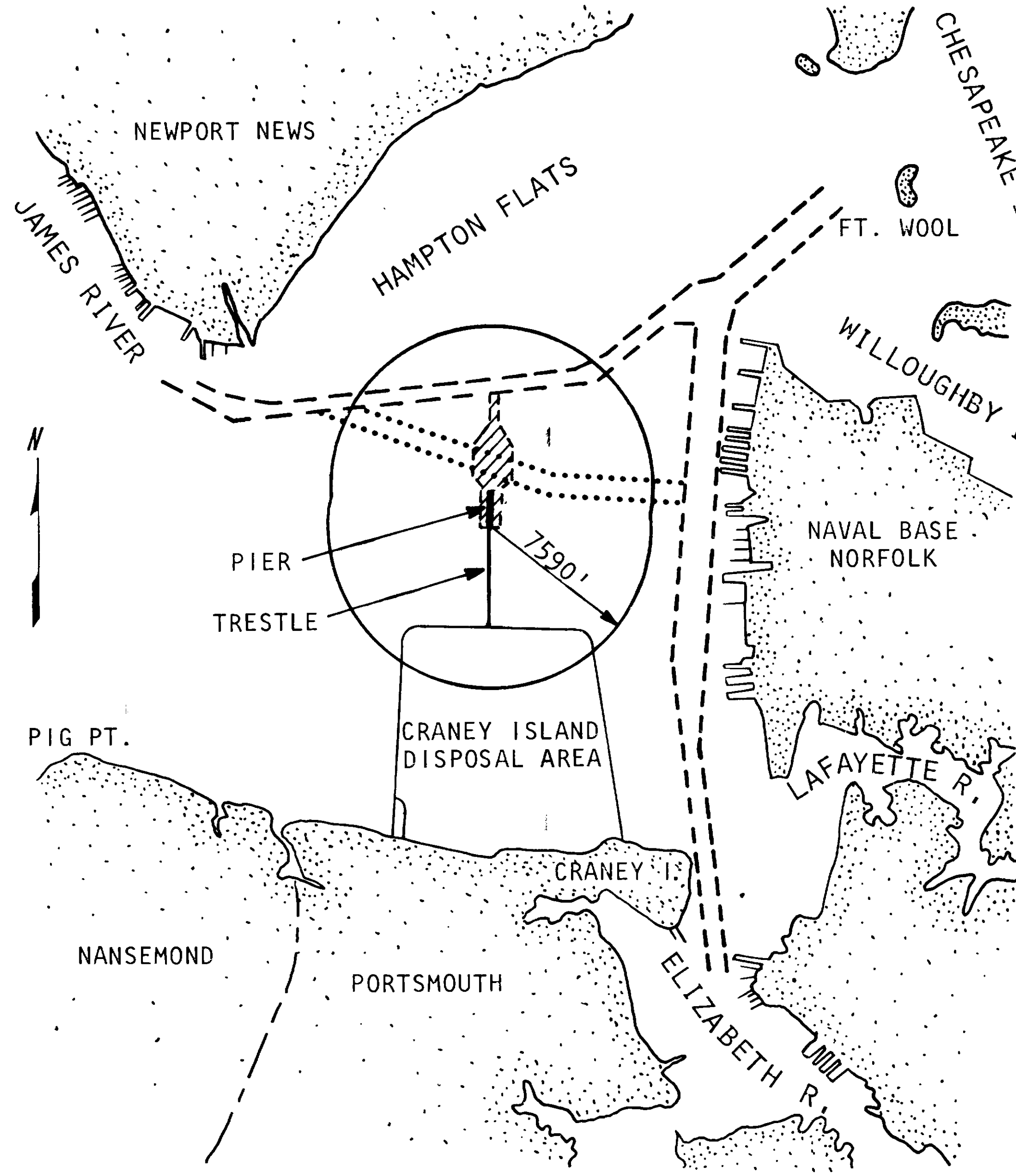
Merrifields and West Norfolk have plans for residential and industrial development. As previously mentioned, existing development in Merrifields is primarily residential, while West Norfolk is primarily industrial and governmental. Large vacant tracts exist in both neighborhoods and the comprehensive plan calls for future development in these areas to follow the existing pattern.

Upon completion, the Craney Island Disposal Area would be appropriate for a variety of uses in addition to the proposed AOE homeport. Its size, configuration, and location, and the availability of outstanding rail, highway and waterborne transportation network have brought forth numerous suggestions for eventual development of the Craney Island Disposal Area. Included among the ideas are seven alternative developments: an airport, a government center, housing, industry, port facilities, recreation, or a wildlife area. With more than 2,500 acres ultimately available, it appears that there certainly could be a combination of these suggestions in one development plan.

D. AOE HOMEPORTING REQUIREMENTS

Figure K-1 depicts a conceptual layout of pier facilities for AOE homeport adjacent to the Craney Island disposal area. Homeporting facilities would involve the following components:

- Acquisition and development of approximately 250 acres of the Craney Island Disposal area for these waterfront facilities. In addition, approximately 260 acres adjacent to the pier area will



CURRENT PROJECT DEPTH - 45'

AOE HOMEPORT ALTERNATIVE
CRANEY ISLAND, VIRGINIA

4000 0 4000 8000 12000

SCALE IN FEET

KEY:

SAFE EXPLOSIVE DISTANCE FOR INHABITED BUILDINGS- 2 AOEs

AREA TO BE DREDGED (-47 MLW)

SHALLOW-DRAFT FAIRWAY

DREDGED CHANNELS

FIGURE K-1

fall within the ESQD arch and will have to be acquired for Navy control.

- Access road, about two miles long;
- New pier and trestle;
- Pier utilities and waste collection;
- Dredging for an approach channel and turning basin of approximately six to seven million cubic yards;
- Parking for 400 cars; and
- Other shore support facilities, such as intermediate maintenance facilities, battery recharge, sheds, etc.

Under this alternative, refueling would be accomplished at the adjacent Craney Island Fuel Depot. NWS Yorktown would not act as homeport, but would continue to provide explosives supplies to the AOEs, either directly at the Yorktown pier or by barge or helicopter transport to the AOEs at Craney Island to top off their cargo. In those instances, expected to be infrequent, when barging is deemed inefficient and when the AOE contains a full-load of oil, unloading of some of the fuel at Craney Fuel Depot would be necessary for draft clearance for the trip to NWS Yorktown. With explosives supply completed, the AOEs can homeport with a full fuel cargo in a safe explosive setting at the Craney Island Disposal area.

E. IMPACTS OF AOE HOMEPORTING

This site offers many potential advantages as an AOE homeport site. It is situated in close proximity to deep water channels with ready access to the sea. No relocation of AOE crews would be necessary as existing residential areas are within commuting distance. The AOEs would be closer to the Fleet. With the exception of ship hotel services, all other support could be obtained at NS Norfolk.

Of the alternative sites for fully-loaded AOE homeports, the Craney Island alternatives involves the least dredging and the least impact from the combined dredging and disposal operations. Furthermore, disposal is not a problem as it is for the NWS Charleston and NWS Yorktown sites. Dredged material can be pumped directly onto the Craney Island disposal area.

While there are several proposals for the ultimate disposition of the disposal area, it is presently vacant. Therefore, a safe explosive environment can be established now, and protected against future encroachment.

A shallow draft fairway which crosses from Newport News Channel to Newport Harbor Reach Channel, as well as a number of explosive anchorages in the Harbor, would be displaced if this alternative were implemented. The major dredged channels would not be encumbered by the ESQD are for ship channels (4555 feet for two AOEs). An increased area of restricted navigation would be imposed around the new pier and trestle as at the proposed NWS Earle piers.

APPENDIX L

LABORATORY BIOACCUMLATION STUDY OF PROJECT DREDGED MATERIALS

A. INTRODUCTION

The U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA) have published a guidance document, Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Water (USEPA/USACOE July 1977 and April 1978). On February 15, 1979, the U.S. Army Corps of Engineers, New York District in conjunction with USEPA Region II issued Guidance for Performing Tests on Dredged Material to be Disposed of in Ocean Waters. The regional guidance (USACOE, February, 1979) identifies specific procedural items such as selection of bioassay organisms, chemical constituents required to be analyzed in bioaccumulation tests etc. The evaluation of previous (1977 and 1978) bioassay testing and chemical analysis following the Implementation Manual is presented in Appendix F and discussed in Section IV.C.2 of the Draft Environmental Impact Statement. This addendum reports the results of the bioaccumulation tests following the New York District's February, 1979 guidance document.

B. FIELD PROGRAM

Six short borings (four with lengths of 15 feet and two of 10 feet) were drilled in the muddy bottom areas of the proposed terminal channel and turning basin (Figure 1) on April 19 and 20, 1979. Upper portions of cores consisted of dark silt and graded to sandy silt and silty sands at depth.

Reference sediment required for the bioassay/bioaccumulation testing was collected from an area east of the Ambrose Channel as recommended by the U.S. Army Corps of Engineers, New York District.

Position navigation was measured using a Del Norte Trisponder (Range - Range) Radio Positioning System. Optical visual techniques were used to locate the reference stations. Trisponder ranges for the six boring locations are presented in Table 1.

Sample collection and preservation were performed as specified in the Implementation Manual (USEPA/USCOE, 1977 & 1978). A composite sample of the borings were prepared by combining the continuous sampling from 5-feet Osterberg tubes (3" O.D.). Samples were stored on ice and delivered for laboratory testing on April 20, 1979.

C. LABORATORY TESTING PROCEDURES

At the laboratory, core samples were throughly mixed to provide a composite test sample. The solid phase bioassay/bioaccumulation test was conducted according to accepted procedures (USEPA/USACOE, 1977 and 1978; USEPA, 1976a; USEPA, 1978a and 1978b). The organisims used in the solid phase bioassay were Nereis virens (polychaete worm), Mercenaria mercenaria (clam) and Palaemonetes pugio (shrimp).

Liquid phase chemical tests were run for mercury, cadmium, DDT and PCB in accordance with EPA approved procedures. Two runs were made, one utilizing laboratory prepared salt water as part of the routine for preparing the bioassay test material, and one utilizing dredge site water as recommended in the New York District Guidance (February, 1979).

D. RESULTS

The results of the solid phase bioassay are presented in Table 2 for Mercenaria, Nereis and Palaemonetes. The results of bioaccumulation testing for mercury, cadmium, DDT, PCB and petroleum hydrocarbons for Mercenaria, Nereis and Palaemonetes are provided in Tables 3, 4 and 5, respectively. The results of liquid phase (filtered elutriate) chemical tests for mercury, cadmium, DDT and PCB for the April, 1979 composite, using laboratory salt mixture and dredge site water are presented in Table 6. For comparison, the results of earlier chemical analysis, from 1977 and 1978 sampling and testing, are also presented in Table 6.

D.1 Significant Mortality

No significant mortality was found in any of the solid phase bioassay tests (Table 2). Survival was 100 percent for Merceneria and Palaemonetes and 99 percent for Nereis. This is consistent with two earlier solid phase bioassays as reported in the DEIS Appendix F and Section IV.C.2.

D.2 Sublethal Effects

Observation of organism activities (feeding, burrowing, etc.) were noted throughout the 10-day bioassay period for signs of impaired functions as indications of sublethal impacts. These observations indicate no sign of impaired functions or sublethal effects (Aqua Survey, May 30, 1979).

D.3 Bioaccumulation

a. Cadmium - An analysis of variance was conducted to determine if the cadmium levels recorded in the three species represent a significant increase at the 95th percent confidence interval. The procedure followed is that recommended in USEPA/USACOE Implementation Manual (EPA/COE, 1977 and 1978). The results of this analysis indicate that at the 95th percent confidence interval, no significant differences exist between cadmium levels in the controls compared to the dredge samples and thus uptake is not indicated.

b. Mercury - No significant uptake is indicated for mercury, with both controls and dredge specimens below detection limits.

c. PCB - Significant differences in the levels of PCB were noted in tests of *Nereis* only (Table 4). Levels of PCB in *Merceneria* and *Palaemonetes* in all cases were below detection limits.

d. DDT - No uptake is indicated for DDT; all results were below detection limits.

e. Petroleum Hydrocarbons - Significant differences occur in the levels of petroleum hydrocarbons between control and test dredge material specimens for all three species, with highest levels recorded in the worm, *Nereis* and lowest levels in the shrimp, *Palaemonetes*.

D.4 Water Quality of Elutriate

Chemical analysis of the liquid phase elutriate has been conducted a number of times in conjunction with the resampling due to project changes etc.

(See Appendix F for details). The results of these analysis for mercury, cadmium, DDT and PCB are presented in Table 6. The July, 1978 and April, 1979 samplings represent the project as presently defined. The levels of PCB reported for the April, 1979 sample using a laboratory salt water mix are much higher (to 2.1 ppb) than other test results, including those measured on the same April, 1979 composite sample using dredge site water for the mixture.

Based on this comparison, it is concluded that high values (1.7, 2.1 and 2.0 ppb) for the PCB levels in the May 30, 1979 results are anomalous. This is also supported indirectly by the results of the bioaccumulation data for <u>Palaemonetes pugio</u> discussed below. Previous tests (USEPA, 1976b) showed accumulation factors for a specific PCB (Aroclor 1254) of 3.2×10^3 to 11×10^3 above PCB levels of the test water concentrations. The fact that no PCB were detected (above 0.04 ppm) for <u>Palaemonetes pugio</u> in the present test suggests that the test water had concentrations below 0.012 ppb. This conclusion is compatible with most of the elutriate test results.

E. DISCUSSION

The "state-of-the-art" on use of laboratory bioaccumulation tests as a predictive tool to assess whether disposal of dredged material is likely to cause a meaningful elevation of contaminants in the body tissue of marine organisms is presently in the early stages of development.

These laboratory procedures, by their nature, cannot quantitatively incorporate the real differences that are known to exist between the laboratory conditions and actual field conditions. For instance, considerations of mixing as a result of disposal operations cannot be treated through the laboratory bioaccumulation results, as required by the ocean dumping regulations.

Other considerations that must be considered in the overall assessment of the bioaccumulation results include: (USEPA/USACOE, 1977, 1978)

- Tissue concentration of most constituents in most species cannot be quantitatively related to biological effects.

- The magnitude of bioaccumulations shown.
- The toxicological significance of the material (s) bioaccumulated.
- The proportion of sediment sampling sites which produced uptake.
- The number of different constituents bioaccumulated.
- The position in the human and non-human food chain of the species showing uptake.
- The presence of motile species at the site that might serve as transportation vectors removing bioaccumulated materials from the disposal area.

In the present laboratory bioaccumulation tests, only two constituents, PCB and petroleum hydrocarbons, showed statistically significant increases in tissue levels over the control organisms. The fact that PCB has shown accumulation is cause for concern. However, of the three organisms tested, only the polychaete (worm) Nereis showed any increase of PCB above detectable limits (ranging from 0.21 to 0.89 ppm). The polychaete worm is a burrower and represents a lower trophic level in the food chain. The bioaccumulation exhibited by Nereis could be due to its association with the sediment. Whereas the fleshy parts of both Mercenaria and Paleomonetes are not normally in contact with the sediment, the polychaete being a burrower becomes physically surrounded with sediment. Additionally Nereis will ingest sediment while feeding. All or most of this ingested sediment should be purged during the two day cleansing period following the test. This process however may take longer than two days, and it is possible that sediment may be included in the test results.

As discussed above, the toxicological significance of this level of PCB uptake is not known. The present limit placed by the Food and Drug Administration (FDA) on restrictions on edible tissue for fish is 5.0 ppm. Effective August 28, 1979, the FDA tolerance limit will be reduced to 2.0 ppm (Federal Register, Vol. 44, No. 127, June 29, 1979).

Presumably, transfer of PCBs from the polychaete Nereis would be through the food chain. However, sufficient data is not available to predict the extent or magnitude of such a transfer. However, a qualitative indication for this possibility can be gained by reviewing available data on PCBs in the lower Hudson estuary. The levels of PCB for various fish, including bottom dwelling summer and winter flounder, for Raritan Bay and adjacent areas for 1975 data are presented in Table 7 (Sandy Hook Marine Fisheries Laboratory, 1979). Presumably these levels reflect the combined effects of bioaccumulation from bottom sediments in Raritan Bay. Such levels may reflect the general level to be expected should these sediments be exposed at the ocean floor of the dredged material disposal site. In addition, some mixing and dispersal to lower levels may be expected due to the dumping operation.

Composite samples for summer and winter flounder taken from Raritan Bay ranged from 0.067 to 1.341 ppm. Of all the species listed in Table 7, one of the more motile striped bass one composite average for eels and one for blues in Raritan Bay showed levels above the new FDA 2.0 ppm limit for edible tissue.

The relatively low levels for the summer and winter flounder may be an indication of the overall low levels available and/or the lack of significant transfer to higher trophic levels through feeding. These flounders feed on bottom organisms such as polychaetes, crustaceans, some molluscs and fish. The composite averages of flounders taken within the Earle Channel are even lower than for the Bay in general (0.067, 0.081 ppm for flounders).

The major source of PCB contamination for the New York Harbor is from upstream in the Hudson River. Surface sediment concentrations of PCB range from 3 to 5 ppm for upper New York Harbor. Surface sediment PCB levels are not available for Raritan Estuary sediments, but they would be expected to show lower levels than those for the upper Harbor which are closer to the source of contamination.

Some insight into the potential bioaccumulation impacts that might result from the disposal of the project dredged materials comes from field data on bioaccumulation from other disposal operations involving sediments contaminated with PCBs. The river sediments of Duwamish River, Seattle, Washington were contaminated with PCB. Average levels of PCB were 2.05 ppm (range from 0.01 to 6.98 ppm) and levels of PCB in elutriate tests ranged from 0.012 to 0.439 ppb (Pavlou et al., 1978). These elutriate levels are comparable to those obtained for the Navy project dredged materials. The disposal site for the Duwamish River sediments was located in Elliott Bay, Puget Sound.

Some of the field bioaccumlation studies at the disposal site in Elliott Bay are not conclusive due to the limited number of animals (for sea cucumber, English sole, sport shrimp and pink shrimp) and the magnitude of the variations in background levels of PCB in this area which is located directly downstream from a polluted river (Tatem and Johnson, 1978). Comparison of PCB levels at the disposal site and adjacent reference sites show no obvious changes in PCB levels in selected marine animals as a result of disposal of PCB-laden dredged material. Since English sole and pink shrimp collected at the reference and disposal site prior to dredging already contained substantial amounts of PCBs and the variation between samples was significant, the effects from disposal could not be separated from fluctuations between samples. However, spot shrimp caged at the disposal site for 3 days during dumping did not accumulate PCBs to significant levels above background. In addition, sea cucumber exposed for up to 3 weeks after disposal closed showed no change in PCB levels (Tatem and Johnson, 1978). Mussels, also held in cages for up to 3 weeks following disposal, did not accumulate PCBs to levels that were statistically significant (at the 95th percent confidence level) above background levels.

Thus, although the laboratory bioaccumulation levels of PCB in the polychaete Nereis for the project dredged material are of concern, the lower position of Nereis in the food chain, the lack of uptake in the other tested organisms, the qualitative comparisons of PCB levels in the project area fauna, the generally impoverished condition of the benthic ecosystem at the disposal site (Section II.D.7 of DEIS), the lack of accountability for the mixing process in the tests, and the results of field bioaccumulation studies of the disposal of PCB-contaminated sediments, suggests that significant ecologic harm due to bioaccumulation would not result from the disposal of these dredged materials.

Little is known about the bioavailability and toxicity to benthic animals of sediment adsorbed petroleum hydrocarbons. Uptake of petroleum hydrocarbons in marine organisms may result in tainting of edible species and/or accumulation of potentially carcinogenic polycyclic aromatic fractions into marine food chains (Hyland and Schneider, 1976). The major route of accumulation of the more toxic aromatics would appear to be through the water column and sediment exposures (Whipple, et al., 1973). Exposure of some animals, particularly filterfeeding bivalves, to as little as 1 ppb dissolved petroleum hydrocarbons can result in tainting, and humans can taste petroleum hydrocarbons in animal tissue at concentrations between 5 and 50 ppm.

Fish may be more resistant to toxic effects of oil than other organisms since their surfaces are coated with mucous which acts as an oil repellent.

The uptake levels in the test species (less than 1 ppm for the shrimp Palaemonetes; to 8 ppm for the clam Mercenaria and to 26 ppm for the polychaete worm Nereis) indicates a potential exists for tainting due to bioaccumulation of the bottom dwellers, especially the burrowers. The extent of significant ecological impacts of these levels of accumulation is not presently known.

The reported uptake of petroleum hydrocarbons in Nereis and Palaemonetes did not appear to alter these organisms habits. Records of organism activity during the 10-day solid phase testing indicated that the polychaete burrowed actively and that the shrimp were seen swimming quite normally. Additionally, both organisms were seen actively feeding. Sublethal concentrations of petroleum hydrocarbons have, however, been shown to supress growth rates, retard development of sexal maturity or egg maturation, increase or decrease respiratory response, cause anaesthesis and narcosis, interfere directly with reception of chemical cues, and interfere with feeding, nutrition and communication. Identification of sublethal effects such as these were not attempted during this study.

Exposure of polychaetes to sediments contaminated with oil results in the ingestion of some of the hydrocarbon with subsequent metabolism to different hydroxylated derivaties. Studies by Rossi (1976) indicate that Nereis succijea and N. virens metabolized these hydroxylated and conjugated product during oxidation reactions and they were subsequently excreted. Polychaete burrowing and reworking of the sediment can enhance microbial action of the hydrocarbon adsorbed to the sediment. Rossi (1976) has shown that third generation worms exposed to fuel oil are more resistant to oil than the first generation animals because of the presence of higher levels of hydrocarbon degrading enzymes. These enzymes are found in the lower portion of the intestines of these polychaetes.

Various species of crab, shrimp and lobster can take up petroleum hydrocarbons from either the water or their food. In the blue crab, most of the hydrocarbons are not assimilated into body tissues but rather passed down the intestinal tract and eliminated in the feces. Cox et al. (1975) have found that, after exposure to various polycyclic aromatic hydrocarbons, shrimp and crabs are able to completely depurate after 10 days. Since Palaemonetes was allowed to purge for only 1.5-2.0 days in this test, results of petroleum hydrocarbons in body tissues may have been negligible had the depuration period extended for 10 days.

In summary, although uptake of petroleum hydrocarbons were evident in the shrimp, Palaemonetes pugio, the clam, Mercenaria mercenaria and the polychaete, Nereis, the testing technique measuring hydrocarbons also included biogenic hydrocarbons which are important to the survival of an organism, and did not provide information on the more toxic aromatic hydrocarbons and cycloparaffins. Evidence exists that most hydrocarbons enter molluscs, crustaceans and fish via gill membranes, and that various organisms exposed to ambient water with lower concentrations do not retain high levels of petroleum hydrocarbons.

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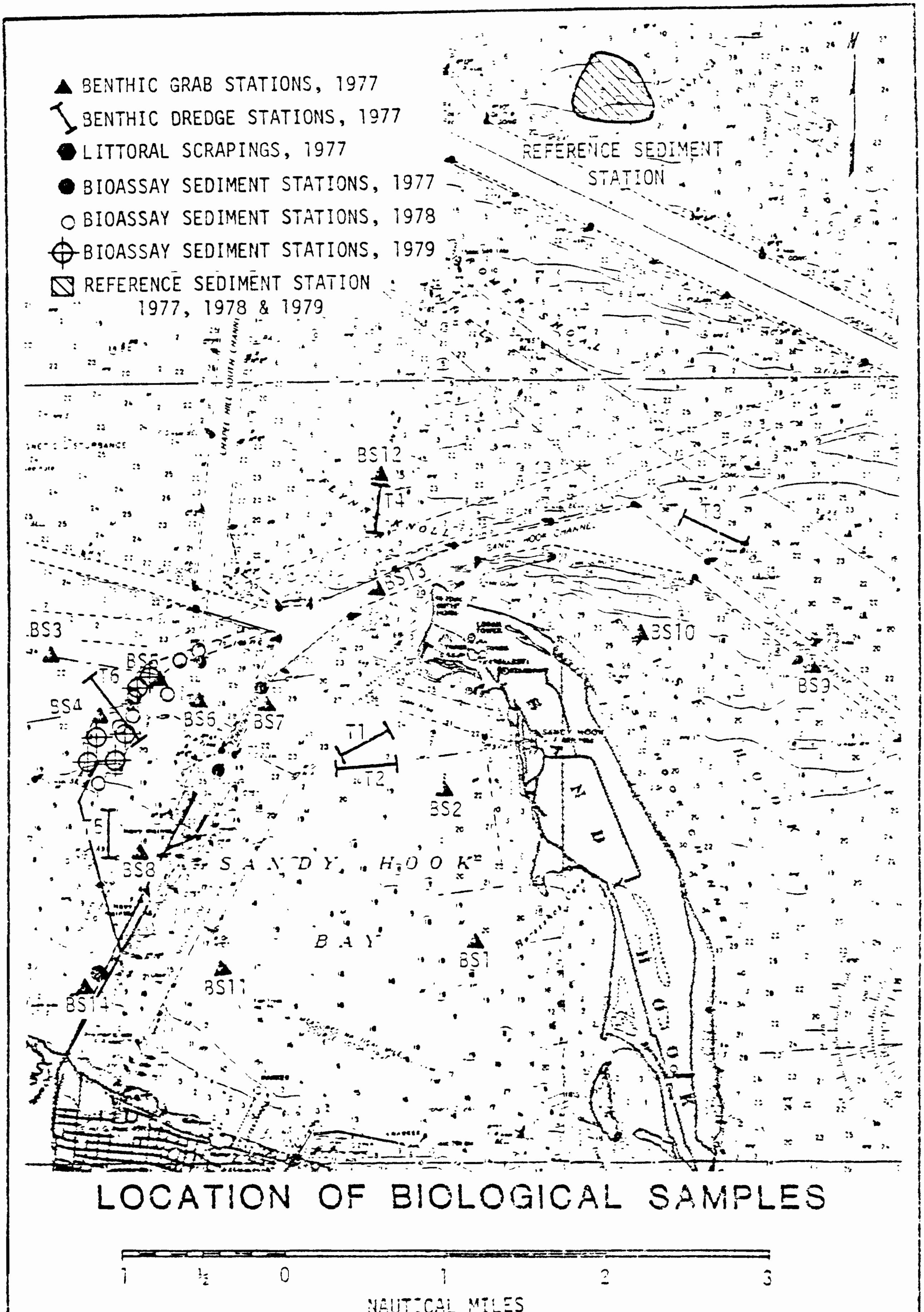

LOCATION OF BIOLOGICAL SAMPLES

FIGURE 1

TABLE 1

LOCATION OF BORINGS

Boring Number	Transponder Code 1[a]	Range Centimeters Code 2[b]
B-5	3144	4315
B-6	3456	4549
B-7	3775	4672
B-8	4152	5035
B-9	3633	4610
B-10	3938	4920

[a]Code 1 - Show Station Location in Sandy Hook Point Beacon - Offset

x 2,180,332.80 x East

y 597,082.18 y North

[b]Code 2 - Ft. Hancock Flag Pole - Offset

x 2,183,804.95

y 593,379.15

TABLE 2

SOLID PHASE BIOASSY RESULTS

Mercenaria mercenaria

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment	1	20	20	100
	2	20	19	95
	3	20	20	100
	4	20	20	100
	5	20	20	100
Total		100	99	99
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
Total		100	100	100

Nereis virens

Exposure Condition	Replicate	Organisms Seeded	Organisms Recovered	Percent Survival
Reference Sediment	1	20	19	95
	2	20	20	100
	3	20	20	100
	4	20	19	95
	5	20	20	100
Total		100	98	98
Dredge Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	19	95
	5	20	20	100
Total		100	99	99

(TABLE 2 - Continued)

Palaemonetes pugio

Exposure Condition	Replicate	Organisms Seeded	Organism Recovered	Percent Survival
Reference Sediment	1	20	19	95
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
Total		100	99	99
Dredged Material	1	20	20	100
	2	20	20	100
	3	20	20	100
	4	20	20	100
	5	20	20	100
Total		100	100	100

Source: Aqua Survey, May 30, 1979

TABLE 3

BIOACCUMULATION DATA FROM SOLID PHASE - MERCENERIA

Sample		Cd (ppm)	Hg (ppb)	PCB (ppm)	DDT (ppm)	Pet. Hydro. (ppm)
control	1	<0.25	<0.2	<0.04	<0.02	<0.1
control	2	0.41	<0.2	<0.04	<0.02	<0.1
control	3a	0.30	<0.2	<0.04	<0.02	<0.1
control	3b	0.34	<0.2	<0.04	<0.02	<0.1
control	3c	0.37	<0.2	<0.04	<0.02	<0.1
control	4	<0.25	<0.2	<0.04	<0.02	<0.1
control	5	<0.25	<0.2	<0.04	<0.02	<0.1
sample	1	0.51	<0.2	<0.04	<0.02	5.8
sample	2	0.48	<0.2	<0.04	<0.02	4.2
sample	3a1	0.35	<0.2	<0.04	<0.02	3.7
sample	3b1	0.32	<0.2	<0.04	<0.02	3.0
sample	3c1	0.31	<0.2	<0.04	<0.02	3.2
sample	3a2	0.37	<0.2	<0.04	<0.02	<0.1
sample	3b2	0.38	<0.2	<0.04	<0.02	<0.1
sample	3c2	0.31	<0.2	<0.04	<0.02	<0.1
sample	4	<0.25	<0.2	<0.04	<0.02	6.3
sample	5	0.75	<0.2	<0.04	<0.02	8.1

Notes: Three sub-samples of Sample 3 in control and dredged sample (a, b, and c) were run to evaluate analytical precision.

These sub-samples of the dredged sample were also redigested and re-extracted (a2, b2 and c 2) to determine the percent recovery of the original extraction a1, a2 and a3.

Source: Aqua Survey, May 30, 1979

TABLE 4

BIOACCUMULATION DATA FROM SOLID PHASE - NEREIS

Sample		Cd (ppm)	Hg (ppb)	PCB (ppm)	DDT (ppm)	Pet. Hydro. (ppm)
control	1	0.31	<0.2	<0.04	<0.02	<0.1
control	2	0.28	<0.2	<0.04	<0.02	0.2
control	3a	<0.25	<0.2	<0.04	<0.02	0.1
control	3b	<0.25	<0.2	<0.04	<0.02	0.2
control	3c	<0.25	<0.2	<0.04	<0.02	0.2
control	4	0.38	<0.2	<0.04	<0.02	0.3
control	5	<0.25	<0.2	<0.04	<0.02	0.1
sample	1	0.42	<0.2	0.89	<0.02	25.6
sample	2	0.52	<0.2	0.76	<0.02	24.3
sample	3a1	0.45	<0.2	0.62	<0.02	19.5
sample	3b1	0.40	<0.2	0.55	<0.02	15.0
sample	3c1	0.35	<0.2	0.49	<0.02	16.3
sample	3a2	0.28	<0.2	<0.04	<0.02	<0.1
sample	3b2	0.25	<0.2	<0.04	<0.02	<0.1
sample	3c2	0.25	<0.2	<0.04	<0.02	<0.1
sample	4	<0.25	<0.2	0.21	<0.02	21.5
sample	5	<0.25	<0.2	0.68	<0.02	26.0

Notes: Three sub-samples of Sample 3 in control and dredged sample (a, b and c) were run to evaluate analytical precision.

These sub-samples of the dredged sample were also redigested and re-extracted (a2, b2 and c2) to determine the percent recovery of the original extraction in a1, a2 and a3.

Source: Aqua Survey, May 30, 1979

TABLE 5

BIOACCUMULATION DATA FROM SOLID PHASE - PALAEMONETES

Sample		Cd (ppm)	Hg (ppb)	PCB (ppm)	DDT (ppm)	Pet. Hydro. (ppm)
control	1	<0.25	<0.2	<0.04	<0.02	<0.1
control	2	0.28	<0.2	<0.04	<0.02	<0.1
control	3a	0.29	<0.2	<0.04	<0.02	<0.1
control	3b	<0.25	<0.2	<0.04	<0.02	<0.1
control	3c	<0.25	<0.2	<0.04	<0.02	<0.1
control	4	0.48	<0.2	<0.04	<0.02	<0.1
control	5	0.27	<0.2	<0.04	<0.02	<0.1
sample	1	0.35	<0.2	<0.04	<0.02	0.4
sample	2	<0.25	<0.2	<0.04	<0.02	0.9
sample	3a1	<0.25	<0.2	<0.04	<0.02	0.6
sample	3b1	<0.25	<0.2	<0.04	<0.02	0.7
sample	3c1	<0.25	<0.2	<0.04	<0.02	0.7
sample	3a2	<0.25	<0.2	<0.04	<0.02	<0.1
sample	3b2	<0.25	<0.2	<0.04	<0.02	<0.1
sample	3c2	<0.25	<0.2	<0.04	<0.02	<0.1
sample	4	0.42	<0.2	<0.04	<0.02	0.3
sample	5	0.30	<0.2	<0.04	<0.02	0.8

Notes: Three sub-samples of Sample 3 in central and dredged sample (a, b and c) were run to evaluate analytical precision.

These sub-samples of the dredged sample were also redigested and re-extracted (a2, b2 and c2) to determine the percent recovery of the original extraction a1, a2 and a3.

Source: Aqua Survey, May 30, 1979

TABLE 6

CHEMICAL ANALYSIS OF SEDIMENT ELUTRIATE

		Mercury (ppb)	Cadium (ppb)	DDT (ppb)	PCB (ppb)
April, 1979 [a] Composite with Dredge Site Water	1	<0.01	1.6	<0.05	0.27
	2	<0.01	1.7	<0.05	0.35
	3	<0.01	1.8	<0.05	0.20
April, 1979 [b] Composite with Laboratory Salt Water Mixture	1	0.3	0.2	<0.05	1.7
	2	0.4	0.3	<0.05	2.1
	3	0.4	0.3	<0.05	2.1
October, 1977 [c] Sample	1	3.0	<1.0	<0.1	<0.1
	2	1.0	<1.0	<0.1	<0.1
	3	4.0	<1.0	<0.1	<0.1
July, 1978 [d] Sample	1	<1.0	<1.0	<1.0	<1.0
	2	<1.0	<1.0	<1.0	<1.0
	3	<1.0	<1.0	<1.0	<1.0

Source:

a - Aqua Survey, May 11, 1979
b - Aqua Survey, May 30, 1979
c - Pedneault Assoc., December, 1977
d - Pedneault Assoc., August, 1978

TABLE 7

PCB LEVELS IN FAUNA OF RARITAN BAY AND ADJACENT AREAS

Source/ Date Rec'd	Species	No. Individuals	PCB in ppm
NMFS/NWURC 24 1X 75	Striped bass	12 fish; 2-7 pounds; Romer Light, Raritan Bay	11 fish ranging from 0.644 to 1.820 in edible tissue; one fish 17.2 ppm.
NMFS/NWURC 24 1X 75	Striped bass	one fish; diseased off Long Branch	0.368 in edible tissue
NMFS/NWURC 15 Oct. 75	Spot	6 fish; Earle Channel, Raritan Bay	Average of 0.533 in composite sample
NMFS/NWURC 15 Oct. 75	Summer Flounder	11 fish; Raritan Bay	Average of 0.032 in in composite sample
NMFS/NWURC	Summer Flounder	5 fish; Earle Channel	Average of 0.067 in composite sample
NMFS/NWURC 15 Oct. 75	Winter Flounder	7 fish; Earle Channel	Average of 0.181 in composite sample
NMFS/NWURC	Winter Flounder	6 small (60-165 mm) fish; Raritan Bay	Average of 0.373 in composite sample
NMFS/NWURC 15 Oct. 75	Winter Flounder	6 large (220-495 mm) fish; Raritan Bay	Average of 0.144 in composite sample
NMFS/NWURC 15 Oct. 75	Lobster	3; Earle Channel	Average in: tail meat 0.178, claw meat 0.225, "liver" 7.450
FDA, N.J. 19 XII 75	Eels	10 from Raritan Bay (Frozen)	Average of 3.32 in composite sample
FDA, N.J. 19 XII 75	Eels	10 from Raritan Bay (Live)	Average of 1.80 in composite sample
FDA, N.J. 19 XII 75	Eels	10 from Raritan Bay (Live)	Average of 1.46 in composite sample

(TABLE 7 - Continued)

Source/ Date Rec'd	Species	No. Individuals	PCB in ppm
FDA, N.J. 19 XII 75	Snapper blues	10 from Raritan Bay	Average of 3.09 in composite sample
FDA, N.J. 19 XII 75	Weakfish	10 from Raritan Bay	Average of 0.63 in composite sample
FDA, N.J. 19 XII 75	Winter/ summer Flounder	12 of each in composite; Raritan Bay	Average of 1.34 in composite sample

Source: NMFS/NEFC, 1979