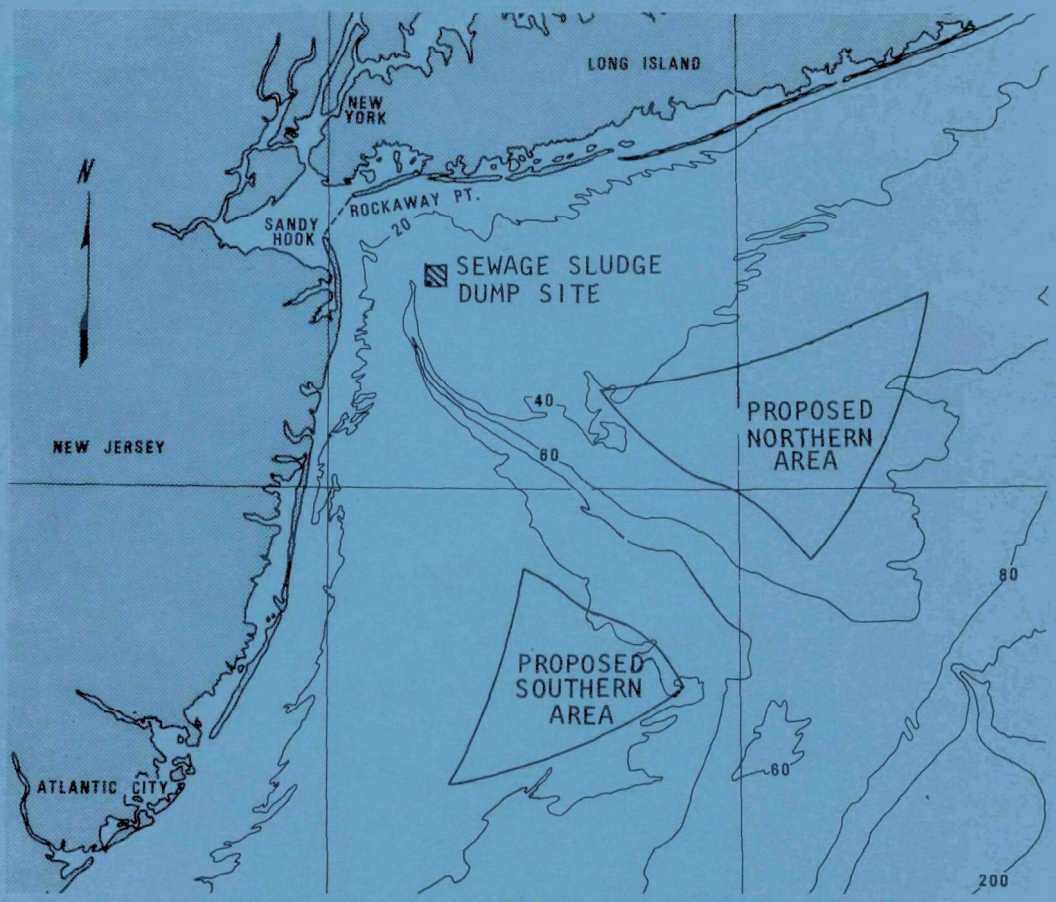
EPA-2-NY,NJ-OCEAN DUMPING-76

ENVIRONMENTAL IMPACT STATEMENT ON THE OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT

DRAFT

FEBRUARY 1976



U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION II

26 FEDERAL PLAZA

NEW YORK, NEW YORK 10007

ENVIRONMENTAL IMPACT STATEMENT

ON THE

OCEAN DUMPING OF SEWAGE SLUDGE

IN THE

NEW YORK BIGHT

DRAFT

FEBRUARY 1976

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Contract No. 68-01-2834

TABLE OF CONTENTS

Chapter	Title	Page
I	SUMMARY	1
II	BACKGROUND	22
	A. The New York Bight	22
	1. Geographic Description of the New York Bight	22
	2. Existing Dump Sites in the New York Bight	25
	B. Ocean Dumping of Sewage Sludge in the New York Bight	27
	1. Wastewater Treatment and Sewage Sludge.	27
	2. Current Sources	29
	3. Dumping Vessels	40
	4. Future Sources	43
	C. Ocean Dumping at Other Sites in the New York Bight	50
	1. Dredged Material Site	50
	2. Cellar Dirt Site	54
	3. Acid Wastes Site	55
	4. Wreck Site	56
	5. Chemical Wastes Site	56
	D. Overview of Pollutant Loading in the New York Bight	58
	1. Suspended Solids	61
	2. Carbonaceous Materials	61
	3. Heavy Metals	61
	4. Nitrogen and Phosphorous	62
	5. Microbial Contamination	62
	E. Federal Legislation and Control Programs	63
	1. The Marine Protection, Research, and Sanctuaries Act of 1972 (PL92-532)	63
	2. Related Legislation	64

TABLE OF CONTENTS (Continued)

Chapter	Title	Page
	3. EPA Ocean Dumping Permit Program.....	65
	4. COE Dredged Material Permit Program....	69
	5. USCG Surveillance Responsibilities.....	69
	6. FDA Responsibilities.....	72
	F. International Considerations.....	74
	1. United States Laws.....	74
	2. International Agreements.....	75
	3. Proposed United States Legislation.....	76
	G. Other Activities in the New York Bight.....	78
	1. Commercial Fishing.....	78
	2. Recreational Uses.....	80
	3. Navigation.....	82
	4. Potential Mineral Resources.....	82
	5. Potential Deepwater Ports.....	87
	6. Potential Offshore Islands.....	88
III	DETAILED DESCRIPTION OF THE PROPOSED ACTION.....	89
	A. History of the Proposed Action.....	91
	B. Proposed Northern and Southern Areas.....	94
	C. Cost of the Proposed Action.....	96
	D. Relationship to Other Dumping Activities in the New York Bight.....	97
	E. Relationship to Other Activities in the New York Bight.....	98
IV	DESCRIPTION OF THE ENVIRONMENT.....	99
	A. Study Program.....	99
	1. Study Areas.....	99
	2. Data Collection.....	102
	B. Physical Oceanography.....	104
	1. Hydrographic Characteristics.....	104
	2. Currents.....	110

TABLE OF CONTENTS (Continued)

Chapter		Title	Page
	C.	Biological Oceanography	124
		1. Benthos	124
		2. Fisheries Resources	128
		3. Plankton	139
		4. Coliform Contamination, Antibiotic Resistant Bacteria, and Diseases of Marine Resources	141
	D.	Geological Oceanography	147
		1. Geomorphology	147
		2. Surficial Sediments	150
		3. Suspended Particulate Matter	151
		4. Northern Area	156
		5. Southern Area	160
	E.	Chemical Oceanography	168
		1. Heavy Metals	168
		2. Dissolved Oxygen	169
		3. Nutrients	175
		4. Organic Carbon	180
		5. Chlorinated Hydrocarbons	184
		6. Summary	188
V.		ALTERNATIVES TO THE PROPOSED ACTION	189
	A.	Land-Based Alternatives	189
		1. Land Application	190
		2. Incineration	191
		3. Pyrolysis	191
		4. Sale as a Soil Conditioner or Fertilizer	192
		5. ISC Conclusions	192
	B.	Ocean Dumping Alternatives	194
		1. No Action - Use of the Existing Dump Site	194
		2. Proposed Action - Immediate Use of an Alternate Dump Site	199
		3. Phased Action - Continued Use of the Existing Dump Site and Future Use of an Alternate Site	201
		4. Dumping Methodology	202

TABLE OF CONTENTS (Continued)

Chapter	Title	Page
VI	FATE OF SEWAGE SLUDGE DUMPED AT THE PROPOSED AREAS	205
	A. Settling and Dispersion in the Water Column	205
	1. Bulk Density	206
	2. Settling Velocities	206
	3. Modeling Results	207
	B. Resuspension	211
	1. Storm Waves and Currents	212
	2. Internal Waves	212
	3. Bottom Currents	213
	C. Chemical Equilibria and Biological Oxidation	214
	1. Heavy Metals	214
	2. Organic Matter	217
	D. Comparison to Other Dump Sites	217
	1. Philadelphia Dump Site	217
	2. Dump Sites in Other Waters	220
	E. Summary	220
VII	IMPACTS OF THE PROPOSED ACTION	222
	A. Impacts on Public Health and Water Quality	222
	1. Swimming	223
	2. Shellfish	224
	3. Floatables	225
	4. Hazards to Navigation	226
	B. Impacts on the Ecosystem	228
	1. The Benthos	229
	2. Fisheries Resources	232
	3. Plankton	235
	4. Short Dumping	237
	5. Potential for Recovery	239

TABLE OF CONTENTS (Continued)

Chapter	Title	Page
	C. Economic Impacts	241
	1. Sludge Transportation Costs	241
	2. Commercial Fishing	246
	3. Mineral Resource Development	248
	4. Loss of Sewage Sludge as a Potentially Valuable Resource	250
	D. Impacts With Respect to Other Dumping Activities in the New York Bight	254
	1. Dredged Material	254
	2. Wrecks	254
	3. Other Dumping Activities	255
	E. Miscellaneous Impacts	256
	1. Potential Impact on Marine-Related Recreational Activities	256
	2. Effect on Population Growth in the New York-New Jersey Metropolitan Area	256
	3. International Legal Implications	257
VIII	ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSED ACTION BE IMPLEMENTED	259
IX	RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	261
X	IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED	264
XI	CONCLUSIONS AND RECOMMENDATIONS	266
	A. Summary of General Background	266
	B. Comparative Evaluation of a Northern or Southern Alternate Dump Site and the Existing Dump Site	269

TABLE OF CONTENTS (Continued)

Chapter	Title	Page
	C. Conclusions Regarding the Continued Use of the Existing Sewage Sludge Dump Site.....	272
	D. Conclusions Regarding Dumping Further Offshore at Either Alternate Dump Site Area.....	274
	E. Conclusion Regarding Selection of a New Sewage Sludge Dump Site.....	276
	F. Recommendations.....	276
	ABBREVIATIONS USED.....	281
	METRIC EQUIVALENTS OF ENGLISH UNITS.....	284
	BIBLIOGRAPHY.....	285
	APPENDICES	
	Appendix A - Sample form: Marine Protection, Research, and Sanctuaries Act (Ocean Dumping) Permit.....	303
	Appendix B - Interstate Sanitation Commission Phase 1 Report: Chapter III. Conclusions and Recommendations.	315
	Appendix C - National Oceanic and Atmospheric Administration Marine Ecosystems Analysis Draft Report: Chapter I. Summary, Conclusions, and Recommendations.....	327

LIST OF TABLES

Number	Title	Page
1	Existing Dump Sites In and Adjacent to the New York Bight	26
2	Treatment Practices of Ocean Dumping Permittees (1975)	31
3	Average Characteristics of Ocean Dumped Sludge (1973)	32
4	Heavy Metal Characteristics of Ocean Dumped Sludge	34,35
5	Volumes of Waste Dumped at Sites In and Adjacent to the New York Bight (1960 to 1975)	37,38
6	Volumes of Sewage Sludge Dumped in the New York Bight (1973 to 1975)	39
7	Sludge Dumping Vessels Permitted for Use in the New York Bight	41,42
8	Future Treatment Practices of Ocean Dumping Permittees (1981)	45
9	Volumes of Sewage Sludge Estimated for Dumping in the New York Bight	47,48
10	Comparison of Dredged Material and Sewage Sludge Mass Loads	52
11	Total New York Bight Loads by Source	59
12	Ocean Dumping Orders in the New York Bight	68
13	Commercial Fisheries Landings in the New York-New Jersey Metropolitan Area (1973)	79
14	Commercial Shellfish Landings in the New York-New Jersey Metropolitan Area (1973)	81
15	Beach Ownership and Use in the New York-New Jersey Metropolitan Area	83
16	Beach Attendance at State and National Parks in the New York-New Jersey Metropolitan Area (1974)	84

LIST OF TABLES (Continued)

Number	Title	Page
17	Predicted Maximum Average Velocities of Upper, Middle, and Lower Tidal Currents in the Northern Area	112
18	NOAA-MESA Current Meter Deployments: Water Depth and Location in Water Column	116
19	The Common Fisheries Resources of the New York Bight	129
20	Concentrations of Dissolved Heavy Metals in the Water Column of the New York Bight	170
21	Concentrations of Heavy Metals in the Sediments of the New York Bight	171
22	Loading of Heavy Metals in the Bight Apex	172
23	Sources of Oxidizable Carbon in the Bight Apex	174
24	Dissolved Oxygen Levels at the Northern Area	176
25	Nutrient Concentrations in the New York Bight	178
26	Chlorinated Hydrocarbons in the Sediments of the New York Bight	187
27	Model Results of Transport and Dispersion of Sewage Sludge at the Northern (60 m Depth) and Southern (50 m Depth) Area	209
28	Release from Sludge of Heavy Metals in Seawater	215
29	Fleet Hauling Capacity	242
30	Sludge Hauling Costs	244
31	Comparison of Alternative Sewage Sludge Disposal Methods for the Metropolitan Area	252
32	Comparative Evaluation of a Northern or Southern Alternate Dump Site and the Existing Dump Site	270,271

LIST OF FIGURES

Number	Title	Page
1	The New York Bight	23
2	Bight Apex and Existing Dump Sites	24
3	Waste Dumping in and Adjacent to the New York Bight	36
4	Sources of Pollutants in the New York Bight	60
5	Navigational Lanes and Proposed Deepwater Ports and Offshore Islands in the New York Bight	85
6	Potential Mineral Resources in the New York Bight	86
7	Location of Existing and Proposed Dump Site Areas in the New York Bight	90
8	Study Areas and Subareas	100
9	Mean Monthly Percentages of Annual Discharge for the Hudson and Connecticut Rivers	105
10	Late Winter Temperature-Salinity Profile at Subarea 1A(R)	107
11	Late Summer Temperature-Salinity Profile at Subarea 1A(R)	109
12	Tidal Currents at Lightship Stations, Montauk Point to Barnegat Bay	111
13	Mean Spring Surface Currents in the New York Bight	115
14	General Residual Current Along the Bottom of the New York Bight	117
15	Mean Spring Bottom Currents in the New York Bight	119
16	Benthic Faunal Types in the Mid-Atlantic Bight	125
17	Surf Clam Distribution in the New York Bight (1965)	133
18	Surf Clam Distribution in the New York Bight (1969)	134

LIST OF FIGURES (Continued)

Number	Title	Page
19	Surf Clam Distribution in the Mid-Atlantic Bight (1974)	135
20	Ocean Quahog Distribution in the Mid-Atlantic Bight (1974)	136
21	Sea Scallop Distribution in the Mid-Atlantic Bight (1975)	137
22	Area Closed to Shellfishing in Vicinity of Sewage Sludge Dump Site	143
23	Geomorphic Elements of the Mid-Atlantic Continental Shelf	148
24	Percentage of Mud in Bottom Sediments of the New York Bight	152
25	Schematic Model of Suspended Particulate Matter Distribution on the Continental Shelf	154
26	Bathymetry and Sample Locations for Subarea 2D1	157
27	Geophysical Tracts	158
28	Mean Grain Size of Bottom Sediments in Subarea 2D1	159
29	Percentage of Gravel in Subarea 2D1	161
30	Percentage of Mud in Bottom Sediments from Subarea 2D1	162
31	Percentage of Gravel in Bottom Sediments of Subarea 2D2	164
32	Mean Grain Size in Bottom Sediments of Subarea 2D2	165
33	Mesoscale Bedforms	167
34	Percentage of Total Organic Carbon in New York Bight Sediments	181

LIST OF FIGURES (Continued)

Number	Title	Page
35	Distribution of Carbon/Nitrogen Ratios in New York Bight Sediments	183
36	Distribution of TCH/TOC Ratios in New York Bight Apex Sediments	185
37	Coliforms in Long Island Coastal Waters	196
38	Coliforms in New Jersey Coastal Waters	197
39	Typical Transport and Dispersion of Sewage Sludge in Ocean Waters	210
40	Bottom Areas Affected at Existing Sewage Sludge Dump Sites in the Mid-Atlantic Bight	219
41	Sludge Transportation Costs	245
42	Recommended Alternate Dump Site	278

ENVIRONMENTAL IMPACT STATEMENT ON THE OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT

I. SUMMARY

DATE: February 1976.

TYPE OF STATEMENT: Draft.

RESPONSIBLE FEDERAL AGENCY: U.S. Environmental Protection Agency - Region II.

TYPE OF ACTION: Administrative.

OVERVIEW:

Since the early 1900's, the sewage sludge generated at municipal wastewater treatment plants in the New York-New Jersey metropolitan area has been disposed of by dumping it in the ocean. Some of the older treatment plants in the metropolitan area provide only primary wastewater treatment. These plants will have to be upgraded to provide at least secondary treatment, as mandated by the Federal Water Pollution Control Act Amendments of 1972. One of the effects of upgrading will be an increase in the volume of sludge that must be disposed of.

The existing sewage sludge dump site is located in the section of the Atlantic Ocean known as the New York Bight. Currently, about 4 million cu m (5.2 million cu yd) of sewage sludge are dumped here every year. The volume of sludge to be dumped will steadily increase. By 1981 it is expected to be double what it is in 1976.

Concern over the possible effects of dumping greatly increased volumes of sludge at the existing dump site led EPA to consider the need for a new dump site farther out in the Atlantic. The EPA had already stated its intention to completely phase out ocean dumping of sewage sludge by 1981, provided that acceptable land-based disposal methods could be substituted. Still, it was not known whether the existing site could accommodate the sludge to be dumped in the interim. Therefore, in 1974 EPA proposed that a new ocean dump site be designated for use until sludge dumping could be replaced by environmentally, technically, and economically viable land-based disposal methods.

The EPA took this step as a precaution against any possible public health effects that might result from overtaxing the existing dump site. The next step was to determine whether such a precaution was necessary, and if so, whether the proposed action was the best possible way of preventing public health hazards and coastal water quality degradation. To accomplish this, an in-depth evaluation of the proposed action and the alternatives to it was undertaken. The conclusion of this in-depth evaluation was that EPA's proposed action was environmentally unnecessary, and might in fact be more environmentally damaging than taking no action whatsoever. This environmental impact statement (EIS) explains how that conclusion was arrived at.

Based on the information reported in this EIS, EPA has made a preliminary decision not to go ahead with the pro-

posed action. Instead, EPA now recommends: 1) continued use of the existing dump site, 2) a comprehensive monitoring program for the existing dump site, and 3) designation of an alternate dump site that can be used if and when the monitoring program indicates that the existing site cannot safely accommodate any more sewage sludge.

The EPA no longer supports its originally proposed action, that is, designation and immediate use of a new dump site. Nevertheless, this alternative is referred to throughout the EIS as the proposed action. It was only through the reports and studies connected with this EIS that the originally proposed action was discredited. All of these reports and studies took as their starting point EPA support for the proposed action, and the EIS reflects that perspective.

DESCRIPTION OF THE PROPOSED ACTION:

The EPA proposes to abandon the existing sewage sludge dump site in the Apex of the New York Bight and to designate an alternate dump site farther out in the Bight. Depending on which of the two areas under consideration is chosen, the Northern Area or the Southern Area, the dump site will be located at a minimum of 46 km (25 n mi) off the coast of Long Island or off the coast of New Jersey. Under the proposed action, use of the alternate dump site will commence in July 1976 and will continue until suitable land-based sludge disposal alternatives can be implemented in the New York-New Jersey metropolitan area. The additional cost of implementing the proposed action is from 27 to 33 million dollars. This represents a 56 to 69 percent in-

crease over costs associated with use of the existing dump site (48 million dollars), for the period 1976 through 1981. (See Chapter III.)

ALTERNATIVES TO THE PROPOSED ACTION:

There are two categories of alternatives to the proposed action considered in this EIS: land-based sludge disposal alternatives (long-term) and other ocean dumping alternatives (short-term).

The feasible land-based sludge disposal alternatives are:

- Land application
- Incineration
- Pyrolysis
- Sale as a soil conditioner or fertilizer.

These land-based alternatives are being studied by the Interstate Sanitation Commission (ISC) under a grant from EPA. When completed, the ISC studies will form the basis for developing a Sludge Disposal Management Plan for New York-New Jersey metropolitan area. Because of their preliminary status, only a general discussion of these alternatives is possible in this EIS.

The other, ocean dumping, alternatives are:

- Continued use of the existing site (No Action).
- Continued use of the existing site and designation of an alternate site to be used if necessary (Phased Action).

Since the implementation of land-based disposal methods in the metropolitan area is still some years off, a suitable interim ocean dumping alternative is needed. The proposed action and the other ocean dumping alternatives are discussed in detail in this EIS.

(See Chapter V.)

ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTION:

The proposed action will have a number of general effects and a number of site specific ones. Among its general effects will be a significant adverse impact on the benthos, the bottom-dwelling organisms, at and near an alternate dump site. In response to sludge dumping, the benthic community will probably increase in numbers, but decrease in diversity. After awhile, the species that remain will be representative of a polluted bottom environment, such as that at the existing dump site in the Bight Apex.

The sediments on and in which the benthic organisms dwell will be degraded. The concentrations of heavy metals, organic matter, coliforms, chlorinated hydrocarbons, and possibly of nutrients (nitrogen and phosphorous) in the sediments will increase over background concentrations. Pollutant concentrations in the water itself will vary according to the particular composition of each load of sludge, the degree of dispersion in the water column, and seasonal conditions.

The site specific effects of the proposed action will become manifest if the alternate dump site is located in the

Southern Area. Sludge dumping in the Southern Area may damage commercial shellfishing, particularly surf clam harvesting, off the New Jersey coast. It may also interfere with the potential development of mineral resources (oil and gas, sand and gravel) in and adjacent to the Southern Area. The most serious and most imminent conflict will be with the proposed oil and gas development on the outer continental shelf.

The Northern Area does not present any problems which are site specific. Commercial shellfishing in the area is minimal and is likely to remain so. No developable mineral resources have been identified in or near the Northern Area.

The only significant irreversible and irretrievable resource commitment involved in implementing the proposed action is the cost. Through 1981, it will cost 56 to 69 percent more than it does at present to transport sewage sludge for ocean dumping; the increased cost is directly attributable to the increased distance to an alternate dump site farther out in the Bight.

The continued loss of sewage sludge which is a potentially valuable resource, through ocean dumping, is an irreversible and irretrievable commitment. However, until land-based disposal methods can be implemented in the metropolitan area, the beneficial use of sludge is impossible. Until it is possible, ocean dumping of sewage sludge is an unavoidable but insignificant commitment of these resources.

(See Chapters VI, VII, VIII, IX, and X.)

RECOMMENDED ACTION:

After careful evaluation of the available alternatives and of the effects of ocean dumping, EPA recommends that use of the existing sewage sludge dump site in the Bight Apex continue. As a safeguard, EPA recommends: 1) that an alternate dump site in the Northern Area be immediately designated for use in the future, if necessary, 2) that the existing dump site and nearby sensitive recreational and marine resource areas (Hudson Shelf Valley) near Long Island and New Jersey be closely monitored for potential hazards to public health or water quality, and 3) that upon confirmation of such hazards, permittees be required to use the alternate dump site.

A thorough review of the most recent information, including onsite investigations, indicates that the proposed action, immediate designation and use of an alternate dump site, is unjustified. Continued use of the existing dump site is not a present threat to public health or to water quality along the beaches of Long Island or New Jersey. Moving the present sludge dumping operations to an alternate site without adequate justification will result in the unnecessary contamination of a relatively pristine area of the Bight. Moreover, contamination of a new area will not be balanced off by recovery of the existing dump site. The existing site and its surrounding area are not expected to significantly improve even if sludge dumping is terminated because pollution from other sources will continue. (See Chapter XI.)

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

Federal Agencies:

Council on Environmental Quality
Washington, D.C.

Department of Agriculture
Washington, D.C.

Department of Commerce
Washington, D.C.

U.S. Coast Guard
New York, N.Y.

National Marine Fisheries Service
Gloucester, Mass.
Sandy Hook, N.J.

National Oceanic and Atmospheric Administration
Bolder, Colo.
Rockville, Md.
Stony Brook, N.Y.

National Weather Service
Garden City, N.Y.

Department of Defense

Army Corps of Engineers
New York, N.Y.
Vicksburg, Miss.

Office of the Oceanographer of the Navy
Alexandria, Va.

Department of Health, Education, and Welfare
New York, N.Y.

Food and Drug Administration
Brooklyn, N.Y.
Davisville, R.I.

Department of Housing and Urban Development
New York, N.Y.

Federal Agencies (Cont'd):

Department of Interior
Washington, D.C.

Gateway National Recreation Area
Brooklyn, N.Y.

Energy Research and Development Administration
Washington, D.C.

United States Environmental Protection Agency
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Narragansett, R.I.
Philadelphia, Pa.
Washington, D.C.

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Honorable Joseph R. Biden, Jr.
Honorable James Buckley
Honorable Clifford P. Case
Honorable Jacob K. Javits
Honorable Charles McC. Mathias, Jr.
Honorable John O. Pastore
Honorable Claiborne Pell
Honorable Abraham A. Ribicoff
Honorable William V. Roth, Jr.
Honorable Lowell P. Weicker, Jr.
Honorable Harrison A. Williams

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Senate Subcommittee on Environmental Pollution
Senate Subcommittee on Oceans and the Atmosphere

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Honorable Jerome Ambro, Jr.
Honorable Herman Badillo
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Honorable Pierre S. DuPont
Honorable Millicent Fenwick

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Honorable Frederick W. Richmond
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Honorable James H. Scheuer
Honorable Stephen J. Solarz
Honorable Frank Thompson, Jr.
Honorable Lester L. Wolff
Honorable John W. Wydler
Honorable Leo C. Zeferetti

House Committee on Merchant Marine and Fisheries
House Subcommittee on Fisheries and Wildlife Conservation and the Environment
House Subcommittee on Oceanography
House Committee on Science and Technology
House Subcommittee on Environment and the Atmosphere

State and Local Governmental Agencies:

Mayor, Village of Atlantic Beach
Atlantic Beach, N.Y.

State and Local Governmental Agencies (Cont'd):

Erie County Environmental Health Services
Buffalo, N.Y.

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

Lacey Township
Forked River, N.J.

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

Maryland Water Resources Administration
Annapolis, Md.

Middlesex County Planning Board
New Brunswick, N.J.

Monmouth County Planning Board
Freehold, N.J.

Nassau County Department of Health
Mineola, N.Y.

Nassau County Environmental Management Council
Mineola, N.Y.

Nassau County Planning Commission
Mineola, N.Y.

Nassau-Suffolk Regional Planning Board
Hauppauge, N.Y.

New Jersey Department of Environmental Protection
Trenton, N.J.

New Jersey Department of Health
Trenton, N.J.

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

New York City Chamber of Commerce and Industry
New York, N.Y.

New York City Department of Health
New York, N.Y.

State and Local Governmental Agencies (Cont'd):

New York State Assembly and Senate
Albany, N.Y.

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

New York State Atomic and Space Development Authority
New York, N.Y.

New York State Department of Commerce
Albany, N.Y.

New York State Department of Environmental Conservation
Albany, N.Y.
New York, N.Y.
Stony Brook, N.Y.
White Plains, N.Y.

New York State Department of Health
Albany, N.Y.

New York State Office of Parks and Recreation
Albany, N.Y.

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

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

Suffolk County Department of Environmental Control
Hauppauge, N.Y.

Suffolk County Department of Health Services
Hauppauge, N.Y.

Suffolk County Executive Office
Hauppauge, N.Y.

Suffolk County Water Authority
Oakdale, N.Y.

Mayor, Borough of Surf City
Surf City, N.J.

Tennessee Valley Authority
Chattanooga, Tenn.

State and Local Governmental Agencies (Cont'd):

Tonawanda Town Environmental Commission
Kenmore, N.Y.

Department of Public Works
Yaphank, N.Y.

Interstate Agencies:

Interstate Sanitation Commission
New York, N.Y.

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

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

Ocean Dumping Permittees:

American Cyanamid Co.
Linden, N.J.

Bergen County Sewerage Authority
Little Ferry, N.J.

Caldwell Trucking Co., Inc.
Fairfield, N.J.

Borough of Fairfield
Fairfield, N.J.

General Marine Transportation Corp.
Bayonne, N.J.

City of Glen Cove
Glen Cove, N.Y.

Joint Meeting of Essex & Union Counties
Irvington, N.J.

Linden Roselle Sewerage Authority
Linden, N.J.

City of Long Beach
Long Beach, N.Y.

Ocean Dumping Permittees (Cont'd):

Middlesex County Sewerage Authority
Sayreville, N.J.

Middletown Sewerage Authority
Belford, N.J.

Modern Transportation Co., Inc.
South Kearny, N.J.

Nassau County Department of Public Works
Mineola, N.Y.

New York City Environmental Protection Administration
Department of Water Resources
New York, N.Y.

Passaic Valley Sewerage Commissioners
Newark, N.J.

Pollution Control Industries, Inc.
West Caldwell, N.J.

S.B. Thomas, Inc.
Totowa, N.J.

Westchester County
White Plains, N.Y.

West Long Beach Sewer District
Atlantic Beach, N.Y.

Whippany Paper Board Co., Inc.
Whippany, N.J.

Citizen Groups:

American Littoral Society
Highlands, N.J.

Atlantic Beach Taxpayers Association
Long Beach, N.Y.

Citizens for Clean Environment
Sayville, N.Y.

Colts Neck Environmental Commission
Colts Neck, N.J.

Citizen Groups (Cont'd):

Committee of Concerned Citizens of Wantagh
Wantagh, N.Y.

East End Council of Organizations
East Hampton, N.Y.

Environmental Defense Fund
East Setauket, N.Y.

Federated Conservationists of Westchester County
Tarrytown, N.Y.

Friends of the Earth
New York, N.Y.

Hudson River Sloop Restoration Association
Poughkeepsie, N.Y.

Long Island Baymen's Association
Islip, N.Y.

Long Island Environmental Council
Port Washington, N.Y.

Long Island Fishermen's Association
Quoque, N.Y.

Malverne Environmental Council
Malverne, N.Y.

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

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

National Boatmen's Alliance
Hauppauge, N.Y.

National Coalition for Marine Conservation
Boston, Mass.

National Wildlife Federation
Washington, D.C.

Citizen Groups (Cont'd):

New Jersey Marine Science Consortium
Highlands, N.J.

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

New York League of Women Voters
Setauket, N.Y.

New York Water Pollution Control Association
Syracuse, N.Y.

Passaic River Coalition
Basking Ridge, N.J.

Regional Marine Resources Council
Hauppauge, N.Y.

Resources for the Future
Washington, D.C.

Rochester Committee for Scientific Information
Rochester, N.Y.

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

Shellfish Commission
Milford, Conn.

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

Sierra Club
New York, N.Y.

South Branch Watershed Association
Clinton, N.J.

Academic/Research Institutions:

American University
Department of Biology
Washington, D.C.

Academic/Research Institutions (Cont'd):

Associated Universities
Brookhaven National Laboratory
Upton, N.Y.

Lamont-Doherty Geological Observatory
Palisades, N.Y.

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

Marine Sciences Research Center
Stony Brook, N.Y.

Marine Sciences Research Group
Brooklyn College - CUNY
Brooklyn, N.Y.

National Academy of Sciences
Washington, D.C.

New York Ocean Science Laboratory
Montauk, N.Y.

New York State University (SUNY)
Agriculture and Technical College
Farmingdale, N.Y.

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

University of Delaware
Newark, Del.

Woods Hole Oceanographic Institution
Woods Hole, Mass.

News Media Agencies:

Atlantic City Press
Toms River, N.J.

Buffalo Evening News
Buffalo, N.Y.

CBS News
New York, N.Y.

News Media Agencies (Cont'd):

Daily Observer
Toms River, N.J.

Herald News
Passaic, N.J.

Nautilus Press
Washington, D.C.

Newsday
Garden City, N.Y.

New York Times
New York, N.Y.

Private Consultants/Industries:

Alpha Analytical Labs
Jersey City, N.J.

American Petroleum Institute
Washington, D.C.

Lewis Berger and Associates
East Orange, N.J.

Camp, Dresser & McKee
Boston, Mass.

Cherne Industrial
Edina, Minn.

Ciba-Geigy Corp.
Ardsley, N.Y.

Cleary, Gottlieb, Steen, and Hamilton
Washington, D.C.

Consolidated Edison Co.
New York, N.Y.

Cory Laboratories
Menominee, Mich.

Delta Laboratories
Rochester, N.Y.

Private Consultants/Industries (Cont'd):

Delta Scientific Corp.
Lindenhurst, N.Y.

M. Disko Associates
West Orange, N.J.

Ecolotrol
Bethpage, N.Y.

Fantus Company
South Orange, N.J.

Find Motor Company
Englewood Cliffs, N.J.

Fisher Scientific Company
King of Prussia, Pa.

General Electric Corp.
Selkirk, N.Y.

General Mills, Inc.
Buffalo, N.Y.

Havens and Emerson, Ltd.
Saddle Brook, N.J.

Howard, Needles, Tammen, and Bergendoff
Alexandria, Va.
New York, N.Y.

International Hydronics Corp.
Princeton, N.J.

Interstate Electronics Corp.
Anaheim, Ca.

Ionics, Inc.
Lexington, Kentucky

Kirby and Sommerer Labs
New York, N.Y.

Limnetics, Inc.
Milwaukee, Wis.

Arthur D. Little, Inc.
Cambridge, Mass.

Private Consultants/Industries (Cont'd):

Jack McCormick and Associates
Devon, Pa.

Metcalf & Eddy, Inc.
Sayreville, N.J.

Modern Transportation Company
South Kearny, N.J.

Mogul Corp.
Chagrin Falls, Ohio

N.L. Industries
New York, N.Y.

NUS Corp.
Pittsburg, Pa.

Orion Research, Inc.
Cambridge, Mass.

Pouch Terminal
Staten Island, N.Y.

Pro-Tech, Inc.
Malvern, Pa.

Public Service Electric and Gas Co.
Newark, N.J.

Raytheon Co.
Portsmouth, R.I.

Reynolds Metal Co.
Richmond, Va.

Rollins Environmental Services, Inc.
Wilmington, Delaware

John Jay Ryan and Co.
Newark, N.J.

Scranton Publishing Co.
Chicago, Ill.

Shell Oil
New York, N.Y.

Private Consultants/Industries (Cont'd):

Technicon Industrial Systems
Tarrytown, N.Y.

Toms River Chemical Corp.
Toms River, N.J.

Universal Oil Products Co.
San Diego, Ca.

Williams Brothers Waste Control
Tulsa, Okla.

Winer, Neuburger, and Sive
New York, N.Y.

Libraries:

Atlantic City Free Public Library
Atlantic City, N.J.

Nassau Library System
Garden City, Long Island, N.Y.

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

Free Library of Philadelphia
Logan Square
Philadelphia, Pennsylvania

Princeton Library
Princeton, N.J.

Rutgers Science/Medicine Library
New Brunswick, N.J.

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

SUNY Library
Stony Brook, N.Y.

Trenton Free Public Library
Trenton, N.J.

U.S. EPA Library
Edison, N.J.
New York, N.Y.

II. BACKGROUND

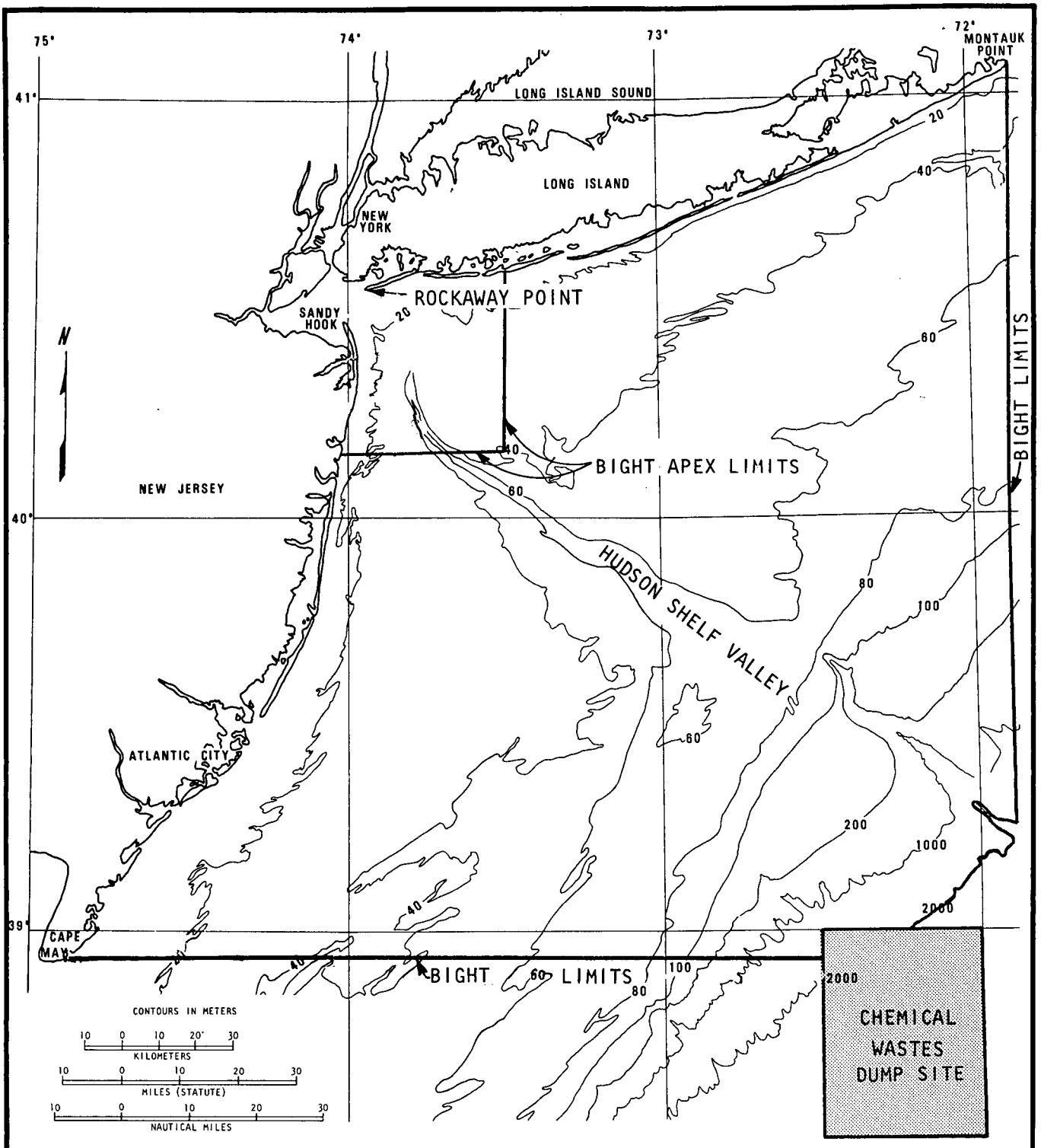
A. THE NEW YORK BIGHT

1. Geographic Description of the New York Bight

The New York Bight is the section of the Atlanic Ocean that extends from Cape May, New Jersey north and east to Montauk, Long Island. The Bight covers more than 39,000 sq km (11,350 sq n mi), 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 km (43 to 54 n mi) seaward of the coast (Figure 1). The coastline of the Bight is characterized by sandy beaches and by numerous bays and estuaries.

The Bight Apex, which covers 645 sq km (188 sq n mi), extends from Atlantic Beach, New York south and west to Manasquan, New Jersey (73°30'W to 74°00'W and 40°10'N to 40°35'N). It is immediately adjacent to the New York-New Jersey metropolitan area and is more or less centered on the apex of the Hudson Shelf Valley (Figure 2).

The New York Bight is delineated from the estuarine waters of Outer New York Harbor by the Sandy Hook-Rockaway Point transect (Figure 2). The Outer Harbor (Lower Bay, Sandy Hook Bay, and Raritan River) 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).



THE NEW YORK BIGHT

SOURCE: USEPA, APRIL 1975.

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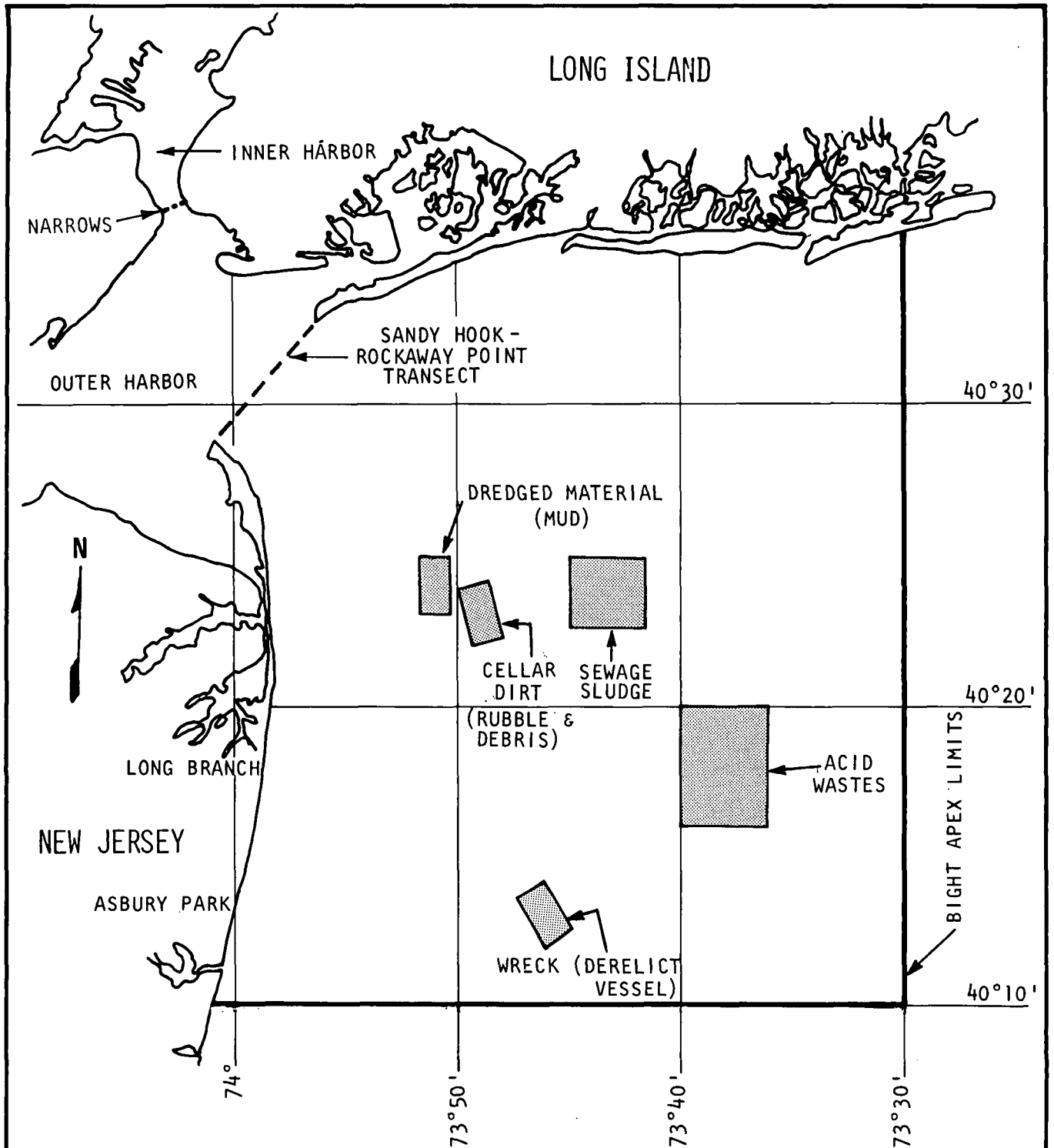
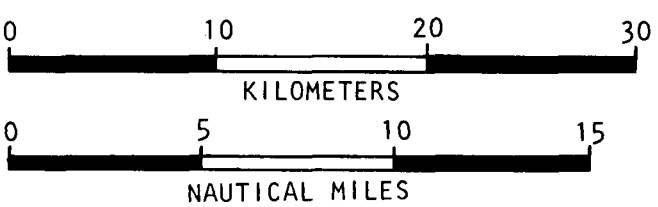
FIGURE 1



BIGHT APEX AND EXISTING DUMP SITES



SOURCE: USEPA, JULY 1974.

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FIGURE 2

2. Existing Dump Sites in the New York Bight

There are currently five dump sites in the New York Bight where the disposal of toxic and nontoxic wastes is permitted under the authority of the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA). These sites are all located within the Bight Apex (Figure 2). They include the sewage sludge site, the dredged material (mud) site, the cellar dirt (rubble and debris) site, the acid wastes site, and the wreck (derelict vessel) site (Table 1). A sixth dump site, the chemical wastes site, is located approximately 196 km (106 n mi) from the harbor entrance, on the edge of the continental shelf. This dump site is just outside the New York Bight (Figure 1 and Table 1). Roughly 70 percent of the municipal wastes and 60 percent of the industrial wastes that are ocean dumped in the United States are dumped at these six sites (USEPA, July 1974).

Ocean dumping at the existing sewage sludge site is described in detail in Section IIB. Dumping at the other sites is discussed in Section IIC.

TABLE 1

EXISTING DUMP SITES IN AND ADJACENT TO THE NEW YORK BIGHT

Dump Site	Coordinates Latitude and Longitude	Area Sq Kilometers (Sq N Miles)	Depth Meters (Feet)	Approximate Distance Kilometer (N Miles) L.I.	Approximate Distance Kilometer (N Miles) N.J.
Sewage Sludge	40°22'30"N to 40°25'00"N 73°41'30"W to 73°45'00"W	22.7(6.6)	27 (90)	20 (11)	20 (11)
Dredged Material	40°24'10"N, 73°51'00"W[1]	6.9(2.0)	27 (90)	20 (11)	9 (5)
Cellar Dirt	40°23'00"N, 73°49'00"W[1]	6.9(2.0)	31 (103)	22 (12)	11 (6)
Acid Wastes	40°16'00"N to 40°20'00"N 73°36'00"W to 73°40'00"W	41.0(12.0)	24 (80)	27 (15)	27 (15)
Wreck	40°13'00"N, 73°46'00"W[1]	6.9(2.0)	60 (200)	30 (16)	20 (11)
Chemical Wastes	38°40'00"N to 39°00'00"N 72°00'00"W to 72°30'00"W	1,550.0(450.0)	1,800.0(6000)	-	-

[1]Center Coordinates

Source: USEPA, November 15, 1975.

B. OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT

The existing sewage sludge dump site in the Bight Apex is used almost exclusively for the disposal of sewage sludges from large municipal treatment facilities in the New York-New Jersey metropolitan area. Prior to 1974, some industrial wastes were also dumped at this site. Only small quantities of sludge resulting from the biological treatment of industrial wastes are now dumped here.

The present location was selected by the States of New York and New Jersey in 1924, following a United States Supreme Court settlement. This settlement was the culmination of a suit brought by the City of New York against the Passaic Valley Sewerage Commissioners (PVSC) to prevent the discharge of sewage sludge into Upper New York Bay. The existing site was chosen to maintain the integrity (public health and aesthetics) of the Long Island and New Jersey beaches, as well as to avoid possible hazards to navigation within New York Harbor.

1. Wastewater Treatment and Sewage Sludge

Sewage sludge is a broad term used to describe the mixture of sewage and settled solids removed from municipal wastewater during treatment. Its characteristics depend mainly upon the type and degree of treatment provided. In general, sludges transported for ultimate ocean disposal at the existing sewage sludge site are derived from the primary and secondary treatment of municipal wastewater and from domestic septic tanks.

Raw municipal wastewater is a combination of liquid and solids; the liquid fraction is much greater than the solids fraction. Consequently, raw municipal wastewater entering a treatment plant generally has a very low suspended solids concentration (100 to 300 mg/l or 0.01 to 0.03 percent solids by weight). One of the purposes of treatment is to remove as much of the solids as possible from the wastewater. Through treatment, most of the solids become concentrated in a small fraction of the liquid; this mixture is called sludge. The sludges that result from the combined primary and secondary treatment of municipal wastewaters have much higher solids concentrations (3 to 5 percent) than the raw wastewater.

Primary treatment, the most basic type of wastewater treatment, removes from 50 to 60 percent of the suspended solids present in the raw wastewater. Sludges withdrawn from primary sedimentation tanks are usually gray and slimy, and have an offensive odor.

Secondary treatment, which EPA* is requiring all municipal facilities to implement in the near future, removes approximately 85 percent of the suspended solids. Activated sludge and trickling filters are the two secondary treatment processes most commonly used by municipal facilities in the New York-New Jersey metropolitan area. Sludges resulting from the activated sludge process generally have a brown, flocculent

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*Please note that "EPA" is a general reference to the U.S. Environmental Protection Agency. Where it is necessary to differentiate between the Headquarters office and the Region II office of the agency, the appropriate designation is made.

appearance and an inoffensive odor. These sludges have a tendency to quickly become septic. When this occurs, the color becomes quite dark, and there is a disagreeable odor of putrefaction. Sludges resulting from the trickling filter process are brownish, flocculent, and have a relatively inoffensive odor. As with activated sludges, there is a tendency for trickling filter sludges to quickly become septic.

In some cases, sludges resulting from primary or secondary treatment are digested in order to anaerobically decompose the organic materials present. Sludges resulting from the digestion process are dark brown to black in color; when thoroughly digested, their odors are relatively faint and inoffensive.

Sludges derived from domestic septic tanks are black and, unless well-digested by long storage, have an offensive odor.

Additional information on wastewater treatment processes, solids, and sludge treatment can be found in the literature (USEPA, October 1971 and October 1974; Metcalf & Eddy, 1972). The characteristics of the sewage sludges dumped in the New York Bight are discussed below.

2. Current Sources

In July 1975, EPA issued eighteen Interim Permits for ocean dumping at the existing sewage sludge site. Twelve of these permits were granted to municipalities or sewerage author-

ities in the New York-New Jersey metropolitan area. The wastewater and sludge treatment practiced by the permittees, which directly affects the type of sludge produced, is shown in Table 2.

With the exception of New York City and Westchester County, which operate their own sludge transportation vessels, these permittees contract commercial barging companies to transport their sludge to the dump site. Three permits were issued to commercial haulers in New Jersey (Modern Transportation Company, Caldwell Trucking Company, and General Marine Transportation Corporation). The commercial haulers collect and transport sewage sludge and domestic septic tank wastes to the dump site. These commercial permittees serve local septic tank cleaners and small municipal and sewerage authority wastewater treatment plants in New Jersey.

Three permits were issued to industries in New Jersey (Whippany Paper Board, American Cyanamid, and S.B. Thomas). These three industries produce small volumes of waste activated sludge from private, onsite, secondary treatment facilities.

A sample ocean dumping permit form is included in Appendix A to familarize the reader with the type of information EPA requires of an applicant.

a. Sludge Characteristics. Based upon weighted average data from the 1973 permittees (Table 3), the sludge being dumped in the New York Bight contains 4.5 percent total solids (see Table 2 for percentage of solids in the sludge dumped by each

TABLE 2

TREATMENT PRACTICES OF OCEAN DUMPING PERMITTEES
(1975)

1975 Permit Number[1]	Permittee	Treatment Level	Sludge Treatment	Percent Solids
NJ002	Middletown Sewerage Authority	Secondary	Thickening, Digest & Dewatering	3.2
NJ003	Passaic Valley Sewerage Commissioners	Primary	None	6.6
NY007	City of Long Beach	Secondary	Digestion and Heat Conditioning	2.3
NJ008	Middlesex County Sewerage Authority	Primary	Thickening	3.2
NY009	City of New York	-	-	-
	Bowery Bay	Secondary	Thickening and Digestion	2.6
	Coney Island	Secondary	Thickening and Digestion	4.8
	Hunts Point	Secondary	Thickening and Digestion	1.9
	Jamaica	Secondary	Thickening and Digestion	7.2
	Owls Head	Secondary	Thickening and Digestion	2.1
	Newtown Creek	Secondary	Thickening and Digestion	3.2
	Port Richmond	Primary	Digestion	2.8
	Rockaway	Secondary	Thickening and Digestion	2.7
	Tallman Island	Secondary	Thickening and Digestion	3.7
	Wards Island	Secondary	Thickening	6.9
	26th Ward	Secondary	Thickening and Digestion	3.6
NJ017	Modern Transportation Co.	Mostly Primary	Partial Digestion	NA
NJ019	Bergen County Sewerage Authority	Secondary	Thickening and Digestion	1.6
NJ021	Linden Roselle Sewerage Authority	Primary	Thickening	5.8
NJ022	Joint Meeting of Essex & Union Counties	Primary	Digestion	8.8
NY028	Nassau County	Secondary	Thickening and Digestion	2.0
NY029	Westchester County	Primary	Thickening and Digestion	3.6
NY031	West Long Beach Sewer District	Secondary	Thickening	8.5
NJ063	Whippany Paper Board	Secondary	NA	NA
NY068	City of Glen Cove	Secondary	Thickening	NA
NJ103	Caldwell Trucking Co.	Mostly Primary	Partial Digestion	NA
NJ106	American Cyanamid	Secondary	NA	NA
NJ109	S.B. Thomas	Secondary	NA	NA
NJ111	General Marine Transportation Corp.	Mostly Primary	Partial Digestion	NA

NA = Not Available.

[1]EPA-Region II permit number.

Sources: USEPA, January 21, 1976; ISC, 1975.

TABLE 3

AVERAGE CHARACTERISTICS OF OCEAN DUMPED SLUDGE (1973)[1]

Characteristic	Weighted Average[2] Concentration (mg/l)
Total Solids (TS)	45,000
Suspended Solids (SS)	39,000
Total Dissolved Solids (TDS)	5,500
Alkalinity (Alk)	2,700
Biochemical Oxygen Demand (BOD_5)	17,000
Chemical Oxygen Demand (COD)	93,000
Total Organic Carbon (TOC)	9,200
Oil and Grease (O & G)	1,900
Ammonia (NH_3-N)	890
Total Kjeldahl Nitrogen (TKN)	1,500
Nitrites and Nitrates (NO_2 + NO_3 -N)	3.9
Total Nitrogen (Total-N)	1,500
Total Phosphorous (Total-P)	400
Cadmium (Cd)	3.7
Chromium (Cr)	63
Copper (Cu)	60
Mercury (Hg)	1.1
Lead (Pb)	63
Zinc (Zn)	160
Arsenic (As)	120
Beryllium (Be)	0.02
Nickel (Ni)	9.5
Selenium (Se)	100
Vanadium (V)	0.75
Fecal coliform (organisms/100ml)	310,000

[1] Sludge characteristics based upon values from EPA-Region II, ocean dumping permit files for the period May 1 through December 31, 1973.

[2] Weighted average. Heavy metals and oil and grease averages based upon eight values for each source. Other parameters are based upon one to eight values for each source.

Source: Mueller and Jeris, unpub.

permittee) and 3.9 percent suspended solids. It is also characterized by high concentrations of heavy metals (chromium, copper, lead, mercury, nickel and zinc). Representative concentrations of heavy metals are shown in Table 4. The high ratio of chemical oxygen demand (COD) to biochemical oxygen demand (BOD), or of COD to total organic carbon (TOC), is characteristic of sludges having significant industrial wastewater contributions.

The total solids present are approximately 20 percent organic material, as reflected by the TOC concentrations. Most domestic sewage sludges contain between 25 and 50 percent organic material. Total nitrogen and total phosphorous account for about 3 percent and 1 percent, respectively, of the total solids, which can be considered within the normal range for domestic sludges. The oil and grease concentration, approximately 4 percent of total solids, appears to be more representative of a metropolitan area, where combined sewers, carrying both sanitary wastes and urban runoff, commonly serve existing wastewater treatment facilities.

b. Volumes of Sludge Dumped. Although dumping at the existing sewage sludge site began in 1924, accurate records prior to 1960 are not available. The volume of sewage sludge dumped into the New York Bight has increased slowly from 2.9 million cu m (3.8 million cu yd) in 1960 to 4.3 million cu m (5.6 million cu yd) in 1973 (Figure 3 and Table 5). In 1974 and 1975 (Table 6), the volume dropped slightly to 3.7 and 3.4 million cu m (4.9 and 4.8 million cu yd), respectively. Similar fluc-

TABLE 4

HEAVY METAL CHARACTERISTICS OF OCEAN DUMPED SLUDGE

1975 Permit Number[1]	Permittee	Heavy Metals (µg/l) Mercury (Hg)	Cadmium (Cd)	Arsenic (As)	Lead (Pb)	Copper (Cu)	Zinc (Zn)
NJ002	Middletown Sewerage Authority	136	268	<17	5,425	19,050	44,250
NJ003	Passaic Valley Sewerage Commissioners	1,110	11,375	81	164,478	44,806	277,793
NY007	City of Long Beach	380	410	<4,000	NA	NA	NA
NJ008	Middlesex County Sewerage Authority	170	2,621	46	97,950	52,953	233,998
NY009	City of New York						
	Bowery Bay	465	1,230	2,400	56,000	119,000	143,000
	Coney Island	310	380	2,400	66,000	106,000	101,000
	Hunts Point	<50	338	2,000	26,000	38,000	48,000
	Jamaica	215	430	2,500	38,000	65,000	90,000
	Owls Head	260	600	9,500	34,000	103,000	118,000
	Newtown Creek	145	1,465	960	284,000	65,000	76,000
	Port Richmond	260	88	1,500	16,000	16,000	46,000
	Rockaway	315	435	1,400	64,000	173,000	134,000
	Tallman Island	630	240	5,700	84,000	108,000	120,000
	Wards Island	135	230	170	30,000	56,000	41,000
	26th Ward						
NJ017	Modern Transportation Co.	143	7,151	<20	11,936	33,499	101,771
NJ019	Bergen County Sewerage Authority	1,314	17,903	<30	42,336	73,375	106,711
NJ021	Linden Roselle Sewerage Authority	290	3,757	<19	23,714	106,814	254,194
NJ022	Joint Meeting of Essex & Union Counties	852	6,263	15	45,708	95,980	102,602
NY028	Nassau County	<5	130	<1	8,100	24,200	22,900
NY029	Westchester County	1,674	5,981	4,000	33,000	53,000	74,000
NY031	West Long Beach Sewer District	NA	NA	NA	NA	NA	NA
NJ063	Whippany Paper Board[2]	-	-	-	-	-	-
NY068	City of Glen Cove	NA	NA	NA	NA	NA	NA
NJ103	Caldwell Trucking Co.[3]	-	-	-	-	-	-
NJ106	American Cyanamid[2]	-	-	-	-	-	-
NJ109	S.B. Thomas[3]	-	-	-	-	-	-
NJ111	General Marine Transportation Corp.	15.3	4.1	30	15,300	2,300	30,800

TABLE 4 (Continued)

HEAVY METAL CHARACTERISTICS OF OCEAN DUMPED SLUDGE

1975 Permit Number[1]	Permittee	Heavy Metals (µg/l) Selenium (Se)	Vanadium (V)	Beryllium (Be)	Chromium (Cr)	Nickel (Ni)
NJ002	Middletown Sewerage Authority	<59	<485	<260	8,200	5,704
NJ003	Passaic Valley Sewerage Commissioners	<9	<200	<20	99,628	13,814
NY007	City of Long Beach	NA	NA	NA	NA	NA
NJ008	Middlesex County Sewerage Authority	<8	<560	<20	33,358	9,730
NY009	City of New York					
	Bowery Bay	9,900	1,800	40	64,000	17,000
	Coney Island	5,030	2,000	40	10,000	9,900
	Hunts Point	6,800	1,500	33	7,400	3,200
	Jamaica	11,500	1,200	36	14,000	14,000
	Owls Head	8,500	2,200	45	30,000	8,500
	Newtown Creek	13,100	1,400	36	95,000	13,500
	Port Richmond	6,900	1,000	36	1,700	2,100
	Rockaway	6,300	2,600	54	14,500	6,000
	Tallman Island	20,000	1,700	37	40,000	84,000
	Wards Island	5,600	1,000	42	12,000	2,200
	26th Ward	6,500	2,800	46	34,000	7,200
NJ017	Modern Transportation Co.	<59	<485	<260	8,200	5,704
NJ019	Bergen County Sewerage Authority	28	<445	<20	194,883	15,168
NJ021	Linden Roselle Sewerage Authority	<680	<314	<23	42,829	9,143
NJ022	Joint Meeting of Essex & Union Counties	8	<550	<20	62,978	5,989
NY028	Nassau County	<65	480	<40	NA	2,240
NY029	Westchester County	<10	<80	<240	11,300	4,000
NY031	West Long Beach Sewer District	NA	NA	NA	NA	NA
NJ063	Whippany Paper Board[2]	-	-	-	-	-
NY068	City of Glen Cove	NA	NA	NA	NA	NA
NJ103	Caldwell Trucking Co.	-	-	-	-	-
NJ106	American Cyanamid[2]	-	-	-	-	-
NJ109	S.B. Thomas[3]	-	-	-	-	-
NJ111	General Marine Transportation Corp.	140	<1,000	<20	710	1,000

NA = Not Available.

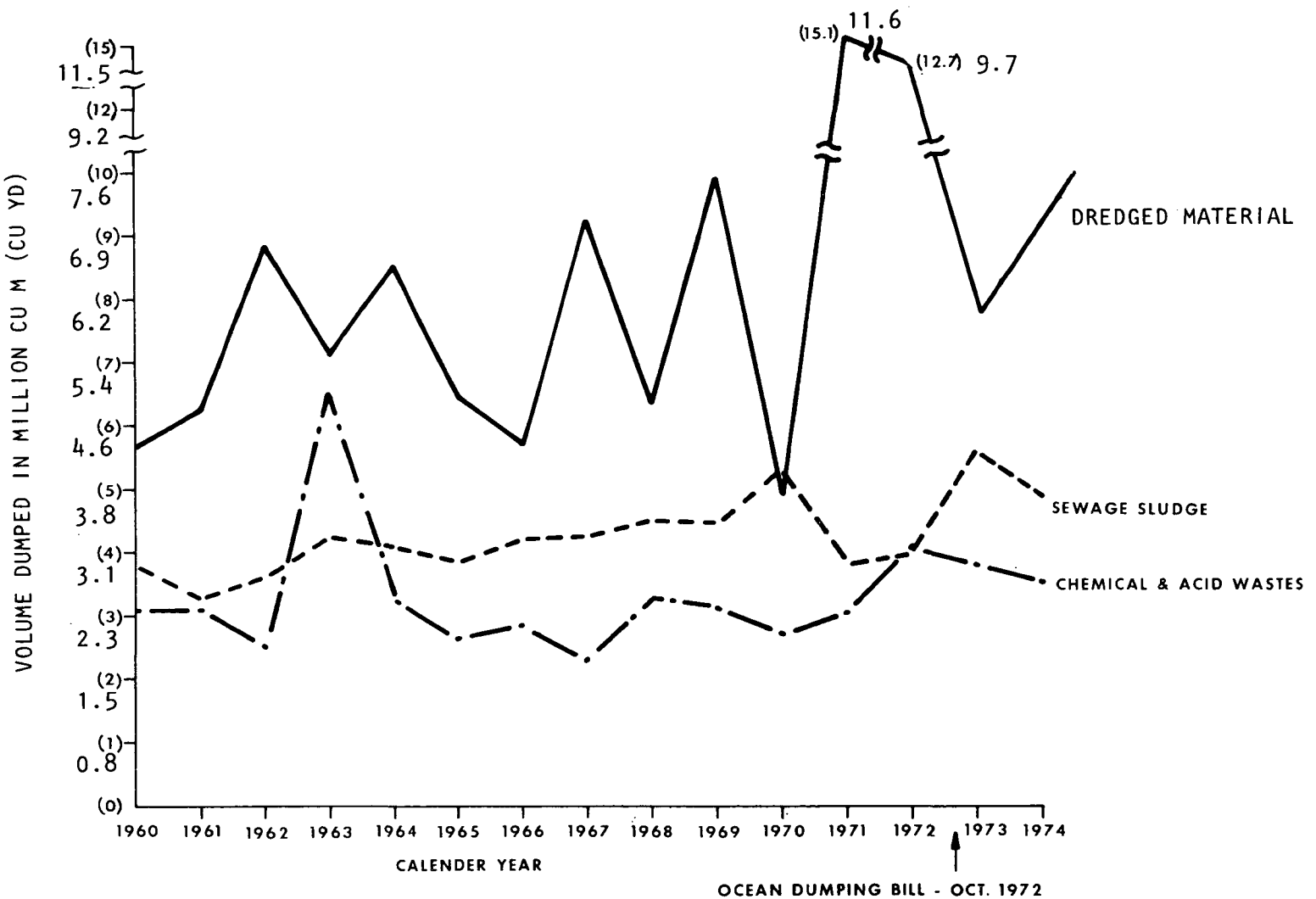
[1]EPA-Region II permit number.

[2]Included with NJ017.

[3]Included with NJ111.

Source: USEPA, April 1975.

WASTE DUMPING IN AND ADJACENT TO THE NEW YORK BIGHT



SOURCE: USEPA, APRIL 1975.

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FIGURE 3

TABLE 5

VOLUMES OF WASTE DUMPED AT SITES IN AND ADJACENT TO THE NEW YORK BIGHT (1960 to 1975)

In Thousands of Cubic Meters (Cubic Yards)

Waste	1960	1961	1962	1963	1964	1965	1966	1967
Sewage Sludge	2,921 (3,820)	2,564 (3,354)	2,772 (3,626)	3,256 (4,259)	3,118 (4.078)	2,954 (3,863)	3,212 (4,201)	3,261 (4,265)
Dredged Material	4,290 (5,611)	4,770 (6,238)	6,741 (8,816)	5,494 (7,186)	6,530 (8,540)	4,955 (6,480)	4,348 (5,687)	7,045 (9,214)
Cellar Dirt	564 (738)	619 (810)	617 (807)	755 (988)	578 (756)	697 (912)	244 (319)	389 (509)
Acid Wastes	2,348 (3,071)	2,370 (3,100)	1,951 (2,551)	4,432 (5,797)	2,531 (3,310)	2,014 (2,634)	2,184 (2,857)	1,756 (2,297)
Wreck[1]	-	-	-	-	-	-	-	1
Chemical Wastes	-	5 (7)	10 (13)	528 (690)	-	-	-	115 (150)
Total Bight	10,123 (13,240)	10,328 (13,509)	12,091 (15,813)	14,465 (18,920)	12,757 (16,684)	10,620 (13,889)	9,988 (13,064)	12,566 (16,435)

TABLE 5 (Continued)

VOLUMES OF WASTE DUMPED SITES IN AND ADJACENT TO THE NEW YORK BIGHT (1960 to 1975)

In Thousands of Cubic Meters (Cubic Yards)

Waste	1968	1969	1970	1971	1972	1973	1974	1975
Sewage Sludge	3,426 (4,481)	3,406 (4,455)	4,042 (5,287)	2,928 (3,830)	3,024 (3,955)	4,281 (5,600)	3,716 (4,860)	3,650 (4,774)
Dredged Material	4,864 (6,361)	7,554 (9,880)	3,750 (4,905)	11,516 (15,062)	9,775 (12,785)	6,216 (8,130)	8,410 (10,820)	4,660 (6,100)
Cellar Dirt	306 (400)	483 (632)	609 (796)	517 (676)	741 (969)	632 (827)	801 (1,048)	130 (170)
Acid Wastes	2,403 (3,143)	2,335 (3,054)	1,992 (2,605)	2,162 (2,828)	2,379 (3,112)	2,397 (3,136)	2,271 (2,970)	1,990 (2,600)
Wreck[1]	-	-	-	3	3	1	-	-
Chemical Wastes	64 (83)	66 (86)	122 (160)	170 (222)	721 (943)	508 (664)	447 (585)	550 (725)
Total Bight	11,063 (14,468)	13,844 (18,107)	10,515 (13,753)	17,293 (22,618)	16,640 (21,764)	14,034 (18,357)	15,645 (20,283)	10,980 (14,369)

[1]Number of derelict vessels/wrecks disposed on-site.

Source: USEPA, April 1975 and January 21, 1976.

TABLE 6

VOLUMES OF SEWAGE SLUDGE DUMPED IN THE NEW YORK BIGHT
(1973 to 1975)

1975 Permit Number[1]	Permittee	Sewage Sludge in Thousands of Cubic Meters (Cubic Yards) 1973		1974		1975 (est.)	
NJ002	Middletown Sewerage Authority	17	(22)	10	(13)	18	(23)
NJ003	Passaic Valley Sewerage Commissioners	537	(702)	573	(750)	459	(600)
NY007	City of Long Beach	18	(24)	18	(24)	18	(24)
NJ008	Middlesex County Sewerage Authority	307	(402)	321	(427)	285	(383)
NY009	City of New York	2,471	(3,231)	1,815	(2,372)	1,812	(2,370)
	Bowery Bay	343	(448)	172	(225)	-	-
	Coney Island	112	(146)	86	(113)	-	-
	Hunts Point	218	(285)	83	(108)	-	-
	Jamaica	168	(219)	130	(170)	-	-
	Owls Head	179	(234)	76	(99)	-	-
	Newtown Creek	888	(1,162)	744	(973)	-	-
	Port Richmond	21	(28)	25	(32)	-	-
	Rockaway	27	(35)	45	(59)	-	-
	Tallman Island	65	(85)	18	(23)	-	-
	Wards Island	391	(512)	372	(487)	-	-
	26th Ward	59	(77)	64	(83)	-	-
NJ017	Modern Transportation Co.	236	(308)	293	(383)	185	(242)
NJ019	Bergen County Sewerage Authority	218	(285)	181	(237)	224	(293)
NJ021	Linden Roselle Sewerage Authority	48	(63)	63	(82)	59	(77)
NJ022	Joint Meeting of Essex & Union Counties	93	(121)	106	(138)	111	(145)
NY028	Nassau County	224	(293)	225	(295)	31	(410)
NY029	Westchester County	77	(100)	77	(100)	102	(133)
NY031	West Long Beach Sewer District	3	(4)	3	(4)	3	(4)
NJ063	Whippany Paper Board[2]	-	-	-	-	-	-
NY068	City of Glen Cove	NA	(NA)	NA	(NA)	3	(4)
NJ103	Caldwell Trucking Co.[3]	-	-	-	-	-	-
NJ106	American Cyanamid[2]	-	-	-	-	-	-
NJ109	S.B. Thomas[3]	-	-	-	-	-	-
NJ111	General Marine Transportation Corp.	28	(37)	31	(41)	51	(66)
	TOTALS	4,277	(5,592)	3,722	(4,866)	3,361	(4,774)

NA = Not Available.

[1]EPA-Region II permit number.

[2]Included with NJ017.

[3]Included with NJ111.

Sources: USEPA, April 1975 and January 21, 1976.

tuations were noted in 1971 and 1972. The average annual volume dumped from 1960 to 1975 was 3.3 million cu m (4.3 million cu yd).

The twelve municipal or sewerage authority permittees produce about 95 percent of the sludge dumped in the Bight. The largest source is New York City, which generates approximately 54 percent of all the sludge dumped. Four other municipal or sewerage authority permittees (Passaic Valley Sewerage Commissioners, Middlesex County Sewerage Authority, Nassau County, and Bergen County Sewerage Authority) and one commercial permittee (Modern Transportation Company) account for approximately 36 percent. The remaining 10 percent of the sludge is dumped by the other six permittees.

3. Dumping Vessels

Sewage sludge is currently transported to the existing dump site by barges and sludge tankers. The barges are towed to the site; the sludge is dumped by gravity through an opening in the bottom of the barge. Sludge tankers are self-propelled vessels capable of pumping sludge through openings beneath the waterline.

At present, fourteen vessels (eight barges and six tankers) are permitted by EPA to transport sewage sludge to the existing site (Table 7). Two of these vessels (the barge, Judson K. Stickle, and the tanker, Coney Island) are undergoing repairs and modifications. They may be available for use in the Bight by 1977. Two other vessels (the barges, Forest and Liquid Waste No. 1) are currently used for ocean dumping in other areas

TABLE 7

SLUDGE DUMPING VESSELS PERMITTED FOR USE IN THE NEW YORK BIGHT

Permittee	Vessel Name	Type	Tonnage Metric Tons (Tons)	Carrying Capacity Cubic Meters (Cubic Yards)	Age Years	Length Meters (Feet)	Beam Meters (Feet)	Loaded Draft Meters (Feet)	Propulsion
Modern Transportation Company	Forest[1]	Barge	7,300 (8,000)	7,193 (9,408)	16	83 (272)	21 (68)	5.6 (18.5)	Towed
	Lisa	Barge	7,300 (8,000)	7,193 (9,408)	16	83 (272)	21 (68)	5.6 (18.5)	Towed
	Judson K. Stickle[2]	Barge	6,400 (7,000)	6,247 (8,170)	16	91 (300)	20 (64)	4.7 (15.5)	Towed
	Raritan	Barge	2,700 (3,000)	2,650 (3,466)	22	64 (211)	13 (43)	4.1 (13.5)	Towed
	Liquid Waste No. 1[1]	Barge	2,700 (3,000)	2,650 (3,466)	25	64 (211)	13 (43)	4.1 (13.5)	Towed
	Ocean Disposall No. 2	Barge	5,400 (6,000)	5,300 (6,932)	7	81 (266)	17 (56)	5.0 (16.5)	Towed
New York City	North River	Tanker	2,376 (2,617)	3,087 (4,037)	2	99 (324)	15 (50)	4.9 (16)	Self-Propelled
	Newtown Creek	Tanker	2,321 (2,557)	3,052 (3,992)	8	99 (324)	15 (50)	4.9 (16)	Self-Propelled
	Bowery Bay	Tanker	1,432 (1,578)	1,869 (2,444)	16	82 (268)	14 (45)	4.0 (13)	Self-Propelled
	Owls Head	Tanker	1,492 (1,643)	1,869 (2,444)	23	82 (268)	14 (45)	4.0 (13)	Self-Propelled

TABLE 7 (Continued)

SLUDGE DUMPING VESSELS PERMITTED FOR USE IN THE NEW YORK BIGHT

Permittee	Vessel Name	Type	Tonnage Metric Tons (Tons)	Carrying Capacity Cubic Meters (Cubic Yards)	Age Years	Length Meters (Feet)	Beam Meters (Feet)	Loaded Draft Meters (Feet)	Propulsion
Westchester County	Westco I	Barge	728 (802)	1,415 (1,850)	15	61 (201)	11 (36)	3.0 (0)	Towed
General Marine Transportation Corporation	Susan Frank	Tanker	1,297 (1,429)	1,457 (1,906)	NA	76 (249)	13 (42)	3.7 (12)	Self-Propelled
	Rebecca K	Tanker	1,297 (1,429)	1,457 (1,906)	NA	76 (249)	13 (42)	3.7 (12)	Self-Propelled
	Coney Island[3]	Tanker	1,297 (1,429)	1,457 (1,906)	NA	76 (249)	13 (42)	3.7 (12)	Self-Propelled
Totals and Means	14 Vessels		44,040 (48,484)	46,896 (61,334)	16.6	80 (262)	15 (50)	4.4 (14.2)	

[1] Forest and Liquid Waste No. 1 are presently in use in Philadelphia or Puerto Rico, but may be in the New York area in the future.

[2] Judson K. Stickle is currently under repair and will not be available until 1977.

[3] Coney Island is currently being modified for permitted use in the Bight and may be available in 1977.

Sources: Pollution Control Industries, August 15, 1975; NYCEPA, July 28, 1975; Westchester County, July 7, 1975; General Marine Transportation Corporation, July 6, 1975; USEPA, January 21, 1976.

(Philadelphia and Puerto Rico), but may be available in the future. The carrying capacity of this fourteen vessel fleet would be 46,900 cu m (61,300 cu yd) per trip.

The City of New York owns and operates a fleet of four self-propelled sludge tankers, whose total carrying capacity is approximately 9,900 cu m (12,900 cu yd), or 21 percent of the potential carrying capacity. The two commercial sludge haulers, Modern Transportation Company and General Marine Transportation Corporation, have potential carrying capacities of 31,800 and 3,900 cu m (35,000 and 4,300 cu yd), respectively. Together they represent 76 percent of the potential barging capacity in the metropolitan area. The barge operated by Westchester County accounts for the remaining 3 percent.

4. Future Sources

The twelve municipal and sewerage authority permittees, along with the three commercial permittees, are expected to be the only significant sources of sewage sludge, on a volumetric basis, dumping in the New York Bight from 1976 through 1981. During this period, these sources are, at the direction of EPA, to develop environmentally acceptable land-based methods of sludge disposal. The EPA has already established schedules for phasing out sludge dumping by the three industrial permittees (Whippany Paper Board, American Cyanamid, and S.B. Thomas) by 1977. It is EPA's stated goal to implement environmentally acceptable alternatives to ocean dumping of all sewage sludge in the Bight by 1981, where environmentally, technically, and economically feasible.

Within the next few years, the six primary wastewater treatment facilities in the metropolitan area that dump sewage sludge in the Bight will be upgraded to provide secondary treatment (Tables 2 and 8). Around 1981, New York City will add a new facility (the North River Plant) to the eleven wastewater treatment facilities it already operates. A total of twenty-three large wastewater treatment facilities in the metropolitan area, all operated by the present municipal and sewerage authority permittees, will be dumping sewage sludge in the New York Bight by 1981. All of these facilities should be practicing secondary treatment by then.

The three commercial haulers will probably continue to provide sludge dumping services to septic tank cleaners and small municipalities and sewerage authorities in New Jersey. The EPA intends to phase out commercial sludge dumping by 1981.

a. Sludge Characteristics. In the interval, 1976 to 1981, the sewage sludge dumped in the New York Bight should generally resemble that being dumped at present, as described previously in this section and as shown in Tables 2, 3, and 4. It is assumed that concentrations of heavy metals will remain about the same because conventional secondary treatment does not remove heavy metals. Pretreatment requirements for discharge of industrial effluent to municipal systems are not expected to be operational until 1977, and only slight in-house process reductions in heavy metals discharged from industries in the metropolitan area are anticipated.

TABLE 8

FUTURE TREATMENT PRACTICES OF OCEAN DUMPING PERMITTEES
(1981)

1975 Permit Number[1]	Permittee	Treatment Level	Sludge Treatment	Percent Solids
NJ002	Middletown Sewerage Authority	Secondary	Incineration	-
NJ003	Passaic Valley Sewerage Commissioners	Secondary	Thickening, Digestion & Dewatering	10.0
NY007	City of Long Beach	Secondary	Digestion and Heat Conditioning	3.5
NJ008	Middlesex County Sewerage Authority	Secondary	Digestion	4.5
NY009	City of New York			
	Bowery Bay	Secondary	Thickening and Digestion	3.5
	Coney Island	Secondary	Thickening and Digestion	3.5
	Hunts Point	Secondary	Thickening and Digestion	3.5
	Jamaica	Secondary	Thickening and Digestion	2.8
	Owls Head	Secondary	Thickening and Digestion	5.0
	Newtown Creek	Secondary	Thickening and Digestion	3.5
	Port Richmond	Secondary	Digestion	4.7
	Rockaway	Secondary	Thickening and Digestion	3.5
	Tallman Island	Secondary	Thickening and Digestion	2.5
	Wards Island	Secondary	Thickening and Digestion	3.7
	26th Ward	Secondary	Thickening and Digestion	3.5
	North River (1981)	Secondary	Thickening and Digestion	3.5
NJ017	Modern Transportation Co.	NA	NA	NA
NJ021	Linden Roselle Sewerage Authority	Secondary	Thickening and Digestion	5.8
NJ022	Joint Meeting of Essex & Union Counties	Secondary	Thickening and Digestion	3.5
NY028	Nassau County	Secondary	Incineration	-
NY029	Westchester County	Secondary	Incineration	3.5
NY031	West Long Beach Sewer District	Secondary	Incineration	-
NJ063	Whippany Paper Board[2]	-	-	-
NY068	City of Glen Cove	-	Incineration (1979)	-
NJ103	Caldwell Trucking Co.	NA	NA	NA
NJ106	American Cyanamid[2]	-	-	-
NJ109	S.B. Thomas[2]	-	-	-
NJ111	General Marine Transportation Corp.	NA	NA	NA

NA = Not Available.

[1]EPA-Region II permit number.

[2]Whippany Paper Board, American Cynamid and S.B. Thomas are to phase out of ocean dumping of sewage sludge by 1977.

Sources: USEPA, April 1975 and January 21, 1975; ISC, 1975.

In the future, the concentrations of heavy metals from the New York City and New Jersey sewage sludge sources may decline as pretreatment and in-house changes in industrial processes are implemented. This may make these sludges more acceptable for agricultural uses (Section VA).

Sludges from secondary treatment facilities generally have a lower solids concentration than sludges from primary facilities. As the remaining primary treatment plants in the metropolitan area are upgraded to provide secondary treatment, there may be a slight decrease in the solids concentration of sewage sludge dumped in the ocean. Specific sludge treatment methods can be used to increase the solids concentration, thereby reducing the total volume of sludge, and making barging to an ocean dump site more economical. Therefore, many of the upgraded wastewater treatment facilities are expected to provide solids concentration in addition to conventional sludge treatment.

b. Volumes of Sludge to be Dumped. The volume of sewage sludge dumped in the New York Bight is expected to double between 1976 and 1981 (Table 9). Approximately 99 percent of this volume (up from 95 percent in 1975) will be generated by the present municipal and sewerage authority permittees. The remaining 1 percent of the future load (down from 5 percent in 1975) will be dumped by the three present commercial permittees. Projections are that in 1981, a total of 10.2 million cu m (13.3 million cu yd) of sewage sludge will be dumped in the Bight.

TABLE 9

VOLUMES OF SEWAGE SLUDGE ESTIMATED FOR DUMPING IN THE NEW YORK BIGHT

1975 Permit Number[1]	Permittee	Sewage Sludge in Thousands of Cubic Meters (Cubic Yards)							
		1976		1977		1978		1979	
NJ002	Middletown Sewerage Authority	18	(23)	24	(31)	30	(39)	36	(47)
NJ003	Passaic Valley Sewerage Commissioners	459	(600)	459	(600)	459	(600)	765	(1,000)
NY007	City of Long Beach	29	(38)	31	(40)	32	(42)	34	(44)
NJ008	Middlesex County Sewerage Authority	308	(403)	319	(417)	743	(972)	765	(1,000)
NY009	City of New York	2,982	(3,900)	3,942	(5,155)	4,078	(5,333)	4,351	(5,690)
NJ017	Modern Transportation Co.	310	(406)	310	(406)	310	(406)	310	(406)
NJ019	Bergen County Sewerage Authority	217	(284)	223	(292)	225	(294)	229	(300)
NJ021	Linden Roselle Sewerage Authority	92	(120)	120	(157)	148	(194)	177	(231)
NJ022	Joint Meeting of Essex & Union Counties	111	(145)	111	(145)	111	(145)	333	(435)
NY028	Nassau County	365	(478)	382	(500)	400	(523)	417	(545)
NY029	Westchester County	141	(185)	424	(555)	436	(570)	531	(694)
NY031	West Long Beach Sewer District	3	(4)	3	(4)	4	(5)	4	(5)
NJ063	Whippany Paper Board[2]	-	-	-	-	0	(0)	0	(0)
NY068	City of Glen Cove	41	(54)	43	(56)	44	(58)	Inc.	(Inc.)
NJ103	Caldwell Trucking Co.	-	-	-	-	-	-	-	-
NJ106	American Cyanamid[2]	-	-	-	-	0	(0)	0	(0)
NJ109	S.B. Thomas[3]	-	-	-	-	-	-	-	-
NJ111	General Marine Transportation Corp.	38	(50)	38	(50)	38	(50)	38	(50)
	TOTALS	5,114	(6,690)	6,429	(8,408)	7,058	(9,231)	7,990	(10,447)

TABLE 9 (Continued)

VOLUMES OF SEWAGE SLUDGE ESTIMATED FOR DUMPING IN THE NEW YORK BIGHT

1975 Permit Number[1]	Permittee	Sewage Sludge in Thousands of Cubic Meters (Cubic Yards)					
		1980		1981		2000	
NJ002	Middletown Sewerage Authority	42	(55)	48	(63)	Inc.	(Inc.)
NJ003	Passaic Valley Sewerage Commissioners	994	(1,300)	994	(1,300)	1,860	(2,443)
NY007	City of Long Beach	35	(46)	37	(48)	46	(60)
NJ008	Middlesex County Sewerage Authority	912	(1,193)	924	(1,208)	2,449	(3,203)
NY009	City of New York	4,621	(6,044)	5,880	(7,690)	6,975	(9,122)
NJ017	Modern Transportation Co.	310	(406)	310	(406)	310	(406)
NJ019	Bergen County Sewerage Authority	234	(306)	239	(312)	693	(907)
NJ021	Linden Roselle Sewerage Authority	205	(268)	232	(305)	403	(527)
NJ022	Joint Meeting of Essex & Union Counties	333	(435)	333	(435)	544	(711)
NY028	Nassau County	434	(567)	451	(590)	Inc.	(Inc.)
NY029	Westchester County	681	(891)	701	(917)	Inc.	(Inc.)
NY031	West Long Beach Sewer District	4	(5)	4	(5)	Inc.	(Inc.)
NJ063	Whippany Paper Board[2]	0	(0)	0	(0)	0	(0)
NY068	City of Glen Cove	Inc.	(Inc.)	Inc.	(Inc.)	Inc.	(Inc.)
NJ103	Caldwell Trucking Co.[3]	-	-	-	-	-	-
NJ106	American Cyanamid[2]	0	(0)	0	(0)	0	(0)
NJ109	S.B. Thomas[3]	0	(0)	0	(0)	0	(0)
NJ111	General Marine Transportation Corp.	38	(50)	38	(50)	38	(50)
	TOTALS	8,843	(11,566)	10,191	(13,329)	13,318	(17,419)

Inc.= Incinerated.

[1]EPA-Region II permit number.

[2]Volumes included in Modern Transportation Company totals until 1977 when Whippany Paper Board and American Cyanamid will be phased out of ocean dumping.

[3]Volumes included in General Marine Transportation Corporation totals until 1977 when S.B. Thomas, will be phased out of ocean dumping.

Sources: ISC, 1975; Bergen County Sew. Auth., October 12, 1975; Joint Meeting, September 10, 1975; Middlesex County Sew. Auth., September 18, 1975; PVSC, September 24, 1965; Nassau County, September 18, 1975; Westchester County, September 15, 1975; NYCEPA, October 28, 1975.

The City of New York, Westchester County, Middlesex County, Passaic Valley, Linden, Roselle, and Joint Meeting are expected to remain the largest generators of sludge volumes in 1981 (Table 9). The greatest growth in volume, a fivefold increase, is projected for Westchester County. New York City will continue to be the largest sludge generator in New York State, and Passaic Valley and Middlesex County the largest generators in New Jersey.

Three small municipal or sewerage authority treatment facilities (Middletown, Glen Cove, and West Long Beach), and possibly Nassau and Westchester counties, are to begin incinerating sewage sludge by 1981. Incineration would replace the current practice of ocean dumping.

C. OCEAN DUMPING AT OTHER SITES IN THE NEW YORK BIGHT

Besides the sewage sludge dump site, the other existing dump sites in the New York Bight are the dredged material, cellar dirt, acid wastes, and wreck sites (Figure 2 and Table 1). Although the chemical wastes site is outside the Bight, it will be discussed here (Figure 1 and Table 1). For the most part, ocean dumping at these five sites will continue until at least 1981.

1. Dredged Material Site

The principal wastes dumped at this site are materials dredged from navigable waterways, including channels, harbors, anchorage grounds, and vessel berths. Up until 1973, ash residues from fossil-fueled power plants were also dumped here. The dredged material currently dumped here results from projects, authorized by the Corps of Engineers (COE), involving maintenance dredging in harbors and channels of the New York-New Jersey metropolitan area. Both the COE hopper dredges and privately owned bottom-dump scows use this site.

a. Past Activities. The original site within New York Harbor was established in 1888. 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. Dredged material has generally been the major source of wastes dumped in the Bight, based upon estimated annual volumes.

From 1960 to 1974, nearly 92 million cu m (120 million cu yd) of dredged material were dumped at the existing site

(Figure 3 and Table 5). The peak annual volume for this period was 11.5 million cu m (15.1 million cu yd) in 1971. The average annual volume for the period was approximately 6 million cu m (8 million cu yd).

b. Present Waste Characteristics. Based upon mass loading comparisons with sewage sludge (Table 10), the dredged material being dumped at the existing site consists primarily of particulate solids. It is characterized by high concentrations of heavy metals, especially cadmium, chromium, copper, lead, and zinc. Dredged material apparently exerts the same biochemical oxygen demand (BOD) as sewage sludge, but only one-half of the chemical oxygen demand (COD) and only one-fifth of the total organic carbon (TOC). The mass loading of oil and grease (O & G) in the dredged material is extremely low. The total Kjeldahl nitrogen (TKN) and total phosphorous (Total-P) levels in dredged material appear to be nearly four times as high as those in sludge.

c. Future Activities. Based on historical permit data, the COE expects a future annual increment of 46 to 54 thousand cu m (60 to 70 thousand cu yd) of dredged material. In 1975, 4.7 million cu m (6.1 million cu yd) of material were dumped at the site (USEPA, January 21, 1976). Utilizing the projected increment, the 1981 volume would be about 4.8 million cu m (6.2 million cu yd); this is much less than has been dumped in the past. However, large dredging projects could change this significantly.

TABLE 10

COMPARISON OF DREDGED MATERIAL AND SEWAGE SLUDGE MASS LOADS

Parameter	Dredged Material	Sewage Sludge	Dredged Material to Sewage Sludge Loading Ratio
	Metric Tons/Day[1]		
Total Solids (TS)	13,400	530	25.28
Biochemical Oxygen Demand (BOD_5)	200	210	0.95
Chemical Oxygen Demand (COD)	1,100	2,100	0.52
Total Organic Carbon (TOC)	110	540	0.20
Oil and Grease (O & G)	22	300	0.07
Total Kjeldahl Nitrogen (TKN)	63	17	3.70
Total Phosphorous (Total-P)	63	17	3.70
Cadmium (Cd)	2.0	0.04	50.00
Chromium (Cr)	2.3	0.073	31.50
Copper (Cu)	6.3	0.70	9.00
Mercury (Hg)	0.013	0.013	1.00
Lead (Pb)	4.7	0.72	6.53
Zinc (Zn)	7.3	1.8	4.06

[1]Metric ton = 1.10 tons.

Source: Mueller and Jeris, unpub.

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 possibly using an alternate dump site within the Northern or Southern Area. The plan was to include consideration of alternatives to ocean dumping, potential navigation hazards, economic impacts, and an implementation schedule. The request was based upon the significant volume of dredged material being dumped annually, the high pollutant loading associated with the material dumped, and the decision to move the existing 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 on the basis of potential effects on water quality, shellfish beds or fisheries resources, wildlife, or recreational areas. In addition, the COE anticipates that transporting dredged material to an alternate dump site in either the Northern or Southern Area will significantly increase the costs of the waterways dredging and port development program in the metropolitan area. Currently, the COE is studying alternative sites and methods of dredged material disposal and has indicated a willingness to relocate the existing dump site if studies show that it presents a hazard to navigation or public health (USACOE, December 12, 1974).

In July 1975, the COE suggested that dredged material dumping be shifted slightly offshore and to the southeast of the existing dump site. This proposal was prompted by the ac-

cumulation of solids at the dump site, the need for maintaining a maximum 15 m (50 ft) water depth onsite, and the trend toward increased vessel draft (USACOE, July 14, 1975).

Monitoring studies conducted by NOAA-MESA indicate that the "great bulk" of dredged material already dumped onsite has not been transported any significant distance from the release point (NOAA, March 14, 1975). Recently (November 1975), NOAA-MESA stated that use of the existing dredged material and sewage sludge 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).

The EPA is currently evaluating the need to relocate the dredged material dump site.

2. Cellar Dirt Site

Cellar dirt is composed mainly of construction rubble, broken concrete, excavated earth and rock, and other non-floatable material. The bulk of this material comes from construction in the metropolitan area. Cellar dirt is ocean dumped because there is little or no land area left for its disposal in the metropolitan area. A great deal of the material recently dumped at the cellar dirt site resulted from blasting and tunneling operations in New York City, especially for the Second Avenue Subway and the new water tunnel.

a. Past Activities. Cellar dirt has been dumped into the Bight since 1908, when the original dump site was established. Since then, the site has been moved several times because of the potential hazards to navigation as the cellar dirt material accumulated. The existing site was designated in 1940. From 1960 through 1974, this dump site received over 8.4 million cu m (11.0 million cu yd) of material (Table 5) for an average annual contribution of over 535 thousand cu m (700 thousand cu yd).

b. Future Activities. In 1975, 268 thousand cu m (350 thousand cu yd) of cellar dirt material were dumped at the site (USEPA, January 21, 1976). This reduction in volume is due to decreased construction activity in the metropolitan area. The volume of material dumped at the cellar dirt site varies according to economic conditions in the construction business.

3. Acid Wastes Site

Currently, the acid wastes dump site is used by only two industries (NL Industries and Allied Chemical), both of which are located in New Jersey. Prior to 1974, DuPont dumped caustic wastes here; these wastes are now dumped at the chemical wastes site. Acid wastes, which consist of the by-product (process) acid solutions, are generally transported to the site aboard rubber-lined tank barges. They are then released below water level, while the barges are underway, to insure maximum dispersion and dilution.

a. Past Activities. The existing acid wastes dump site in the Bight Apex was established in 1948. Prior to 1948, acid

wastes were dumped at the sewage sludge dump site. Between 1960 and 1974, over 35 million cu m (46 million cu yd) of acid wastes were dumped (Figure 3 and Table 5), for an average annual contribution of 2.3 million cu m (3.0 million cu yd).

b. Future Activities. The volume of acid wastes dumped in the Bight is not expected to increase between 1976 and 1981. The two industries that currently use the site are under an implementation schedule to phase out ocean dumping by 1981 (USEPA, January 21, 1976).

4. Wreck Site

Derelict vessels and wrecks, which represent hazards to navigation, are permitted to be disposed of at this dump site. Abandoned recreational craft generally are handled under EPA permit by the COE, while larger abandoned vessels are turned over to their owners for disposal.

a. Past Activities. The wreck site has been used very sparingly in recent years. Only eight vessels were dumped at the site between 1960 and 1974 (Table 5).

b. Future Activities. The USCG and the COE have proposed that the existing wreck site be relocated outside of existing navigational lanes. This action is now under review by EPA. For the immediate future (1976), EPA will not permit use of the existing site.

5. Chemical Wastes Site

The chemical wastes dump site was created as an alternative to the land disposal of industrial chemical wastes which might contaminate potable water supplies.

a. Past Activities. The chemical wastes site was established in 1965 based upon geographical limits recommended by the U.S. Fish and Wildlife Service. From 1960 to 1974, less than 2.5 million cu m (3.5 million cu yd) of chemical wastes were dumped here (Figure 3 and Table 5), for an average annual contribution of slightly over 176 thousand cu m (230 thousand cu yd).

b. Future Activities. There are currently nineteen industrial waste generators permitted to use this site. Of these, fifteen are under an implementation schedule to phase out ocean dumping by July 1977. The remaining four industries are under implementation schedules to phase out ocean dumping by 1981 (USEPA, November 15, 1975).

D. OVERVIEW OF POLLUTANT LOADING IN THE NEW YORK BIGHT

The present pollutant loading in the New York Bight can be attributed to dumping and non-dumping contaminant sources. The non-dumping loading comes from three major sources: atmospheric fallout, wastewater (municipal and industrial) discharges, and surface (gaged and urban) and groundwater runoff (Table 11 and Figure 4).

The Mueller and Jeris report (unpub.) represents the best current estimate of the non-dumping loading to the New York Bight. Admittedly, it contains data gaps and relies heavily upon unverified discharge information. Nonetheless, the report gives a relatively good general description of non-dumping pollutant loading.

The actual contaminant input to the New York Bight continental shelf waters cannot be precisely quantified because of the difficulty in identifying the reductions that occur in the pollutant load before it reaches the Bight. For the most part, the contaminant loading presented by Mueller and Jeris identifies loadings from three separate zones: the Sandy Hook-Rockaway Point transect zone, the New Jersey coastal zone, and the Long Island coastal zone.

Barging sources, as defined by Mueller and Jeris, include dredged material, sewage sludge, cellar dirt, and acid wastes dumped directly into the waters of the Bight. The pollutant loading from wreck dumping was considered to be insignificant. In terms of absolute volumes, dredged material constituted the major source of pollutants dumped in the Bight.

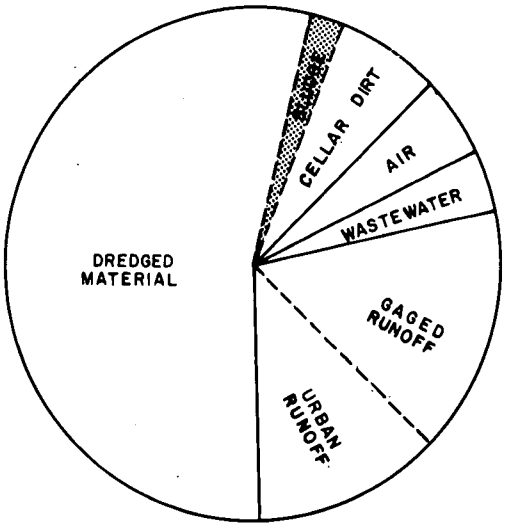
TABLE 11

Total New York Bight Loads by Source

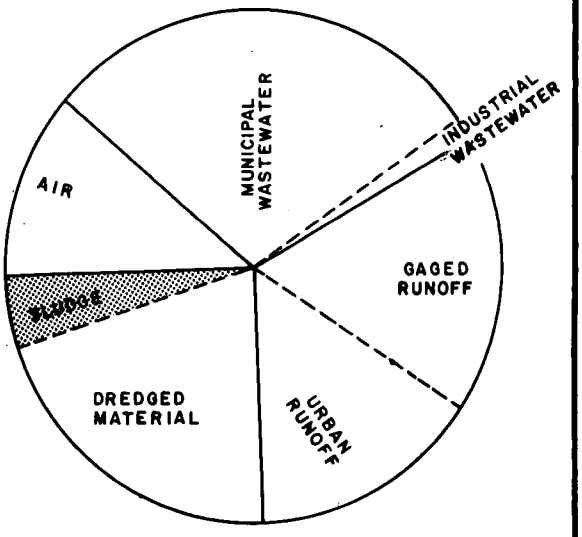
Parameter	Percentage Contribution						
	Direct Bight		Coastal Zone				
			Wastewater		Runoff		
	Barge[1]	Atmospheric	Municipal	Industrial	Gaged	Urban	Groundwater
Flow	0.02	59	5	0.4	33	2	0.4
Suspended Solids (SS)	63	5	4	0.2	16	12	0
Biochemical Oxygen Demand (BOD)	21	9	48	2	11	9	0.01
Chemical Oxygen Demand (COD)	32	10	35	1	13	9	0.01
Total Organic Carbon (TOC)	25	12	29	1	18	15	0.02
Oil & Grease (O&G)	38	-	22	0.7	16	23	-
Ammonia (NH_3-N)	24	4	55	3	10	4	0.04
Organic Nitrogen (Org-N)	19	9	45	2	21	5	0.02
Total Kjeldahl Nitrogen (TKN)	21	6	51	2	15	5	0.02
Nitrite & Nitrate (NO_2-N & NO_3-N)	0.07	33	6	0.3	60	0.6	0.7
Total-Nitrogen	16	13	40	2	25	4	0.2
Ortho-Phosphorous	-	1	72	-	18	9	0
Total-Phosphorous	50	0.7	35	1	9	4	0
Cadium (Cd)	82	2	5	0.6	5	5	0.001
Chromium (Ch)	50	1	22	0.8	10	16	0
Copper (Cu)	51	3	11	9	10	16	0.006
Iron (Fe)	79	3	5	0.5	6	6	0.01
Mercury (Hg)	9	-	71	2	13	5	-
Lead (Pb)	44	9	19	3	6	19	0.004
Zinc (Zn)	29	18	8	2	21	22	0.009
Fecal Coli-winter	<0.001	0	87	0.01	0.01	13	0
summer	<0.001	0	85	0.02	0.01	15	0
Total Coli-winter	<0.001	0	91	0.02	0.05	9	0
summer	<0.001	0	84	0.03	0.1	16	0

[1]Barging includes dredged material, sewage sludge, cellar dirt, and acid wastes dumping.

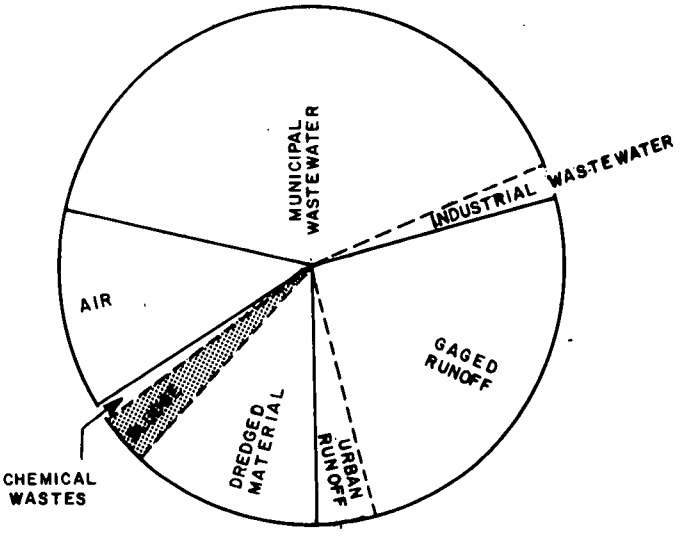
Source: Mueller and Jeris, unpub.



SUSPENDED SOLIDS



ORGANIC CARBON



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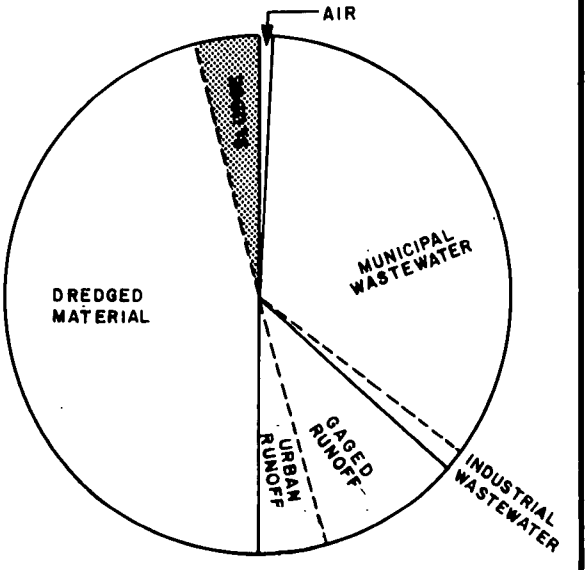

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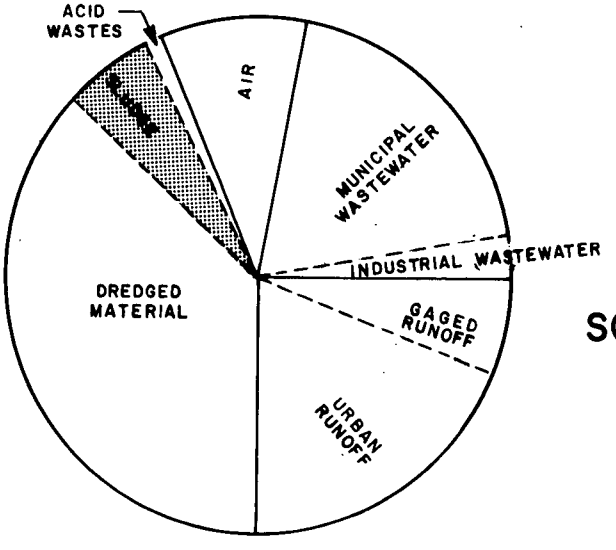

LEAD

SOURCES OF POLLUTANTS IN THE NEW YORK BIGHT

SOURCE : MUELLER AND JERIS , UNPUB.

DAMES & MOORE

FIGURE 4

Mueller and Jeris concluded that the greatest pollutant input to the Bight originates in the Sandy Hook-Rockaway Point transect zone. Inputs from the New Jersey and Long Island coastal zones are small, contributing less than 6 percent of the total pollutant loading to the Bight.

1. Suspended Solids

The major input of suspended solids (SS) to the New York Bight waters (63 percent) comes from barged sources, principally dredged material. Atmospheric fallout contributes approximately 5 percent of the total, while runoff contributes about 28 percent. Wastewater discharges contribute the remaining 4 percent.

2. Carbonaceous Materials

Municipal wastewater discharges are the source of about half (48 percent) of the biochemical oxygen demand (BOD) loading reaching the Bight. Barging (21 percent), runoff (20 percent), and atmospheric fallout (9 percent) account for most of the remaining load.

Barging and municipal wastewater discharge loadings account for approximately 67 percent of the COD and 54 percent of the TOC loading in the Bight. The COD and TOC loadings from atmospheric fallout are approximately 11 percent and 15 percent, respectively. Likewise, the COD and TOC loadings from runoff are approximately 11 percent and 15 percent, respectively.

3. Heavy Metals

Barging appears to be the major source of heavy metals contamination to the New York Bight, with the exception of mer-

cury (from municipal wastewater discharges). Runoff and municipal wastewater discharges are the second and third largest sources. Almost all of the barge-related heavy metal loadings are the result of dredged material dumping; sewage sludge accounts for less than 6 percent of these loadings.

4. Nitrogen and Phosphorous

Approximately half of the oxidizable nitrogen (ammonia, organic nitrogen, and nitrate-nitrogen) in the Bight appears to result from municipal wastewater discharges. Runoff and barging, almost equally, account for the remaining oxidizable nitrogen.

Gaged runoff (60 percent) is by far the largest source of nitrites and nitrates (NO_2-N and NO_3-N) in the Bight. Atmospheric fallout (33 percent) is the second major source of these contaminants.

Municipal wastewater discharges account for 72 percent of the dissolved phosphorous (Ortho-P) loading in the New York Bight. The remainder of the dissolved phosphorous results from runoff. Barging, primarily of dredged material, accounts for 50 percent of the total phosphorous loading to the Bight.

5. Microbial Contamination

Municipal wastewater discharges appear to be the major source (84 to 91 percent) of microbial contamination (fecal and total coliform) to the Bight. The remaining coliform loading results from urban runoff. Barging is an insignificant source of fecal contamination of the New York Bight.

E. FEDERAL LEGISLATION AND CONTROL PROGRAMS

1. The Marine Protection, Research, and Sanctuaries Act of 1972 (PL 92-532)

The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) regulates the dumping of waste materials in U.S. ocean waters (U.S. Congress, October 23, 1972). It includes mechanisms for designating dump sites, for issuing dumping permits, and for carrying out associated surveillance and enforcement activities. It also provides for establishing marine sanctuaries and for researching the causes and effects of marine pollution. Under the MPRSA, EPA is assigned overall responsibility for administration and enforcement activities. Other responsibilities are assigned to the COE, the USCG, the Department of Commerce (through NOAA), the Department of State, and the U.S. Attorney General.

The transportation from the United States of "any radiological, chemical or biological warfare agent or any high-level radioactive waste" for the purpose of dumping it into any ocean waters is specifically forbidden by the MPRSA. This prohibition was required of any signatories of the International Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, which was ratified by the U.S. Senate in August 1973.

The responsibilities of the federal agencies under the MPRSA are discussed below.

The EPA issues dumping permits for the transport and dumping of all materials, except dredged material, into ocean

waters; establishes criteria for review of permit applications; designates ocean dump sites; assesses environmental impacts of ocean dumping; and provides for enforcement of ocean dumping permits.

The COE issues permits for the dumping of dredged material, subject to EPA review.

The USCG conducts surveillance and other appropriate enforcement activities to prevent unlawful transportation of material for dumping.

The Department of Commerce (through NOAA) conducts comprehensive monitoring and research programs regarding the effects of ocean dumping, including possible long-range effects of pollution, overfishing, and man-induced changes of ocean ecosystems; designates marine sanctuaries, after consultation with other affected federal agencies; and regulates all activities within such sanctuaries.

The Department of State protects the marine environment by establishing international agreements which further the goals of the MPRSA.

The U.S. Attorney General initiates civil and criminal actions at EPA's direction "for such relief as may be appropriate", including injunctions to cease ocean dumping.

2. Related Legislation

The New York Harbor Act of 1888, the Rivers and Harbors Act of 1899 (otherwise known as the Refuse Act), and the Rivers and Harbors Act of 1905 were the first federal laws that attempted to regulate the dumping of refuse and dredged materi-

al into the navigable waters of the United States, including the ocean. The MPRSA has superseded these Acts and other related legislation with regard to ocean dumping of waste materials.

The Federal Water Pollution Control Act Amendments (FWPCAA) of 1972 (PL 92-500) are the source of EPA's authority to regulate the discharge of treated wastewater (effluent) into U.S. waters, including wastewater discharge through ocean outfalls. Both the MPRSA and the FWPCAA provide for the establishment of criteria to control the dumping and discharge of wastes in ocean waters.

The Fish and Wildlife Coordination Act of 1965 and the National Environmental Policy Act of 1969 (NEPA) indirectly relate to ocean dumping in that they require the conservation of marine resources and the assessment of environmental impacts, respectively, where federal actions are concerned. Prior to the passage of the MPRSA in 1972, these laws were frequently used to halt or regulate ocean dumping (Pararas-Carayannis, 1973).

3. EPA Ocean Dumping Permit Program

Under the MPRSA, EPA is authorized to establish a permit program for regulating the transport and dumping of waste materials, except dredged material, in ocean waters. Region II of EPA has been delegated the responsibility for regulating ocean dumping in the waters off New York, New Jersey, Puerto Rico, and the U.S. Virgin Islands.

a. Existing Regulations. On October 15, 1973, EPA-Headquarters published Subchapter H, Ocean Dumping Regulations (40

CFR, Parts 220 to 227), as authorized under the MPRSA, which established guidelines for the review, evaluation, and issuance of ocean dumping permits.

Part 220 of these regulations describes five types of permits that may be issued: General, Special, Emergency, Research, and Interim. The EPA has, with few exceptions, issued only Interim Permits. These permits are non-renewable and have a term of one year or less. A new Interim Permit may be issued to an applicant that has already received one Interim Permit only if that applicant has demonstrated compliance with an approved schedule to implement an environmentally acceptable alternative to ocean dumping. The EPA's policy has been to hold public hearings on the issuance of most ocean dumping permits. A sample permit form is contained in Appendix A.

The EPA has issued Special Permits to users of the cellar dirt dump site because the materials that are dumped there are considered nontoxic. Special Permits are renewable and have a term of three years or less.

Parts 221 through 226 describe required information for application, action on application, contents of permits, records, COE permits, and enforcement procedures for the regulation of ocean dumping.

Part 227 contains the technical criteria, including applicable maximum concentrations of toxic substances, used in the evaluation of wastes proposed for ocean dumping. The establishment of these criteria was authorized under Section 104 of

the MPRSA and Section 403 of the FWPCAA; the criteria apply to both ocean dumping and discharge through ocean outfalls.

The EPA-Headquarters has issued two General Permits (40 CFR Part 229), one for burial-at-sea and the other for transport and sinking of target vessels by the U.S. Navy. A third General Permit is being drawn up for the dumping of wrecks (derelict vessels). No Research or Emergency Permits, which can only be issued by EPA-Headquarters, have been granted for the New York Bight area to date (January 1976).

b. Proposed Regulations. At present, EPA-Headquarters is revising Parts 220 to 227 of the ocean dumping regulations and is preparing a new Part 228, regarding management of dump sites. When completed, these revisions will be published in the Federal Register as proposed regulations, and will be subject to public review and comment.

c. Enforcement Actions. Since the MPRSA became effective, EPA-Region II has initiated eight enforcement actions on alleged ocean dumping permit violations in the New York Bight (Table 12). These actions were based upon referrals from the USCG, NASA, and EPA's own staff. Three of these orders (No. 73-1, 74-2, and 75-4) were issued for alleged misuse of the existing sewage sludge site. The remaining five orders were for alleged violations at the chemical wastes or acid wastes site.

Over 100 USCG referrals to EPA have been for the permittee's "failure to notify" the USCG prior to leaving port.

TABLE 12

OCEAN DUMPING ORDERS IN THE NEW YORK BIGHT

Order No.	Respondents' Name	Referral From	Type of Violation	Notice of Violation	Disposition	Dump Site
73-1	General Marine Transport Corp.	EPA-Region II	Permit condition violation and dumping without permit	11/21/73	Final Order 05/15/74 Hearing officer upheld GMTC on both counts	Sewage Sludge
74-1	Moran Towing & Transportation Co.	USCG	Dumped outside authorized dump site	01/23/74	Final Order 05/27/75 $25,000 penalty payment Appealed U.S. District Court	Acid Wastes
74-2	Modern Transportation Company	USCG	Dumped outside authorized dump site	04/02/74	Final Order 01/22/75 Charges withdrawn	Sewage Sludge
74-4	Spentonbush Transport Service, Inc.	USCG	Dumped outside authorized dump site	06/06/75	Pending	Chemical Wastes
75-2	Modern Transportation Company	EPA-Region II	Higher concentration of several parameters than that reported in the permit application	03/05/75	Pending	Chemical Wastes
75-3	Chemical Recovery Corp., EPL Industries, Inc.	EPA-Region II	Higher concentration of several parameters than that reported in the permit application	03/05/75	Pending	Chemical Wastes
75-4	Nassau County	EPA-Region II	Failure to segregate industrial waste	05/06/75	Final Order 06/16/75 No Penalty; ordered to terminate dumping of industrial wastes	Sewage Sludge
75-5	Moran Towing & Transportation Co.	NASA & EPA-Region II	Dumped outside authorized dump site	08/14/75	Pending	Acid Wastes

Source: USEPA, October 24, 1975.

The facts did not warrant initiation of administrative action, although, in some cases, a letter of reprimand was sent to the permittee.

4. COE Dredged Material Permit Program

The COE is authorized to issue permits for the dumping of dredged material into navigable waters, under the FWPCAA, and into ocean waters, under the MPRSA. Passage of these two Acts in 1972 relieved the COE of all responsibility for the regulation of waste discharges, as either effluent or solid waste materials.

The COE has published interim final regulations (33 CFR Part 209) containing guidelines for the regulation of dredging operations and for the issuance of permits for the transport of dredged material for dumping. The criteria to be used by the COE in evaluating applications for ocean dumping of dredged material are those promulgated under the aforementioned Ocean Dumping Regulations (40 CFR Part 227).

5. USCG Surveillance Responsibilities

The USCG has the responsibility under the MPRSA to "conduct surveillance and other appropriate enforcement activity to prevent unlawful transportation of material for dumping, or unlawful dumping" and to "supply to the EPA Administrator and the U.S. Attorney General, as appropriate, such information of enforcement as they may require in carrying out their duties relative to penalty assessment (fines), criminal prosecutions, or other actions involving litigation." Under the MPRSA, the

USCG is authorized to issue regulations to carry out "the responsibilities and authority conferred."

a. Existing Program. The USCG to date (January 1976) has not promulgated any regulations under the MPRSA. For the present, the USCG has defined its surveillance responsibilities under an internal order (Commandant Instruction 5992.9A), which can be briefly summarized as follows:

- Spot checks will be conducted on dumping vessels for valid permits.

- Surveillance will be concentrated on the dumping of toxic material, EPA requests for vessel/dump monitoring, and 10 percent of other disposal activities.

- Surveillance will be accomplished by using a USCG vessel to intercept and/or escort the permittee vessel, by aircraft overflight of the assigned dump site during dumping activity, by stationing shipriders (USCG personnel) on permittee vessels, and by radar coverage.

- Random surveillance missions will be conducted in designated and non-designated areas to discourage illegal dumping.

- For purposes of enforcement, the USCG will report violations of the ocean dumping permit conditions to EPA.

- The USCG will review both EPA and COE draft permits for ocean dumping such that specific surveillance conditions may be made part of the final permit.

The U.S. Coast Guard-Third District, which has jurisdiction over coastal waters from Connecticut to Delaware, is

responsible for the surveillance of ocean dumping in the New York Bight. Within the Bight Apex, patrol vessels conduct surveillance of the existing dump sites and record vessel sitings, activities, and positions. Daily helicopter patrols are conducted over the five existing dump sites in the Bight Apex, weather conditions permitting.

The use of shipriders is an effective method of surveillance, but requires an exceptional commitment of manpower. Therefore, shipriders are used only for surveillance at the chemical wastes dump site. In 1974, 44 percent of the vessels going to the chemical wastes site carried shipriders. Interception by aircraft or ship is not routinely attempted because of the inaccuracy in estimating the dumping vessel's time of arrival and because of the relatively short endurance time of the patrol helicopters (USCG, July 8, 1975).

From April 1973 (the effective date of the MPRSA) to December 1974, the USCG-Third District made twenty-two enforcement referrals to EPA. Fifteen of these referrals, containing a total of 133 possible violations, were for failure of the permittee to notify the USCG of vessel departure. The other seven referrals included three cases of illegal short dumping, two instances of liquid wastes spilled en route, and two cases of no permit on board the vessel (USCG, June 2. 1975). Three of the twenty-two USCG referrals resulted in enforcement actions by EPA (Table 12).

b. Proposed Program. The USCG is conducting research on the development of a positive recording system, based on elec-

tronic navigation. The prototype, tested in the summer of 1975, is based on LORAN C (Long Range Aid to Navigation). The sealed recording navigation equipment can record the trackline of the dump vessel on a tape, providing a permanent record of whether the vessel reaches the designated site. Although the prototype does not have a dump sensor, such a sensor is electronically possible. The legal aspects of this equipment being placed aboard a private vessel are also being researched (USCG, July 8, 1975).

6. FDA Responsibilities

Operating under the Food, Drug, and Cosmetics Act and the Public Health Service Act, the Food and Drug Administration (FDA) administers the National Shellfish Sanitation Program. This program gives FDA the responsibility to assure that bivalve shellfish (clams, oysters, etc.) shipped in interstate commerce are of a safe and wholesome nature. The FDA is responsible for classifying the waters beyond the 3-mile (5.6 km) limit.* Since 1970, FDA has monitored waters beyond the 12-mile (22.2 km) limit. (USEPA, November 21, 1975).

In the metropolitan area, FDA has closed to shellfishing the waters within an 11.1 km (6.0 n mi) radius and shoreward of the existing sewage sludge dump site (Section IVC). The closure includes both a polluted area and a safety or buffer zone.

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* All limits in ocean waters are expressed in nautical miles (n mi): e.g., 3-, 12-, and 200-mile limits.

The states are responsible for classifying, according to water quality, the ocean waters from the coastline out to the 3-mile (5.6 km) limit. The USCG monitors these closed areas and reports to FDA any vessels seen harvesting shellfish. Although FDA is empowered to seize the cargo, it usually notifies state officials to take appropriate actions. These actions include seizure of the cargo, fines, and license suspension.

F. INTERNATIONAL CONSIDERATIONS

An alternate sewage sludge dump site in either the Northern or Southern Area in the New York Bight would lie outside currently recognized U.S. waters. International guidelines on ocean dumping are somewhat vague, despite the recent proceedings of the Third United Nations Law of the Sea Conference (UNLOS III). The United States has proposed legislation that would extend economic control to the 200-mile (371 km) limit.

1. United States Laws

The United States has maintained a territorial limit (territorial sea) of 3 nautical miles (5.5 km) since 1783. The waters, air space, seabed, and subsoil within this limit are subject to United States sovereignty. The coastal states also have jurisdiction over the waters within the 3-mile (5.6 km) limit.

In 1945, a Presidental proclamation (Proc. No. 2668) gave the United States jurisdiction over the subsoil and seabed resources beyond the 3-mile (5.6 km) limit to the edge of the continental shelf. This proclamation also established U.S. claims to oil and gas deposits in the shelf. The Outer Continental Shelf Lands Act of 1953 reinforced the proclamation and gave the federal government sole jurisdiction over submerged lands from the 3-mile (5.6 km) limit to the edge of the continental shelf. A companion bill, the Continental Shelf Submerged Lands Act of 1953, gave the coastal states jurisdiction over seabed and subsoil resources within the territorial sea.

In 1966, the U.S. Congress passed the Territorial Fisheries Act (PL 89-658), which extended exclusive fishing rights to a 12-mile (22.0 km) limit (U.S. Congress, October 14, 1966). Under international law, this area is known as the contiguous zone.

The MPRSA gave the United States control of ocean dumping in coastal ocean waters over which the United States has jurisdiction or may exercise control, under accepted principles of international law (Baxter *et al.*, 1974).

2. International Agreements

The Convention on the Territorial Sea and the Contiguous Zone defined the territorial sea as the waters extending 3 nautical miles (5.6 km) seaward of a defined baseline, as determined by the Department of State. The contiguous zone is that area between the baseline and a 12-mile (22.2 km) limit. Ocean waters include those waters of the open sea lying seaward of the baseline.

Under international law, a coastal nation has exclusive control over its internal waters (bays, estuaries, and other semi-enclosed areas) and territorial sea. It also has authority to designate dump sites and enact pollution control laws that protect public welfare and private property. A coastal nation has the right to prevent pollution of the contiguous zone, based upon potential contamination of the territorial sea (*Marine Technology Society Journal*, July 1974).

In August 1973, the U.S. Senate ratified the International Convention on the Prevention of Marine Pollution by Dump-

ing of Wastes and Other Matter. This convention became effective in September 1975. Annex II of the convention requires the issuance of a special permit for dumping wastes into the ocean (especially sewage sludge or dredged material) which contain "significant amounts" of heavy metals, toxic compounds, organohalogens, pesticides, and high-level radioactive materials. The MPRSA initially implemented the provisions of this convention for U.S. controlled and adjacent waters.

The Third United Nations Law of the Sea Conference (UNLOS III) is now addressing economic development and control of the seabed resources beyond a 12-mile (22.2 km) limit. There are many issues to be resolved, such as the guarantee of transit through international straits, delineation of boundaries, and multinational arrangements. The Conference appears to be moving toward the establishment of a 200-mile (371 km) economic zone, in which a coastal nation will have exclusive right to authorize and regulate all economic activities. The United States has advocated a set of conditions for this zone, including adequate pollution control, protection of foreign investments, compulsory settlement of disputes, international revenue sharing, and non-interference with other ocean activities (Marine Technology Society Journal, July 1974).

3. Proposed United States Lesiglation

The slow progress of the UNLOS III Conference in providing agreements or treaties has led United States lawmakers to propose a bill extending commercial fisheries and pollution con-

trol jurisdiction to the 200-mile (371 km) limit. Such a bill recently (January 1976) passed the Senate and is under review by a joint committee (House and Senate) to reconcile differences with the original House version. The Administration wishes to delay the implementation date for a 200-mile (371 km) limit to 1977, as contained in the Senate version of the bill. This would give the UNLOS III Conference an opportunity to reach a final agreement on such a limit, prior to unilateral U.S. action.

G. OTHER ACTIVITIES IN THE NEW YORK BIGHT

1. Commercial Fisheries

Based on annual dollar earnings, commercial fishing is probably the most important activity in the New York Bight at present. In 1973, a total of 84.3 million kg (185.5 million lb) of fish and 9.9 million kg (21.9 million lb) of shellfish, valued at 10.4 million and 20.7 million dollars, respectively, were landed in the New York-New Jersey metropolitan area (Table 13). Most of this catch was taken in the Bight. However, significant quantities of commercial fish and shellfish, especially surf clams, were caught in waters off other states (Maryland, Delaware, and Virginia).

Nassau and Suffolk counties in New York and Monmouth and Ocean counties in New Jersey accounted for approximately 97 percent of the value of all commercial fish landed in the metropolitan area during 1973 (Table 13). The reported value of fish and shellfish landed in Suffolk County was 62 percent of the 1973 total. Suffolk County also accounted for 73 percent of all shellfish landed in the metropolitan area during 1973. In 1974, New York and New Jersey had 5,364 full-time and 2,942 part-time commercial fisherman (BLM, November 1975).

Most of the commercial fish landed in the metropolitan area during 1973 were whiting, flounders (blackback, fluke, and yellowtail), striped bass, red hake, bluefish, butterfish, cod, menhaden, sea trout, porgy, and mackerel. The most common spe-

TABLE 13

COMMERCIAL FISHERIES LANDINGS IN THE NEW YORK-NEW JERSEY METROPOLITAN AREA (1973)

County, State	FISH Kilograms (Pounds) in Thousands		FISH Dollars in Millions	SHELLFISH Kilograms (Pounds) in Thousands		SHELLFISH Dollars in Millions
New York, N.Y.	19	(42)	0.014	70	(154)	0.306
Kings, N.Y.	852	(1,875)	0.383	109	(240)	0.192
Nassau, N.Y.	1,021	(2,245)	0.515	2,039	(4,486)	1.465
Suffolk, N.Y.	7,881	(17,339)	3.778	4,394	(9,666)	15.172
Monmouth, N.J.	70,822	(155,809)	4.209	404	(889)	0.706
Ocean, N.J.	3,717	(8,178)	1.449	2,937	(6,462)	2.821
Total	84,312	(185,488)	10.348	9,953	(21,897)	20.662

Sources: NOAA-NMFS, 1974 a and b.

cies of commercial shellfish landed were hard clams (ocean quahogs), oysters, American lobster, and surf clams, in that order. These species accounted for approximately 93 percent of the value of the 1973 commercial shellfish landings for the metropolitan area (Table 14). Scallops, crabs, and clams, other than hard clams and surf clams, do not appear to be economically important to the commercial fisheries of the region at this time; oysters are not currently harvested in the Bight, except in the local bays and estuaries. The 1974 surf clam catch exceeded the 1973 catch by more than 10 percent (FDA, December 18, 1975). During the last decade, the surf clams taken from the Bight and from adjacent bays and estuaries have accounted for more than 50 percent of the edible clam meats harvested in United States waters (McHugh, 1975).

The potential commercial fisheries development, especially shellfisheries, is discussed further in Section VIIC.

2. Recreational Uses

a. Sport Fishing. About 5.3 million residents of the northeastern United States fished in the waters of New York and New Jersey during 1974, as a recreational activity. Approximately half of these sport fishermen actually made use of the New York Bight (NOAA-NMFS, 1975a). Most sport fishing off the New York and New Jersey shores is devoted to species which are also commercially exploited, such as sea bass, striped bass, white perch, salmon, and some trout. Approximately 75 percent of these species depend upon the coastal zone waters during some or all of their life cycle (Ketchum, 1972).

TABLE 14

COMMERCIAL SHELLFISH LANDINGS IN THE NEW YORK-NEW JERSEY METROPOLITAN AREA (1973)[1]

Shellfish	Kilograms (Pounds) in Thousands		Dollars in Millions
American Lobster	878	(1,932)	3.141
Hard Clams (ocean quahogs)	3,720	(8,185)	11.721
Razor Clams	2	(5)	0.003
Soft Clams	55	(121)	0.134
Surf Clams	3,490	(7,678)	1.098
Oysters	639	(1,405)	3.285
Sea Mussels	311	(685)	0.195
Bay Scallops	104	(229)	0.467
Sea Scallops	71	(155)	0.307
Squid	323	(710)	0.146
Conch	20	(44)	0.013
Blue Crabs	254	(559)	0.137
Red Crabs	12	(27)	0.002
Rock Crabs	73	(161)	0.009
Total	9,952	(21,896)	20.658

[1]Total landings for Kings, Nassau, Suffolk, Monmouth, Ocean and New York counties (see Table 13).

Sources: NOAA-NMFS, 1974a and b.

b. Beach Attendance. The shorelines of Long Island and northern New Jersey support an estimated two-billion-dollar beach industry (IEC, 1973c). The popularity of the Long Island and New Jersey beaches is due to the quality of the low sandy beaches and to their easy accessibility by means of the well-developed metropolitan area highway system. Shore property in the New York-New Jersey metropolitan area is owned by federal, public, and private entities (Table 15). In 1970, an estimated 65.7 million persons attended these beaches (Table 15). In 1974, beach attendance at state and national parks in the metropolitan area was about 9.8 million people (Table 16).

3. Navigation

The USCG is responsible for establishing navigational lanes (separation zones) in the New York Bight. There are three traffic separation zones leading into Ambrose Channel and the Ports of New York and New Jersey (Figure 5). These separation zones are designated as the Barnegat, Hudson Canyon, and Nantucket navigational lanes. The circular area at the intersection of the three navigational lanes at the Bight Apex is a precautionary area characterized by a high level of ship traffic. The existing sewage sludge dump site is located within this area. The proposed Northern and Southern Areas are for the most part located outside these separation zones (Figure 5).

4. Potential Mineral Resources

a. Sand and Gravel. The distribution of sand and gravel in the New York Bight is shown in Figure 6 (Schlee, 1975). At

TABLE 15

BEACH OWNERSHIP AND USE IN THE NEW YORK-NEW JERSEY METROPOLITAN AREA

County, State	Shore Ownership Kilometers (Miles) Federal	Private	Public	Total Shore Length Kilometers (Miles)	1970 Beach Attendance (persons)
Monmouth, N.J.	9.8 (6.1)	15.1(9.4)	18.2(11.3)	43.1(26.8)	6,940,000
Richmond, N.Y.	0.5 (0.3)	6.0(3.7)	14.5(9.0)	20.9(13.0)	698,000
Kings, N.Y.	0.03(0.02)	2.6(1.6)	5.6(3.5)	8.2(5.1)	21,818,100
Queens,N.Y.	1.6 (1.0)	3.2(2.0)	11.2(7.0)	16.1(10.0)	22,372,000
Nassau,N.Y.[1]	- -	- -	27.4(17.0)	27.4(17.0)	13,900,000
Totals	11.9(7.4)	26.9(15.7)	76.9(47.8)	115.7(71.9)	65,728,100

[1]Includes Jones Beach, and approximately 16.1 km (10 miles) of beaches in Suffolk County along with Captree State Park at Fire Island Inlet.

Source: IEC, 1973.

TABLE 16

BEACH ATTENDANCE AT STATE AND NATIONAL PARKS IN THE NEW YORK-NEW JERSEY METROPOLITAN AREA (1974)

Park	Attendance
Island Beach State Park, N.J. (1973)[1]	524,580
Gateway National Recreation Area, Sandy Hook, N.J.[2]	1,597,202
Smith Point Co. Park, Fire Island[3]	720,000
Robert Moses State Park, Fire Island[4]	2,526,668
Captree State Park, Long Island[4]	1,556,591
Fire Island National Seashore[5]	555,000
Fire Island "Other" (1973)[5]	2,301,000
	9,781,041

Sources:

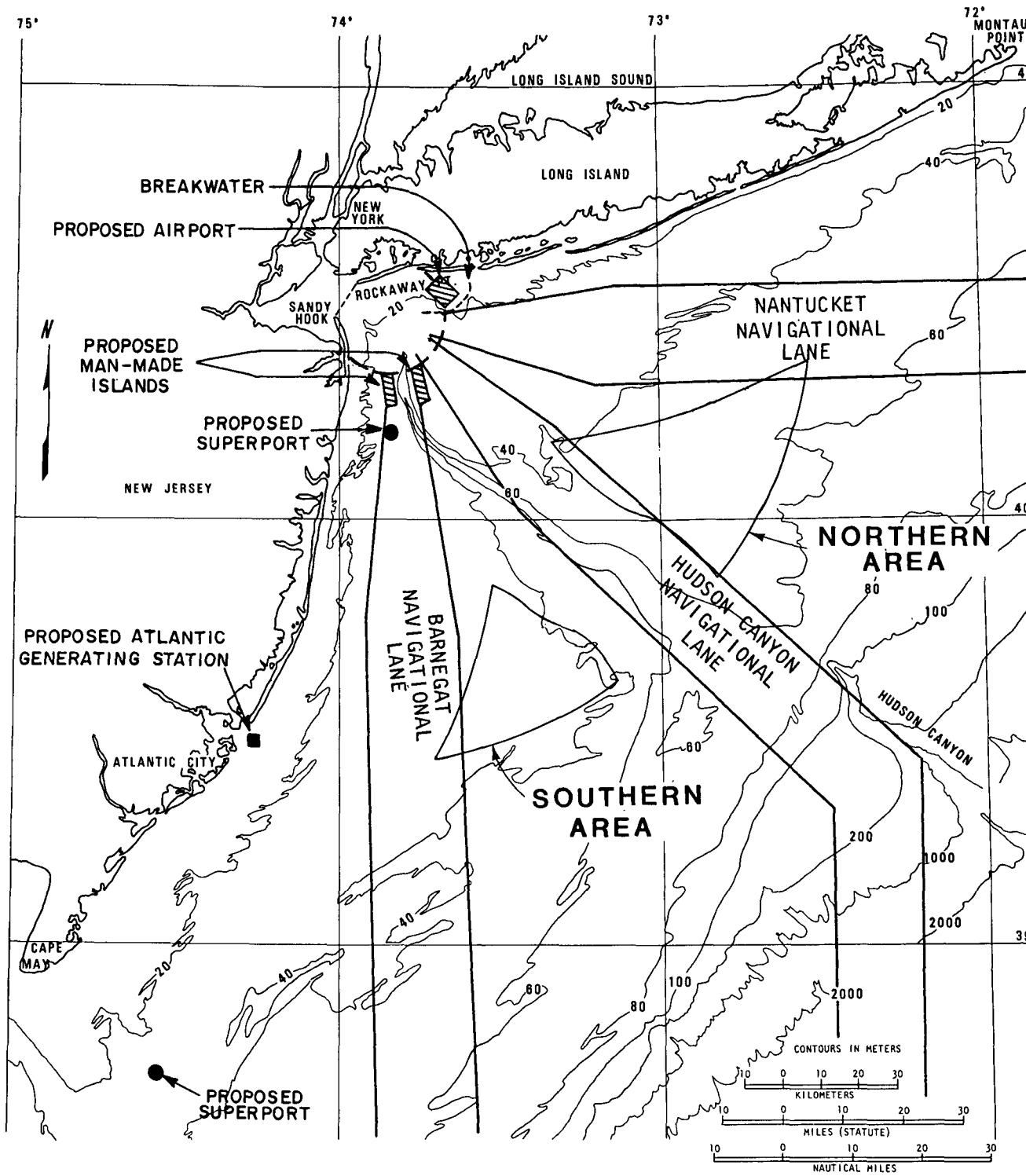
[1]NJDEP, July 1975.

[2]National Park Service, July 1975.

[3]Suffolk County, July 1975.

[4]NYSDEC, July 1975.

[5]National Park Service, 1975.

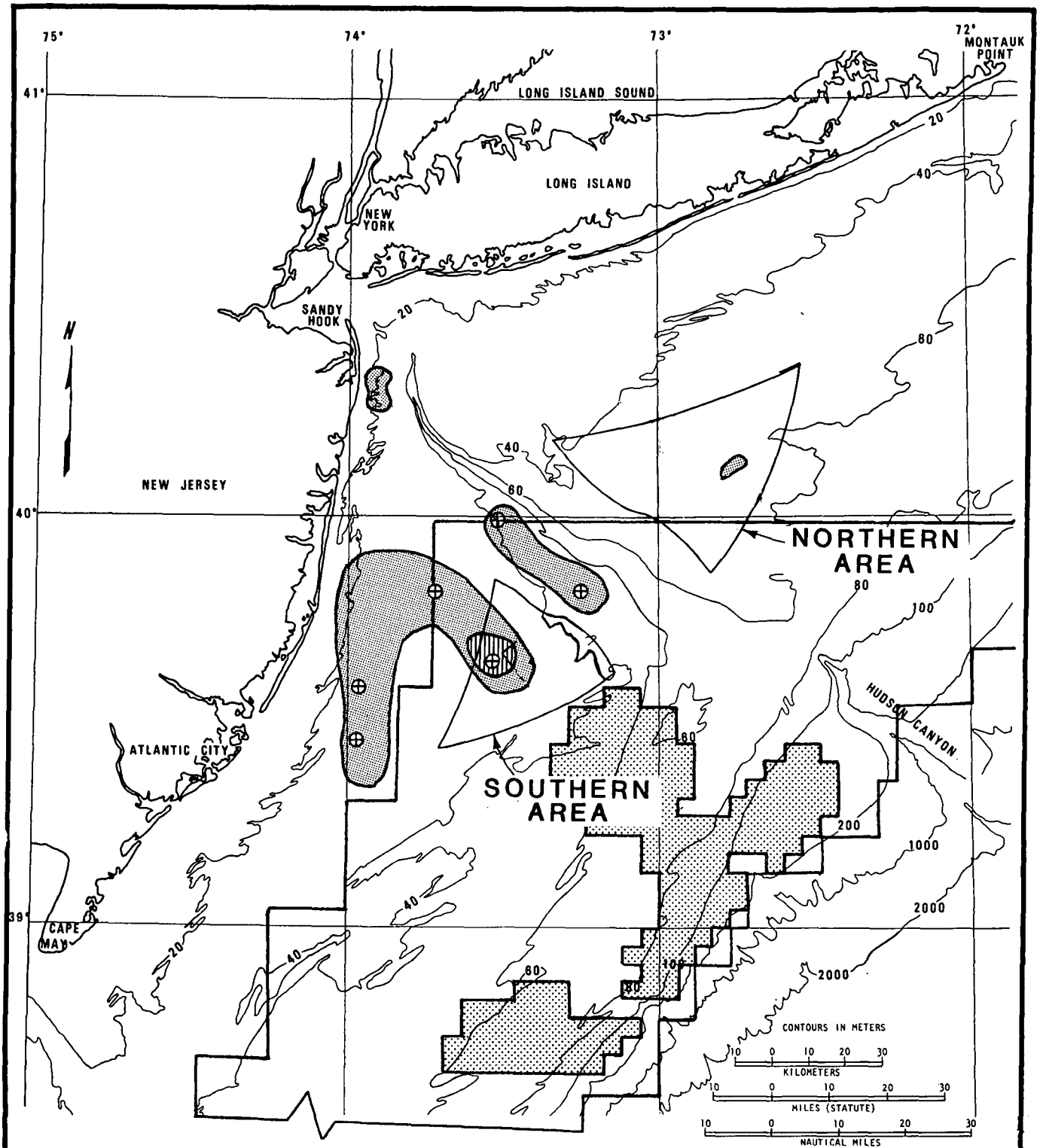


NAVIGATIONAL LANES AND PROPOSED DEEPWATER PORTS AND OFFSHORE ISLANDS IN THE NEW YORK BIGHT

SOURCES: IEC, 1973; DAMES & MOORE 1975.

DAMES & MOORE

FIGURE 5



POTENTIAL MINERAL RESOURCES IN THE NEW YORK BIGHT

KEY:

OCS OIL & GAS LEASE TRACT #40

OIL & GAS AREA OF CALL

⊕ SAMPLE LOCATIONS FOR SAND & GRAVEL

GRAVEL IN PERCENT

> 50 25-50 < 25

SOURCES: SCHLEE, 1975; BLM, NOVEMBER 1975.

DAMES & MOORE

FIGURE 6

present, most sand and gravel used in the metropolitan area is mined at inland sites. New York Harbor is also the site of a very large sand mining operation. As these sources become depleted and increasingly difficult to find, the economics are expected to shift in favor of developing offshore sand and gravel mining operations.

b. Oil and Gas. The Bureau of Land Management (BLM), has issued a tentative list of 154 tracts totaling 354,816 hectares (876,750 acres) for a proposed sale of oil and gas leases (OCS Lease Tract #40) on the mid-Atlantic outer continental shelf (Figure 6). The sale of the lease areas is expected to occur in 1976 (BLM, November 1975).

5. Potential Deepwater Ports

Deepwater ports, generally used for oil transfer facilities, must be located in offshore waters with sufficient depth, ranging from 30 to 34 m (100 to 110 ft), to accommodate supertankers. Current design appears to favor the use of single point mooring buoys for the transfer operations, with underwater pipelines connected to onshore storage and refining facilities. In one case (Raritan Bay, New Jersey), an artificial harbor/dock arrangement has been proposed for unloading.

Potential deepwater port locations off the New York, New Jersey, and Delaware coasts are shown in Figure 5. At present, the USCG feels that a port located somewhere in the Hudson Shelf Valley near-shore waters may satisfy the operational constraints for safe supertanker transfer off the metropolitan area (USCG, April 18, 1975).

6. Potential Offshore Islands

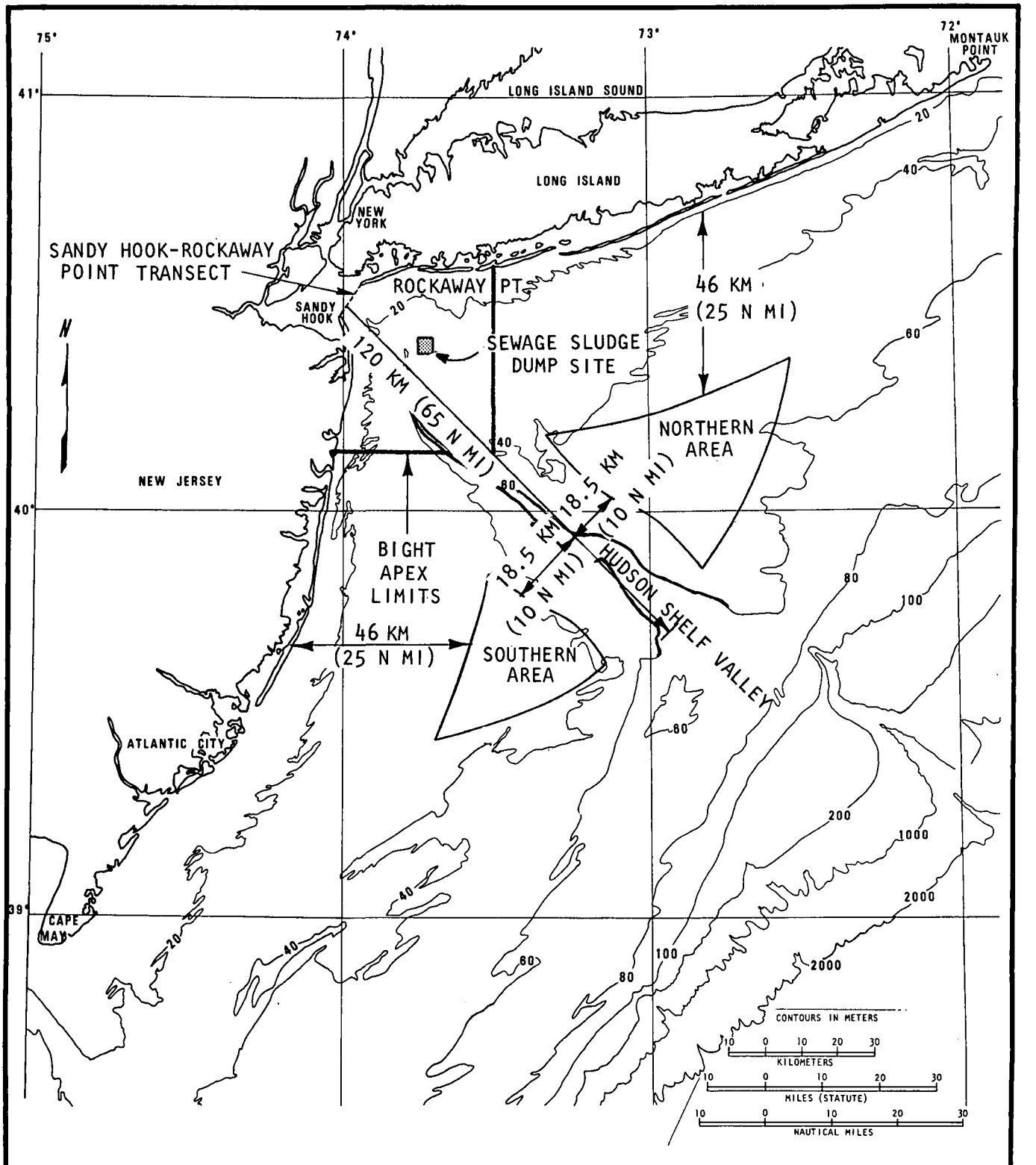
Two major uses have been proposed for artificial offshore islands in the New York Bight: floating nuclear power plants (Atlantic Generating Station) and commercial facilities (airports, refineries, and harbors). A number of factors have combined to delay development of these activities in this region. These include unresolved safety problems associated with construction and operation of floating nuclear power plants, excessive construction costs in waters deeper than 22 m (70 ft), the post-1973 economic slump, and the lack of a national energy policy. Offshore facilities that have been proposed for the Bight are shown in Figure 5. The Atlantic Generating Station may be the only proposal that still remains viable (Dames & Moore, 1975).

III. DETAILED DESCRIPTION OF THE PROPOSED ACTION

The proposed action involves abandonment of the existing sewage sludge dump site in the Apex of the New York Bight, and designation and interim use of an alternate dump site located within the proposed Northern or Southern Area of the New York Bight (Figure 7). The proposed action is based upon the premise that the existing dump site cannot accommodate the anticipated 1981 volume of sludge (Section IIB), without affecting the recreational quality of Long Island and New Jersey coastal waters (USEPA, January 17, 1975). Present sludge volumes are expected to double by 1981 as a result of upgrading several large municipal treatment facilities in the metropolitan area (Tables 8 and 9).

Although studies conducted by EPA, NOAA-MESA, FDA, and state and local agencies indicate that the current use of the existing dump site poses no public health hazard to the nearshore waters of Long Island or New Jersey, the impact of dumping increased volumes of sewage sludge at this location is unknown. The EPA recognizes that there are potential adverse impacts associated with dumping greatly increased volumes of sludge at the existing site. Concern over these potential impacts led EPA to consider the proposed action.

This environmental impact statement (EIS) has been prepared to assess the effects of the proposed action and to provide specific recommendations, especially with regard to the continued use of the existing dump site and the designation and



LOCATION OF EXISTING AND PROPOSED DUMP SITE AREAS IN THE NEW YORK BIGHT

SOURCE: NOAA, SEPTEMBER 17, 1974.

DAMES & MOORE

FIGURE 7

use of an alternate dump site. The most acceptable dump site will be selected, based upon environmental considerations and other factors. The EPA will designate an alternate dump site in July 1976, after public review of and comment on this EIS.

A. HISTORY OF THE PROPOSED ACTION

The significant events leading up to the proposed action are described below.

October 1972. The U.S. Congress passed the MPRSA. This Act authorized EPA to regulate ocean dumping as of April 23, 1973 (Section IIE).

April 1973. The EPA-Region II issued Interim Permits to municipal and industrial waste generators who were practicing ocean dumping in the New York Bight under COE permits.

The EPA-Headquarters issued interim ocean dumping regulations (40 CFR, Parts 220 to 227) covering the transportation and dumping of material in ocean waters. The first action of EPA-Region II under these regulations was to identify the individual dumpers according to the quantity and types of wastes being dumped in the New York Bight. As a result, forty-seven permittees were required to cease dumping in the Bight because acceptable alternatives were available.

July 1973. The EPA-Region II issued Interim Permits under the regulations to those dumpers with no immediate alternative to ocean dumping in the Bight.

October 1973. The EPA-Headquarters issued final ocean dumping regulations (40 CFR, Parts 220 to 227). The EPA-Region

II consigned all liquid industrial wastes, except acid wastes, to the chemical wastes dump site (just outside the New York Bight). Previously, most of these liquid industrial wastes were dumped at the existing sewage sludge dump site (Figure 2).

The EPA-Region II contacted NOAA-MESA regarding the possibility of designating an alternate dump site, pending the development and implementation of environmentally acceptable land-based alternatives for the disposal of sewage sludge.

March 1974. The NOAA-MESA made preliminary recommendations to EPA regarding two study areas in the New York Bight at which an alternate sewage sludge dump site could be located. The EPA requested that NOAA-MESA evaluate these preliminary study areas (NOAA-MESA, March 8, 1974).

April 1974. The EPA-Region II notified all users of the existing dump site that it intended to shift sludge dumping operations to an alternate site in July 1976 or earlier, depending upon the results of an EPA onsite monitoring program. In response, municipal and sewerage authority permittees indicated that they could not commit the necessary resources to effect such a move on the basis of a notification of "intention" alone (USEPA, July 15, 1975).

The NOAA-MESA agreed to assist EPA in evaluating the two preliminary study areas, and tentatively scheduled several seasonal sampling cruises of the areas for 1974 and 1975 (NOAA-MESA, April 11, 1974).

The EPA-Region II held a public hearing regarding the issuance of twenty-four Interim Permits, under the final regulations, to users of the existing sewage sludge dump site.

The EPA initiated a comprehensive sampling program to monitor water quality in the New York Bight Apex. With the concurrence of NOAA-MESA, EPA recommended continued use of the existing site, pending completion of a program for reducing volumes of wastes and/or finding an alternate site or methods of handling these wastes. To this end, EPA gave the Interstate Sanitation Commission (ISC) a grant to study land-based disposal alternatives in the metropolitan area.

May 1974. The NOAA-MESA recommended two general areas, the Northern Area and the Southern Area (Figure 7), for study as potential locations for an alternate dump site (NOAA-MESA, September 23, 1975). As previously requested by EPA, NOAA-MESA agreed to conduct several cruises to collect baseline data in these two areas of the Bight (Section IVA).

The EPA-Headquarters contracted with the Raytheon Company to perform three cruises to collect baseline data in a small portion of the Northern Area (Section IVA). This information was intended to supplement NOAA-MESA cruise data.

September 1974. The NOAA stated that it would concentrate its study efforts on two subareas, 2D1 in the Northern Area and 2D2 in the Southern Area, because of limitations of resources and time (Section IVA). In addition, NOAA indicated that if the Northern and Southern Areas were unacceptable for

sewage sludge dumping, a site within "an equivalent distance" should be available (NOAA, September 17, 1974).

October 1974. The EPA-Region II sent a second letter of notification to all users of the existing sewage sludge dump site stating that its position was "firm" and that permits would not be issued after July 1976 for continued use of the existing site (USEPA, October 2, 1974).

December 1974. The EPA-Region II contracted with Dames & Moore to prepare an EIS on the proposed action in accordance with the requirements of NEPA and of EPA's EIS regulations.

January 1975. The EPA issued an official "notice of intent" to prepare this EIS (USEPA, January 17, 1975).

April 1975. The EPA-Region II held a public hearing regarding the issuance of fourteen Interim Permits for use of the existing sewage sludge dump site (USEPA, April 1, 1975).

May 1975. The EPA-Region II signed a formal Letter of Understanding with NOAA-MESA concerning baseline surveys and evaluations of the Northern and Southern Areas. As per this agreement, NOAA-MESA provided EPA-Region II with a report of its findings (NOAA-MESA, November 1975) for input to this EIS.

July 1975. The EPA-Region II held a public hearing regarding the issuance of four additional Interim Permits for use of the existing dump site.

B. PROPOSED NORTHERN AND SOUTHERN AREAS

Based on the information collected by NOAA and on the recommendations made by NOAA, EPA has proposed that an alternate

sewage sludge dump site be located within either the Northern or Southern Area (Figure 7). The Northern Area is located roughly 46 km (25 n mi) from the Long Island coast; it is about 1,650 sq km (490 sq n mi) in area, and lies in 40 to 60 m (132 to 198 ft) of water. The Southern Area is roughly 46 km (25 n mi) from the New Jersey coast; it is about 900 sq km (260 sq n mi) in area, and lies in 30 to 40 m (100 to 132 ft) of water. The distance from the Sandy Hook-Rockaway Point transect to the farthest point in either area is 120 km (65 n mi).

The use of either area as a sewage sludge dump site may conflict with other present or potential uses. Although both areas are outside existing navigational lanes (Figure 5), they may contain commercially valuable shellfish resources (Section IVC). The Southern Area abuts the OCS Lease Tract #40 for oil and gas (Figure 6 and Section IIG) and may contain some valuable sand and gravel deposits. Detailed descriptions of both areas are given in Section IVA.

The selection of the Northern and Southern Areas was based upon the following considerations:

- The MPRSA recommends that ocean dumping be conducted off the continental shelf, where feasible. However, EPA and NOAA-MESA scientists agreed that the many unknowns associated with dumping sewage sludge in the ocean made "off-the-shelf" dumping an undue environmental risk.

- The alternate dump site must minimize the chances of sewage sludge reaching the Long Island or New Jersey shoreline.

- The alternate dump site must minimize adverse impacts upon the living marine resources of the New York Bight. For this reason, the boundaries of the proposed areas were set at a minimum of 18.5 km (10.0 n mi) from the Hudson Shelf Valley, where bottom dwelling and migratory marine species are prevalent.

- The economics and logistics of ocean transportation of sludge require that the distance from the Sandy Hook-Rockaway Point transect to the dump site be no more than 120 km (65 n mi). This constraint is based on the limited range of the existing fleet of dumping vessels (Table 7) and on the undue economic burden of hiring or constructing new, long-range vessels.

C. COST OF THE PROPOSED ACTION

The proposed action will increase the total costs for hauling sewage sludge from 56 to 69 percent by 1981 (Section VIIC). This is a direct result of the increased distance to an alternate dump site in either the Northern or Southern Area.

Capital expansion of the existing fleet of sludge dumping vessels (Table 7) is unnecessary because the available carrying capacity is sufficient for the near future (Section VIIC). Also, the general consensus among permittees is that capital outlay for fleet modification or expansion is not cost-effective in light of EPA's intention to phase out ocean dumping in 1981.

The proposed action may result in reduced commercial shellfish catches, especially of surf clams, in the vicinity of either the Northern or Southern Area. Commercial shellfisheries along the New Jersey coast and offshore toward the Southern Area appear most sensitive in this respect (Section VIIC).

The proposed action could also interfere with the potential development of identified mineral resources (sand and gravel, oil and gas) in the Southern Area and the immediate vicinity. No potential mineral resources have been identified in or near the Northern Area (Section VIIC).

The sludge itself is a potentially valuable resource because it is now possible to convert sludge into soil conditioners and fertilizers. Dumping sewage sludge into the ocean results in the loss of this potentially valuable resource. However, this value cannot be realized until the land-based methods of sludge disposal that are now being studied are implemented in the metropolitan area (Section VIIC).

D. RELATIONSHIP TO OTHER DUMPING ACTIVITIES IN THE NEW YORK BIGHT

The proposed action is not expected to interfere with other dumping activities in the New York Bight (Section VIID). However, EPA is considering the need to relocate the existing dredged material and wreck dump sites. The EPA has specifically requested that the COE consider using the alternate sewage sludge dump site for the dumping of dredged material (Section IIC). Such combined dumping activities could magnify the poten-

tial adverse environmental impacts at the alternate dump site (Section VIID). The proposed action will not affect or be affected by the possible relocation of the wreck dump site (Section VIID).

E. RELATIONSHIP TO OTHER ACTIVITIES IN THE NEW YORK BIGHT

The proposed action is not expected to affect marine related recreational activities (sport fishing, pleasure boating, or beach attendance) or population growth in the New York-New Jersey metropolitan area (Section VIIE). However, it may have international legal implications if the United States attempts to control fishing within a 200-mile (371 km) limit (Section VIIE).

IV. DESCRIPTION OF THE ENVIRONMENT

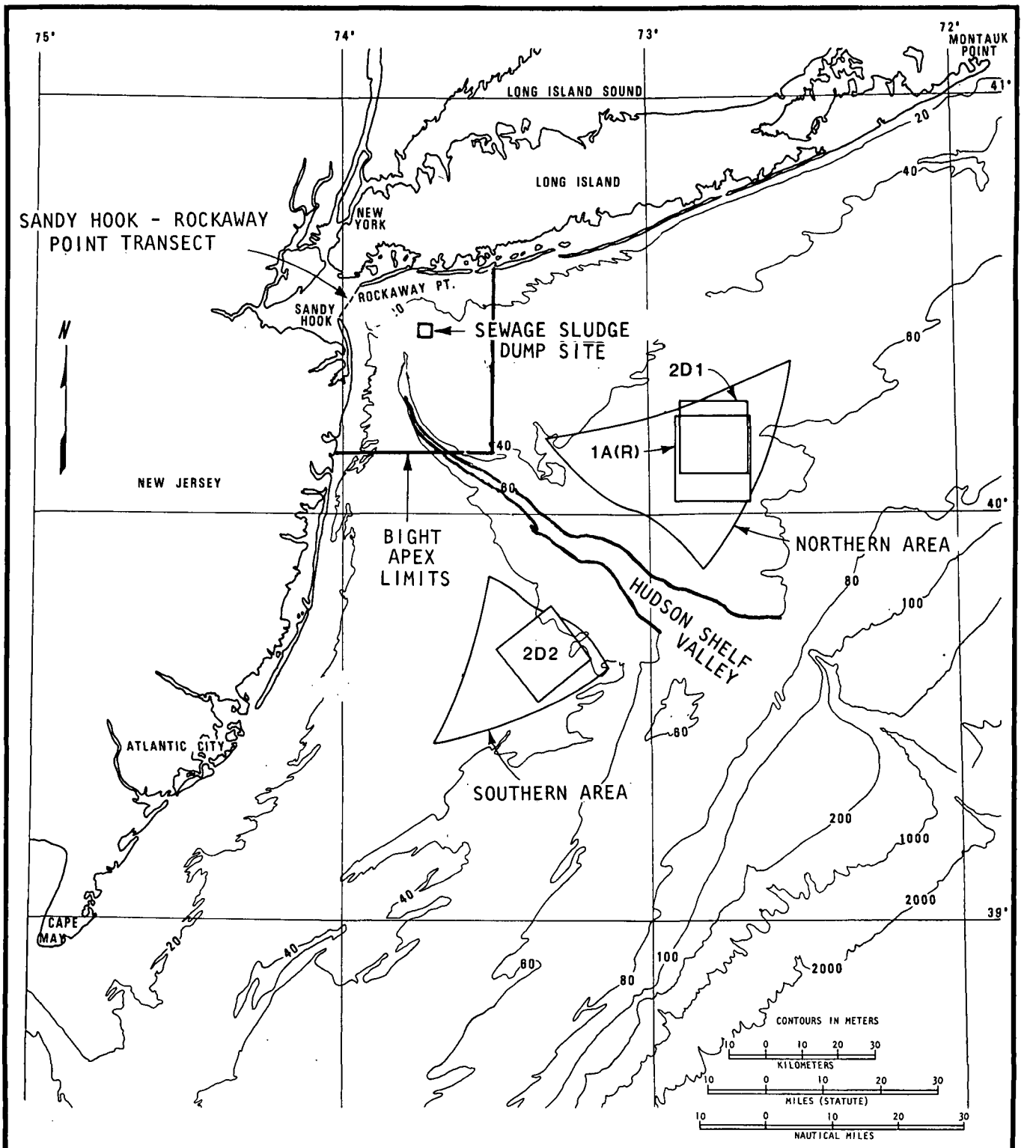
This chapter synthesizes the oceanographic data (physical, biological, geological, and chemical) needed to assess the impact of the proposed action. Appropriate data from previous studies have been combined with the data from the NOAA-MESA and Raytheon studies of the proposed areas that were conducted specifically for this assessment. These data are required to establish the nature of, and the temporal and spatial variations in the environmental parameters needed to predict the fate of dumped sewage sludge and to assess the resulting impacts on the ecosystem at both the Northern and Southern Areas.

A. STUDY PROGRAM

1. Study Areas

In May 1974, NOAA recommended that EPA study two large areas (Figure 8) in the New York Bight, identified as the Northern Area and the Southern Area, as possible locations for an alternate sewage sludge dump site. Because of the large areas involved and the short time before the July 1976 target date for designating an alternate dump site, NOAA further recommended that two subareas, one in the Northern Area and one in the Southern Area, be given study emphasis (NOAA, September 17, 1974). Descriptions of the areas and subareas follow:

The Northern Area is described by three boundaries (Figure 8). The northern boundary is a line roughly parallel to and 46 km (25 n mi) south of the Long Island coast and seaward



STUDY AREAS AND SUBAREAS

SOURCE: NOAA, SEPTEMBER 17, 1974.

DAMES & MOORE

FIGURE 8

of the 37 m (120 ft) depth contour; the southern boundary is a line roughly parallel to and 18.5 km (10.0 n mi) north of the axis of the Hudson Shelf Valley; and the eastern boundary is an arc of a circle with a radius of 120 km (65 n mi) from the Sandy Hook-Rockaway Point transect. The approximate area is 1,650 sq km (490 sq n mi).

Subarea 2D1 is a square measuring 22 km (12 n mi) on a side located within the Northern Area, adjacent to the northern and eastern boundaries, with center coordinates of 40°12.0'N and 72°46.5'W (Figure 8). The area is 484 sq km (144 sq n mi). The Raytheon Company studied a slightly different configuration of Subarea 2D1 in the Northern Area (Figure 8). Known as Subarea 1A(R), it is a square measuring 26 km (14 n mi) on a side; it has essentially the same center coordinates as NOAA-MESA's Subarea 2D1. The area is 676 sq km (196 sq n mi).

The Southern Area is likewise described by three boundaries (Figure 8). The western boundary is a line roughly parallel to and 46 km (25 n mi) east of the New Jersey coast and seaward of the 37 m (120 ft) depth contour; the northern boundary is a line roughly parallel to and 18.5 km (10.0 n mi) south of the axis of the Hudson Shelf Valley; and the southern boundary is the arc of a circle with a radius of 120 km (65 n mi) from the Sandy Hook-Rockaway Point transect. The approximate area is 900 sq km (260 sq n mi).

Subarea 2D2 is a square measuring 22 km (12 n mi) on a side located within the Southern Area, adjacent to the eastern

and southern boundaries, with center coordinates of 39°41'N and 73°18'W (Figure 8). The area is 484 sq km (144 sq n mi).

2. Data Collection

In May 1974, EPA initiated a program of data collection to determine the marine baseline (physical, biological, geological, and chemical oceanography) conditions in the Northern and Southern Areas. This program consisted of seasonal data gathering cruises conducted independently by NOAA-MESA and by the Raytheon Company from the summer of 1974 to the summer of 1975. The specific NOAA-MESA and Raytheon study activities are outlined below.

a. NOAA-MESA Activities. In order to collect the necessary baseline data, NOAA-MESA stepped up its regular marine sampling program in the New York Bight for the duration of the study period. Subareas 2D1 and 2D2 (Figure 8) were frequently and intensively sampled. A grid of twenty to thirty equidistant stations at each subarea was used to sample the water column, and the sediments. A detailed description of the NOAA-MESA study activities, with regard to the proposed action, is contained in the May 1975 Letter of Understanding between NOAA-MESA and EPA, which is available from EPA-Region II. The data collected by NOAA-MESA for EPA became a major input to the November 1975 NOAA-MESA report on proposed ocean dumping in the Bight and to this EIS.

b. Raytheon Activities. In May 1974, EPA-Headquarters awarded a contract to the Raytheon Company of Portsmouth,

Rhode Island, to perform three seasonal baseline data gathering cruises in Subarea 1A(R). These cruises were conducted in September-October 1974, April-May 1975, and July 1975. Approximately fifteen stations were sampled for a combination of physical, biological, geological, and chemical parameters.

Data reports for all three cruises were available for this EIS, although the data for the last cruise was provided too late for inclusion. Reduction of data from the first two cruises was undertaken as part of this assessment, and the results have been incorporated into this EIS. Review of the data report for the third cruise indicates general agreement with the previous cruise results.

B. PHYSICAL OCEANOGRAPHY

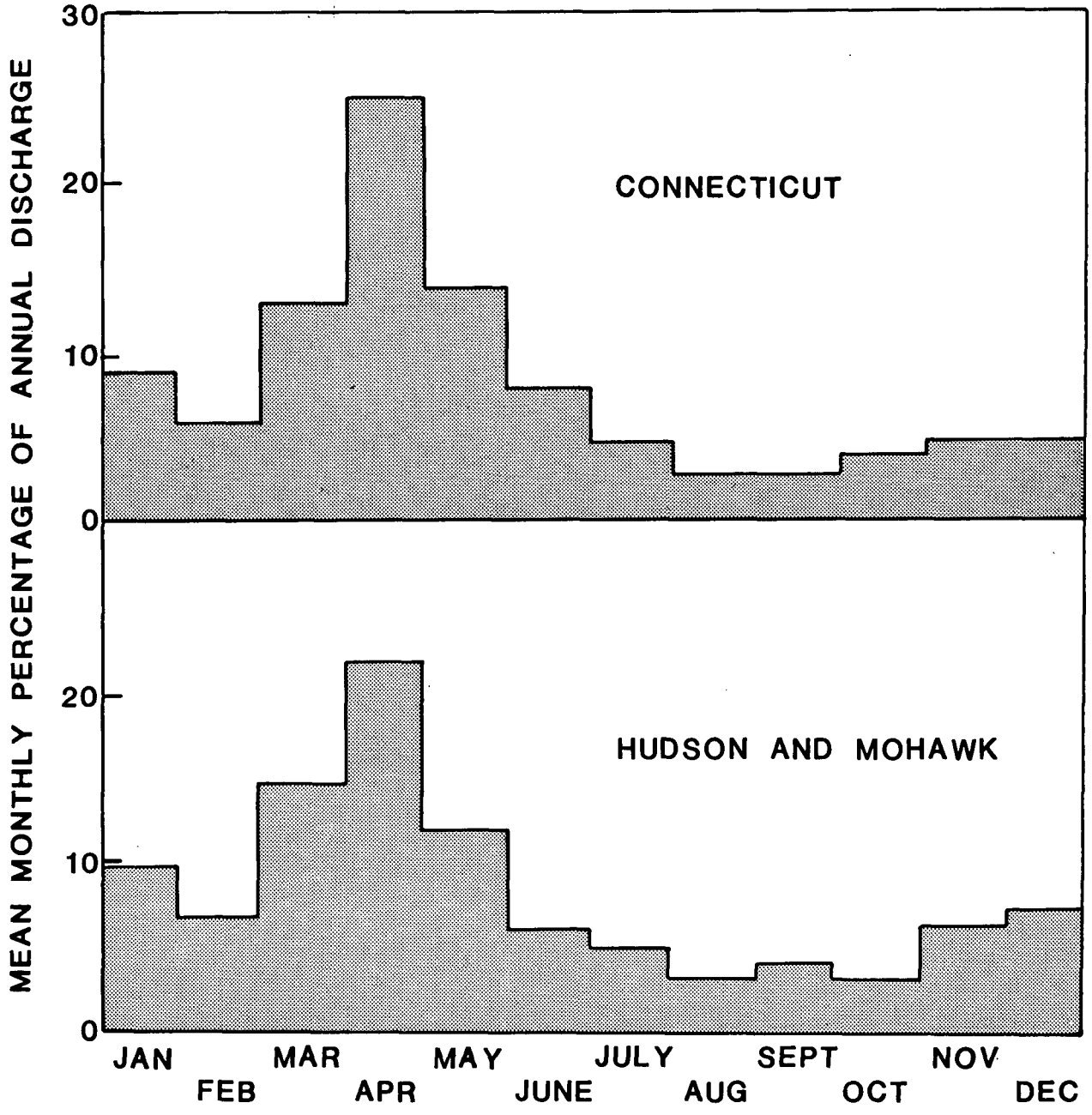
This section on physical oceanography includes descriptions of the hydrographic characteristics and currents in the New York Bight and at the Northern and Southern Areas.

1. Hydrographic Characteristics

a. Water Masses. Most of the continental shelf, including the existing and proposed dump sites, is characterized by coastal or shelf water. The hydrographic characteristics of this water (its temperature and salinity) are controlled by seasonal sea-air exchange processes (such as precipitation, evaporation, and heat exchange), by the influx of fresh water, and by mixing of the shelf water with more oceanic water (slope water) near the shelf edge. The major freshwater inputs to the New York Bight are the Hudson and Connecticut rivers (Figure 9).

The shelf water mass tends to exhibit a two-layer profile. The upper layer, surface shelf water, has a salinity range of 30 to 32.5 0/00 (parts per thousand) and a temperature range of 20 to 27°C (68 to 81°F). The lower layer, bottom shelf water, has a somewhat higher salinity range of 32.5 to 34.5 0/00 and a lower temperature range of 5 to 11.5°C (41 to 53°F).

b. Seasonal Variations in Temperature and Salinity Patterns. Winter and summer are the seasons of the most extreme conditions in the New York Bight. In winter, the Bight is characterized by well-mixed conditions, and in summer, it is characterized by heavily stratified conditions. Spring and fall are



MEAN MONTHLY PERCENTAGES OF ANNUAL DISCHARGE FOR THE HUDSON AND CONNECTICUT RIVERS

SOURCE: BIGELOW AND SEARS, 1936.

DAMES & MOORE

FIGURE 9

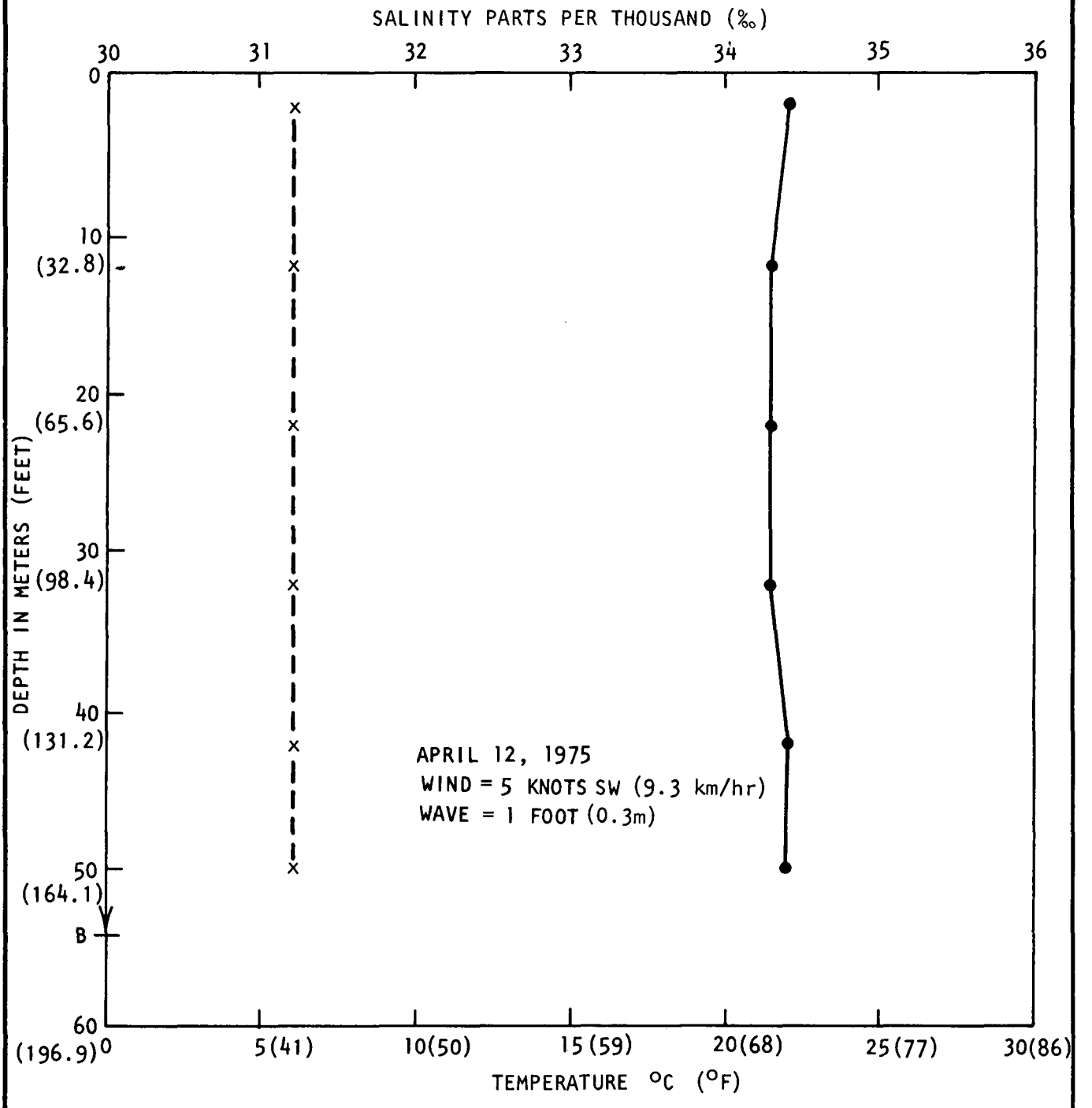
transitional periods between the extremes of winter and summer. The following synopsis of seasonal conditions is from Bowman and Wunderlich (1975).

Winter Conditions (January and February). As a consequence of low-volume river runoff and strong verticle mixing, water within the Bight is, for most part, vertically homogeneous during the winter. The coldest temperatures occur near shore and increase steadily seaward; the temperature ranges from less than 5°C near shore to 13°C (41 to 54.5°F) near the shelf edge. Similarly, maximum salinities of 33 0/00 are found on the inner shelf with a small increase to 34 0/00 on the edge of the shelf. Temperature-salinity measurements taken during late winter (Raytheon, 1975b) show the well-mixed conditions that prevail during the winter in the middle shelf (Figure 10).

Spring Progression (March through May). In March, April, and May, dilution of the Bight waters results from high-volume river runoff. This freshwater inflow causes a strong lateral variation in surface salinities.

In spring, the Hudson River discharge can be as high as 1,200 cu m/sec (43,000 cfs). This discharge produces a low-salinity plume (26 to 30 0/00) which tends to flow south along the New Jersey coastline. Increased solar heating of the Bight waters is reflected in a gradual temperature rise at the surface.

Summer Conditions (June through August). During the summer, the Bight waters exhibit a strong thermocline, with surface temperatures reaching a maximum of 24°C (50°F). Although



LATE WINTER TEMPERATURE-SALINITY PROFILE AT SUBAREA 1A(R)

KEY:

● SALINITY

x TEMPERATURE

SOURCE: RAYTHEON, 1975B.

DAMES & MOORE

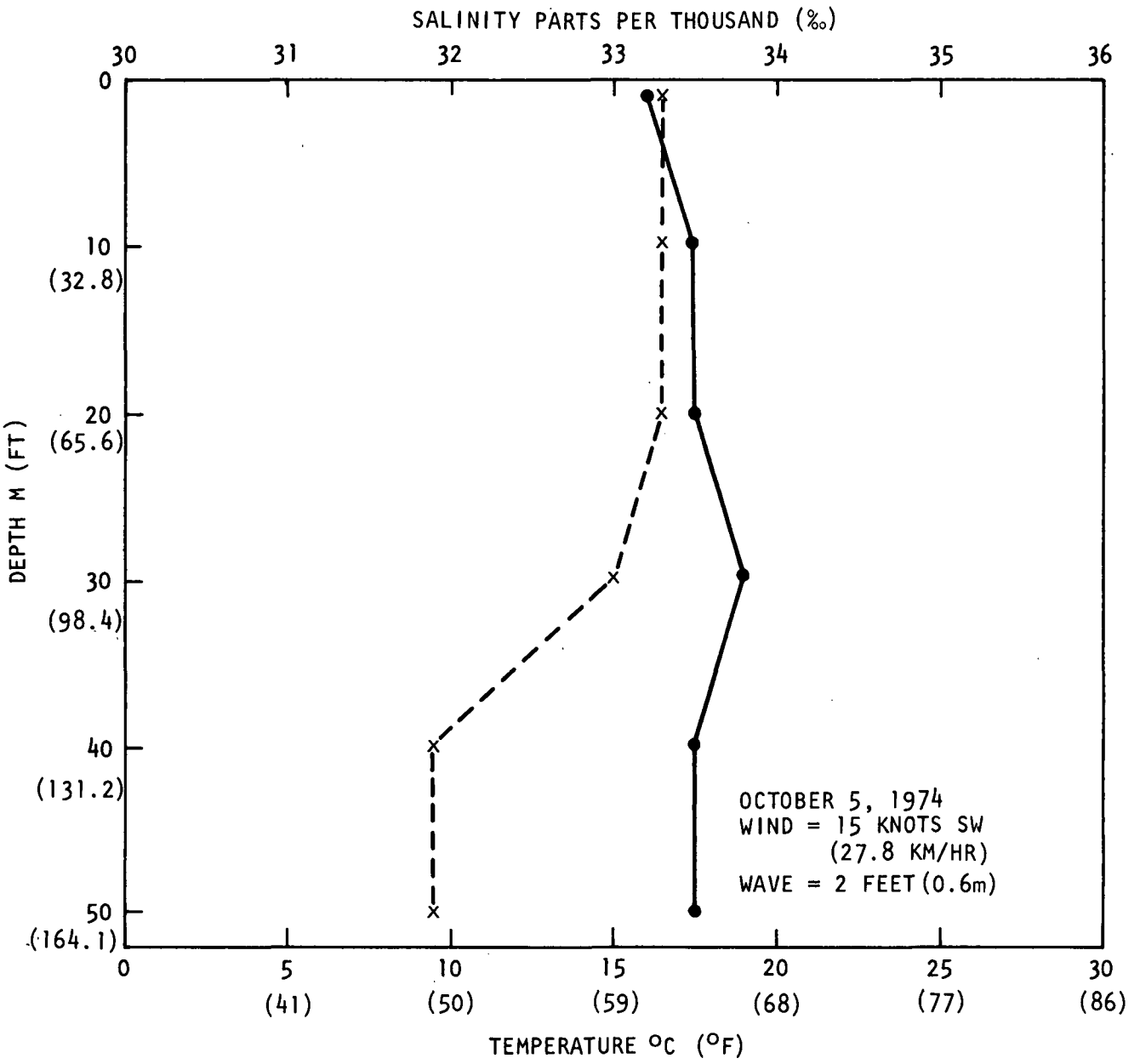
FIGURE 10

there is some warming of bottom water over winter conditions, it is relatively slight with temperatures remaining below 12°C (54°F) over most of the Bight.

The depth of the warm, mixed layer of water is about 10 to 15 m (33 to 49 ft), and the thermocline generally lies at depths of 15 to 30 m (49 to 98 ft). Salinities do not differ significantly from previous values. Temperature-salinity measurements taken during the late summer (Raytheon, 1975a) show that the vertical stratification persists into October (Figure 11).

Fall Progression (September and October). In September and October, surface cooling and wind-driven mixing start to break down the summer thermocline. Surface temperatures decrease to approximately 16 to 18°C (61 to 65°F) in the inner Bight by the end of October. As the surface temperatures decrease, the bottom temperatures increase toward 12°C (54°F) as a result of the vertical mixing. Mixing also results in a more homogeneous salinity field and in an overall increase in salinity values as more saline water from the slope is introduced.

Early Winter Conditions (November and December). In November and December, strong vertical mixing continues to homogenize the water column over the Bight Apex. During November, the temperature gradient from the Bight Apex to the shelf break is small. As December progresses, cooler inshore temperatures develop. Vertical salinity values become uniform and the horizontal gradient of salinity from the Apex to the shelf break is slight.



LATE SUMMER TEMPERATURE-SALINITY PROFILE AT SUBAREA IA(R)

KEY:

● SALINITY

× TEMPERATURE

SOURCE: RAYTHEON, 1975A.

DAMES & MOORE

FIGURE 11

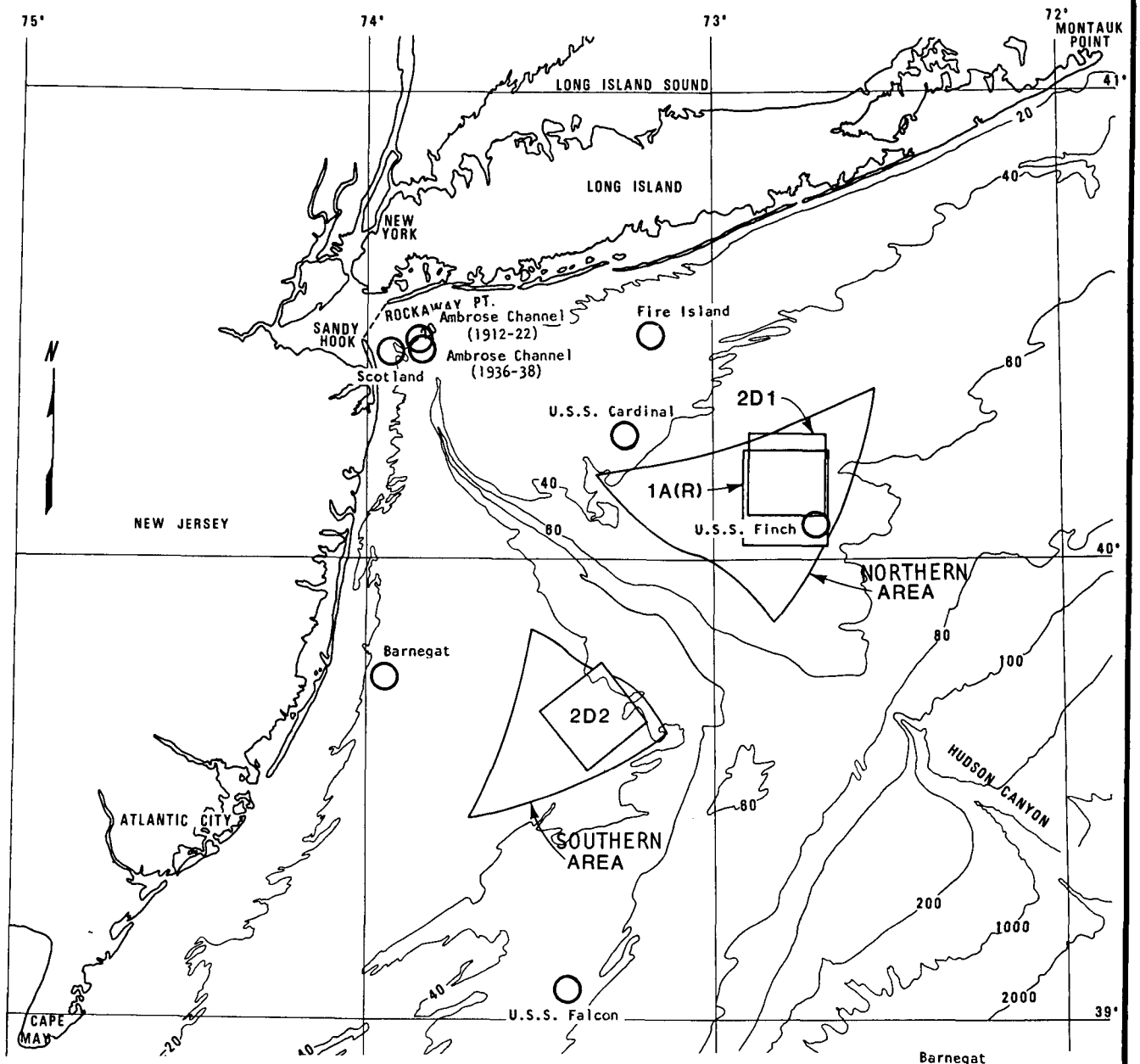
2. Currents

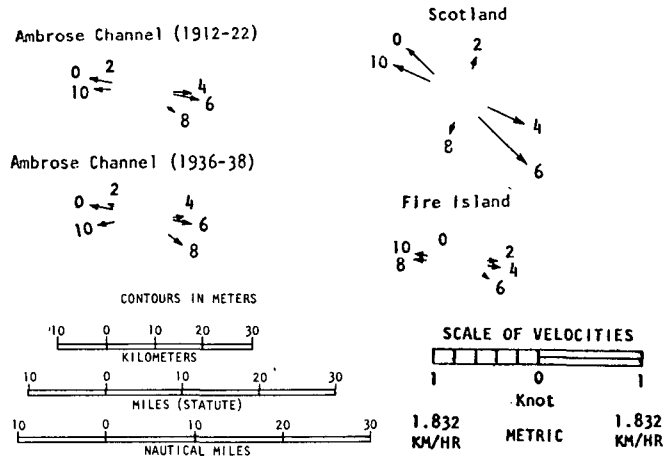
The current circulation patterns over the continental shelf are both complex and variable. Current circulation patterns are subject to a number of forces which vary in time and space. The components of the shelf current circulation are described here in order to provide a setting for the discussion of the fate of dumped sewage sludge in Chapter VI.

a. Tidal Currents. The tidal current direction in the middle shelf region of the New York Bight is clockwise. Estimates of tidal currents from staff measurements in the Bight are given in Figure 12 (Haight, 1942). The maximum average tidal current measured near the Northern Area (USS Finch) was reported to be 7.2 cm/sec (2.8 in/sec). Tidal current velocities in the Northern Area were calculated from harmonic analyses of data collected on the first two Raytheon cruises (Raytheon, 1975a and b). The velocity of tidal currents shows a vertical and seasonal variation (Table 17). Similar values of tidal current velocity are expected in the Southern Area.

Tidal currents are important in the initial distribution of dumped materials on the bottom (mixing and dispersion). Tidal currents are also important as a source of energy for the resuspension of settled solids. Bottom tidal current velocities may be low, about 10 cm/sec (4 in/sec), but when coupled with wind-driven currents during storm events, they can cause resuspension and subsequent redistribution of sediments.

b. Surface Currents. Freshwater inflow to the New York Bight, primarily from the Hudson and Connecticut rivers, influ-





THE LOCATION OF EACH LIGHTSHIP STATION IS SHOWN BY A CIRCLE ACCOMPANIED BY THE NAME OF THE STATION.

THE DIRECTIONS AND VELOCITIES OF THE TIDAL CURRENTS FOR THE EVEN NUMBERED SOLAR HOURS FROM 0 TO 10 HOURS AFTER THE GREENWICH TRANSIT OF THE MOON ARE SHOWN BY ARROWS FOR A NUMBER OF STATIONS.

THE LENGTH OF THE ARROW REPRESENTS THE AVERAGE OBSERVED VELOCITY ON THE SCALE SHOWN BELOW. THE FIGURES AT THE ARROW HEADS ARE THE HOURS AFTER THE GREENWICH TRANSIT. HOURS AT WHICH THE VELOCITY IS ZERO ARE PRINTED NEAR THE CENTER OF THE DIAGRAM WITHOUT ARROWS. ABOVE EACH DIAGRAM IS THE NAME OF THE LIGHTSHIP STATION TO WHICH IT APPLIES.

TIDAL CURRENTS AT LIGHTSHIP STATIONS, MONTAUK POINT TO BARNEGAT BAY

SOURCE: EG&G, 1975c.

DAMES & MOORE

FIGURE 12

TABLE 17

PREDICTED MAXIMUM AVERAGE VELOCITIES OF UPPER, MIDDLE, AND LOWER TIDAL CURRENTS IN THE NORTHERN AREA

in cm/sec (in/sec)

Layer	Winter	Summer
Upper	22.5	17.5
	(8.7)	(6.9)
Middle	18.5	13.6
	(7.3)	(5.4)
Lower	13.8	11.0
	(5.4)	(4.3)

Sources: Raytheon, 1975 a and b.

ences surface currents in the Bight. Fresh water is not as dense as salt water. The presence of lighter water on the inner portion of the shelf causes the water surface to be slightly higher here than it is farther offshore. This condition generally prevails along the continental shelf and moves a density-driven coastal current toward the southwest. Occasionally, in the winter, there is intense cooling of the inner shelf waters. This, combined with low freshwater runoff, results in denser waters inshore. As a result, the current flows toward the north (E.G. & G., 1975).

Superimposed upon this general circulation pattern is the seasonally variable wind-driven current system. The resulting surface current is the vector sum of these two current systems.

Bumpus and Lauzier (1965) have characterized the seasonal nontidal surface drift on the Middle Atlantic Continental Shelf. The results have been inferred from drift bottle data obtained from 1958 to 1962. Except for the Hudson Shelf Valley, the net surface drift in winter is toward the south, with an offshore component. Surface currents in the summer more closely parallel the coast because wind effects are smaller and the density-driven coastal current becomes dominant.

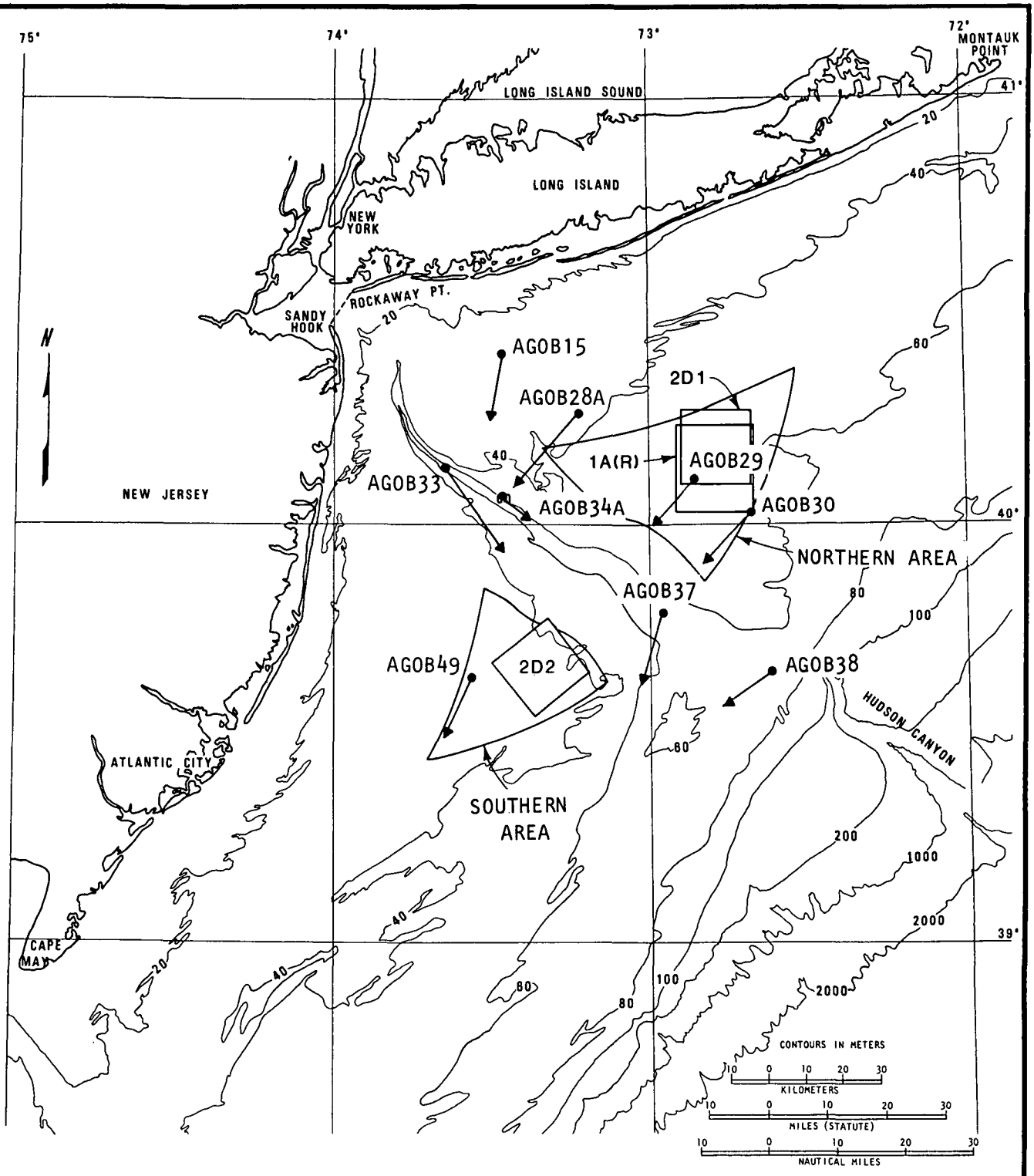
Both NOAA-MESA (November 1975) and Raytheon (1975b) have taken current measurements in the proposed areas. However, these data should be intepreted with caution because verification procedures have not been completed. The preliminary

data indicate that in the winter, the mean surface current is 6 cm/sec (2.4 in/sec) in a southerly direction, and that from late winter through early spring, it is 5 cm/sec (2 in/sec) in the alongshore direction. The mean surface current in the Northern Area was not notably different from that in the Southern Area during the spring (Figure 13 and Table 18). Current observations made during the summer cruises are similar to previous cruise results, which show that the mean surface velocity is 7 cm/sec (2.6 in/sec) in a southwesterly direction.

c. Bottom Currents. Bottom currents have been studied through the use of seabed drifters (Bumpus, 1961; Lee *et al.*, 1965). Bumpus' results revealed a southwestward (alongshore) and shoreward movement of residual bottom drift on the inner continental shelf. The rates of drift were between 0.2 and 1.8 cm/sec (0.08 to 0.71 in/sec). Based on observations he made in 1961 and 1964, Bumpus (1965) drew the following conclusions:

- The residual drift is variable, not always in the same direction, and at times it appears nearly reversed. In spite of these variations, a general tendency is indicated.

- Offshore from a line drawn about one-half to three-quarters of the distance between the shore and the 91 m (300 ft) contour at depths of 55 to 64 m (180 to 210 ft), the tendency is toward an offshore drift (Figure 14). Shoreward of this line, the tendency is for the flow to be westerly or southerly with a component toward the coast. The location of this line is not sharply defined; it moves on or offshore from time to time ,



MEAN SPRING SURFACE CURRENTS IN THE NEW YORK BIGHT

KEY:

CURRENT VECTOR SCALE 10cm/sec (3.9in/sec)

SOURCE: NOAA-MESA, NOVEMBER 1975.

DAMES & MOORE

FIGURE 13

TABLE 18

NOAA-MESA CURRENT METER DEPLOYMENTS: WATER DEPTH AND LOCATION IN WATER COLUMN[1]

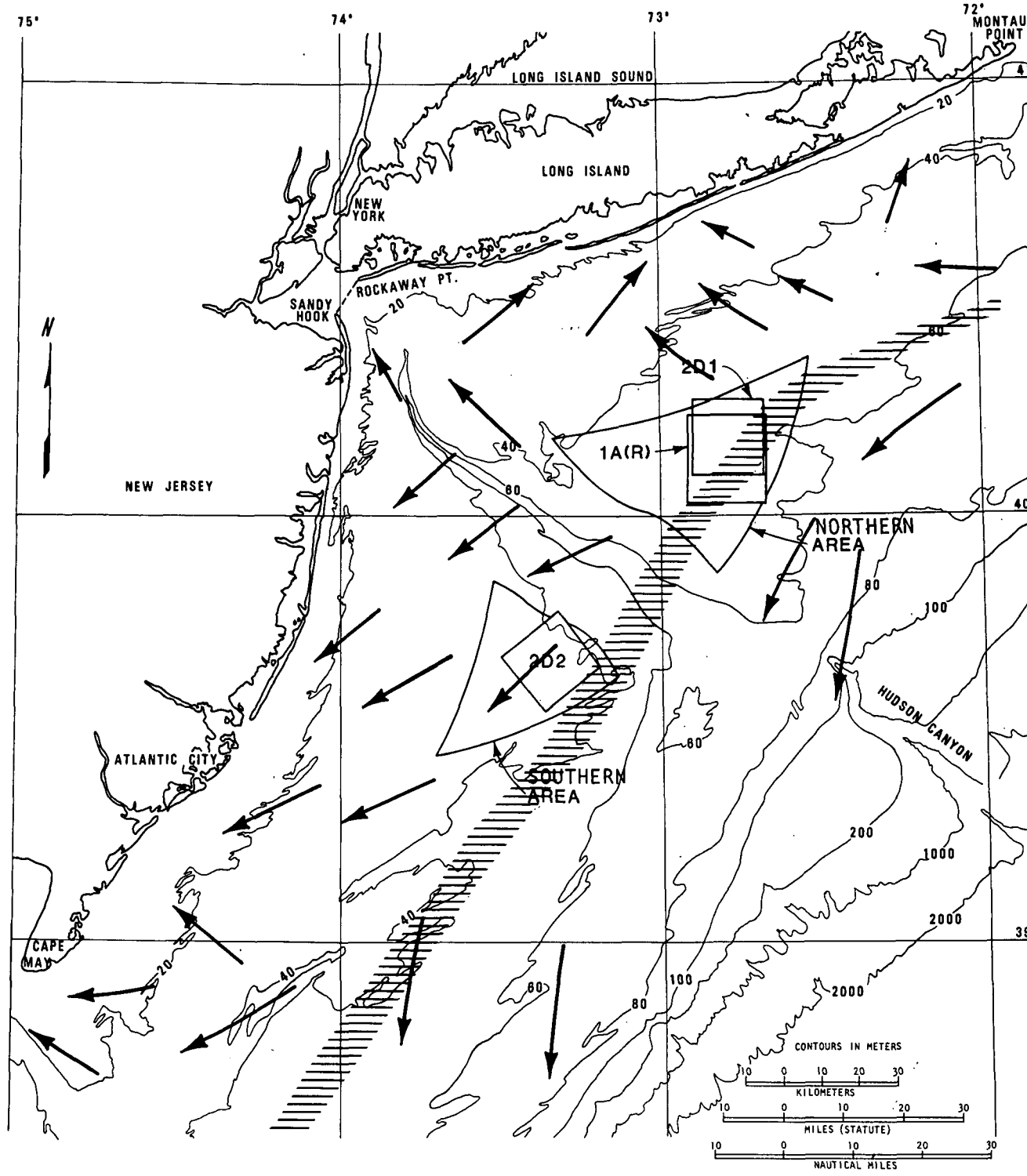
Station No.	Water Depth in meters	(ft)	Distance from Bottom in meters	(ft)
SURFACE[2]				
AGOB-15	23	(76)	21	(70)
AGOB-28A	38	(126)	37	(120)
AGOB-29	48	(158)	38	(126)
AGOB-30	59	(194)	57	(188)
AGOB-33	59	(193)	51	(166)
AGOB-34A	77	(253)	70	(229)
AGOB-37	76	(249)	74	(243)
AGOB-38	35	(114)	33	(108)
AGOB-49	80	(262)	78	(256)
BOTTOM[3]				
AGOB-15	23	(76)	3	(10)
AGOB-20A	38	(126)	1	(3)
AGOB-29	48	(158)	8	(26)
AGOB-30	59	(194)	17	(56)
AGOB-33	59	(193)	1	(3)
AGOB-34A	80	(262)	1	(3)
AGOB-37	77	(253)	15	(49)
AGOB-38	76	(249)	1	(3)
AGOB-49	35	(114)	1	(3)
P31	47	(155)	5	(15)
P32	75	(245)	5	(15)
P12	62	(202)	5	(15)
P11	33	(109)	5	(15)
R9	55	(181)	5	(15)
R10	46	(151)	5	(15)
R11	37	(122)	5	(15)

[1]Periods of current meter deployment vary between stations.

[2]Stations shown on Figure 13.

[3]Stations shown on Figure 15.

Source: NOAA-MESA, November 1975.



GENERAL RESIDUAL CURRENT ALONG THE BOTTOM OF THE NEW YORK BIGHT

KEY:
SHADED AREA INDICATES LINE OF DIVERGENCE OF ONSHORE AND OFFSHORE FLOW

NOTE: MAGNITUDE IS NOT IMPLIED BY LENGTH OF ARROWS

SOURCES: BUMPUS, 1965; CHARLESWORTH, 1968.

DAMES & MOORE

FIGURE 14

probably on a seasonal basis (this line is called the Bumpus line of divergence).

- There is a definite residual drift towards the mouths of the estuaries.

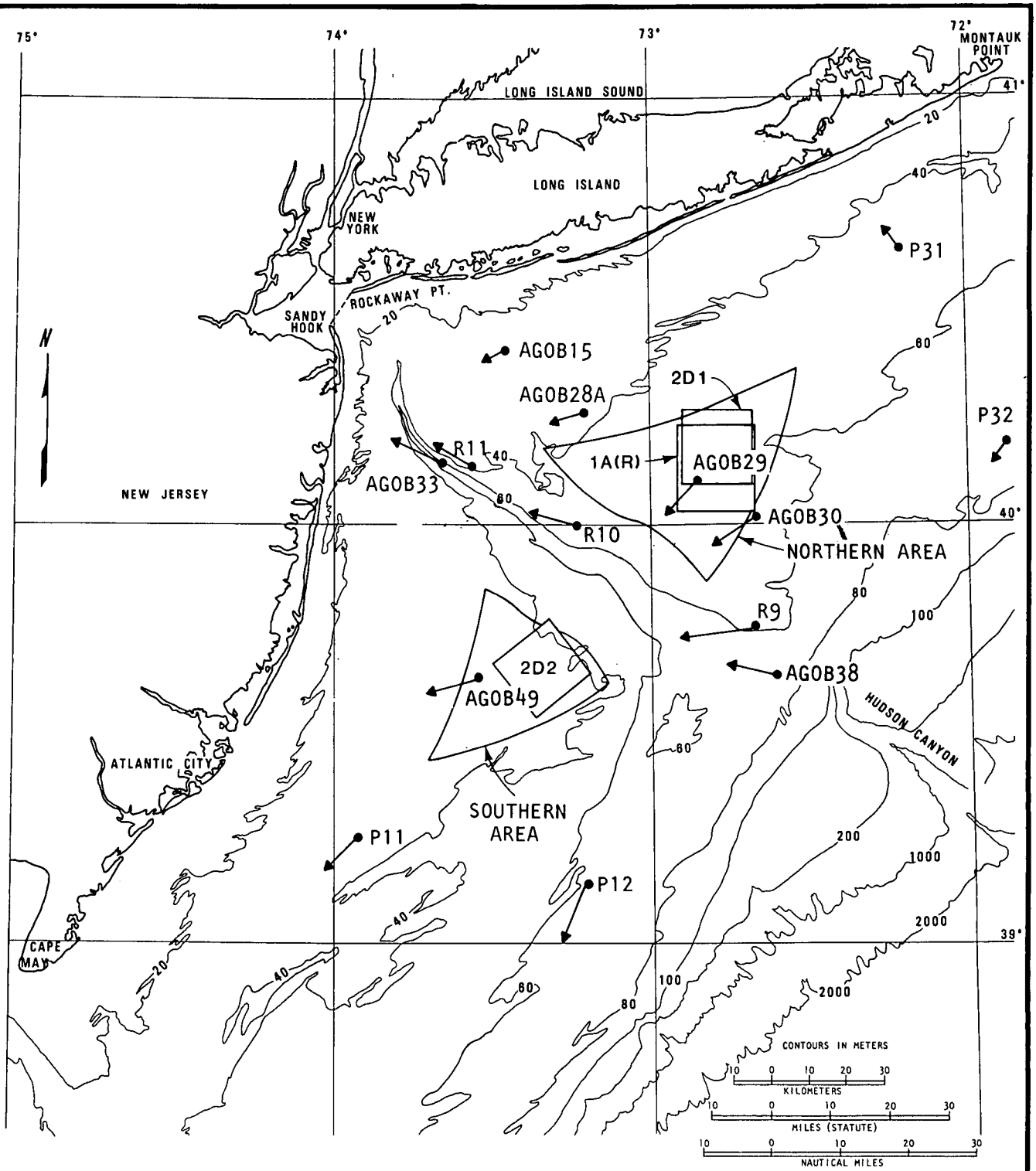
- The rate of residual flow varies from 0.2 to 1.3 cm/sec (0.08 to 0.51 in/sec), but is frequently 0.4 to 0.9 cm/sec (0.15 to 0.35 in/sec).

- The residual current seems to be related to a shoreward flux of shelf bottom water.

Several drifter results obtained by Hardy et al. (1975) for the inner shelf south of Long Island indicate that near-bottom circulation has a strong onshore component within the 27 to 42 m (72 to 220 ft) depth contours. These results appear to confirm the earlier findings of Bumpus (1965). Current measurements, in the form of observed current meter data, also appear to verify Bumpus' results. Both NOAA-MESA and Raytheon observed seasonal variations in velocities of mean bottom currents which appear to verify Bumpus' general results.

During the winter, the mean bottom current in the Northern Area is small, 2 cm/sec (0.8 in/sec), and flows in a southwesterly direction (Figure 15). The NOAA-MESA and Raytheon current meter stations show a systematic shoreward trend of near-bottom currents in the Northern Area. It appears that the currents are directed toward the Hudson Shelf Valley; this results in a net onshore drift.

During the winter, the mean bottom current in the Southern Area is directed downcoast at approximately 3 cm/sec



MEAN SPRING BOTTOM CURRENTS IN THE NEW YORK BIGHT

KEY:

CURRENT VECTOR SCALE 10cm/sec (3.9in/sec)

SOURCE: NOAA-MESA, NOVEMBER 1975.

DAMES & MOORE

FIGURE 15

(1.2 in/sec) with a strong onshore component. This appears to be in agreement with Bumpus' finding that there is a residual drift toward the mouths of estuaries.

Current meter observations made during the summer, when stratified water conditions prevail, are similar to those made during the winter, when well-mixed water conditions prevail. In terms of magnitude and direction, summer bottom currents show that the net drift is around 2 cm/sec (0.8 in/sec) and is directed toward the southwest.

The line of divergence is not evident from current meter data on the Long Island shelf (Figure 15). None of the net bottom currents for the Long Island shelf have offshore components. However, the two most seaward stations have net currents that are more coast-parallel than the inner station currents. All of the currents in and adjacent to the Hudson Shelf Valley have considerable onshore components, perhaps reflecting a unique flow system associated with this feature. The Hudson Shelf Valley's flow system is discussed at the end of this section.

The data from the New Jersey shelf region suggest that a line of divergence may exist near the 60 m (197 ft) depth contour, landward of Station P-12 (Figure 15), where the mean current has a slight offshore component. The station near the Southern Area has a considerable onshore component of net bottom flow.

d. Wind Drift Currents. Seasonal variations in wind conditions also influence current patterns. During the summer, the

prevailing northerly wind flow has only a minor influence on waves and currents because of low wind velocities. Summer storms passing north of the Bight tend to produce winds from the southwest. These storm winds, generally of lower intensity than winter storms, can influence water circulation in the Bight by adding a seaward drift current component. This drift current parallels the Long Island coast.

During the winter, air circulation over the Bight is marked by frequent abrupt changes. These changes are caused by storm centers which usually move from west to east. Winter storms are much more intense than summer storms, and their effects are much more extensive. Storms tracking eastward, south of the Bight, produce east to northeast winds on shore. These storm systems, called Northeasters, can produce significant wind drift currents that move in a west-southwest direction.

The extent of stratification of the water column governs whether the wind energy is transferred through the water to the bottom layers. During the summer, the bottom layers are less affected by wind stress because of the presence of the thermocline and because of the lower levels of wind stress. Conversely, the well-mixed condition of the water during the winter enables energy to be transferred through the water column more easily.

During Raytheon Cruise 2 (March 6 - April 4, 1975), two storm systems were encountered which caused strong wind-induced currents. During March 19-20 and April 3-5, 1975, North-

easters were located off the Bight. Winds were from the ENE at gusts of up to 30 m/sec (65 MPH).

The Northeaster of April 3-5, 1975 illustrates the behavior of the current field when subjected to high wind stress during well-mixed conditions. Comparison of the vertical current structure in component form (N-S, E-W) shows the E-W current components to be large, with maximums of 34.0 cm/sec (13.4 in/sec), 33.2 cm/sec (13.1 in/sec) and 26.5 cm/sec (10.4 in/sec) for the surface, middle, and bottom currents, respectively (Dames & Moore, unpub.). The N-S components were not significantly affected by the wind since it was a westerly wind.

The response of the current field to the intensification of the wind is rapid at the surface, but there is a time lag before the bottom current is impacted. Bottom currents are substantially lower than surface currents during wind-driven storm events.

e. Hudson Shelf Valley. Bottom currents in the axis of the inner Hudson Shelf Valley channel have been studied with regard to their response to surface winds (Lavelle *et al.*, 1975). The direction of summertime nontidal flow in the channel axis appears to be influenced by surface wind events. When the wind blows offshore (towards the southeast), the bottom currents are directed upchannel; conversely, onshore winds cause a net downchannel flow. These results were obtained during the summer, when stratified conditions (two layers) were present.

The data base was too limited to indicate long-term circulation patterns in the Hudson Shelf Valley. However, these results do indicate a possible upwelling/downwelling mechanism controlled by wind events as a contributing factor to circulation in the inner Hudson Shelf Valley.

f. Internal Waves. Internal waves on the continental shelf and in the Hudson Shelf Valley have been identified in satellite imagery studies (Apel *et al.*, 1974). Stratified water conditions must be present for the generation of internal waves. One theory is that an internal wave is generated when the tidal wave propagates onto the shelf; the depth discontinuity causes tidal energy to be transformed into internal waves. The internal waves then propagate onto the shelf until the bottom of the thermocline (density interface) intersects the bottom, where the waves break. Breaking internal waves can contribute to sediment resuspension and must be considered in evaluating bottom sediment transport.

C. BIOLOGICAL OCEANOGRAPHY

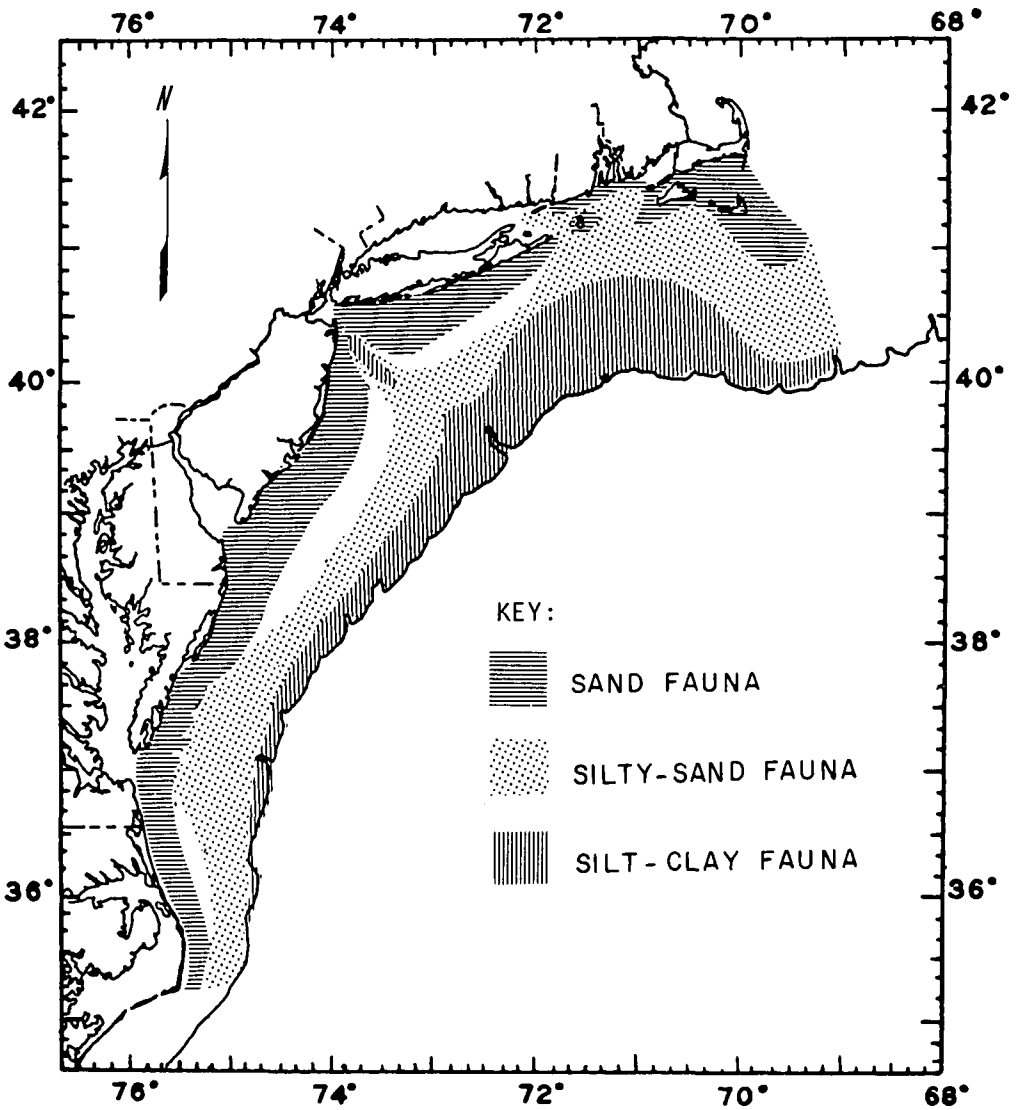
This section on biological oceanography includes descriptions of the benthos, fisheries resources, plankton, and coliform contamination in the New York Bight and the proposed areas.

1. Benthos

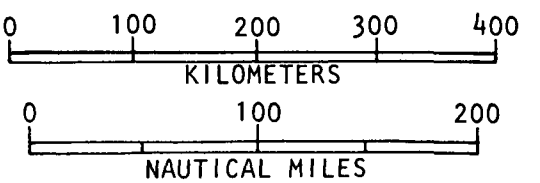
The benthos includes marine species which burrow into the bottom sediments, species which are attached to the bottom, and species which live and move about on the bottom. Due to their ubiquitous nature, limited mobility, and relatively long lifespan, benthic organisms are frequently used as indicators of water quality and sediment quality. In addition, they are often a source of food for fish and man.

a. Common Faunal Communities. The composition of benthic faunal communities is largely controlled by sediment type, although other parameters such as temperature range, salinity, water quality, depth, and currents are also important. The benthic communities of the New York Bight are characteristic of the Mid-Atlantic Bight from Cape Hatteras to Cape Cod. The sand fauna, the silty-sand fauna, and the silty-clay fauna are common to this zone (Figure 16).

The progression from sand fauna to silty-sand fauna to silty-clay fauna generally occurs in an offshore direction. However, the transition is subtle and the communities are not easily delineated. The differentiation is particularly diffi-



BENTHIC FAUNAL TYPES IN THE MID-ATLANTIC BIGHT



SOURCE: PRATT, 1973.

DAMES & MOORE

FIGURE 16

cult near the Hudson Shelf Valley where all three faunal communities may be found (Pratt, 1973).

The sand fauna are found from the shore seaward to depths of 30 to 50 m (100 to 165 ft). The sand fauna are adapted to the shifting sand conditions of their environment. They are not easily moved, and, if buried, they are capable of digging themselves out. Oxygen concentrations in the water and sediment are high and suspended food is abundant. Among the important species of the sand fauna are the surf clam and the rock crab (Pratt, 1973). Communities dominated by the surf clam may be among the most productive communities on the sea bottom (Thorson, 1957).

The silty-sand fauna cover large areas of the continental shelf. They are particularly productive in terms of fish food, and many species of groundfish, as well as lobster and crab, feed in the area. The ocean quahog is representative of the silty-sand fauna. Compared to the sand fauna, the silty-sand fauna have a relatively stable environment. Deposit and suspension feeders occupy permanent tubes and burrows in the sediments. Tube-dwelling amphipods are abundant enough to be an important fish food and a useful indicator of long-term trends in environmental quality (Pearce, 1970).

The silty-clay fauna are found in the fine sediments that are characteristic of protected estuaries and bays of the inner edge of the continental shelf. The silty-clay fauna also are found in the fine sediments distributed throughout the

Hudson Shelf Valley. This faunal community includes deposit-feeding starfish, worms, and bivalves (shellfish). The present value of the silty-clay fauna, in terms of fish food or direct yield to man, is low. However, these fauna support some groundfish as well as migrating lobster.

b. Northern and Southern Areas. Preliminary examination of benthic samples from sixty stations in the Northern and Southern Areas indicates that the offshore region between 37 and 64 m (120 to 210 ft) is characterized by a relatively uniform distribution of faunal communities (NOAA-NMFS, 1975b; Pearce and Radash, 1975). In contrast, an erratic distribution of faunal abundance and composition is found in the Bight Apex, near the existing dump sites.

The proposed areas have approximately the same number of individuals and species as the unpolluted or relatively unstressed portions of the Bight Apex. Surf clams were reported to be abundant in and shoreward of the Southern Area. Ocean quahogs and rock crabs were numerous at both proposed areas. The presence of these species may indicate that both areas are transitional between the highly productive sand fauna community, represented by the surf clam, and the silty-sand fauna, represented by the ocean quahog. Except for differences in shellfish abundance, the Northern and Southern Areas seem to have equally productive benthic communities in terms of fish food value and direct fisheries resource potential.

2. Fisheries Resources

The information presented below has been selected and organized to concentrate on those points that are relevant to impact evaluation and alternate site selection. For simplicity, common names are used. Taxonomic equivalents are given in Table 19. Pelagic fish are those fish that live and feed in the water column; demersal fish are bottom dwellers.

This discussion includes shellfish (which are usually categorized as benthic species) because of their large contribution to fisheries resources in the Bight. Shellfish include the bivalves (clams, scallops, and quahogs) and some crustaceans (lobster and crab).

a. New York Bight. Fish found in the Bight include year-round and seasonal resident species and transient species. The Bight is also an important spawning area for coastal fish. However, these fish do not spawn at specific local sites. The location and areal extent of the most intense spawning varies annually (NOAA-NMFS, 1975b). This annual variation is probably due to temperature and possibly due to larval food supply. As a result of extensive fish surveys in the New York Bight, NOAA-NMFS (1975b) concluded that only general spawning areas could be compared with accuracy.

b. Northern and Southern Areas. The Northern and Southern Areas are within the spawning range of most coastal fish. These areas are also in the migratory path of coastal (north-

TABLE 19

THE COMMON FISHERIES RESOURCES OF THE NEW YORK BIGHT

COMMON NAME	SCIENTIFIC NAME
Species Not Found in the Northern or Southern Area	
bay scallop	*Aequipecten irradians*
blue crab	*Callinectes sapidus*
blue marlin	*Makaira nigricans*
calico scallop	*Argopecten gibbus*
eastern oyster	*Crassostrea mercenaria*
hard clam	*Mercenaria mercenaria*
quahog	*Mercenaria campechiensis*
shad	*Alosa sapidissima*
soft shell clam	*Mya arenaria*
striped bass	*Roccus saxatilis*
swordfish	*Xiphias gladius*
weakfish	*Cynoscion regalis*
white marlin	*Makaira albida*
Species Which Periodically Inhabit or Pass Through the Northern or Southern Area	
alewife	*Alosa pseudoharengus*
American lobster	*Homarus americanus*
Atlantic mackerel	*Scomber scombrus*
Atlantic menhaden	*Brevoortia tyrannus*
black sea bass	*Centropristes striatus*
bluefish	*Pomatomus saltatrix*
cod	*Gadus morhua*
goosefish	*Lophius americanus*
little skate	*Raja erinacea*
ocean pout	*Macrozoarces americanus*
red crab	*Geryon quinquidens*
red hake	*Urophycis chuss*
rock crab	*Cancer borealis*
rock crab	*Cancer irroratus*
scup (porgy)	*Setnotomus chrysops*
silver hake	*Merluccius bilinearis*
squid	*Loligo pealei*
summer flounder	*Paralichthys dentatus*
winter flounder	*Pseudopleuronectes americanus*
yellow tail flounder	*Limanda ferruginea*
Species Which Inhabit the Northern or Southern Area for Most or All of Their Life Cycle	
ocean quahog	*Arctica islandica*
sea scallop	*Placopecten magellanicus*
surf clam	*Spisula solidissima*

Sources: Saila and Pratt, 1973; NOAA-NMFS, 1975b.

south) and inshore-offshore migrants. Population centers of year-round resident species lie either in or near these areas. The year-round resident species include little skate, goosefish, silver and red hakes, ocean pout, yellow tail flounder, and squid (NOAA-MESA, November 1975).

The constituents of the major fisheries are discussed below according to their geographic and migratory distribution patterns. The proposed action will have the least effect on those fish which are not found in the proposed areas during any part of their life cycle. It will have the most pronounced effect on those fish which spend most or a vital part of their life cycle in the proposed areas.

Information on life histories and habits of the major fish species in the Mid-Atlantic Bight was obtained from Saila and Pratt (1973). This review served as the basis for division of the various species into the categories discussed below and shown in Table 19.

Species not found in the Northern or Southern Area include the eastern oyster, hard clam, calico scallop, soft shell clam, and bay scallop which are all bivalves. Because of their limited motility, they are not likely to be found migrating to or through these areas. The striped bass, American shad, swordfish, white and blue marlins, weakfish (all bony fish), and the blue crab (crustacean) are motile species which are not common to either area. However, because of their motility, their absence from the proposed areas is not a certainty.

Nevertheless, both of the proposed areas are outside of the normal distribution range for significant populations of these species.

Species which periodically inhabit or pass through the Northern or Southern Area are numerous, as shown in Table 19. There is little in the way of site selection that can be done to mitigate impacts on these species because they are so common in the Bight.

The red crab fishery is of unknown value, and remains essentially an untapped resource. The American lobster is found in waters from Labrador to North Carolina. South of Long Island, lobster are restricted to deeper water for lack of both suitable substrate and sufficiently cold water temperatures. In the Bight, they are common to silty sands at depths of 27 m (90 ft); they are found in greater abundance near the numerous wrecks off the New Jersey coast. An inshore lobster fishery, which extends from Cape Cod to New Jersey, accounted for approximately one-fifth of the U.S. landings in 1968. It is quite likely that this inshore fishery is currently over-exploited (Saila and Pratt, 1973). Both the red crab and 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).

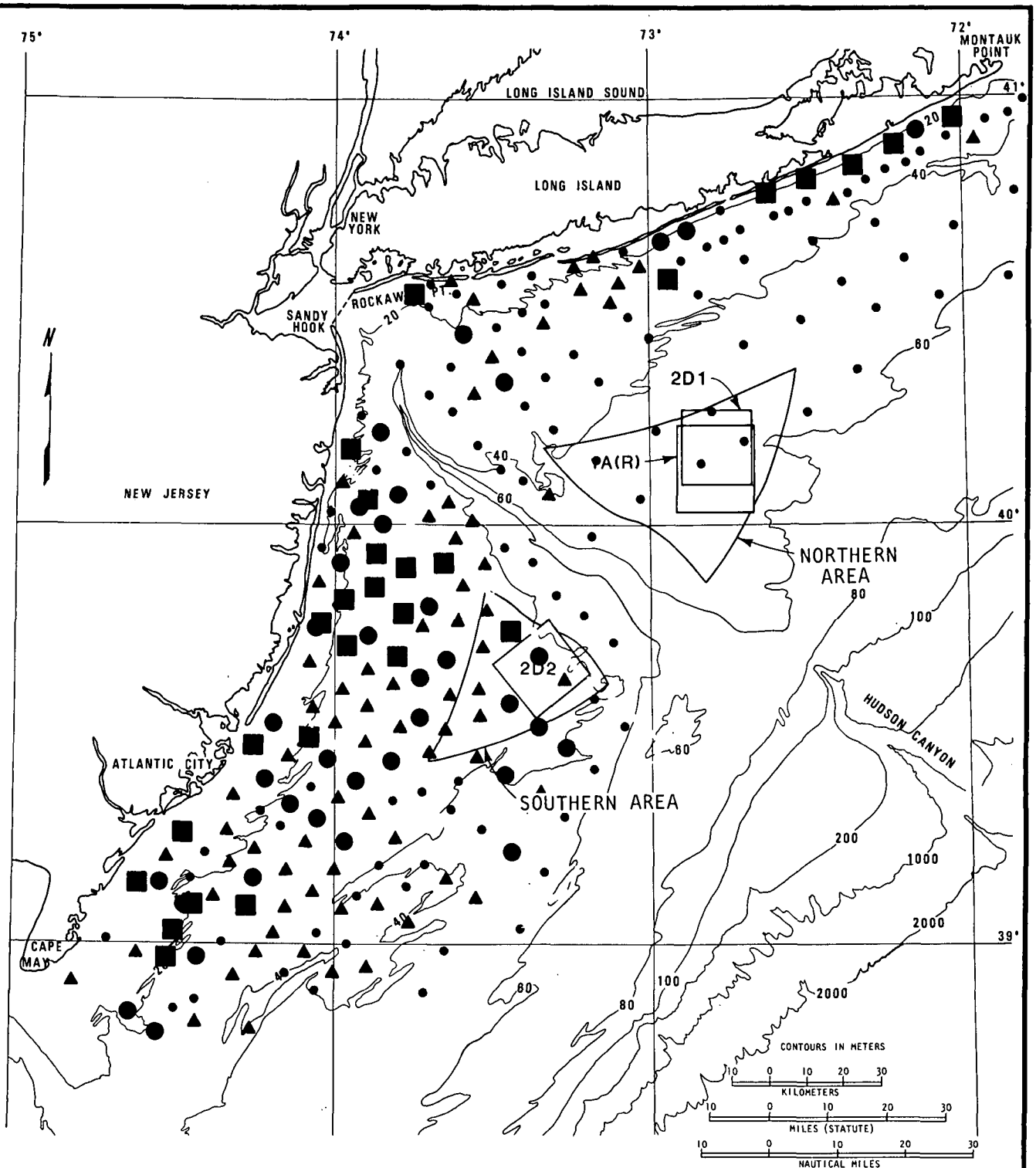
The rock crab is common in coastal waters from Labrador to South Carolina, but the present fishery is centered on the coastal waters of Maine and Massachusetts (Saila and Pratt, 1973). Monthly groundfish surveys by NOAA-NMFS (1975b) revealed

that the rock crab is present, in limited numbers, at both the Northern and Southern Areas.

Species which inhabit the Northern or Southern Area for most or all of thier life cycle primarily include the surf clam, sea scallop, and ocean quahog. Both areas contain these commercially important bivalves, as well as other ecologically important invertebrates. Surf clams and ocean quahogs are abundant over large areas on the continental shelf, from Long Island to Maryland (Figures 17 through 20). Sea scallops, in commercial quantities, are found in patchy distributions throughout the Bight (Figure 21).

Surf clam surveys in 1965 (Figure 17) and 1969 (Figure 18) reported an abundance of these commercial species in and shoreward of the Southern Area. Few surf clams were observed in or near the Northern Area. The most recent survey information from the 1974 Delaware II cruises (Figure 19) indicates that the center of the surf clam fisheries is no longer off the New Jersey coast, but has moved further south off the Delmarva Peninsula. However, surf clams remain abundant near, and especially shoreward of the Southern Area.

Ocean quahogs are generally found far offshore at depths of 25 to 61 m (75 to 185 ft), while surf clams inhabit nearshore waters at depths of about 43 m (135 ft) (Merrill and Ropes, 1969). Because of this difference in distribution with depth, shellfish surveys specifically directed at surf clams probably would not sample the most appropriate ocean quahog



SURF CLAM DISTRIBUTION IN THE NEW YORK BIGHT (1965)

KEY:

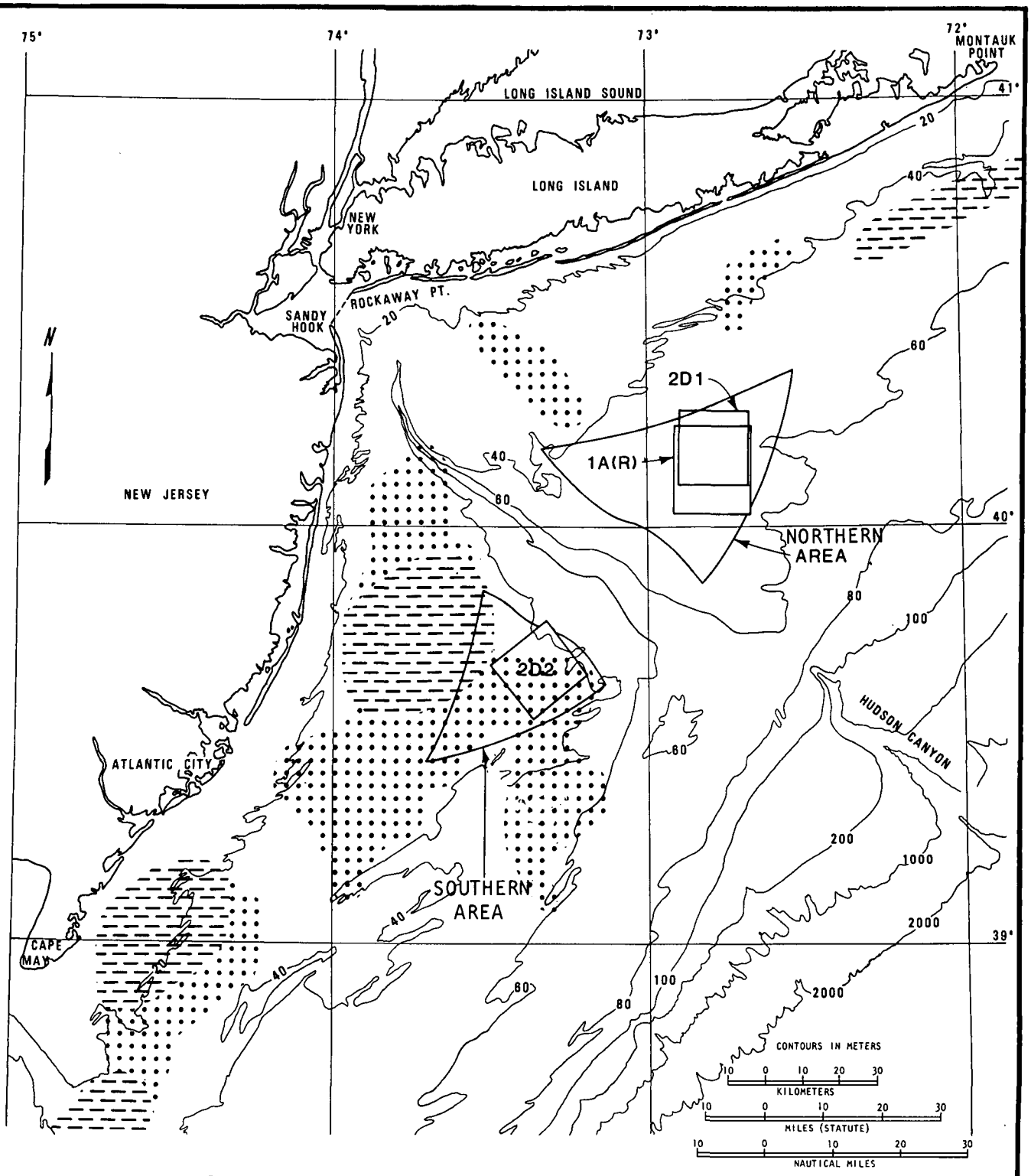
- ● NO SURF CLAMS
- ▲ UNDER ¼ BUSHEL
- ● ¼ TO 1 BUSHEL
- ■ 1 BUSHEL OR MORE

CATCH = 5 MINUTE TOW WITH 30 IN(0.8M) DREDGE

SOURCE: BUELOW ET AL., 1968.

DAMES & MOORE

FIGURE 17



SURF CLAM DISTRIBUTION IN THE NEW YORK BIGHT (1969)

KEY:

1 BUSHEL OR MORE

¼ TO 1 BUSHEL

CATCH = 5 MINUTE TOW WITH 30 IN(0.8M) DREDGE

SOURCES: PEARCE, 1974; CHAMBERLIN AND MERRILL, 1969.

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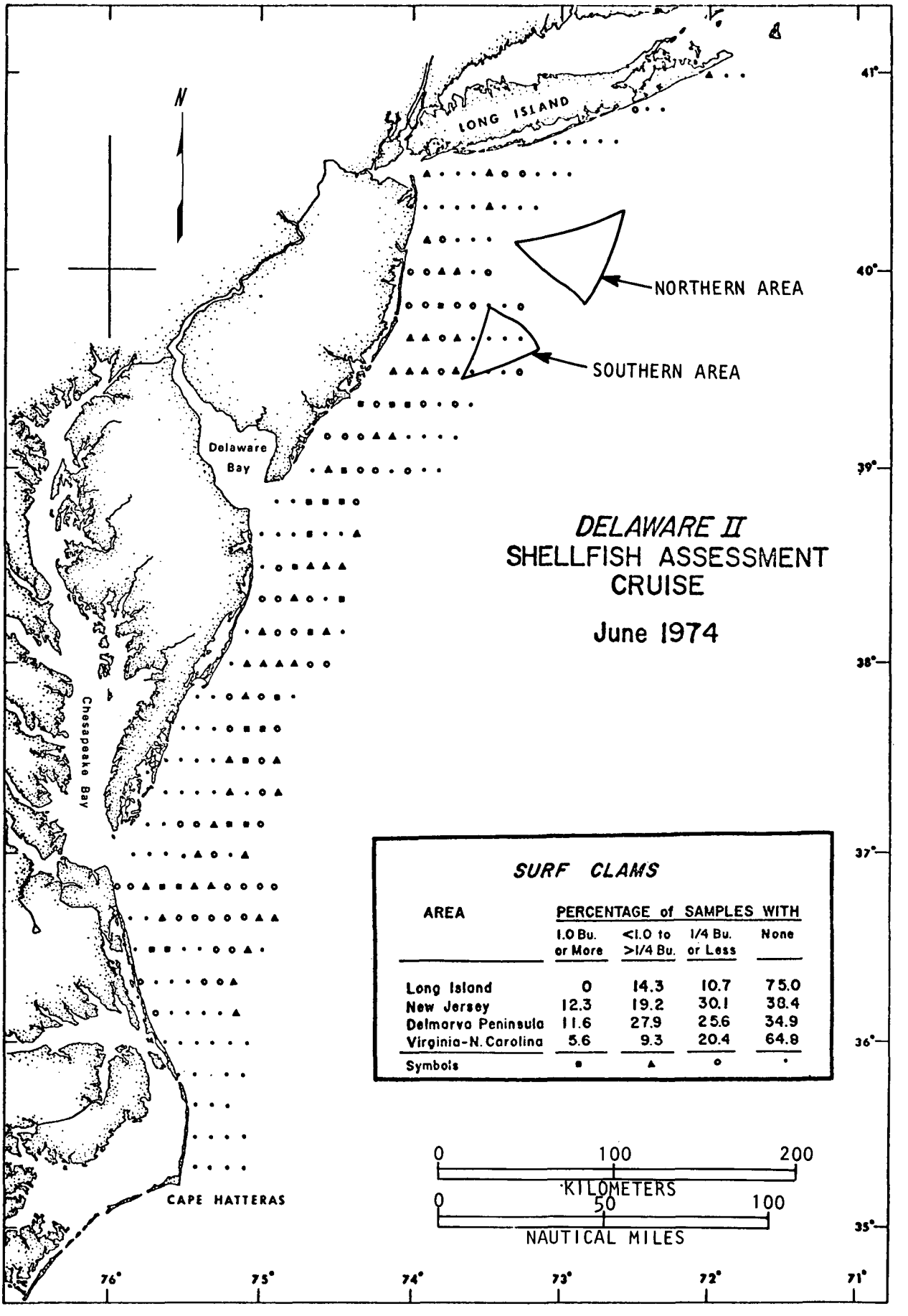
FIGURE 18



SURF CLAMS

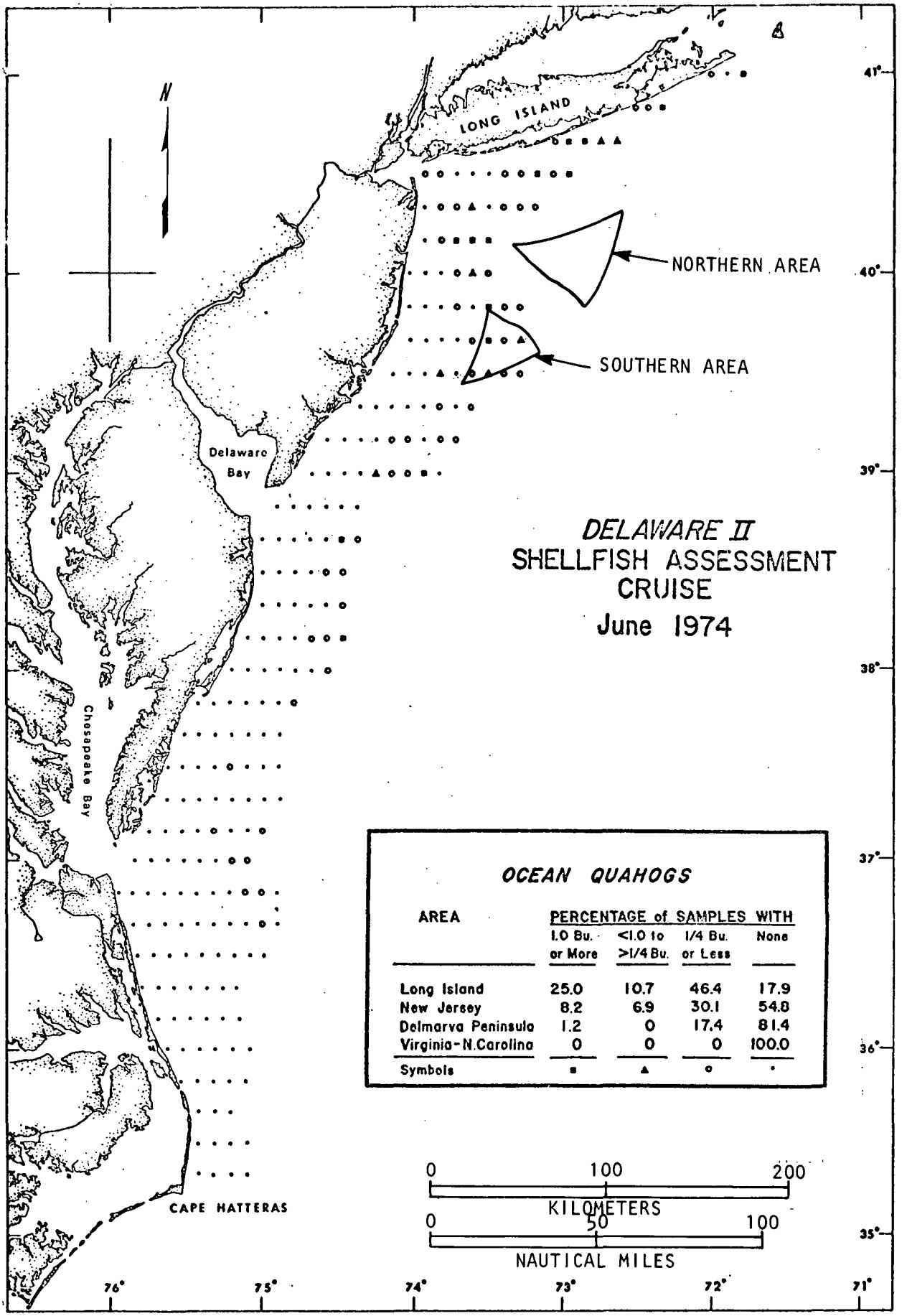
AREA	PERCENTAGE of SAMPLES WITH			
	1.0 Bu. or More	<1.0 to >1/4 Bu.	1/4 Bu. or Less	None
Long Island	0	14.3	10.7	75.0
New Jersey	12.3	19.2	30.1	38.4
Delmarva Peninsula	11.6	27.9	25.6	34.9
Virginia-N. Carolina	5.6	9.3	20.4	64.8
Symbols	■	▲	○	•

SURF CLAM DISTRIBUTION IN THE MID-ATLANTIC BIGHT (1974)

SOURCE: NOAA-NMFS, 1974C.

DAMES & MOORE

FIGURE 19



OCEAN QUAHOGS

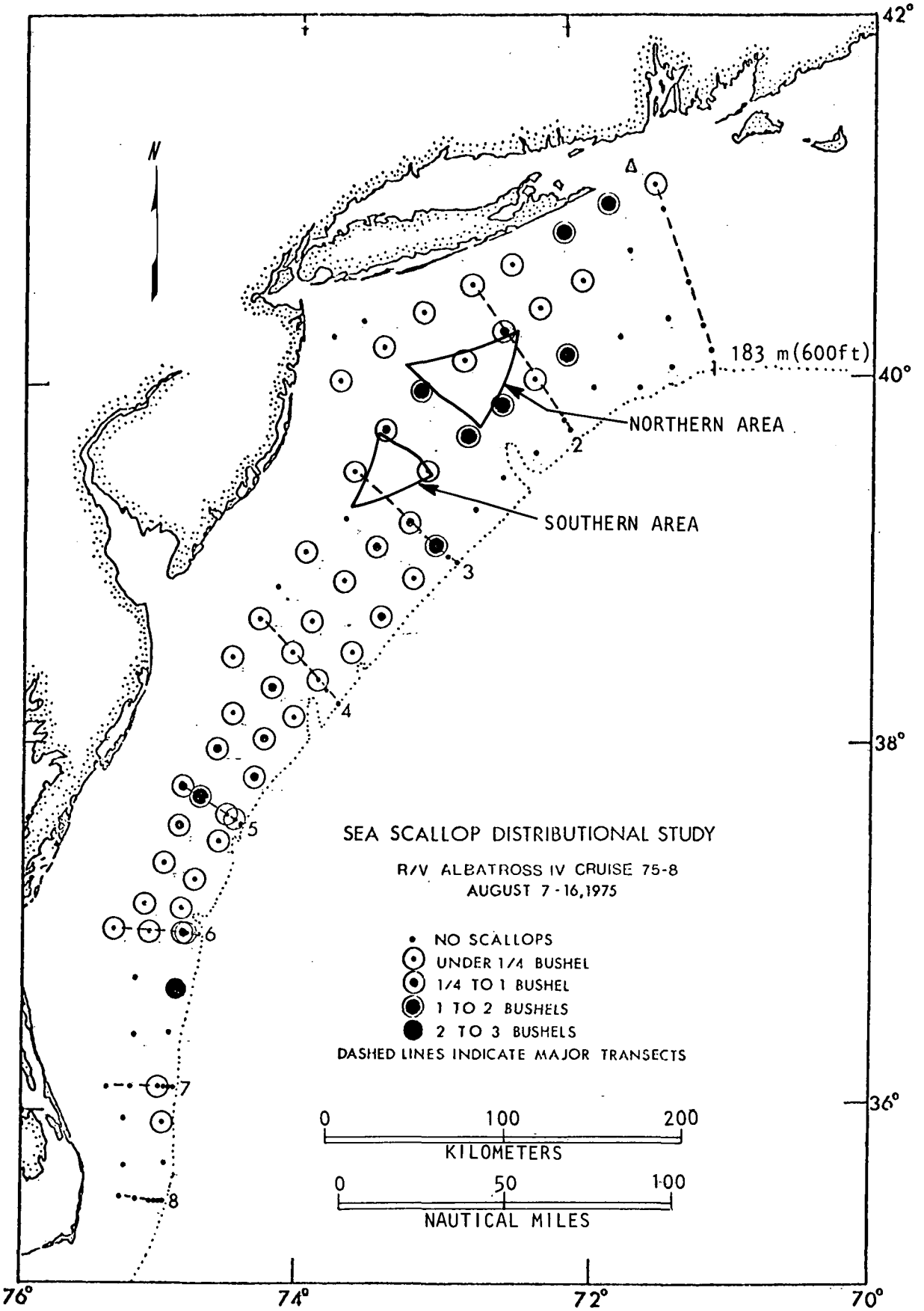
AREA	PERCENTAGE of SAMPLES WITH			
	1.0 Bu. or More	<1.0 to >1/4 Bu.	1/4 Bu. or Less	None
Long Island	25.0	10.7	46.4	17.9
New Jersey	8.2	6.9	30.1	54.8
Delmarva Peninsula	1.2	0	17.4	81.4
Virginia-N.Carolina	0	0	0	100.0
Symbols	■	▲	○	•

OCEAN QUAHOG DISTRIBUTION IN THE MID-ATLANTIC BIGHT (1974)

SOURCE: NOAA-NMFS, 1974c.

DAMES & MOORE

FIGURE 20



SEA SCALLOP DISTRIBUTION IN THE MID-ATLANTIC BIGHT (1975)

SOURCE: NOAA-NMFS, 1975C.

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FIGURE 21

habitats. This fact notwithstanding, the 1974 Delaware II shellfish assessment cruises do provide data on ocean quahog distributions in the nearshore waters of the Mid-Atlantic Bight (Figure 20). The cruise results indicate that ocean quahogs are numerous in the Southern Area. The Northern Area was not sampled. The greatest abundance and frequency of occurrence was found just off Long Island (NOAA-NMFS, 1974a). More recent shellfish surveys of the proposed areas (NOAA-NMFS, 1975b) reported ocean quahogs to be numerous in both areas.

At present, ocean quahogs constitute the largest underutilized clam resource in the Bight (Saila and Pratt, 1973). Underutilization may be attributed to: the rapid growth of the surf clam fishery to meet market demand; the larger yield of meat per bushel provided by the surf clam (Merrill and Ropes, 1969); the greater distance to ocean quahog areas; and the poor keeping properties and strong, variable flavor of ocean quahogs (Mendelsohn et al., 1970; Medcof and Chandler, 1968). Possibly, the ocean quahog could be used in the future as a substitute for surf clams (Mendelsohn et al., 1970).

The major fishing effort for sea scallops is near the Hudson Shelf Valley and off the Virginia Capes (Saila and Pratt, 1973). Sea scallops were found at both the Northern and Southern Areas. However, estimates of their abundance in these areas are lacking because the clam dredge used in this study is not an appropriate device for sampling sea scallop populations (NOAA-NMFS, 1975b). The results of a sea scallop survey in

August 1975 (Figure 21) show that species concentrations were greater on Georges Bank than in the Mid-Atlantic Bight. Sea scallops were found in depths of 31 to 110 m (95 to 340 ft), with 71 percent of the catch occuring between 57 and 73 m (180 to 220 ft) and 21 percent occurring between 36 and 54 m (120 and 165 ft) (NOAA-NMFS, 1975c).

3. 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 (1975) recently prepared a review of plankton taxonomy and distribution for the Bight. Examining seventy-five years of published and unpublished data, he determined that phytoplankton species composition 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 stan-

darized 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 fixed by phytoplankton 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:

- New York Harbor waters, with salinity values of less than 20 ^{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 seasonal variations and low biomass. Pelagic plankton are scarce, but veliger larvae and barnacle cyprids are common.

- 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 (November 1975). Plankton species are similar to those of the harbor water mass.

- 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.

- 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.

4. Coliform Contamination, Antibiotic Resistant Bacteria, and Diseases of Marine Resources

a. Coliform Contamination. Traditionally, coliform bacteria have been used as indicators of pollution from municipal wastewater discharges. While coliforms do not pose a threat to public health, their presence in large numbers indicates a high probability that pathogenic organisms are also present. Only recently has it become possible to monitor directly for pathogenic organisms *in situ* (in place); therefore, most of the available data are for the coliform group.

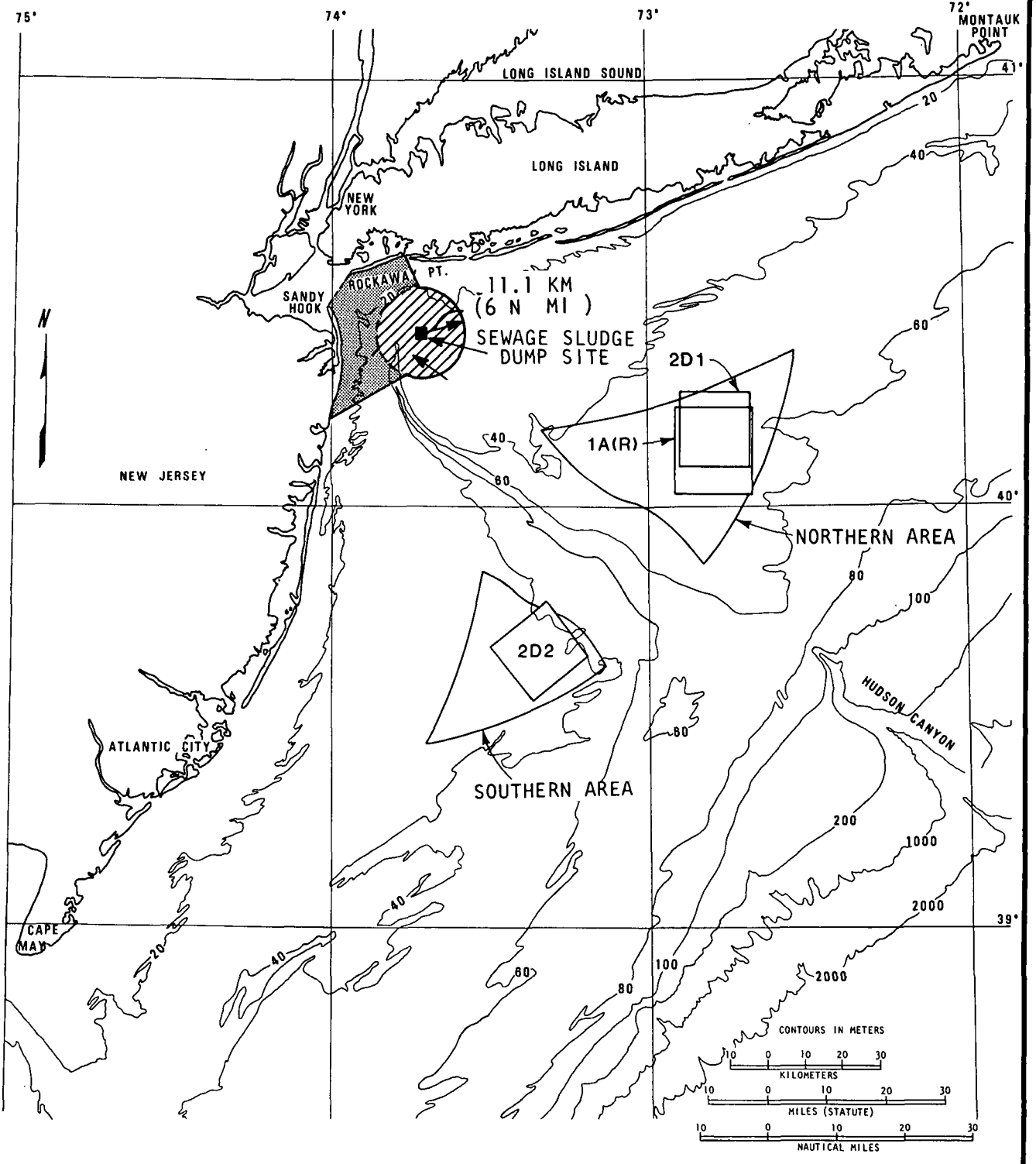
Since 1968, EPA and FDA have been monitoring the bottom sediments and water column in the Bight Apex, especially in the vicinity of the existing sewage sludge dump site, for indications of coliform contamination. This monitoring activity has produced the following observations and actions.

In 1970, FDA prohibited shellfishing in an area of 11.1 km (6.0 n mi) radius around the existing dump site (Fig-

ure 22) 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. Areas adjacent to the closed area were found to be of very high quality and safe for shellfish harvesting. Coliforms contributed by sludge dumping were not accumulating, but were experiencing a relatively rapid die-off following their introduction into the Apex (McGraw, 1969).

In 1972, FDA extended the prohibited shellfishing zone to the Long Island and New Jersey shorelines (Figure 22). 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). The decision to close the additional area was based upon poor surface water quality only; bottom waters and sediments appeared to be of good quality. Coliform sampling data strongly suggest that contamination of shellfish waters beyond the 3-mile (5.6 km) limit is attributable to onshore sources, such as runoff, wastewater discharges, and estuarine inputs, rather than to sludge dumping. The incidence of coliforms in nearshore bottom sediments was low and decreased significantly seaward, indicating onshore sources of contamination.

The most recent FDA (FDA, 1974a) and EPA (July 1974 and April 1975) studies of the waters between the sludge dump site and the Long Island and New Jersey beaches show no significant coliform contamination of the sediments or water column



AREA CLOSED TO SHELLFISHING IN VICINITY OF SEWAGE SLUDGE DUMP SITE

KEY:
CLOSED TO SHELLFISHING
1968
1972

SOURCE: FDA, 1973.

DAMES & MOORE

FIGURE 22

that can be attributed to sludge dumping at the existing dump site. The EPA monitoring program for the Apex continues to show excellent surface and bottom water quality, with regard to coliform densities, surrounding the existing dump site. This monitoring program includes testing for coliform bacterial groups in the bottom sediments and water column, for selected pathogenic bacterial groups in the bottom sediments (negative to date) and, since late 1975, for viruses in the water column (also negative to date). However, FDA still finds the area unacceptable for shellfishing (FDA, December 18, 1975).

b. Antibiotic Resistant Bacteria. The increased use of antibiotics has resulted in mutant bacteria which are resistant to a broad spectrum of antibiotics and possibly even to heavy metals (Davies and Rownd, 1972; Summers and Silver, 1972). The focus of concern is a transfer resistance factor known as R-plasmid, which can be transmitted from one bacterium to another through normal types of bacterial reproduction such as conjugation or transduction (Davies and Rownd, 1972). Recently, such antibiotic resistant bacteria have been isolated from Bight waters in the vicinity of the existing sludge dump site (Koditschek and Guyre, 1974a). It has been suggested that the dump site is a potential "breeding ground" for antibiotic resistant bacteria.

Antibiotic resistant (R-plasmid) bacteria are not unique to sewage sludge or to ocean dumping of sludge. They have been recovered from raw and treated sewage, from river

water, from salt water in Mobile Bay, Alabama (Feary et al., 1972), from the Whippany River, New Jersey (Koditschek and Guyre, 1974b), and from beach water at Sandy Hook, New Jersey (Koditschek and Guyre, 1975). The antibiotic resistant bacteria are an indicator of wastewater contamination.

c. Diseases of Marine Organisms. Several disease conditions have been observed in a variety of marine organisms in the Bight Apex. These include occurrences of fin rot, lobster die-off, necrosis of crustacean exoskeletons, gill fouling, and protozoan parasites on gill tissues. To date, none of these observed conditions have been attributed directly or solely to sludge dumping, nor have the causative agents 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 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, November 1975). Preliminary results from ongoing experiments indicate that survival of caged fish in the Christiansen 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, 1975b; 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.

D. GEOLOGICAL OCEANOGRAPHY

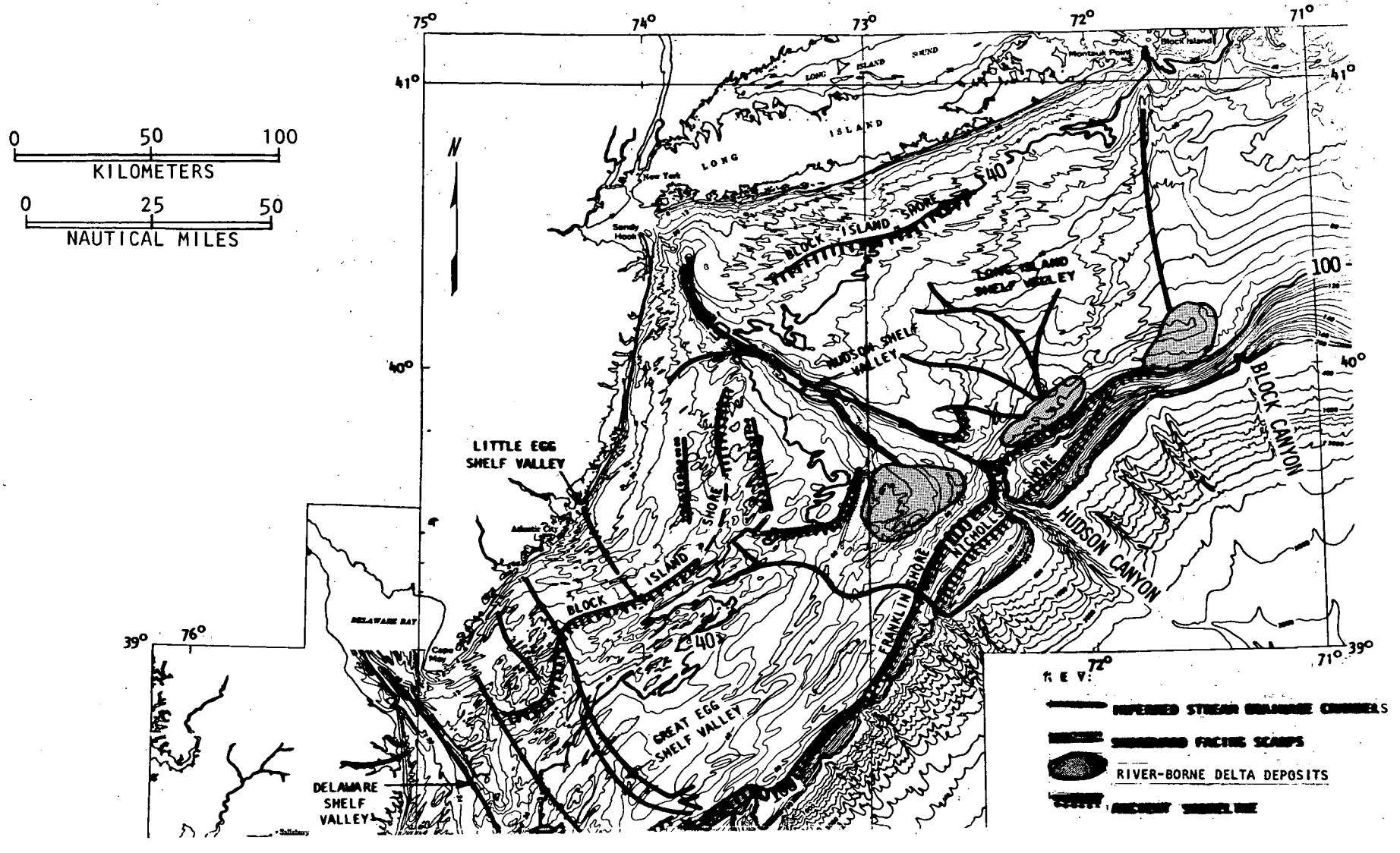
This section on geological oceanography includes descriptions of the geomorphology, surficial sediments, and suspended particulate matter of the New York Bight and the proposed Northern and Southern Areas.

1. Geomorphology

The sea floor is not a smooth, featureless plain; it is characterized by forms and structures (known as geomorphologic features or bedforms) just as the land surface is characterized by features such as hills and valleys.

The continental shelf, including the portion that underlies the New York Bight, exhibits a variety of geomorphologic features, such as relict drainage channels, scarps and terraces, systems of sand ridges, and smaller features (bedforms) (Figure 23). Reviews of the continental shelf's geomorphologic features and their origins can be found in Milliman *et al*. (1972) and Swift *et al*. (1973). In general, the geomorphology of the continental shelf reflects the cumulative processes of erosion and deposition by streams and near-shore currents.

a. Relict Drainage Channels. Relict drainage channels are simply the remains of drainage channels from an earlier geologic period. During glacial periods, when the sea level was low, much of the continental shelf was exposed. Streams associated with large drainage systems, such as the Hudson River, cut deep erosional valleys in the surface of the continental shelf.



GEOMORPHIC ELEMENTS OF THE MID-ATLANTIC CONTINENTAL SHELF

SOURCES: MILLIMAN, ET AL., 1972; SWIFT, 1974;
GARRISON AND McMASTER, 1966; McKINNEY, 1975.

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FIGURE 23

On the Long Island shelf, a trunk drainage system (Long Island Valley) has been implied from analysis of Stearns' (1967) bathymetric charts (Garrison and McMaster, 1966; McKinney and Friedman, 1970).

b. Scarps and Terraces. The shelf surface also displays a series of scarps and terraces which formed in response to the erosion and deposition associated with periods of constant sea level (Veatch and Smith, 1939; Emery and Uchupi, 1972; Garrison and McMaster, 1966; McClennen and McMaster, 1971; Swift *et al.*, 1972). The fact that much of the shelf surface still bears the patterns and features of earlier erosion suggests that there has been very little deposition of sediments on the shelf surface since the last sea level rise.

c. Sand Ridges. The most conspicuous geomorphologic features of the continental shelf are the sand ridges. The sand ridges are 2 to 4 km (1.1 to 2.2 n mi) apart and up to 10 m (33 ft) high and extend for tens of kilometers. Investigations show that the ridges rest on older lagoonal strata (Swift *et al.*, 1973; Stubblefield *et al.*, 1974; Stubblefield *et al.*, 1975; Stahl *et al.*, 1972). The ridges appear to have been caused by storm action in near-shore areas during the last sea level rise. As the sea level rose, they became isolated remnants on the shelf surface (Swift *et al.*, 1973).

d. Smaller Bedforms. The effect of present hydraulic action on the shelf surface is evidenced by the formation of smaller bedforms, such as wave ripples and large-scale current

lineations. The latter appear as elongate forms up to 1.5 m (4.9 ft) high, and they are arranged in furrows, bands, patches, and ribbons of alternating sediment types. These forms are thought to be caused by the bottom hydraulic flow associated with major storm events (McKinney et al., 1974; MacIntyre and Pilkey, 1969).

2. Surficial Sediments

Recent studies of surficial sediments on the eastern continental shelf of the United States reveal that, in general, the shelf surface is a vast sand plain (Emery and Schlee, 1963; Emery, 1966; Schlee, 1973; Milliman et al., 1972). The sand generally accumulates in elongated ridges, which are especially well developed on the inner portions of the shelf. While sand is the most abundant textural component on the shelf, gravel, greater than 2.0 mm (0.08 in) in size, and mud (silt and clay), less than 62 μ (0.002 in) in size, are significant.

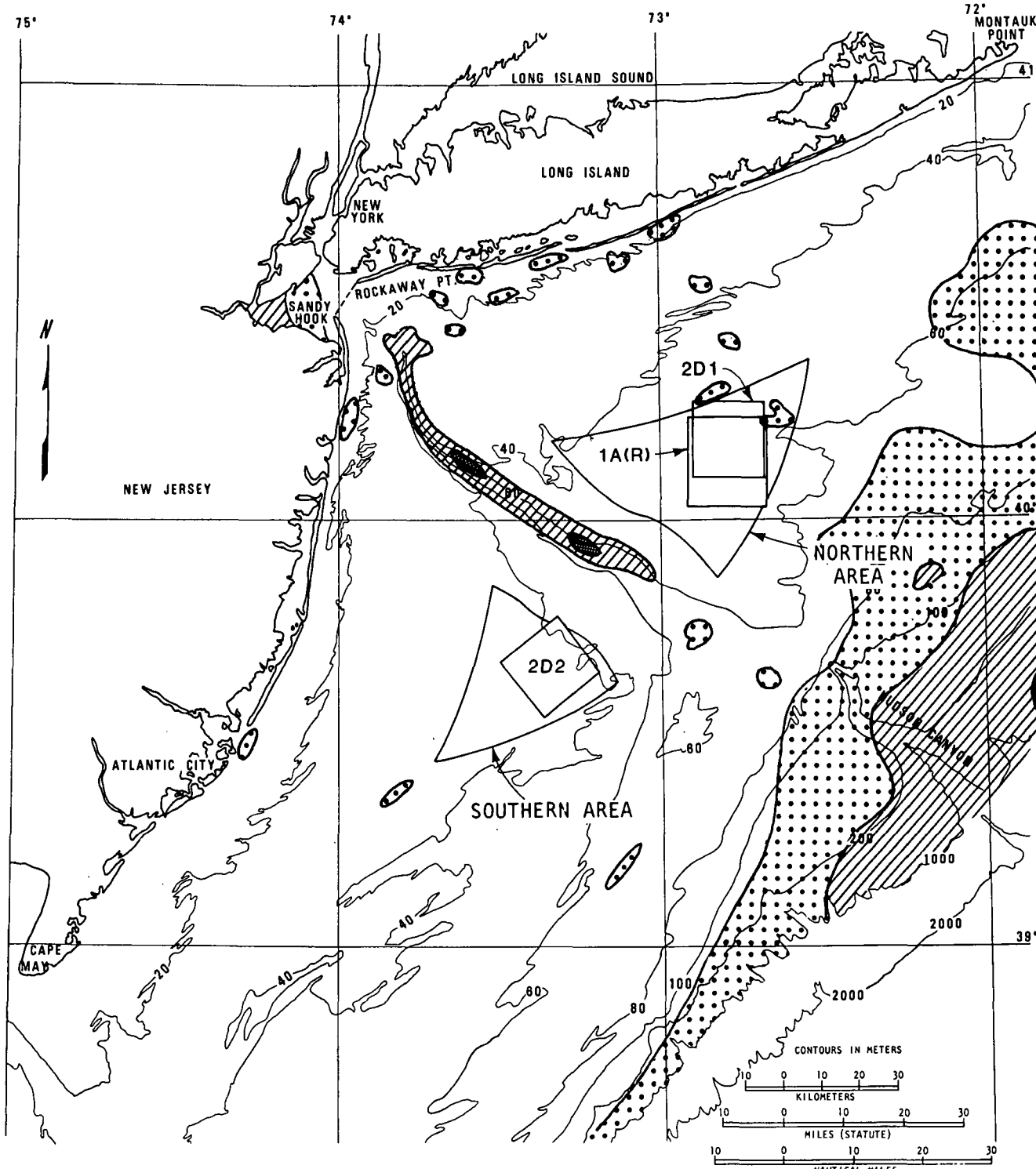
a. Gravel. Indications are that there is a significant gravel deposit on the inner portion of the northern New Jersey shelf; the highest percentage of gravel in the deposit occurs in the proposed Southern Area, as shown in Figure 6 (Schlee and Platt, 1970; Schlee, 1975). The northern New Jersey shelf gravel deposits are thought to be river-borne terrace gravels that were deposited on the exposed shelf by glacial meltwaters, probably from the Hudson River system (Schlee and Platt, 1970). Scattered deposits, high in gravel content, are also present on the Long Island shelf. Bottom samples taken in Subarea 2D2 contain up to 39 percent gravel.

b. Mud. The distribution of mud (fines), less than 62 μ (0.002 in) in size, is shown in Figure 24. The high percentage of fines in the area south of eastern Long Island represents the western edge of a large relict silt deposit of the southern New England shelf (McKinney and Friedman, 1970). In general, the percentage of fines on the inner shelf and middle shelf is quite low (less than 0.5 percent) out to about the 64 m (210 ft) depth contour. Locally, in depressions, the percentage of fines can be higher (up to 5 percent).

Between the 64 and 92 m (209 and 301 ft) depth contours, the shelf is characterized by values of 5 to 10 percent fines. In the depression area of the Long Island Shelf Valley, fines increase to 20 to 30 percent locally. At the 100 m (330 ft) depth contour, the percentages increase markedly. Finally, at the shelf edge, where the depth is about 183 m (600 ft), values of 40 to 50 percent fines occur. The inner and middle segments of the Hudson Shelf Valley are characterized by high percentages of fines, generally greater than 25 percent and locally greater than 50 percent. Overall, the New Jersey shelf is lower in fine material.

3. Suspended Particulate Matter

Studies on suspended particulate matter (SPM) of the continental shelf of Eastern United States (Manheim *et al.*, 1970; Meade, 1969 and 1972; Meade *et al.*, 1975) and of other shelves (McCave, 1972) show that, in both surface and bottom waters, SPM concentrations decrease rapidly away from the coast-



PERCENTAGE OF MUD IN BOTTOM SEDIMENTS OF THE NEW YORK BIGHT

PERCENT LESS THAN 62 μ (0.0024 IN)

KEY:

- < 1.0
- 1.0 TO 25
- 25 TO 50
- 50 TO 75

SOURCES: SCHLEE, 1973; HOLLISTER, 1973; NOAA-MESA, NOVEMBER 1975; McKINNEY AND FRIEDMAN, 1970.

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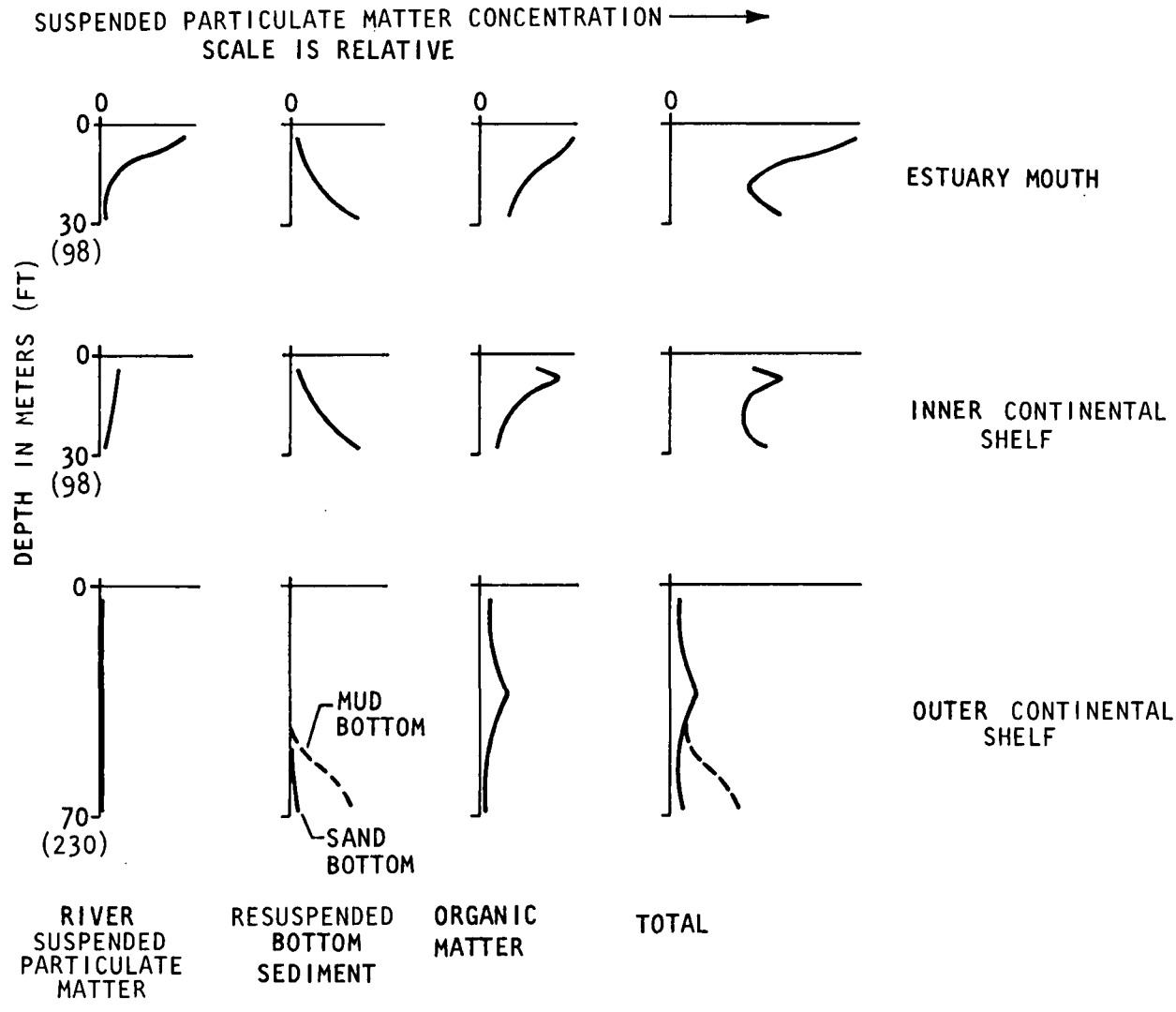
FIGURE 24

al zone. This pattern is aided by the predominantly coast-parallel longshore currents of the inner shelf. Shelf transport from stream discharges occurs in the form of SPM-rich estuarine plumes; for example, the surface flow out of the Hudson River estuary produces a turbid plume which comes within 5 to 10 km (3 to 5 n mi) of the New Jersey coast (Drake, 1974; Charnell et al., 1974). The Hudson River plume at times extends as far south as 35 km (19 n mi) from the New York Harbor entrance.

A schematic model of the distribution of suspended particulate matter across the continental shelf is presented in Figure 25. As indicated in the model, there are three major sources of the SPM found in continental shelf waters: river-borne SPM, resuspended bottom sediment, and organic matter produced on the shelf (Meade et al., 1975).

Over 90 percent of the SPM from rivers is trapped in the estuaries and wetlands (Manheim et al., 1970; Meade et al., 1975; Schubel and Okubo, 1972). Although 10 percent of the SPM actually reaches coastal waters, not all of it remains there. The dominant transport system is a two-layered circulation pattern with a less dense, less saline water flowing seaward in the upper layer and a denser, more saline water returning landward in the bottom layer. The SPM in the upper layer is carried seaward. The SPM in the bottom layer is carried landward. The contribution of river SPM to the continental shelf water system is carried in the river's surface layer plume. The resuspension of fine inorganic sediments near estuary mouths is related to



SCHEMATIC MODEL OF SUSPENDED PARTICULATE MATTER DISTRIBUTION ON THE CONTINENTAL SHELF

SOURCE: MEADE ET AL., 1975.

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FIGURE 25

the effects of wave surge and wind-drift currents in these shallow waters (Section IVB).

In size, the particles of inorganic material in the Bight Apex are generally like fine silt or clay, with less than 10 percent of the particles exceeding 16 μ (0.0006 in). Inorganic material constitutes 25 to 50 percent by volume of the total SPM close to shore and near the bottom. In the seaward portions of the Apex, within the clearer waters of the central shelf, inorganic content ranges from 5 to 10 percent of the total SPM (Drake, 1974).

Drake (1974) estimates that a single November storm resuspended a minimum of 10,000 metric tons (11,000 tons) of fine sediments throughout the water column in the Bight Apex. This demonstrates the strong influence of storm events in resuspending fine sediments. Other agents of resuspension include the activities of benthic organisms and fishing trawlers.

The SPM of the surface waters over the proposed areas consists mostly of combustible plankton and their non-combustible remains (Meade et al., 1975). Total SPM concentrations in surface waters range from 100 to 500 μg/l, of which 80 percent is combustible planktonic matter, 15 percent is siliceous and calcareous, non-combustible planktonic matter, and 5 percent or less is land-derived non-combustible matter.

The SPM concentrations in subsurface waters are the same or somewhat lower, with higher concentrations noted about 10 m (30 ft) above the bottom. The bottom layer has SPM concen-

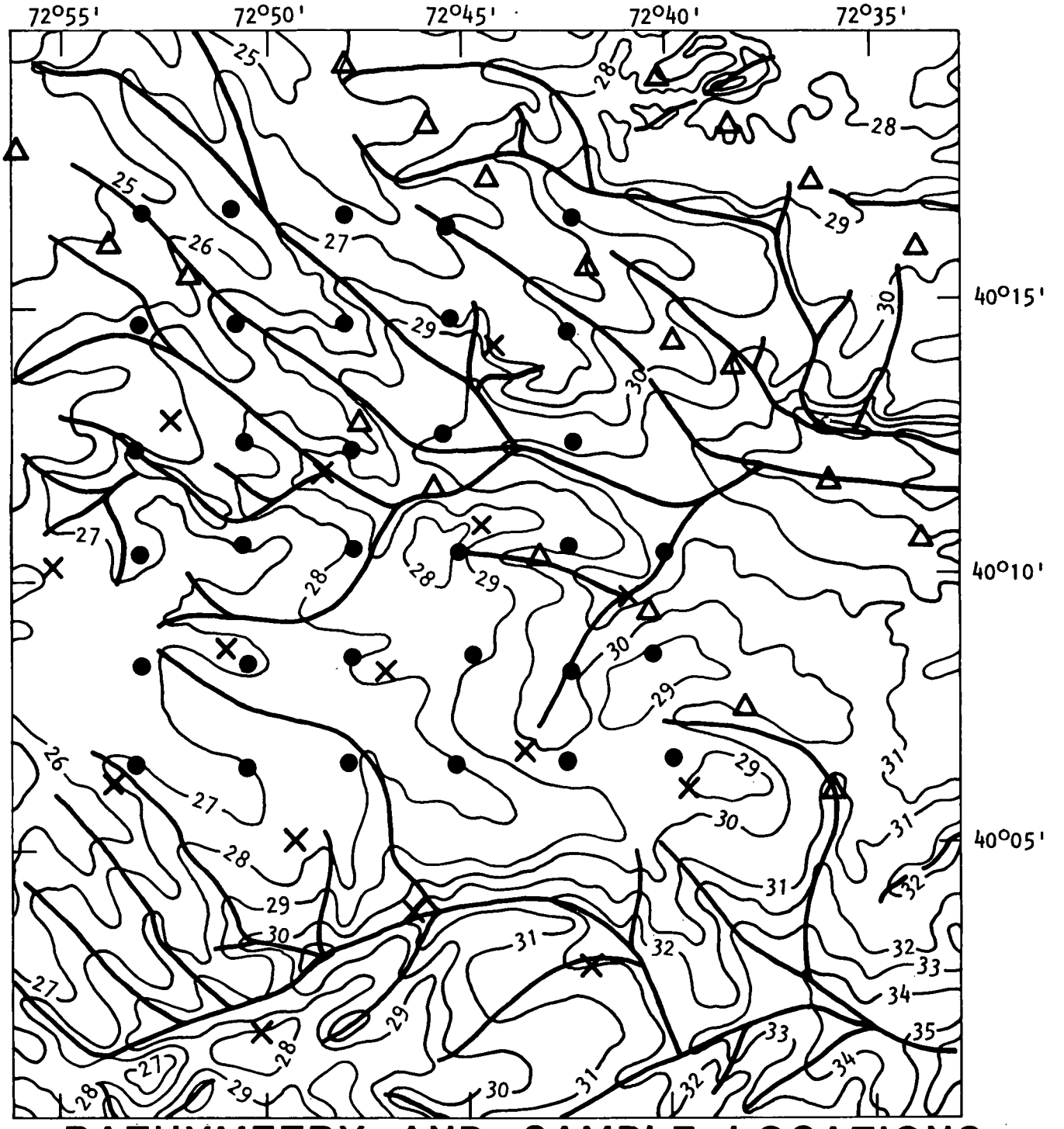
trations of 500 to 2000 μg/l, consisting of 30 to 60 percent combustible matter and 40 to 70 percent non-combustible matter.

4. Northern Area

a. Morphology. The proposed Northern Area is located on the central portion of the Long Island continental shelf near the headward portions of the relict Long Island Shelf Valley (Figure 23). The bathymetry (Figure 26), or depth below sea level, is based on early surveys (1937-1938) which used contours of one fathom intervals (Stearns, 1967). The pattern of the inferred relict drainage system reveals a well-developed drainage element oriented northwest and another oriented east-northeast (Figure 26).

Geophysical surveys (NOAA-MESA, November 1975) have been conducted in Subarea 2D1 (Figure 27). Preliminary results indicate that a surficial sand sheet exists, but it is generally thin, 1.5 to 1.8 m (5 to 6 ft), and is underlain by lagoonal clays. In a number of places these clays are exposed on the sea floor.

b. Surficial Sediments. The NOAA-MESA (November, 1975), Raytheon (1975 a and b), and McKinney and Friedman (1970) have sampled bottom sediments in the Northern Area (Figure 26). The regional sediment distribution on the Long Island shelf has been described previously in this section. Fine sands are located along the axial segments of the relict drainage system (Figure 28). Fine-medium sands are located in the south-central portion, and coarse-medium sands characterize the rest of the area.



BATHYMETRY AND SAMPLE LOCATIONS FOR SUBAREA 2D1

0 1 2 3 4 5 6 7 8 9 10 KILOMETERS
0 1 2 3 4 5 STATUTE MILES
0 1 2 3 4 5 NAUTICAL MILES

CONTOUR INTERVAL = 1 FATHOM = 1.83M (6FT)

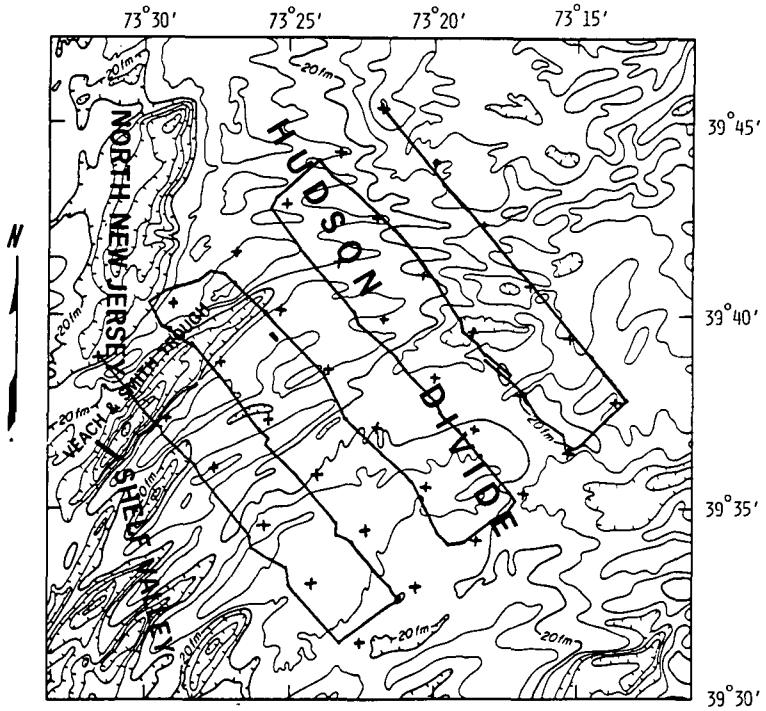
K E Y:

- ● NOOA-MESA SAMPLES
- X RAYTHEON SAMPLES
- △ McKINNEY AND FRIEDMAN 1970
- INFERRED RELICT DRAINAGE PATTERN

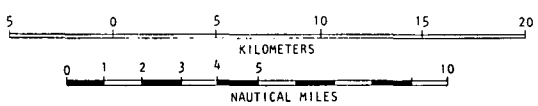
SOURCES: NOAA-MESA, NOVEMBER, 1975;
RAYTHEON, 1975 A AND B;
McKINNEY AND FRIEDMAN 1970.

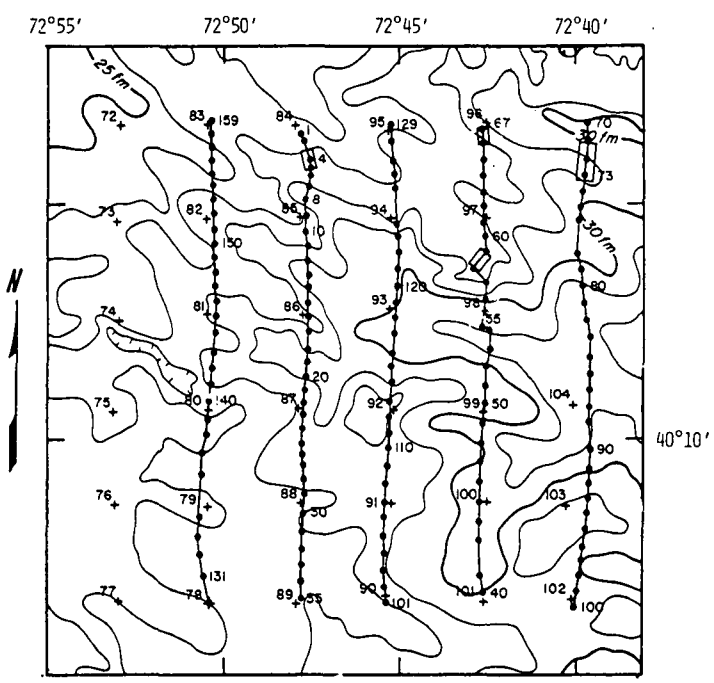
DAMES & MOORE

FIGURE 26



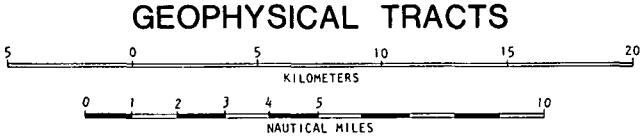
SUBAREA 2D2





SUBAREA 2D1

GEOPHYSICAL TRACTS



KEY:

BATHYMETRIC CONTOUR LINE

CONTOUR INTERVAL = 1 FATHOM = 1.83m (6FT)

TRACT LINES

SOURCE: NOAA-MESA, NOVEMBER 1975.

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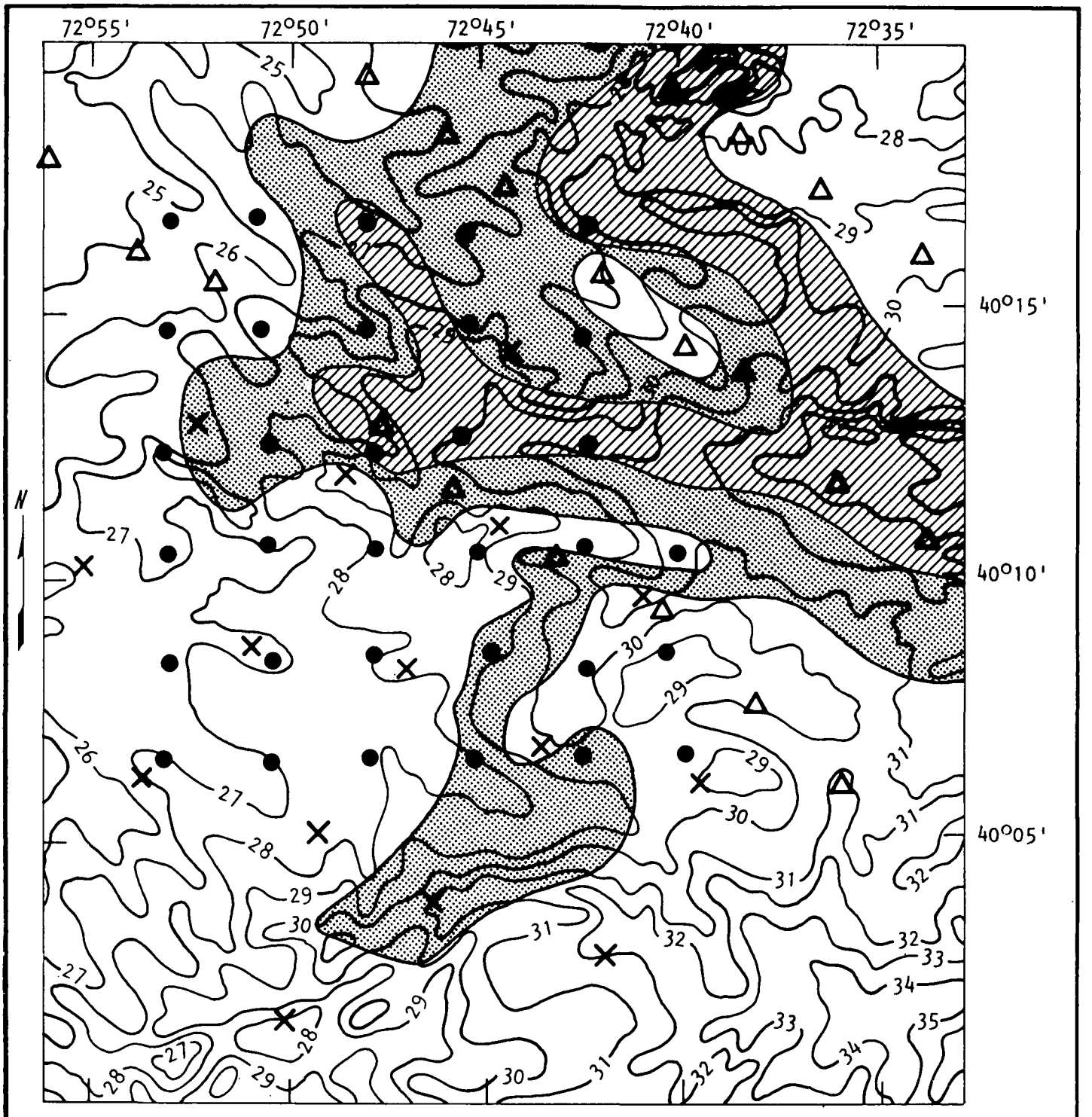
FIGURE 27



MEAN GRAIN SIZE OF BOTTOM SEDIMENTS IN SUBAREA 2D1

0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

0 1 2 3 4 5 STATUTE MILES

0 1 2 3 4 5 NAUTICAL MILES

CONTOUR INTERVAL = 1 FATHOM = 1.83M (6FT)

K E Y:

- ● MOMEMT MEAN OF SAND FRACTION ONLY: BY RAPID SETTLEMENT ANALYZER
- △ MOMENT MEAN: BY SIEVING
- × FOLK GRAPHIC MEAN; BY SIEVING

1MM = (0.03937 IN)

- 0.50 TO 0.35 MM } MEDIUM SAND
- 0.35 TO 0.25 MM } MEDIUM SAND
- 0.25 TO 0.177 MM – FINE SAND

SOURCES: NOAA-MESA, NOVEMBER 1975; RAYTHEON, 1975 A AND B; McKINNEY AND FRIEDMAN 1970.

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FIGURE 28

The highest percentage of gravel in sediments, approximately 40 percent, occurs in the raised areas between the relict valleys (Figure 29). A number of other samples, containing 5 to 10 percent gravel, were obtained from the floors of the valleys.

Most samples have very low percentages of fines (muds), generally less than 1 percent (Figure 30). Higher values, up to 5 percent, are found locally in low topographic areas.

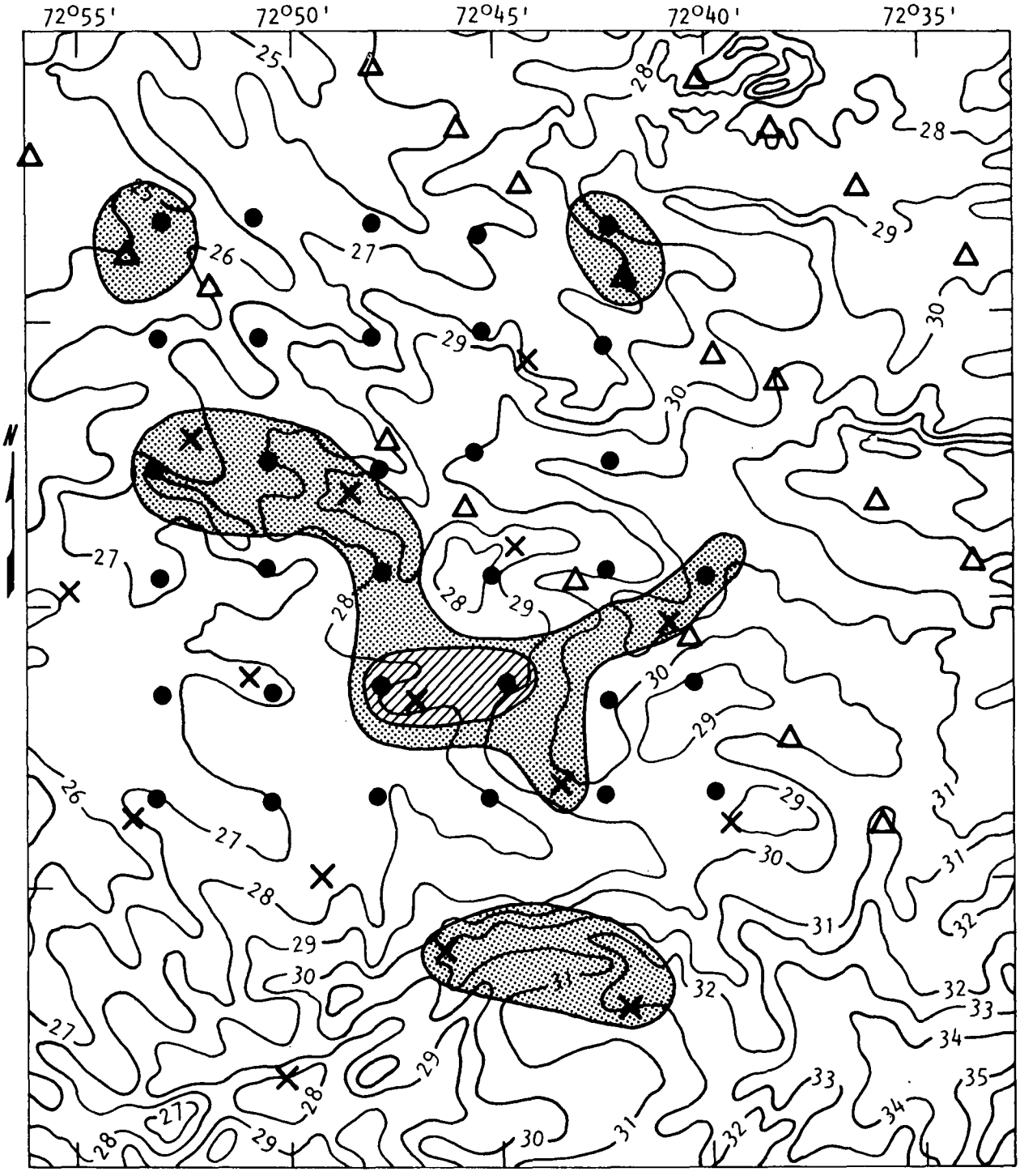
c. Bedforms. The sandy bottom of the Northern Area is characterized by wave ripples and by areas which appear slightly undulated or mounded. The ripples are thought to be the result of bottom currents associated with storms.

Side-scan sonar surveys (NOAA-MESA, November 1975) of the Northern Area reveal longitudinal bedforms (parallel to currents) referred to as large-scale current lineations (McKinney *et al.*, 1974). They occur as sediment zones, oriented on an east-west axis, in the valleys of the northern portion of the study area. This is also the area where thin layers of fine sands cover the underlying "basement of clay".

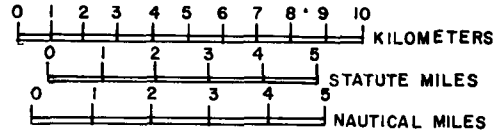
The large-scale current lineations appear to be formed by the movement of fine sands in response to secondary flow in the bottom boundary layer. The fine sand is swept out and away by the downward moving divergent currents and accumulates in the zones of current convergence.

5. Southern Area

a. Morphology. The western portion of the Southern Area is characterized by a north-south chain of depressions, deeper



PERCENTAGE OF GRAVEL IN SUBAREA 2D1



CONTOUR INTERVAL = 1 FATHOM = 1.83m (6FT)

KEY:

- < 5 PERCENT
- 5 TO 10 PERCENT
- 10 TO 40 PERCENT
- ●X△ SAMPLE STATIONS

SOURCES: NOAA-MESA, NOVEMBER, 1975;
RAYTHEON, 1975 A AND B;
McKINNEY AND FRIEDMAN, 1970.

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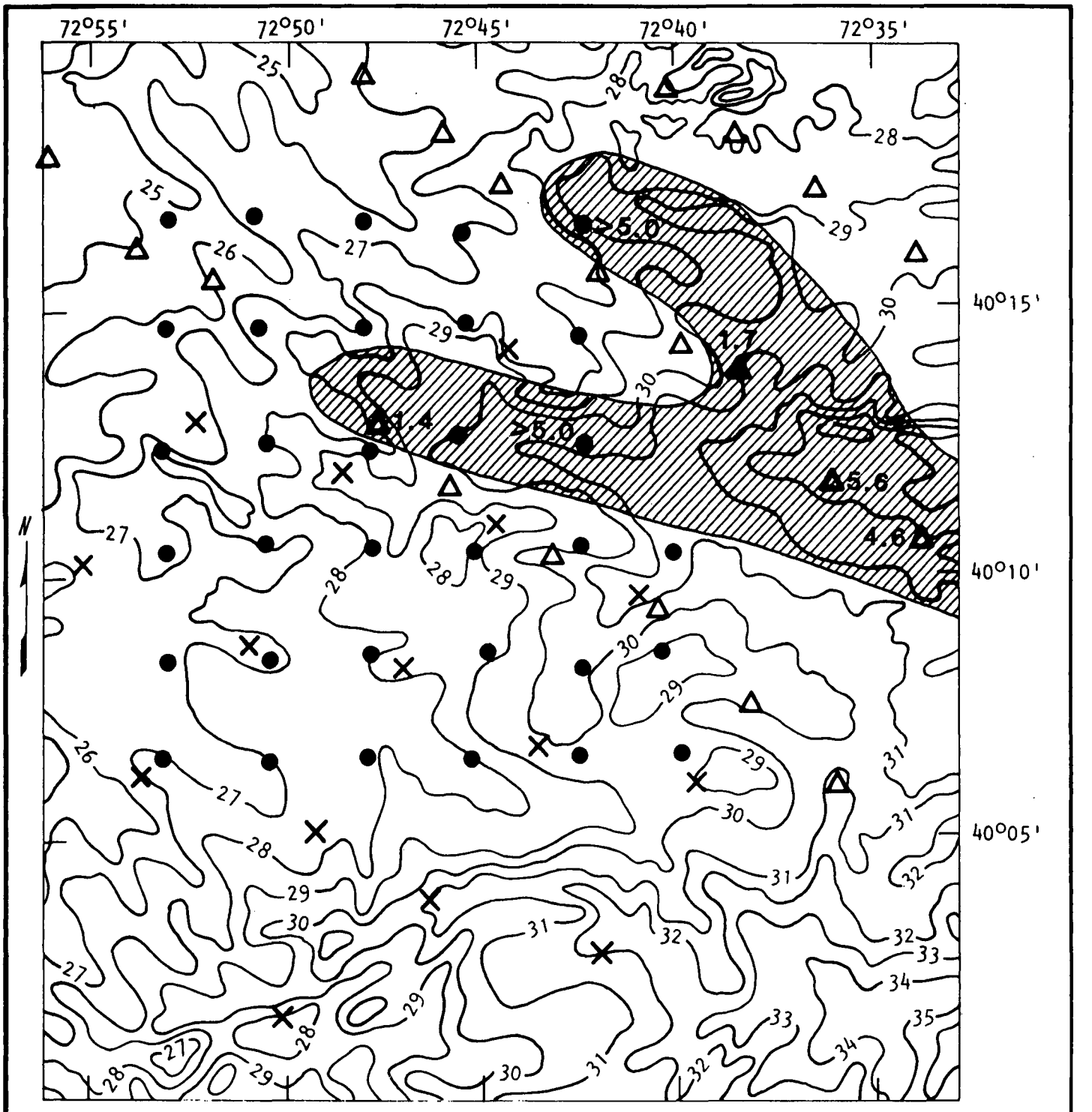
FIGURE 29



PERCENTAGE OF MUD IN BOTTOM SEDIMENTS FROM SUBAREA 2D1

0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

0 1 2 3 4 5 STATUTE MILES

0 1 2 3 4 5 NAUTICAL MILES

CONTOUR INTERVAL = 1 FATHOM = 1.83M (6FT)

K E Y: PERCENT LESS THAN 62μ (0.0024 IN)

△1.7 = 1.7 PERCENT

< 2.0 PERCENT

> 2.0

SOURCES: NOAA-MESA, NOVEMBER, 1975;
RAYTHEON, 1975 A AND B;
McKINNEY AND FRIEDMAN 1970.

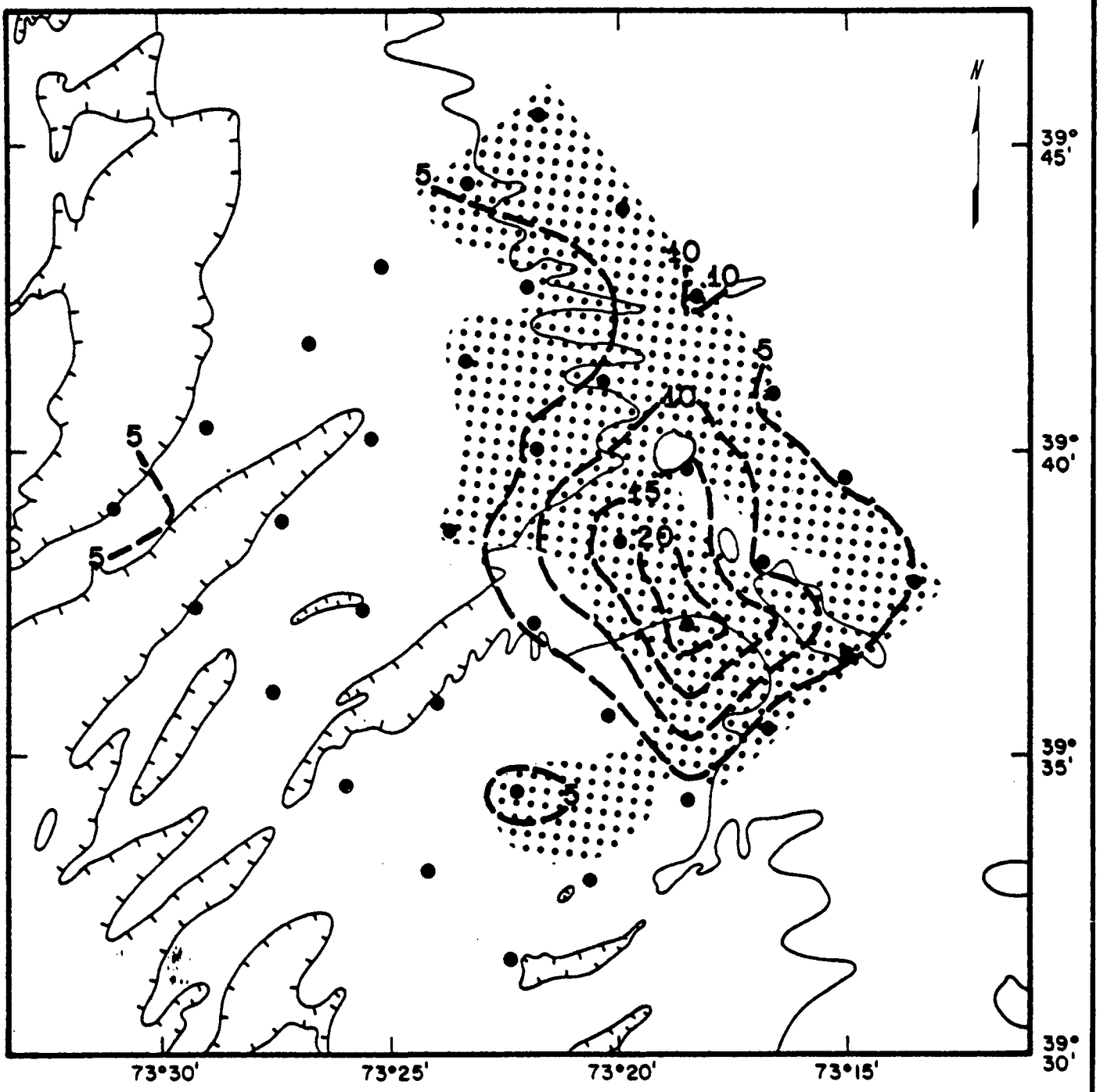
DAMES & MOORE

FIGURE 30

than 37 m (120 ft), and the eastern portion by elongate high regions. Individual depressions in the area are oriented northeast and are up to 6 m (24 ft) deep. These depressions alternate with sand ridges. A dominant landward-facing scarp, which is located to the west of the Southern Area, parallels the north-south depressions and high regions within the Southern Area (Figure 23). The northern portion of the Southern Area is located along the northward-sloping rim of the Hudson Shelf Valley.

Geophysical and geologic data for the shelf and for the Southern Area (NOAA-MESA, November 1975; McClennen, 1973) suggest the following sequence of strata: a surficial sheet of sand forming the shelf underlain by an upper lagoonal clay, underlain by a unit of sand or gravel, underlain by a lower clay. Locally, within the deeper troughs, erosion has cut through the upper sand and clay strata to expose the lower clay strata on the floors of the flatter troughs. The NOAA-MESA (November 1975) reports the presence of a buried channel in the southern portion of the Southern Area. The channel appears to be cut into the lower clay strata and has a general east-west orientation. The bathymetry of Subarea 2D2 is presented in Figure 27.

b. Surficial Sediments. The distribution of surficial sediments has been reported by NOAA-MESA (November 1975). The gravel and sand distributions in Subarea 2D2 are shown in Figures 31 and 32.



PERCENTAGE OF GRAVEL IN BOTTOM SEDIMENTS OF SUBAREA 2D2

KEY:

5% GRAVEL

MEDIUM SAND-0.42 TO 0.50 MM MEAN GRAIN SIZE

0 1 2 3 4 5 6 7 8 9 10 KILOMETERS

0 1 2 3 4 5 STATUTE MILES

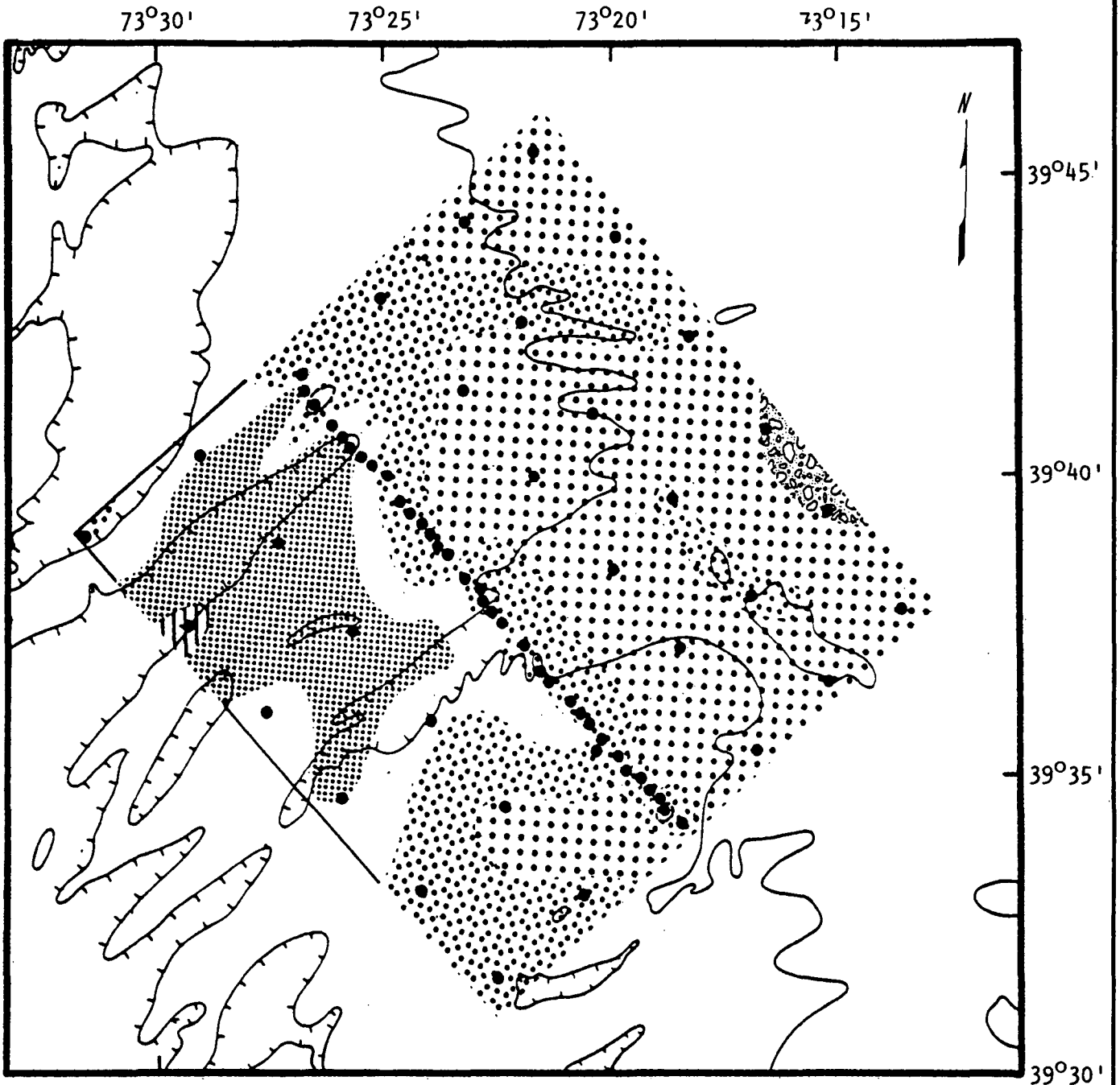
0 1 2 3 4 5 NAUTICAL MILES

1 MM = 0.039371N

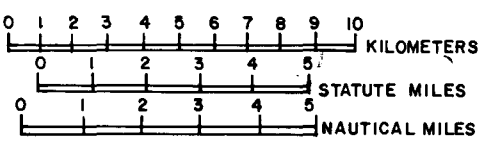
SOURCE: NOAA-MESA, NOVEMBER 1975.

DAMES & MOORE

FIGURE 31



MEAN GRAIN SIZE OF BOTTOM SEDIMENTS OF SUBAREA 2D2



KEY:

	> 0.50 MM	COARSE SAND
	0.50 - 0.42 MM	MEDIUM SAND
	0.42 - 0.35 MM	
	0.35 - 0.30 MM	
	0.30 - 0.25 MM	
	> 0.25 MM	FINE SAND

1 MM = 0.03937 IN

NOTE: <LESS THAN, >GREATER THAN

SOURCE: NOAA-MESA, NOVEMBER 1975.

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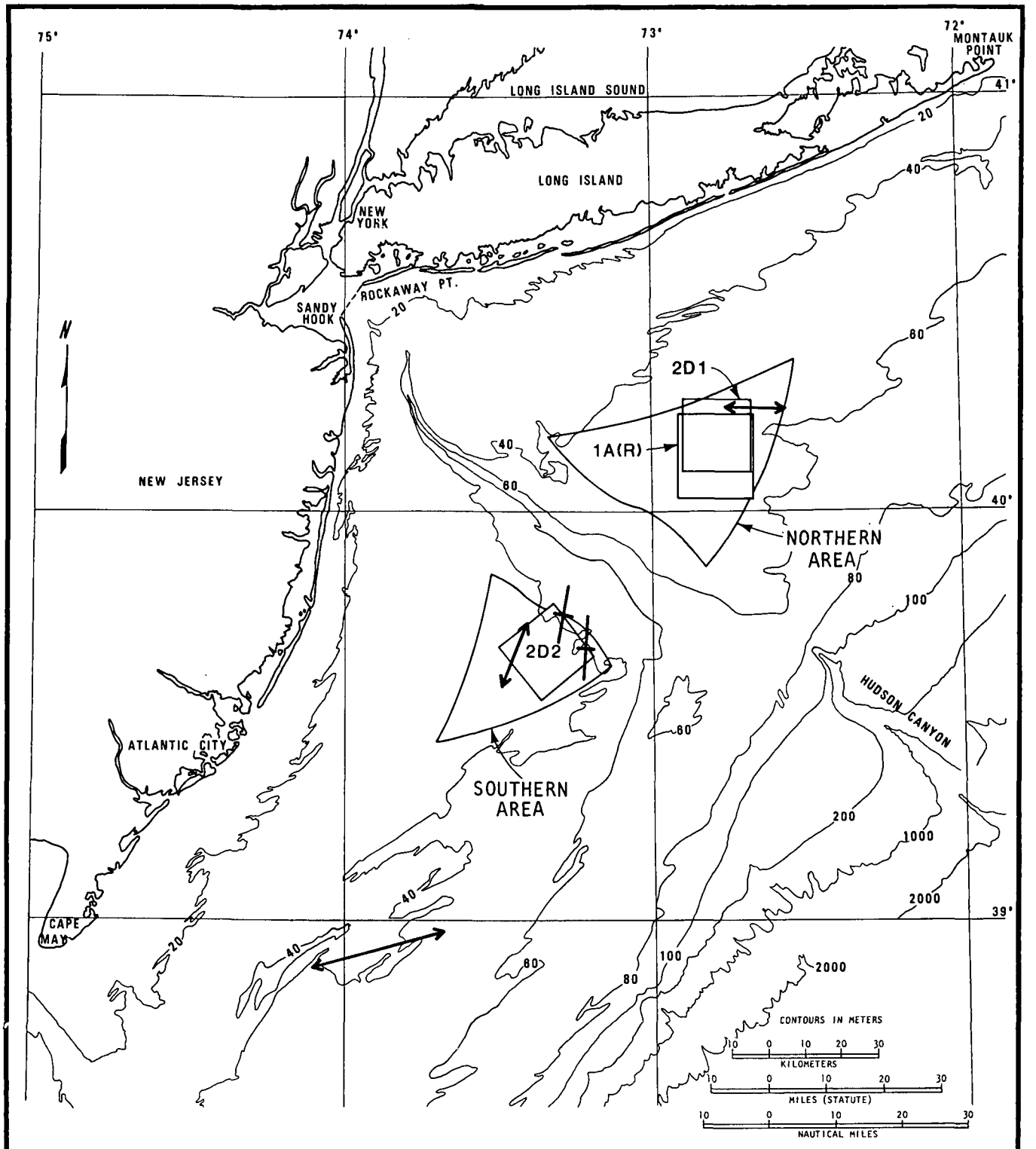
FIGURE 32

The most prominent feature of the bottom sediments is the band of coarse sands and gravelly sands along the northeast rim of the study area, parallel to the rim of the Hudson Shelf Valley. The regional sampling on a 16 km (9 n mi) grid by the U.S. Geological Survey and the Woods Hole Oceanographic Institute also suggests that there are gravelly deposits along the southern rim of the Hudson Shelf Valley to the northwest of the study area (Schlee and Platt, 1970). Progressively finer sands are found to the southwest of the gravelly deposits. This suggests that reworking of these deposits and subsequent southwesterly transport have occurred, perhaps during lower sea levels when the ridges formed.

c. Bedforms. Observations in the Southern Area reveal the same types of bedforms as in the Northern Area (NOAA-MESA, November 1975). Wave ripples up to 1 m (3.3 ft) wide are found in the area. Apparently, winter storms are responsible for the wave ripples. Low relief elongate bands (lineations) and irregular patches of contrasting sediment texture are also found in the area. In addition to the longitudinal forms, widely spaced 3 to 5 m (10 to to 16 ft), low relief, wave-like features were observed in the Southern Area. The orientation of these wave-like (transverse to the flow) and longitudinal forms (parallel to the flow) for the Bight is presented in Figure 33. The hydraulic origin of these forms, especially the wave-like features, is not clear at present. They may have originated from the action of breaking internal waves as discussed in Sections IVB and VI.



MESOSCALE BEDFORMS

KEY:

⟷ LONGITUDINAL LINEATIONS

┼ TRANSVERSE WAVE-LIKE FORMS

SOURCES: NOAA-MESA, NOVEMBER 1975; McKINNEY ET AL., 1974.

DAMES & MOORE

FIGURE 33

E. CHEMICAL OCEANOGRAPHY

This section on chemical oceanography includes descriptions of the heavy metals, dissolved oxygen, nutrients, organic carbon, and chlorinated hydrocarbon concentrations in the New York Bight and more specifically in the Northern and Southern Areas.

1. Heavy Metals

a. Water Column. 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 (Brewer, 1975). 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 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 highest in the Bight Apex, where the influences of man are strongest. The proposed areas are pristine by comparison.

There is little difference between the two proposed areas in concentrations of dissolved heavy metals (Table 20).

b. Sediment. Concentrations of heavy metals in bottom sediments are not uniformly distributed throughout the Bight. Concentrations in the sediments vary according to the sediment grain size, the quantity of organic material present, the mineral composition, and the proximity of sources of heavy metals (metropolitan area). The importance of the proximity of sources of heavy metals is evident from the elevated concentrations in the Bight Apex (Carmody *et al.*, 1973). Based on available data, there appears to be no significant difference between the proposed areas in concentrations of heavy metals in sediments (Table 21).

c. Bight Apex. Sewage sludge dumping at the existing site is a minor source of contamination by heavy metals in the Bight Apex (Table 22). Pollutant sources (dumping and non-dumping) and loadings (percent) to the Bight Apex are discussed in Section IID.

2. Dissolved Oxygen

a. Surface Waters. With the exception of the waters near the Sandy Hook-Rockaway Point transect and in the Lower Bay (Figure 2), 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.

TABLE 20

CONCENTRATIONS OF DISSOLVED HEAVY METALS IN THE WATER COLUMN OF THE NEW YORK BIGHT

Sampling Location	μg/l						
	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Zinc (Zn)
Northern and Southern Areas[1]	0.06 to 19	3 to 15	0.23 to 18	0.69 to 2.4	0.05 to 0.24	0.72 to 1.0	1.8 to 38
Bight Apex in the Vicinity of Sewage Sludge and Dredged Material Dump Sites[2]	0.11 to 46	NA	0.6 to 47	NA	NA	NA	2.1 to 190

NA = Not Available.

Sources:

[1]Raytheon, 1975 a and b; NOAA-MESA October 16, 1975.

[2]NOAA-MESA, October 16, 1975; NOAA-NMFS, 1972.

TABLE 21

CONCENTRATIONS OF HEAVY METALS IN THE SEDIMENTS OF THE NEW YORK BIGHT

Sampling Location	ppm							
	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Zinc (Zn)
Northern and Southern Areas[1]	4 to 8	<14	<22	8	<14	<0.05	<17	<32
Bight Apex in the Vicinity of Sewage Sludge and Dredged Material Dump Sites[2]	<12	<5	0.6 to 460	0.2 to 620	0.9 to 700	<4	0.8 to 50	1.3 to 1500

NA = Not Available.
< = Less than.

Sources:

[1]Greig and Pearce, 1975; Raytheon, 1975 a and b.

[2]Greig *et al.*, 1974; Carmody *et al.*, 1973; NOAA-NMFS, 1972.

TABLE 22

LOADINGS OF HEAVY METALS IN THE BIGHT APEX

Metal	Sewage Sludge Loadings metric tons/day[1]	Total Bight Loadings metric tons/day[1]	Percent from Sewage Sludge
Cadmium (Cd)	0.044	2.4	1.8
Chromium (Cr)	0.073	5.0	1.5
Copper (Cu)	0.7	13.8	5.1
Lead (Pb)	0.72	12.7	5.7
Mercury (Hg)	0.013	0.3	4.3
Zinc (Zn)	1.8	33	5.5

[1]metric ton = 1.10 tons.

Source: Mueller and Jeris, unpub.

b. Mid-Depth Waters. 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 depends upon seasonal changes.

c. Bottom Waters. 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 *et al.*, 1975).

The principal cause of oxygen depletion in bottom waters is the large input of oxidizable organic carbon to the Bight Apex (Segar *et al.*, 1975). The sources are *in situ* (in place) photosynthetically-fixed carbon, river-borne particulate carbon, and ocean dumped carbonaceous materials (Table 23). *In-situ* photosynthetically-fixed carbon is the dominant source of oxidizable carbon in the Bight Apex.

Benthic oxygen demand appears to be responsible for only a small fraction of the oxygen depletion in the Bight Apex (Segar *et al.*, 1975). 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

TABLE 23

SOURCES OF OXIDIZABLE CARBON IN THE BIGHT APEX

Source	Input (Annual Average) millions of kg/day	(lbs/day)
Photosynthetically-Fixed Carbon	2.2	(4.8)
(Summer Average)	6.5	(14.3)
River-Borne Particulate Carbon	1.0	(2.2)
Ocean Dumping		
Sewage Sludge	0.14	(0.31)
Dredged Material	0.26	(0.57)

Source: Segar *et al.*, 1975.

column) ranged from 10 to 60 ml/sq m/hr (3 to 18 lb/ac/day). Highest values were noted near wastewater effluent outfalls along the New Jersey coast. Seabed oxygen consumption rates observed during winter cruises in the Northern Area (NOAA-MESA, November 1975 ranged from 5 to 20 ml/sq m/hr (1.5 to 6 lb/ac/day). The average rate of seabed oxygen consumption for the Northern Area has been reported to be about 6.9 ml/sq m/hr (2.1 lb/ ac/day).

d. Proposed Areas. Recent data (Raytheon, 1975 a, b, and c) indicate that dissolved oxygen concentrations in surface, mid-depth, and bottom waters at the Northern Area are moderately to highly saturated under winter, spring, and critical summer conditions (Table 24). The saturation value for oxgen at these sampling depths probably does not fall below 50 percent at any time of year, and it is usually much higher (75 to 110 percent). Recent investigations performed by NOAA-MESA (October 16, 1975) in both the Northern and Southern Areas revealed similar seasonal and vertical dissolved oxygen trends. There appears to be no significant difference in dissolved oxygen concentrations between the two proposed areas.

3. Nutrients

a. Nitrogen. Mueller and Jeris (unpub.) 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

TABLE 24

DISSOLVED OXYGEN LEVELS AT THE NORTHERN AREA

Position In Water Column	Winter Cruise 1974		Spring Cruise 1975		Summer Cruise 1975	
	Concentration ppm	Saturation percent	Concentration ppm	Saturation percent	Concentration ppm	Saturation percent
Surface	8.3 to 10.0	85 to 105	9.7 to 11.6	75 to 95	7.4 to 9.5	85 to 110
Mid-depth	6.6 to 9.3	60 to 85	11.1 to 12.0	90 to 100	9.1 to 10.2	85 to 100
Bottom	6.4 to 7.4	55 to 65	10.5 to 11.5	80 to 90	7.5 to 7.7	60 to 65

Sources: Raytheon, 1975a, b, and c.

nitrate and nitrite 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 (1,140 mgd) of primary and secondary effluents and 13 cu m/sec (296 mgd) of raw sewage discharge, and sludge dumping (O'Connors and Duedall, 1975).

The ammonium loading from wastewater discharges from the Sandy Hook-Rockaway Point transect zone was estimated to be five to ten times greater than that from sludge dumping (Mueller and Jeris, unpub.). 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 25.

b. 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 ug/l to more than 95 ug/l. Reactive phosphorous in the surface waters of the outer Bight ranges from less than 10 to 57 ug/l. Deeper waters generally show higher phosphorous concentrations. Particulate phosphorous concentrations also range from less than 10 ug/l to more than 95 ug/l (Alexander and Alexander, 1975).

During the summer, when the water column is stratified, total phosphorous concentrations appear to be higher in the

TABLE 25

NUTRIENT CONCENTRATIONS IN THE NEW YORK BIGHT

Sampling Location	ug/l			
	Ammonia (NH_3-N)[a]	Nitrite (NO_2-N)[b]	Nitrate (NO_3-N)[b]	Ortho-Phosphate[b]
Bight Apex	<2 to 126	<2 to 59	<7 to 252	<10 to 133
Northern and Southern Areas	<2 to 28	<2	<2 to 48	<0.1 to 48

< = Less than.

Sources:

[a]Alexander and Alexander, 1975.

[b]NOAA-MESA, October 16, 1975.

deeper waters of the Bight than in the surface waters (Corwin, 1970). However, this trend was not seen during the Raytheon cruise of September 1975. 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 (Section IID).

Generalized concentration ranges of ortho-phosphate in the Bight are shown in Table 25.

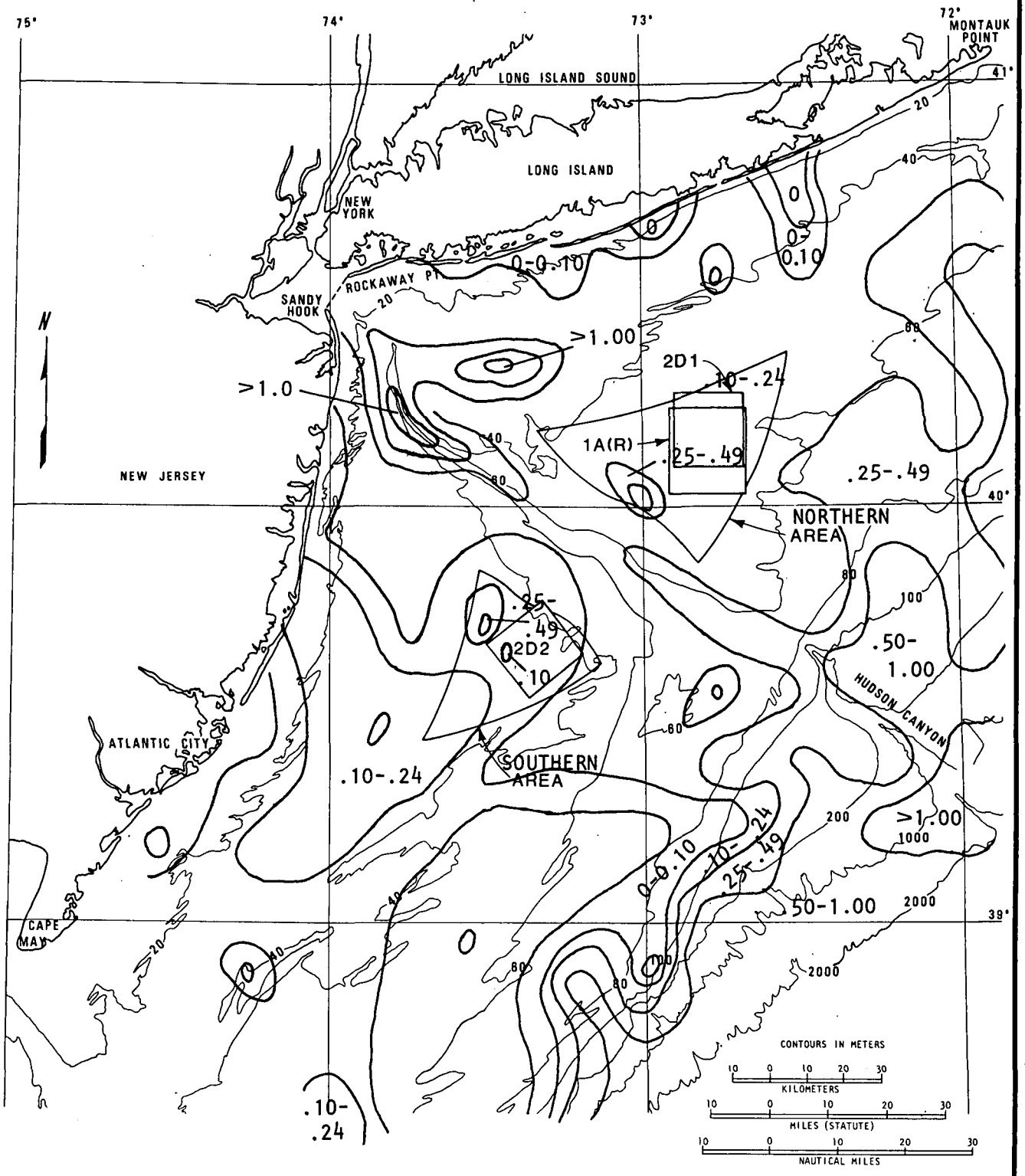
c. Relationship to Productivity. Productivity in the Apex during the summer months is higher than that observed in similar temperate coastal zones (Segar et al., 1975). This appears to be the result of the relatively high nutrient loading within the photic (light penetrating) zone. The major sources of the high nitrogen loading to the Bight are: river-borne nitrogen, supplying 120 thousand kg/day (204 thousand lbs/day); dredged material, supplying 30 thousand kg/day (66 thousand lbs/day); and dumped sewage sludge, supplying 20 thousand kg/day (44 thousand lbs/day). 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 longer in the photic zone. A large amount of the nutrients in dredged material are buried on the bottom and, therefore, are unavailable for photosynthesis.

4. Organic Carbon

a. Water Column. In the fall of 1974 (September to October), the total organic carbon (TOC) in the water column at the Northern Area ranged from 2 to 9 mg/l, with most samples averaging 4 to 5 mg/l. The TOC concentrations did not appear to vary significantly with depth. In the spring of 1975, the TOC concentrations ranged from 2.8 to 7.4 mg/l.

b. Sediments. The TOC in Bight sediments varies according to distance from waste inputs (Figure 34). "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, 1972b). Forty-one percent of New York Harbor is characterized by sediment deposits with a TOC content of more 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 (15 sq n mi) 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. In the shallow coastal regions off Long Island and New Jersey, sediments contain between 0.1 and 0.2 percent TOC (Gross, 1972a). High concentrations of TOC (5 percent or more) were detected at the head of the Hudson Shelf Valley (Charnell, 1975).

c. Proposed Areas. The TOC in the sediments of Subarea 2D1 ranges from 0.0011 to 0.1177 percent, based upon samples collected by NOAA-MESA (August 23, 1975). Raytheon (1975a and b),



PERCENTAGE OF TOTAL ORGANIC CARBON IN NEW YORK BIGHT SEDIMENTS

SOURCE: HATHAWAY, 1971.

DAMES & MOORE

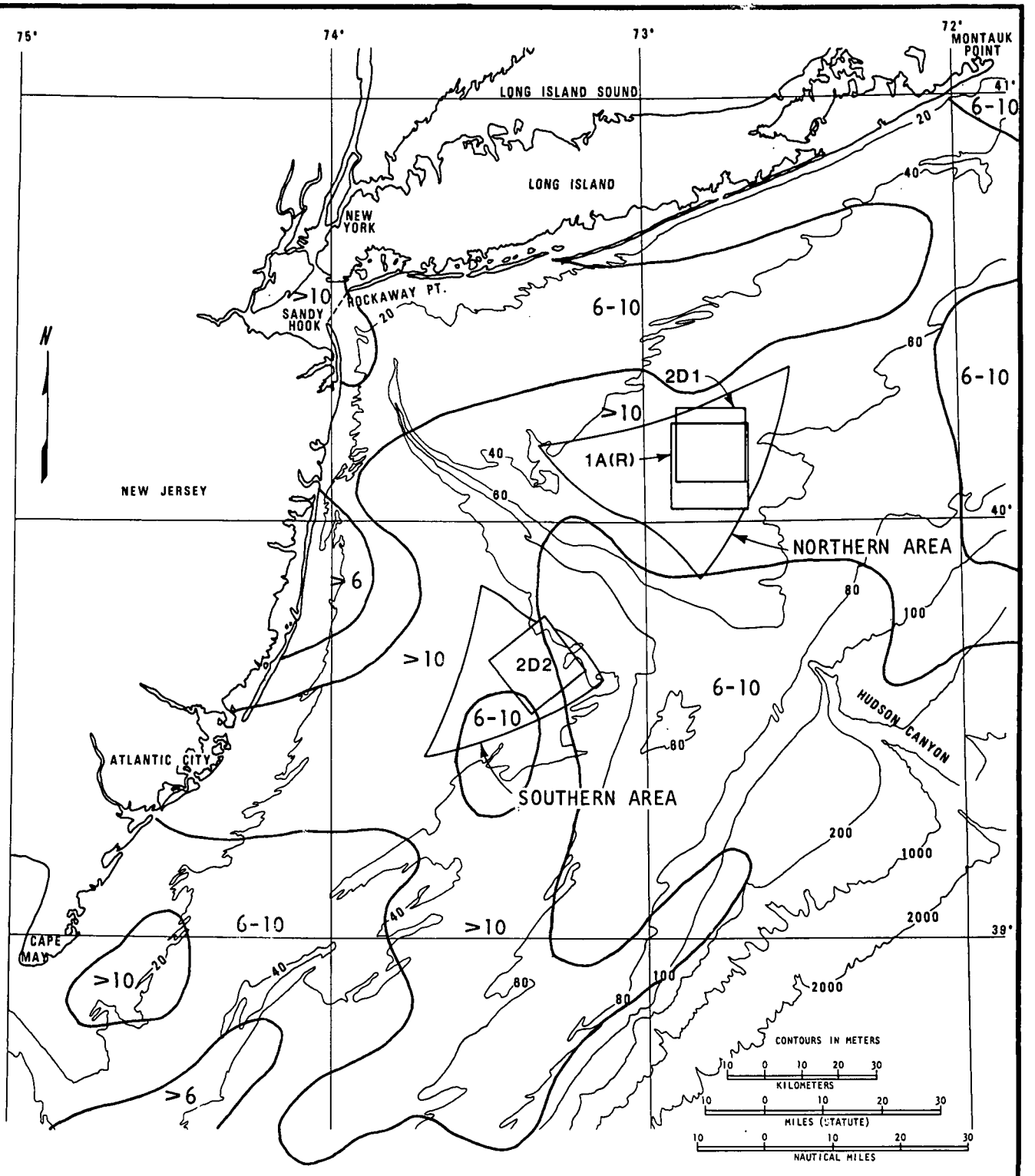
FIGURE 34

using different sampling grids, reported TOC concentrations ranging from 0.034 to 0.131 percent for the spring 1975 cruise and from 0.042 to 0.61 percent for the fall-winter 1974 cruise. These elevated concentration ranges are not easily explained.

The TOC in the sediments of Subarea 2D2 ranges from 0.0271 to 0.0691 percent, based upon samples collected by NOAA-MESA (August 23, 1975). The TOC in sediments from the axis of the Hudson Shelf Valley ranges from 0.1 to 0.2 percent.

d. Relationship to Toxic Substances. The importance of organic carbon in the assessment of the fate of toxic substances (especially heavy metals) is twofold. Organo-metallic complexes and compounds may act as transport agents for toxic substances. Also, sediments rich in organic matter often act as a sink for toxic substances. Organic carbon is often inversely proportional to sediment grain size and, therefore, directly proportional to clays (aluminosilicates), which play an important adsorptive and desorptive role in metal ion distribution.

e. Carbon/Nitrogen Ratio. The carbon (TOC) to nitrogen (Kjeldahl) ratio in sediments of the New York Bight varies greatly (Figure 35). Near the Sandy Hook-Rockaway Point transect, ratios are generally greater than 10. For most of the Bight, ratios range from 3 to 11 (Milliman, 1972). Sediments near shore, which contain a great deal of organic matter from land-based sources, generally have high C/N ratios; these ratios decrease with distance from land. Relict sediments on the shelf may also exhibit high C/N ratios because they are also likely to contain land-derived organic matter.



DISTRIBUTION OF CARBON/NITROGEN RATIOS IN NEW YORK BIGHT SEDIMENTS

SOURCE: MILLIMAN, 1972.

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FIGURE 35

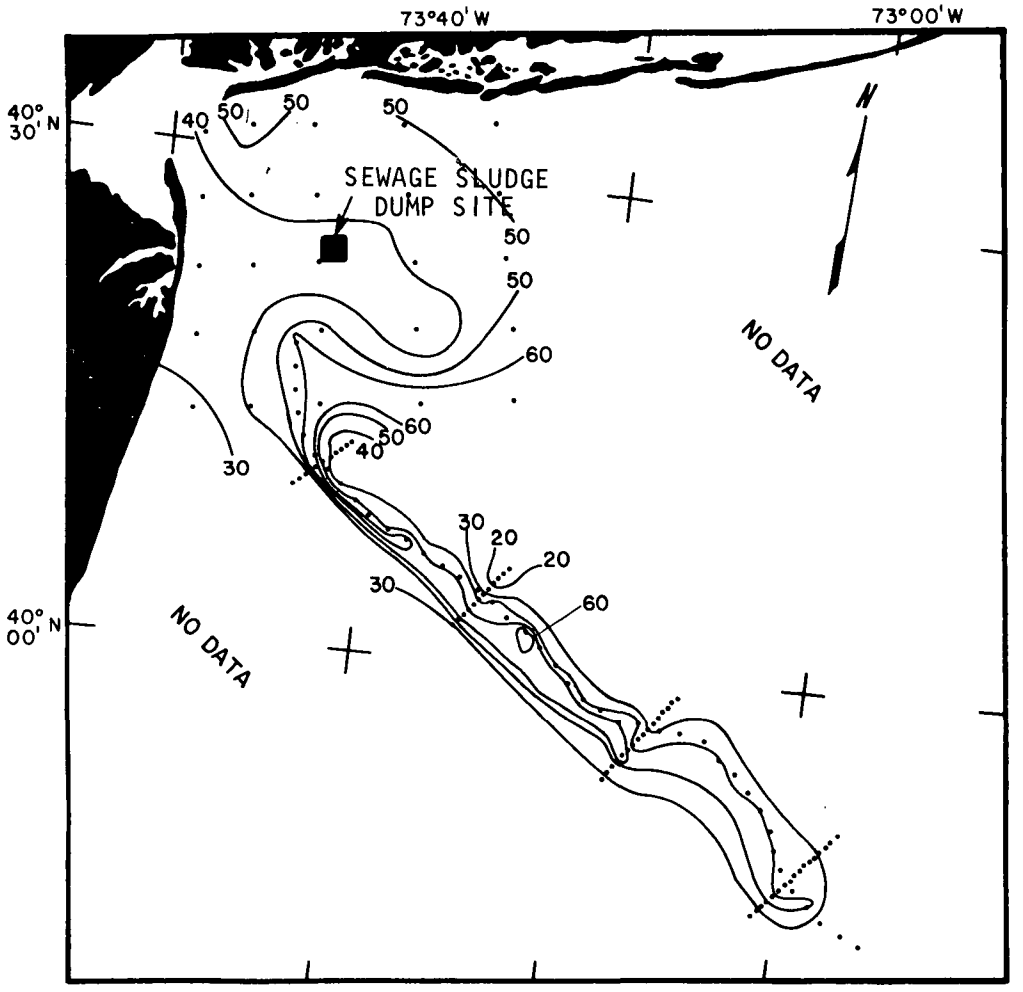
f. TCH/TOC Ratio. Charnell (1975) has devised a useful indicator for sewage-derived components in sediments; this indicator is the ratio of total carbohydrate content (TCH) to total organic carbon (TOC). The technique is based on the assumption that the bulk of carbohydrate materials derived from sewage (dumped or discharged) are oxidation-resistant structural carbohydrates, such as cellulose and hemicellulose. Carbohydrate inputs from the land contain cellulose-deficient materials; thus, their TCH to TOC ratio is low, generally less than 10.

Sediments in the Bight Apex generally have TCH to TOC ratios greater than 20. Samples from the existing dump sites (sludge, dredged material, acid wastes, and cellar dirt) and from the Hudson Shelf Valley have ratios ranging from 30 to 65 (Figure 36). TCH to TOC ratios for samples collected south of Rockaway Beach, Long Beach, and Jones Beach range from 13 to 67. Samples from Jones Inlet and East Rockaway Inlet have ratios ranging from 13 to 24 (Charnell, 1975).

5. Chlorinated Hydrocarbons

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

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



DISTRIBUTION OF TCH/TOC RATIOS IN NEW YORK BIGHT APEX SEDIMENTS

0 10 20 30 40 50 100
KILOMETERS

0 10 20 30 40 50
NAUTICAL MILES

KEY:

ISOBARS OF TCH/TOC RATIO

SAMPLING STATIONS

SOURCE: HATCHER AND KEISTER, 1975.

DAMES & MOORE

FIGURE 36

study (Young et al., 1974a and b, and 1975). The California study concerned 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 wastewater discharge, and less than 0.1 percent by marine antifouling paints. For Arochlor 1254, a PCB, calculations showed that 64 percent was contributed by surface runoff, 34 percent by direct industrial discharge, 1 percent by atmospheric fallout, 1 percent by municipal wastewater discharge, and less than 0.1 percent by marine antifouling paints. Although these data cannot be applied directly to mass balance determinations for the New York Bight, they do indicate potential chlorinated hydrocarbon loadings.

b. The Bight. Published data on chlorinated hydrocarbon distribution in the New York Bight are scarce. Recent studies at the Northern and Southern Areas constitute the only source of chlorinated hydrocarbon data presented in this report (USEPA, March 25, 1975; Raytheon, 1975a and b). The results of these studies are shown on Table 26.

Results from a small number of sediment samples taken in the vicinity of the dredged material and sewage sludge dump sites show slightly elevated levels of DDD (DDT breakdown product) and an anomalously high DDT concentration at one station (X4).

TABLE 26

CHLORINATED HYDROCARBONS IN THE SEDIMENTS OF THE NEW YORK BIGHT

Northern Subarea 1A(R)[a]

Pesticide	Concentration ug/kg dry weight
Aldrin	13
Chlordane	41
Dieldrin	20
Endrin	20
Heptachlor	15
Heptachlorepoxide	12
Methoxychlor	28
P, P[1] DDD	18
P, P[1] DDE	18
P, P[1] DDt	19
Lindane	15
Toxephene	47

Southern Subarea 2D2[b]

Sampling Station	Concentration ug/kg dry weight PCB
29	< 1.0
55	< 1.0
56	< 5.0
54	< 5.0
53	4.0
30	< 5.0
28	< 5.0
27	< 5.0
65	37.0
69	< 5.0
68	< 1.0

Vicinity of Dredged Material and Sewage Sludge Dump Sites[c]

Sampling Station	Concentration ug/kg dry weight		
	DDE	DDD	DDT
X4	13	48	126
X5	17	81	13
X3	19	61	19
Z5	15	39	16

< = Less than.

Sources:

[a]Raytheon, 1975, a and b.

[b]USEPA, March 25, 1975.

[c]NOAA-NMFS, 1972.

6. Summary

The New York Bight Apex is a heavily used and environmentally stressed coastal area. Municipal and industrial wastewater effluents, along with runoff, atmospheric fallout, and the materials disposed of at the different dump sites, contribute large quantities of heavy metals, nutrients, organic matter, and chlorinated hydrocarbons to the waters of the Apex. The distribution of these materials is generally a function of the distance from the source and the composition of the solids that are either suspended or accumulated on the bottom. Within the Bight Apex, the presence of large amounts of organic matter from numerous sources results in localized areas of low dissolved oxygen values. Outside the Bight Apex, nutrient and dissolved oxygen levels are quite predictable and are a function of the water's temperature-salinity structure and the degree of weather-induced mixing.

V. ALTERNATIVES TO THE PROPOSED ACTION

The only real alternative to the proposed action is disposal of sewage sludge on land. Dumping sludge into the New York Bight at either the existing (No Action) or an alternate (Proposed Action) dump site is an interim, or short-term, solution. It will, however, allow the timely implementation of long-term, land-based sludge disposal methods. Different methods of dumping sewage sludge during this interim period have been investigated. These alternative dumping methods are discussed at the end of this chapter. The EPA intends to phase out ocean dumping in the New York Bight by 1981, provided that environmentally acceptable, technically feasible, and economically reasonable alternatives can be developed.

A. LAND-BASED ALTERNATIVES

In June 1975, the Interstate Sanitation Commission (ISC) issued a technical report summarizing available land-based methods of sewage sludge disposal. This report constitutes Phase 1 of a three-phase sludge management study funded by EPA. Subsequent reports scheduled for release in July 1976 will include a detailed study of feasible alternatives (Phase 2) and an examination of legal/institutional implementation problems (Phase 3).

The Phase 1 report considered primarily the following land-based methods of sewage sludge disposal: land application, incineration, pyrolysis, and sale as a soil conditioner or fer-

tilizer. The potential for implementing these methods in the metropolitan area is discussed briefly below.

1. Land Application

Sewage sludge has been applied to land as a soil conditioner and fertilizer. The characteristics of sludge that are important to land application are organic matter, available nutrients (nitrogen, phosphorous, potassium, and trace elements), heavy metals, and toxic organics (especially chlorinated hydrocarbons). In general, there are three factors which limit the immediate implementation of land application of sewage sludge generated in the metropolitan area. First, sewage sludge generated by wastewater treatment facilities in the metropolitan area contains high concentrations of heavy metals (cadmium, chromium, copper, lead, mercury, nickel and zinc) and significant quantities of toxic organics (chlordane, dieldrin, endrin, heptachlor, lindane, and mirex). If these substances leached out of a land application site, they would be highly damaging to adjacent streams and underlying groundwater aquifers. Second, metropolitan area sludge is low in nutrients, as are most domestic sewage sludges, in comparison with commercial fertilizers. Finally, land is not available in the metropolitan area for a large-scale, land-application operation. The cost of transporting great quantities of sludge to suitable land-application sites outside the metropolitan area appears to be prohibitive.

2. Incineration

Sewage sludge incineration results in waste gases, particulates, and a relatively small quantity of sterile ash that retains most of the heavy metals originally present in the sludge. Air pollution controls, such as wet scrubbers, are necessary to remove particulates, odors, nitrogen oxides, sulfur oxides, volatile toxic organics, and air-borne heavy metals (cadmium, lead, and mercury). Multiple-hearth incineration, the incineration method preferred in the Phase 1 report, has the least potential for air pollution, can burn without auxiliary fuel (gas, oil, or coal), and is compatible with a phased change-over to pyrolysis. The ash, which contains heavy metals, must ultimately be disposed of in an environmentally sound manner.

Generally, sludge must be dewatered (to less than 40 percent liquid) to burn without auxiliary fuel. Sludge which is not dewatered has a high (93 to 97 percent) liquid content.

Sludge could be incinerated on ships or platforms anchored offshore to minimize air pollution problems. However, the costs are not justified because there are other, more economical methods of sludge disposal available.

3. Pyrolysis

Pyrolysis (destructive distillation) is the process of breaking down organic matter, such as sewage sludge, by heating it in the absence of oxygen. The resulting by-products are gases (carbon dioxide, carbon monoxide, hydrogen, and methane), a carbon/ash char, and a liquid waste containing a wide variety

of organic compounds. Pyrolysis is generally cheaper than incineration because it produces fewer particulates and, therefore, requires less in the way of air pollution controls. The by-products, char and gases, can be used as fuels. To date, no large-scale pyrolysis tests have been conducted on sewage sludge alone. Thus, prior to implementation of this alternative, a demonstration pilot plant would have to be built. The Phase 1 report recommended that both pyrolysis and incineration of sewage sludge should be investigated in conjunction with the disposal of solid wastes.

4. Sale as a Soil Conditioner or Fertilizer

The constraints on the sale of sewage sludge as a soil conditioner or fertilizer are much the same as those on land application. High concentrations of heavy metals and toxic organic compounds would have to be removed or reduced prior to sale. In addition, the sludge would have to be dried to 5 or 10 percent moisture content and fortified with nutrients for use as a fertilizer. Finally, there is the problem of consumer acceptance.

5. ISC Conclusions

The ISC Phase 1 report (June 1975) drew the following conclusions regarding land-based disposal methods for the metropolitan area and their eventual, phased implementation.

The most feasible alternative to ocean dumping would be dewatering of sludge with filter presses, followed by pyrolysis. This conclusion was based on environmental impact, economic feasibility, and energy recovery. This system would have

the least potential for negative environmental impacts on water, air, and land resources. Such a system could be implemented within ten years.

Multiple-hearth incineration could be implemented sooner than pyrolysis. The multiple-hearth incinerators could be converted to pyrolysis units in time. However, incinerators would cause more difficult siting problems because of potential air pollution and local citizen resistance. The total costs of the incinerators needed to handle all of the sludge generated in the year 2000 by wastewater treatment facilities currently practicing ocean dumping, would be $400 to $500 million (in 1975 dollars).

Land application could be implemented in fringe areas (outside of the metropolitan area), where population density is low, large tracts of land are available, and agricultural enterprises provide a market for sludge-based fertilizers and soil conditioners.

A small scale pilot study should be undertaken immediately with the aid of an equipment manufacturer who is familiar with pyrolysis technololgy and who builds multiple-hearth furnaces. The purpose of the pilot study would be to develop the required engineering parameters prior to full-scale demonstration plant construction.

The complete text of ISC's conclusions and recommendations is presented in Appendix B.

B. OCEAN DUMPING ALTERNATIVES

The interim alternative to land-based disposal of sewage sludge is ocean dumping. The ocean dumping alternatives under consideration in this EIS are: 1) continued use of the existing dump site (No Action), 2) immediate designation and use of an alternate dump site (Proposed Action), 3) immediate designation and future use of an alternate dump site (Phased Action), and 4) modification of dumping methods to mitigate potential marine and shoreward impacts. The EPA goal of phasing out ocean dumping by 1981 would not be changed under any of these alternatives.

1. No Action - Use of the Existing Dump Site

The No Action alternative involves continued use of the existing dump site until alternative land-based methods of disposal can be implemented. The existing dump site would have to accommodate an anticipated twofold increase in sludge volume by 1981, without any significant hazards to public health or irreversible damage to the marine environment. The goal of the No Action alternative would be to limit environmental impacts to the existing site, rather than adversely impacting another area of the marine environment.

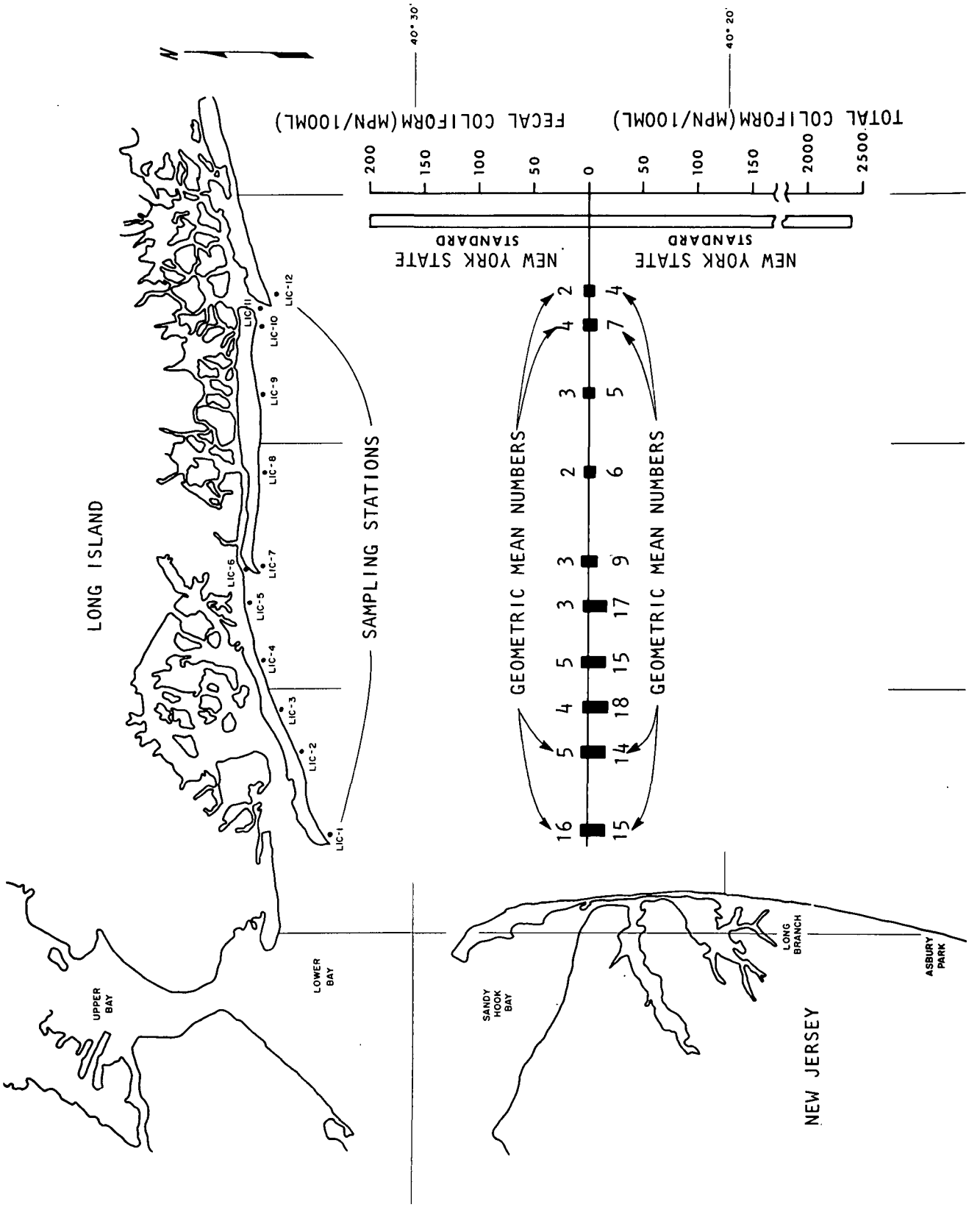
The original argument for moving the sewage sludge dump site (danger to Long Island and New Jersey beaches due to greatly increased volumes of sludge) is thoroughly discussed in Sections IIB and IIIA. Current studies of beach quality indicate that this argument is largely invalid, and tend to support

continued use of the existing site.

a. EPA Monitoring Studies. In April 1974, EPA initiated a monitoring program to investigate the quality of the water and bottom sediments in the New York Bight and along the Long Island and New Jersey beaches (USEPA, July 1974 and April 1975). Data from the surf and near-shore waters along the Long Island and New Jersey beaches indicate that the water quality remains excellent with respect to total and fecal coliform density, and that it is acceptable for contact recreation, as shown in Figures 37 and 38. Some random elevated coliform counts appear, but this does not constitute any violation of standards nor does it appear to indicate any systematic change or degradation of water quality. Sediment data indicate slightly elevated bacterial counts at certain near-shore sampling stations. These elevated counts can be attributed to inland runoff and wastewater outfalls.

Sampling is continuing along transects between the existing dump site and the Long Island shore, the New York Harbor entrance, and the New Jersey shore. Recent results indicate that a clean water and sediment zone, about 10 to 11 km (5.5 to 6 n mi) wide, separates the leading edge of the sludge mass from the Long Island coast.

b. NOAA-MESA Studies. Recently NOAA-MESA prepared two reports (March and November 1975) on dumping at the existing sewage sludge site. The consensus of these reports is that no significant accumulation of sewage sludge is occurring at the existing dump site, but that some sludge particles may be mixing



COLIFORMS IN LONG ISLAND COASTAL WATERS

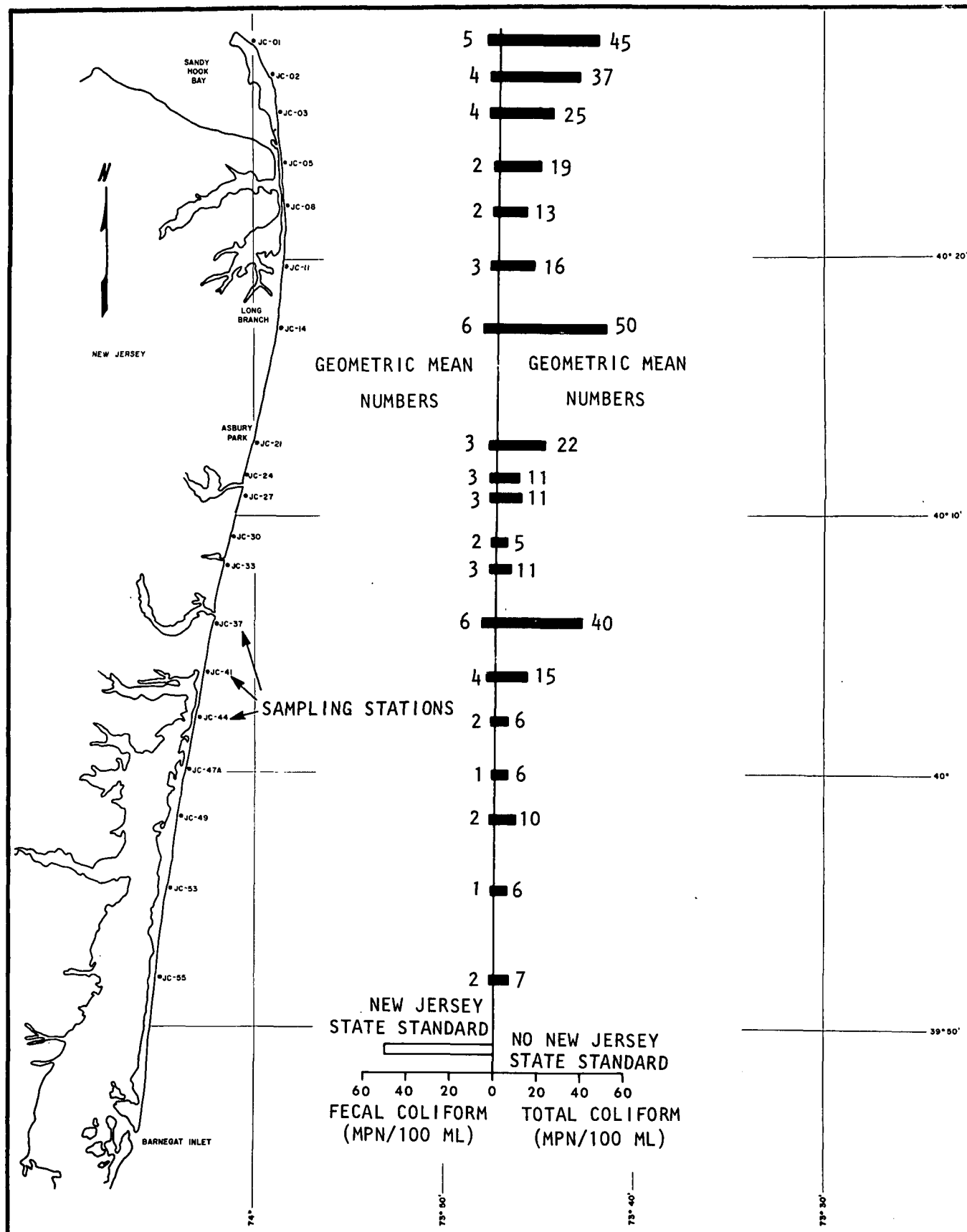
0 10 20 30 40 50
KILOMETERS

0 5 10 15 20 25
NAUTICAL MILES

DAMES & MOORE

SOURCE: USEPA, APRIL 1975.

FIGURE 37



COLIFORMS IN NEW JERSEY COASTAL WATERS

0 10 20 30 40 50
KILOMETERS

0 10 20 30
NAUTICAL MILES

SOURCE: USEPA, APRIL 1975.

DAMES & MOORE

FIGURE 38

with natural fines in the Christiansen Basin, northwest of the dump site. The reports also note that the ecological effects of sewage sludge dumping are indistinguishable from those associated with dredged material and acid wastes dumping, with contaminants in the plume of the Hudson estuary, with shore-zone contributions, and with atmospheric contaminant fallout. However, there is ample evidence that sewage sludge dumping exerts significant local effects. The most obvious effect is smothering of bottom dwelling organisms, such as crabs, lobsters, and clams. Some fish in the Bight Apex are afflicted with fin rot, but this disease is not thought to be attributable solely to sewage sludge dumping.

There is no substantial evidence that commercial or recreational fishing in the Bight is being affected by ocean dumping or by other, non-dumping pollutant sources. However, the catch of groundfish appears to be reduced in high-carbon sediment areas, such as in the vicinity of the existing sewage sludge dump site. Furthermore, it is apparent that very few surf clams reach commercial size within the area now impacted by sewage sludge dumping.

The NOAA-MESA reports do not indicate any shoreward movement of coliform contamination as a result of sludge dumping at the existing site. However, they do note the apparent persistence of coliform bacteria in the vicinity of the existing dump site, especially in the bottom sediments. There is no evidence that cessation of sewage sludge dumping at the existing site would permit reopening of the immediate area (Fig-

ure 22) to shellfishing, under current FDA regulations (Section IIE).

The complete text of NOAA-MESA's conclusions and recommendations (November 1975) is presented in Appendix C.

c. Related Studies. The Mueller and Jeris report (unpub.) indicates that, at most, the dumping of sewage sludge accounts for 15 to 20 percent of the total pollutant loading to the Bight Apex. Loadings from non-dumping pollutant sources (wastewater discharges, runoff, and atmospheric fallout) far outweigh those from all current ocean dumping sources (sewage sludge, dredged material, acid wastes, and cellar dirt). Both dumping and non-dumping pollutant sources are discussed in Section IID.

Other studies (Town of Hempstead, 1974) support the conclusion that sewage sludge dumped at the existing site does not significantly affect the quality of the waters or beaches of Long Island.

2. Proposed Action - Immediate Use of an Alternate Dump Site

The areas under consideration as possible locations for an alternate sewage sludge dump site include: proposed Northern and Southern Areas (Figure 8), other areas in the Bight, areas off the continental shelf, and other existing dump sites in or adjacent to the Bight. These potential site locations are discussed below.

a. Northern and Southern Areas. Based upon preliminary selection criteria and NOAA-MESA recommendations, the EPA has proposed locating an alternate sewage sludge dump site in either

the Northern or Southern Area of the Bight (Section IIIB). A detailed environmental assessment of sludge dumping in these two areas is contained in Chapter VII.

b. Other Areas in the New York Bight. In terms of minimizing the potential for environmental impacts, a site located offshore 148 to 158 km (80 to 85 n mi) from the Sandy Hook - Rockaway Point transect and within the depression of the Long Island Shelf Valley, about 80 m (264 ft) in depth, would be preferable. The potential for sludge transport to adjacent biological resource areas, including the Hudson Shelf Valley and nearshore shellfisheries, would be lowest if dumping were to occur within this area.

However, this area is outside the maximum 120 km (65 n mi) range of the existing barge fleet (Section IIB). Furthermore, it would be difficult to justify the greatly increased transportation and possible fleet capitalization costs in terms of concomitant benefits. Public health benefits would not increase proportionally with distance. In this regard, both the Northern and Southern Areas appear to be far enough off the Long Island and New Jersey shores and in deep enough water to minimize both potential public health and marine impacts.

c. Areas Off the Continental Shelf. Transporting sewage sludge to an alternate dump site off the continental shelf would be cost prohibitive, as noted above. Moreover, the effect of dumping sewage sludge in these waters is unknown.

d. Other Existing Dump Sites. Dumping sewage sludge at other existing sites in the Bight Apex (the dredged material,

acid wastes, cellar dirt, or wreck site) would violate the original concept of segregating wastes by dump site. It would be difficult, if not impossible, to determine the cause of adverse environmental effects at a dump site where two or more different types of wastes were being dumped. The end result would probably be several seriously contaminated dump sites in the Bight Apex, instead of the two that now exist (the sewage sludge and dredged material sites). In addition, the existing dredged material site is only about 9 km (5 n mi) off the New Jersey shore; the existing sludge dump site is about 20 km (11 n mi) offshore.

3. Phased Action - Continued Use of the Existing Dump Site and Future Use of an Alternate Site

Under this alternative, sewage sludge would continue to be dumped at the existing site until a comprehensive monitoring program indicated imminent public health hazards or damage to recreational water quality. Such a monitoring program would safeguard beach quality to the maximum extent, would be reviewed on a timely basis, and would include a decision-making process for terminating use of the existing site. This termination process could include phased use. For example, the existing site could be used during the winter when potential impacts on recreational uses would be lowest.

Under the phased alternative, an alternate dump site would have to be designated and held in reserve for possible future use. Since the phased alternative would maximize use of the existing dump site, adverse impacts on an alternate dump

site would be minimized. In addition, sludge hauling costs would be less under a phased alternative.

The success of the phased alternative would depend greatly upon establishing a suitable monitoring and review procedure to verify that continued use of the existing dump site was not endangering the Long Island and New Jersey shores or the marine environment.

4. Dumping Methodology

The current sludge dumping procedure, as set forth in each ocean dumping permit, is discharge of the sewage sludge within the designated dump site, at a uniform rate, over a specified distance. The rate of discharge is based on bioassay analyses of representative waste samples. Vessel traverses must be at least 1 km (0.5 n mi) apart. If two or more vessels are discharging simultaneously within a dump site, or if two or more vessel trips or legs occur within one hour of each other, a distance of at least 1 km (0.5 n mi) must be maintained between discharges.

Dumping methods which have been considered in this EIS include simple overboard dumping, discharge in the wake of the vessel (present method), and jet discharge.

a. Overboard Dumping. This consists of simply releasing the material from the sludge vessel, such that the material descends by its own momentum. Since the vertical motion is affected by buoyancy, the initial distribution of the dumped material is mainly within the surface water layers.

b. Discharge in the Wake of the Vessel (Present Method). This method results in high initial mixing and dilution. However, vertical motion is still dependent on density differences between the sludge materials and the receiving waters.

c. Jet Discharge. This method involves discharge of sludge through a pumping system. It is effective in passing the sludge material through the surface layers. Jet discharge has a more confined initial distribution, usually at the depth of neutral buoyancy of the sludge.

d. Summary. Based upon the 30 to 60 m (100 to 200 ft) depths and the dispersive flow patterns of the proposed Northern and Southern Areas, the present method of sludge dumping, discharge in the wake of the vessel, should be continued at an alternate dump site in the proposed areas. This conclusion is based upon the following considerations:

- Sewage sludge dumped at or near the surface will settle over a wide area because of its low bulk density, 1.01 g/cu cm.

- Differences in the thermohaline (temperature and salinity) density structure of the ocean would probably slow the settling of sewage sludge under stratified conditions and would negate the effectiveness of a subsurface discharge (through a pumping system from a transport vessel).

- Dispersion at the proposed areas is primarily a function of sea state, depth, and water mass movements. As such, it is not likely to be improved by altering the present dumping

technique. At the existing dump site, tidal influences and inshore currents appear to dominate.

- Given the volumes of sludge projected for dumping through 1981 and the limitations of the present fourteen-vessel fleet, the use of sophisticated dumping techniques would probably be technically impossible and economically prohibitive. Moreover, such techniques would be of little value in improving dispersion patterns.

- Monitoring of the interim dump sites would be facilitated by limiting dumping to a specific surface area.

VI. FATE OF SEWAGE SLUDGE DUMPED AT THE PROPOSED AREAS

The impact of sewage sludge on the marine environment depends on the interactions of sludge with seawater. These interactions control the fate of the dumped sludge. Sludge-seawater interactions are so complex that they cannot be precisely predicted. However, there are theoretical models which, together with the limited information collected at existing dump sites, can give some indication of what happens to the sludge after it is dumped in the ocean.

The fate of sewage sludge depends upon the forces governing initial settling and dispersion, resuspension, and chemical and biochemical reactions.

A. SETTLING AND DISPERSION IN THE WATER COLUMN

The settling and dispersion of sewage sludge dumped in the ocean are affected by many factors, including the characteristics of the sludge itself. Characteristics of sludge that affect the rate at which it settles are its bulk density (which is the density of the sludge mixture, both solids and liquid), its solids density (which is the density of the sludge particles alone), and its solids concentration. Characteristics of the receiving water also affect the rate at which sludge settles. Such characteristics include the water's density structure, which is controlled by its temperature and salinity, and the current patterns (Section IVB).

1. Bulk Density

The bulk density of the sewage sludge that is currently dumped in the Bight averages 1.009 g/cu cm and ranges from 1.0007 to 1.0181 g/cu cm. The bulk density of the sludge is generally less than the density of the ambient seawater, which ranges from 1.019 to 1.025 g/cu cm for the Bight. Since the bulk density of sludge is less than that of seawater, most of the sludge is retained in the upper layer of the ocean. The solids are composed primarily of organic materials (density of 1.02 g/cu cm to 1.7 g/cu cm) and smaller proportions of inorganic mineral matter (density of 2.65 g/cu cm). The density of the sludge ranges from 1.12 to 1.75 g/cu cm and averages 1.50 g/cu cm (Callaway et al., unpub.) Most of the sludge solids, fine, low-density organic matter, will tend to remain in suspension, but the small fraction of heavier minerals will settle rapidly to the bottom.

2. Settling Velocities

The sludge solids will tend to settle at different rates, depending on their size and density. Callaway et al. (unpub.) have monitored the dispersion of sludge solids dumped at the existing site in the Bight Apex. They estimated that the larger, flocculated particles (small diameter particles bound together into large diameter groups) had an average settling velocity of 0.5 to 1.0 cm/sec (0.2 to 0.4 in/sec). The majority of the particles had settling velocities of 0.01 to 0.30 cm/sec (0.004 to 0.12 in/sec), as measured by plotting the settling velocity of the center of mass of the waste field. The remain-

ing fine particles had settling velocities of 0.001 cm/sec (0.0004 in/sec) or less. These *in situ* (in place) determinations of sludge solids settling rates correlate positively with laboratory measurements made by Greene (1974).

During periods of stratification (summer conditions), most of the solids were retained in the upper layer and dispersed laterally (Callaway *et al.*, unpub.). Some of the heavier solids, with faster settling rates around 2 cm/sec (0.8 in/sec), may have passed through the upper layer and settled on the bottom. During periods of non-stratification (winter conditions), the solids were rapidly dispersed throughout the entire water column. Taking into account the currents, initial dilution of the sludge, and the small fraction of heavier particles in the sludge, Callaway *et al.* (unpub.) concluded that the possibility of substantial sludge accumulation on the bottom was remote. These field measurements support the findings of earlier model studies (Edge and Dysart, 1972) that were conducted to predict the physical fate of dumped sewage sludge.

3. Modeling Results

A simple, two-dimensional diffusion model was used to evaluate the fate of dumped sewage sludge at the Northern and Southern Areas. The assumptions of this steady-state mass balance model were: 1) the dumped sludge is a point source, 2) the oceanic velocity and density fields are uniform, and 3) the oceanic dispersion coefficients are constant. The model's ap-

plicability is limited to periods of time greater than tidal periods but less than seasonal ones. The dispersion coefficients used were those given by Neumann and Pierson (1966). Table 27 shows the model results. Figure 39 represents an initial sludge load on the bottom as predicted by the model.

Considering the water depths at the alternate areas and the wide range of settling velocities of sludge solids, most of the sludge particles are expected to remain in suspension for a period of time ranging from one hour to several days. The heavier sludge particles and sludge flocs, which tend to settle out faster, will be greatly affected by short-term currents, such as tidal or storm-wind-driven currents, and by wave activity. Sludge particles with slower settling velocities will oscillate in the water column due to short-term currents, but ultimately will be dispersed by long-term currents, such as density-driven coastal currents, prevailing wind-driven currents, and ocean turbulence.

The model results (Table 27) indicate that heavier sludge particles, settling at 2 cm/sec (0.8 in/sec) or more, will be deposited a maximum of 0.30 km (0.16 n mi) from the dump site; the lighter particles, settling at about 0.1 cm/sec (0.04 in/sec), will be deposited a maximum of 15.0 km (8.1 n mi) from the dump site. The prevailing currents will transport the lightest particles at velocities from 10.0 to 30.0 cm/sec (4.0 to 11.8 in/sec); however, dispersion and biochemical degradation of these particles will result in extremely low sludge particle concentrations beyond 15.0 km (8.1 n mi). Sludge will probably

TABLE 27

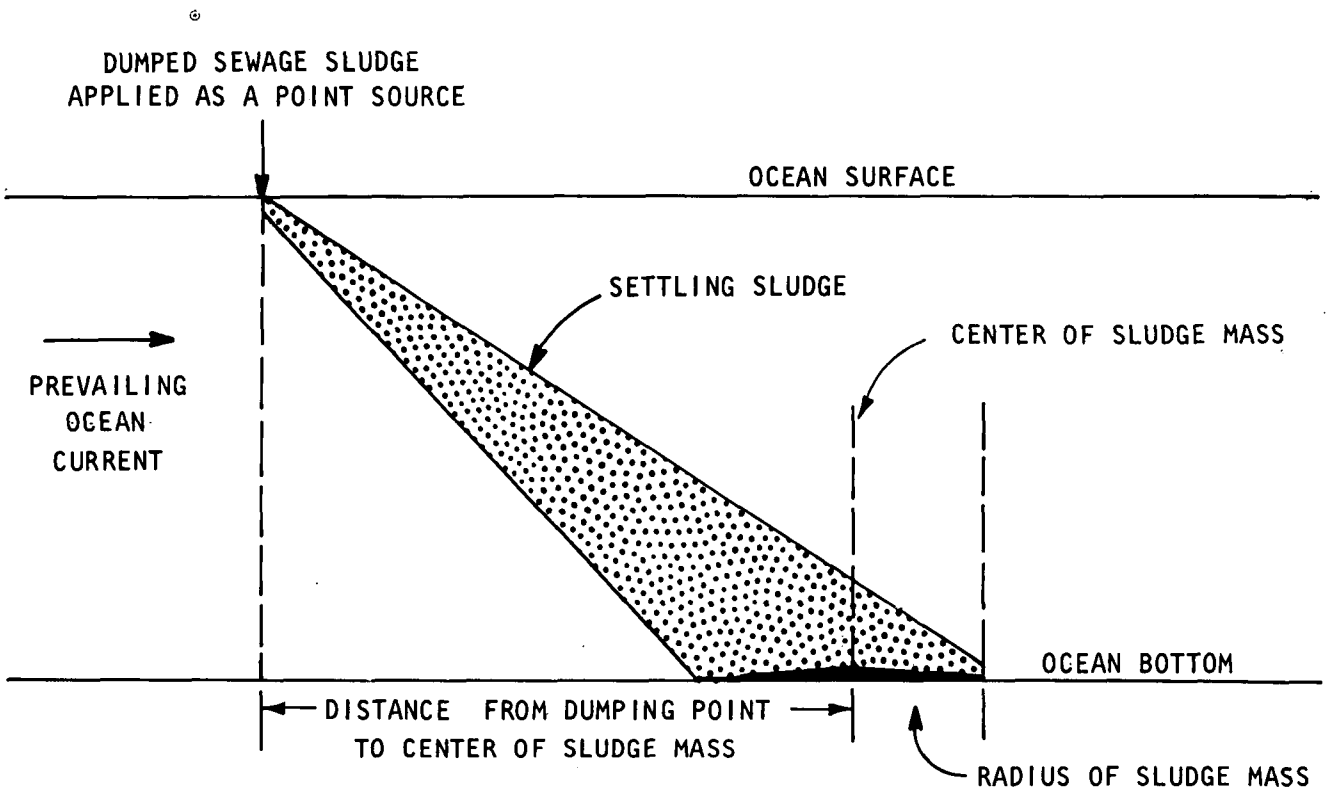
MODEL RESULTS OF TRANSPORT AND DISPERSION OF SEWAGE SLUDGE AT THE NORTHERN (60 m DEPTH) AND SOUTHERN (50 m DEPTH) AREA[1]

Depth	Current Velocity	Settling Velocity of Sludge Solids	Horizontal Dispersion Coefficient	Vertical Dispersion Coefficient	Time	Distance From Dumping Point To Center of Sludge Mass[2]	Radius of Sludge Mass[3]
meters (feet)	cm/sec (in/sec)	cm/sec (in/sec)	sq cm/sec (sq in/sec)	sq cm/sec (sq in/sec)	min	kilometers (n mile)	meters (feet)
50 (164)	10.0 (4.0)	2.0 (0.8)	1,000 (155)	10.0 (1.5)	60	0.25 (0.15)	65 (213)
60 (197)	10.0 (4.0)	2.0 (0.8)	1,000 (155)	10.0 (1.5)	60	0.30 (0.16)	72 (238)
50 (164)	10.0 (4.0)	0.1 (0.04)	1,000 (155)	10.0 (1.5)	1250	5.00 (2.70)	300 (985)
60 (197)	10.0 (4.0)	0.1 (0.04)	1,000 (155)	10.0 (1.5)	1250	6.00 (3.24)	330 (1,082)
50 (164)	10.0 (4.0)	2.0 (0.8)	10,000 (1,550)	10.0 (1.5)	60	0.25 (0.15)	212 (697)
50 (164)	30.0 (11.8)	0.1 (0.04)	10,000 (1,550)	10.0 (1.5)	1250	15.00 (8.09)	950 (3,117)

[1] See Figure 39 for a typical representation of sludge transport and dispersion.

[2] Horizontal distance traveled before reaching the ocean bottom (see Figure 39).

[3] Radius of sludge mass after reaching the ocean bottom (95 percent of mass within radius, see Figure 39).



TYPICAL TRANSPORT AND DISPERSION OF SEWAGE SLUDGE IN OCEAN WATERS

NOTE: SEE TABLE 27.

DAMES & MOORE

FIGURE 39

be more widely distributed during the summer when stratified water conditions prevail than during the winter when vertical mixing prevails. Stratification will result in a longer retention of sludge in the upper water layers and, consequently, wider distribution.

The model (Table 27) estimated that 95 percent of the sludge mass on the bottom would be contained within a maximum radius of 950 m (3,100 ft). This sludge mass represents a very small percentage of the dumped sludge solids; most of the solids are not expected to reach the bottom. The greater depth of the Northern Area will result in a slightly larger area of bottom affected by dumping than in the Southern Area. For materials settling at 0.1 cm/sec (0.04 in/sec), and a current velocity of 10.0 cm/sec (4.0 in/sec), materials will be transported 1 km (0.54 n mi) further in the Northern Area. Although there will be a greater area of bottom affected in the Northern Area, the concentrations of sludge per unit area of bottom will be lower. Callaway *et al*. (unpub.) reached similar conclusions.

B. RESUSPENSION

Only a small fraction of the dumped sludge reaches the sea floor (Callaway *et al*., unpub.). This material is further affected by biological activities and physical forces. Benthic organisms burrowing in the deposits incorporate the material into the existing substrate. Incorporation of the

sludge material reduces the possibility that it will be transported out of the area. Benthic fauna consume the fine sludge solids and void them along with other waste products as coarse pellets. The potential for resuspension of this pelletal debris is much lower than the potential for resuspension of freshly deposited sludge solids.

Bottom sediments are resuspended primarily by storm waves and currents and by internal waves. Once resuspended, these sediments can be transported by bottom currents.

1. Storm Waves and Currents

Strong wind-driven currents associated with storm events can resuspend large quantities of fine bottom sediments in the Bight Apex (Drake, 1974). The bottom sediments in both of the alternate areas exhibit wave ripples. This indicates that these sediments have been moved back and forth by surface waves associated with storms. However, the Northern Area, because of its greater depth, has a slightly lower potential for resuspension of fine grained sediments by surface waves than does the Southern Area.

2. Internal Waves

Internal waves have been observed in the vicinity of the Hudson Shelf Valley. These internal waves dissipate as they break along the bottom at the depth where the density gradient upon which they travel intersects the bottom. Only bottom sediments shoreward of the 30 to 35 m (98 to 115 ft) depth contour are likely to be affected by internal waves. The bedforms observed in the Northern and Southern Areas (Section IVD) may

have been produced by either internal waves or storm currents. The deeper portions of the Northern Area have a lower potential for resuspension of fine bottom sediments by internal waves than do areas within the Southern Area.

3. Bottom Currents

Fine bottom sediments, once resuspended in the water column, will be transported by the bottom currents. Results obtained using bottom drifters indicate that a line of divergence (Figure 14) exists on the continental shelf at depths of about 60 m (197 ft). Shoreward of this line, the bottom drift tends to have an onshore component; seaward of this line, the bottom drift tends to have an offshore current.

All of the Southern Area is shoreward of the line of divergence. If sludge were dumped in this area, the sludge particles that reached the bottom would be subjected to a slow, steady, shoreward movement. The deeper portions of the Northern Area, on the eastern border, are along the line of divergence. If sludge material were transported by the bottom currents in these deeper areas, it would probably move in an offshore direction.

The presence of relict mud deposits in the Northern Area indicates that the agents of resuspension and transport have been ineffective in removing mud from the bottom sediments. Use of a site near the deeper areas in the Northern Area would probably result in the transport of sludge particles to the adjacent low-lying areas of the relict drainage system (Figure

26), where they would remain. Although a physical accumulation on the bottom is not expected, increases in the levels of organic material and heavy metal concentrations are anticipated.

C. CHEMICAL EQUILIBRIA AND BIOLOGICAL OXIDATION

When sewage sludge is dumped into the ocean, it is physically dispersed within the water column. At the same time, it begins to chemically interact with the seawater. Basic laws of chemistry regarding concentration equilibria and adsorption are the major factors affecting the chemical reactions that occur.

1. Heavy Metals

Field analyses at the Hyperion Sewage Treatment Plant in Los Angeles, California show that a significant portion of the heavy metals present in sewage sludge are in the particulate fraction (fines) of the sludge. The analyses at Hyperion also show that many of these metals are released into the seawater (Table 28) (Chen *et al.*, 1974; Rohatgi and Chen, 1975). As soon as the sludge is dumped, there is a rapid, initial (first-stage) release of metals, followed by a slower, long-term (second-stage) release. The first-stage release is attributable to the oxidation of organic particles and metal sulfides and to the desorption of metals from particles. Desorption may be responsible for some of the second-stage releases as well (Rohatgi and Chen, 1975).

The equilibria equations of Morel *et al.* (1975) indicate that the metals that are present in sludge as metal sul-

TABLE 28

RELEASE FROM SLUDGE OF HEAVY METALS IN SEAWATER[1]

Metal	Percent Released
Cadium (Cd)	93-96
Chromium (Cr)	2
Copper (Cu)	5-9
Lead (Pb)	35
Manganese (Mn)	35
Nickel (Ni)	49-64
Zinc (Zn)	18-39

[1]From suspended particulates in digested sludge at equilibrium with seawater.

Source: Rohatgi and Chen, 1975.

fides rapidly dissolve upon mixing with seawater. This dissolution frees the metal ions from the sludge particles and promotes rapid dilution of the metal ions.

In situ studies (Callaway *et al.*, unpub.) at the existing sludge dump site show initial dilutions of seawater to sludge ranging from 500:1 to 1000:1 within ten minutes of release. Other researchers have noted that concurrent with initial dilution there is a drop in the ambient oxygen level in the area of the dump site. Metal concentrations in the water immediately after cessation of dumping are reported to be highly variable. Seven hours after dumping, concentrations of metals in the water column reportedly remain elevated (Hilovsky and Szucs, 1975).

The metals that are not dissolved or oxidized during the first-stage release can be released in time as the organic matter with which they are bound is decomposed or as they are desorbed from inorganic material. Conversely, metals which are in solution or which come into solution during dumping can be immobilized through sorption to suspended particulate matter.

Chromium, copper, lead, and zinc are expected to accumulate in bottom sediments. Cadmium is not expected to accumulate because it is rapidly dissolved in the water column. Segar and Cantillo (1975) calculated the average residence time of heavy metals in the Bight Apex. They concluded that a considerable portion of the metals originating in sewage sludge or dredged material is rapidly flushed out of the Apex.

2. Organic Matter

The organic constituents of ocean dumped sewage sludge are subject to oxidation and scavenging in both the water column and bottom sediments. O'Connors and Duedall (1975) have demonstrated that the organic carbon content of bottom sediments in the vicinity of the dredged material and sewage sludge dump sites is not high when compared to that in other coastal areas. Further, they postulate that different microorganisms act to hydrolyze the organic matter in sludge, and they note specifically that cutin, a common component of sludge, is degraded by bacteria and fungi. These biological oxidation processes reduce the dissolved oxygen levels in seawater.

As discussed in Section IVD, substantial quantities of oxidizable organic matter reach the Bight Apex. The oxidation of this organic matter depletes the dissolved oxygen in the Bight Apex, especially during the summer months when biological activity is high. Segar *et al*. (1975) concluded that relocation of the sewage sludge and dredged material dump sites would not significantly improve the dissolved oxygen levels in the bottom waters of the Apex. They also concluded that a two-fold increase in the nutrient loading into the Apex from inland runoff could raise photosynthetic productivity to a level that would seriously deplete the oxygen in the bottom waters.

D. COMPARISON TO OTHER DUMP SITES

1. Philadelphia Dump Site

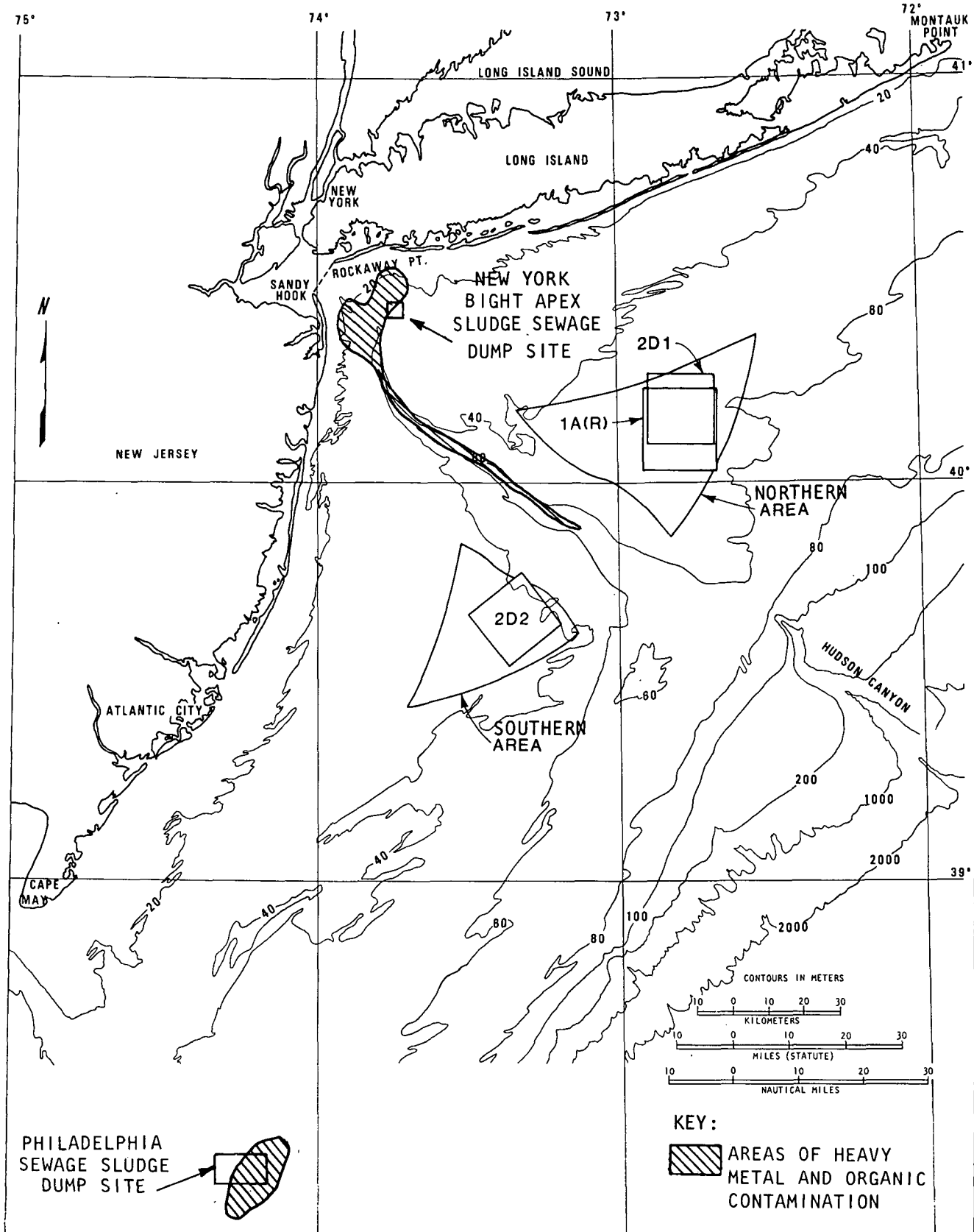
A look at sludge dumping at the newly designated (1973) Philadelphia site can provide some insights into what can

be expected at the proposed alternate areas in the New York Bight. The volume of sludge dumped at the Philadelphia site in 1974 was approximately 0.6 million cu m (0.8 million cu yd), about one-sixth of the volume of sludge dumped in the Bight in 1974 (Lear and Pesch, 1975). The water depth, hydraulic activity, and net drift at the Philadelphia site are similar to conditions within the alternate areas in the Bight.

Organic carbon accumulation in the vicinity of the Philadelphia site is small. Background concentrations are approximately 0.1 percent organic carbon by dry weight; the highest concentration found in the affected areas was only 1.4 percent. The highest organic carbon levels were observed at a station approximately 19 km (10 n mi) south of the dump site.

The highest metal concentrations also were found at this station (Lear and Pesch, 1975). Chromium, lead, and zinc showed accumulation with respect to background concentrations. Manganese and iron also were high, but this was attributed to industrial waste dumping at an adjacent site. Mercury, copper, and nickel had not accumulated in the bottom sediments to any appreciable degree. On the other hand, polychlorinated biphenyls (PCBs) had accumulated in the bottom sediments.

Figure 40 is a general representation, based on metal and organic content, of the bottom area affected by pollutant sources in the Bight Apex and near the Philadelphia dump site. Dumping at the Philadelphia site has a pronounced influence on downcoast areas. This may be the result of coast-parallel transport caused by the predominant southwesterly drift.



BOTTOM AREAS AFFECTED AT EXISTING SEWAGE SLUDGE DUMP SITES IN THE MID-ATLANTIC BIGHT

SOURCES: LEAR, 1973; CARMODY ET AL.; 1973; HATCHER AND KEISTER, 1975.

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FIGURE 40

2. Dump Sites in Other Waters

In Scotland, sludge dumping in the Firth of Clyde has affected an area of between 2.9 and 10.0 km (1.6 to 5.4 n mi) in diameter (Mackay *et al.*, 1972). Concentrations of heavy metals in the immediate vicinity of this dump site are quite similar to those found in the Bight Apex, although the bottom sediments in the Firth of Clyde contain more organic carbon (8.2 percent). Background concentrations of pollutants in the Firth of Clyde are generally higher as well. Water depths in the Firth of Clyde are less than 90 m (295 ft), and tidal flushing is a dominant dispersal agent in this estuary.

In England, studies have been conducted on sludge dumping in the Thames estuary. The estuary is shallow, about 20 m (65 ft), and is subjected to strong tidal currents of about 90 cm/sec, (35.4 in/sec). The studies show no appreciable loss in oxygen concentration in bottom waters (Shelton, 1971).

E. SUMMARY

It is expected that the bottom area surrounding a dump site in either the Northern or Southern Area will be contaminated by increased levels of fine organic matter, heavy metals (chromium, copper, lead, and zinc), bacteria (Sections IVC and VII A, B), and polychlorinated bi-phenyls (PCBs). Detectable contamination from sludge dumping will be limited to areas within 15 km (8 n mi) of the dump site; the affected area will be elongated in the direction of the prevailing currents (to the west and southwest off Long Island, to the

south and southwest off New Jersey). A larger area of bottom will be affected if dumping occurs in the Northern Area because of the greater depth. However, there will be less accumulation of solids per unit area, again because of the greater depth. In general, significant accumulations of sludge solids on the bottom are not expected at a dump site in either area.

The areas with the lowest potential for resuspension and transport of fine sludge contaminants are in the deep, depression areas along the easternmost segments of the Northern Area. These areas are currently characterized by high proportions of fine sediments.

The impact of these sludge contaminants on the ecosystem is discussed in Chapter VII.

VII. IMPACTS OF THE PROPOSED ACTION

The proposed action will have an impact on water quality and the marine ecosystem at and adjacent to the dump site. The significance of this impact will depend on the nature of the sludge and on the environmental conditions at the dump site. The proposed action will also have an impact on shellfish in the area of the dump site, representing a potential public health hazard. The proposed action may have a number of economic impacts beyond those associated with use of the existing dump site in the Bight Apex. These include increased sludge transportation costs, decreased commercial fishing, reduced potential for developing shellfish resources, and interference with mineral resource development. The loss of a potentially valuable resource, the sludge itself, will continue under the proposed action. The proposed action also has the potential to conflict with other dumping activities in the Bight.

A. IMPACTS ON PUBLIC HEALTH AND WATER QUALITY

The proposed action will have no significant adverse effects upon the public health and welfare of beach communities or upon coastal water quality along Long Island or New Jersey. Floatables from an alternate dump site in either the Northern or Southern Area are not expected to reach beaches along these coasts under any weather conditions, including winter storms. Potential coliform contamination of commercial shellfish (surf clams, ocean quahogs, and sea scallops) as a result of sludge

dumping will be limited to the immediate vicinity of the alternate dump site.

1. Swimming

Recent studies (Section VB) indicate that bacterial contamination of bathing (primary contact) waters from the dumping of sewage sludge at the existing site is negligible. Random, elevated coliform levels along the Long Island and New Jersey beaches are attributed to contamination from inland sources rather than to ocean dumping activities (FDA, 1974 a and b; USEPA, July 1974 and April 1975). Data collected by EPA, FDA, and NOAA-MESA along the New Jersey shore indicate that municipal wastewater treatment plant discharges were the principal cause of the elevated coliform levels in the beach waters. These agencies have concluded that there is no indication of coliform contamination of waters along the Long Island and New Jersey beaches as a result of sewage sludge dumping. Bacterial contamination from sludge dumping appears to be confined to the immediate vicinity of the existing dump site. The FDA has closed a circular area, with an 11.1 km (6.0 n mi) radius, around the existing site to all commercial and recreational shellfishing in order to protect public health (Section IVC and Figure 22).

Brook's model has been used to predict the theoretical dispersion of bacteria as a result of ocean dumping at a site with characteristics similar to those of the existing dump site (USEPA, unpub.). Using conservative values for onshore cur-

rents, coliform die-off rates, and dispersion coefficients, it was concluded that there would be a low probability of coliform contamination of waters along nearby beaches. Since the proposed areas are much farther offshore than the existing dump site, and in different current regimes, the potential for bacterial or viral contamination of primary contact waters from use of either the proposed areas is virtually non-existent.

2. Shellfish

Contamination of edible commercial and sport shellfish taken from the New York Bight represents a significant potential public health hazard to the metropolitan area. Shellfishing has been prohibited in the immediate area of the existing dump site, as well as in other estuarine and coastal waters in the Bight Apex (Figure 22). The health hazard implicit in the consumption of contaminated shellfish is much greater than that from direct contact (swimming) because shellfish have the capacity to concentrate microorganisms in their tissues.

Use of a dump site in either of the proposed areas is likely to result in, at least, a temporary FDA closure of the area to commercial and sport shellfishing. It is difficult to predict the size of the area that would be closed. Judging from present FDA practices (Section IIE), a precautionary closure would involve a circular area, 11.1 km (6.0 n mi) in radius, around the designated dump site. The greatest abundance of surf clams is found in and around the Southern Area (Figures 17, 18, and 19). Ocean quahogs are abundant in both areas (Figure 20),

but their resource potential in comparison with surf clams has not been defined.

The potential for health hazards would be greatest in contaminated areas currently and potentially used for large-scale commercial shellfishing. The most intense commercial shellfishing now occurs off the New Jersey coast, shoreward of the Southern Area. Assuming that commercial shellfishing patterns remain essentially the same for the next five years, potential public health hazards due to consumption of contaminated shellfish will be less if a site in the Northern Area is chosen.

A ban on shellfishing at either of the proposed areas would place a restriction on fishing in international waters. Such a restriction is unprecedented; international enforcement may be somewhat tenuous. The great distance from shore presents the additional problems of higher costs and more difficult monitoring and enforcement of shellfishing restrictions.

3. Floatables

Certain aesthetically unpleasant components of dumped sewage sludge (oil, grease, and artifacts) are expected to accumulate in a surface slick within the immediate area of an alternate dump site. Although the possibility exists that some floatables are currently washed up on Long Island and New Jersey beaches from the existing dump site, this cannot be verified (NOAA-MESA, March 1975). Inputs from other sources, the Hudson estuary, inland runoff, municipal wastewater discharges, combined sewer and stormwater runoff, and vessel discharges, are

considered to far outweigh those from sludge dumping at the existing site.

Sewage sludge dumping in either of the proposed areas will have a much lower potential for affecting the beaches because the proposed areas are much farther offshore than the existing dump site. However, floatables associated with the use of an alternate dump site will contribute to the degradation of relatively pristine waters at that dump site.

4. Hazards to Navigation

The proposed action represents an increase in vessel traffic and, thus, a potential hazard to navigation in the New York Bight. Sludge vessels will have to make more and longer trips to dispose of waste if a new site is designated (Section VIIC). Sludge vessels are inherently slow, 13 km/hr (7 knots) for towed barges and 22 km/hr (12 knots) for tankers. Towed barges represent a particular navigation hazard because they are difficult to control and appear on a radar screen as two separate vessels. Sludge vessels could collide with other commercial vessels, such as oil tankers and freighters, or with stationary structures, such as navigation aids, breakwaters, and oil platforms.

a. Precautionary Zone. The greatest potential for collision would occur when the sludge vessels pass through the Precautionary Zone in the Bight Apex (Figure 5). This potential impact would be mitigated somewhat by abandoning the existing dump site, which lies within this zone. Both of the alternate

areas are outside the established navigational lanes and, therefore, relatively hazard-free.

b. The Southern Area. The navigation situation in the Southern Area may be complicated by increased traffic (work boats, supply ships, oil tankers, etc.) associated with the nearby development of potential oil and gas lease tracts (Figure 6). There also is a slight possibility of the sludge vessels colliding with oil platforms in the potential lease area located nearby. Whether these navigation hazards will materialize depends upon the development of oil and gas and on the duration of ocean dumping at the site.

c. Further Hazards. With the exception of oil and gas platforms (Section IIG), it is ulikely that proposed offshore facilities, such as artificial islands and deepwater ports, will be built in the near future.

B. IMPACTS ON THE ECOSYSTEM

The magnitude of adverse impacts on the marine ecosystem will be primarily a function of the concentration of the sludge which reaches the bottom, the areal extent of contaminant coverage on the bottom, and the subsequent transport of contaminants on the bottom. Bottom transport will serve to increase the lateral extent of the impacted area (Section VIA). The characteristics of the sludge that will be dumped in the Bight in the future are not expected to be much different from the characteristics of the sludge that is dumped in the Bight at present (Tables 3 and 4).

Impacts on the biota, especially the benthos, can be mitigated to some degree by dispersing the contaminants in the water column, thereby diluting the contaminants before they reach the bottom. However, dilution necessarily involves an increase in the area affected. Impacts may be minimized either by containing the pollutants in a very small area to concentrate toxic substances or by dispersing the pollutants over a large area to achieve maximum dilution.

With maximum dilution, the impacts caused by those pollutants that eventually reach the bottom will be minimal provided that the potential for resuspension and bottom movement of pollutants to other areas is low. To the extent possible, selection of an alternate dump site should be based upon the optimization of these physical forces.

1. The Benthos

The benthic community is composed of those organisms that live on or in the sediments or substrates (Section IVC). For the purposes of this EIS, demersal fish (bottom feeders) and shellfish (bivalves and crustaceans) are discussed under the next section, Fisheries Resources.

a. Similar Areas. Impacts on the benthos at the Northern and Southern Areas are likely to be of the same nature as those observed at existing sewage sludge dump sites. Until further comprehensive investigations of the benthos at the proposed areas are completed, it is impossible to determine the full significance of the impacts associated with use of these areas. With the data available, it is possible to make only gross estimates based on benthic impacts occurring at existing dump sites.

At present, a bottom area of approximately 52 sq km (15 sq n mi) around the existing dredged material and sewage sludge dump sites shows evidence of reduced biomass and a shift in the composition and diversity of the benthos. Studies by NOAA-NMFS (1975b) found the major impact to be suffocation of the benthic organisms buried by dredged material. In this respect, adverse biological effects due to dumping of dredged material may be more severe than those due to dumping of sewage sludge. Contamination of the nearby Hudson Shelf Valley also has been observed; however, the benthic communities are not as unproductive in the Valley as at the dump sites (NOAA-NMFS, 1972).

A study at the Philadelphia sewage sludge dump site, located about 74 km (40 n mi) east of Ocean City, Maryland, was unable to detect the impacts of sludge dumping on the benthos (Lear, 1973). However, an accumulation of heavy metals in scallops and clams onsite was observed. At the time of Lear's study, this dump site had been used for less than a year, and the volume of sludge that had been dumped there was approximately one-sixth of the annual volume dumped at the existing sewage sludge dump site in the Bight. The depth at the Philadelphia dump site is comparable to that at the Southern Area.

In Scotland, sludge dumping in the Firth of Clyde has resulted in an accumulation of organics and metals, as well as in a change from a clam and starfish community to a polychaete worm community. An increase in the benthic biomass has also been observed. However, this increased biomass appears to be of little or no value as fish food since none of the species were found in the guts of fish from the area (MacKay et al., 1972). Steel et al. (1973) also reported an increase in the level of sludge-related contaminants, with impacts being most evident upon the benthos. The volume of sludge dumped in the Firth of Clyde is approximately one-fourth of that currently dumped in the New York Bight. The depth at the dump site in the Firth of Clyde is comparable to the depth at both the Northern and Southern Areas.

b. Proposed Areas. The Northern Area is somewhat deeper than the Southern Area. Consequently, use of the Northern Area

would result in greater dilution of contaminants and lesser impacts on the benthos. The potential for resuspension and transport of contaminated sediments appears to be somewhat less in deeper portions of the Northern Area than in the Southern Area (Section VIA).

c. Hudson Shelf Valley. Sewage sludge dumped in either of the proposed areas is not likely to reach the Hudson Shelf Valley, based upon predictions of lateral transport in the water column prior to settling or after resuspension (Section VIA). At the worst, extremely low concentrations of fine sludge particles will settle on the bottom at distances of more than 15 to 20 km (8 to 11 n mi) from a dump site located in either the Northern or Southern Area. The distance from the Hudson Shelf Valley to the nearest boundary of either area is 18.5 km (10.0 n mi), as shown in Figure 7.

The Hudson Shelf Valley is receiving contaminated materials from the Bight Apex (NOAA-MESA, March 1975), as shown in (Figure 40). The existing dredged material and sewage sludge dump sites are located immediately adjacent to the rim of the inner terminus of the Hudson Shelf Valley and may be the sources of contamination in the Valley.

The red crab and American lobster, numerous in the lower parts of the Hudson Shelf Valley, would undergo adverse impacts if sludge contaminants accumulated in the Valley. Special emphasis should be placed on avoiding contamination of the upper reaches of the Valley where breeding zones are located.

2. Fisheries Resources

Fisheries resources in the New York Bight include pelagic fish (water column feeders), demersal fish (bottom feeders), and shellfish (bivalves and crustaceans), as described in Section IVC.

Attempts to define impacts on fisheries resources at existing dump sites in the Bight Apex have been hampered by a lack of temporal and spatial coverage, inadequate sampling design, and limited numbers of replicate samples, all of which precludes statistical verification. The motile and highly migratory nature of most finfish species has prevented delineation of cause and effect relationships. The purpose of this EIS is not to quantify impacts, but to recommend an alternate dump site where adverse impacts would be minimal. For this purpose, the data are sufficient since they allow relative comparisons.

a. Proposed Areas. Non-motile shellfish species at or in the vicinity of the proposed areas are the fisheries resources most likely to be impacted by sewage sludge dumping. The surf clam, sea scallop, and ocean quahog are common to both areas, often in numbers suitable for commercial harvesting (Section IVC). Based on recent surveys, greater surf clam resources are found in and around the Southern Area, especially along the New Jersey coast (Figures 17, 18, and 19), than in the Northern Area. Ocean quahogs are numerous in both areas (Figure 20). Sea scallops are less common than either surf clams or ocean quahogs (Figure 21). Surf clams and ocean quahogs are not found in significant numbers at the existing sewage sludge dump site.

The potential impact on shellfish resources would be minimized by dumping within the Northern Area; this judgment is based primarily on the abundance of surf clams in the Southern Area. Use of the Northern Area would also minimize the danger to public health from illegal harvesting of contaminated shellfish, as the Southern Area is currently and potentially a more lucrative commercial source.

Significant impacts on the crustaceans (crab and lobster) that frequent the proposed areas can also be expected. There is no evidence that these species are more or less abundant in either alternate area. Impacts upon crustaceans will be mitigated to some extent by their ability to move out of the affected area.

Since most commercial finfish species are found throughout the Bight (Section IVC), impacts on these species will be about the same at either alternate area. Impacts on finfish might be expected to differ if one of the areas exhibited physical characteristics conducive to migratory behavior. At present, there is no evidence of such characteristics in either area.

b. Fish Activities. As part of a NOAA-NMFS study (1975b), groundfish in the New York Bight were sampled twice yearly to relate dumping to activities of fish. On a seasonal basis, the catch of bony fish in high-carbon sediment areas of the Bight Apex, such as the sewage sludge dump site, was found to be lower than in low-carbon sediment areas. From this, it

was concluded that migratory movements are affected by the ocean dumping of sewage sludge.

Both of the proposed areas exhibit topographical lows which favor the accumulation of high-carbon sediments. Hydraulic activity is lower at the proposed areas than at the existing dump site, which also favors the accumulation of high-carbon sediments. The Northern Area is characterized by slightly deeper waters and somewhat finer-textured sediments than in the Southern Area. This indicates a greater propensity for the accumulation of high-carbon sediments and, consequently, a lower abundance of groundfish in the Northern Area. However, considering the anticipated dilution and dispersion of sludge associated with depth, alterations of migratory habits should not result from sludge dumping at either of the proposed areas.

c. Fin Rot. The occurrence of fin rot in demersal fishes has been attributed to polluted conditions in the Bight Apex and in Raritan Bay (Murchelano and Ziskowski, 1975). Causative agents have not been defined, nor has the anomaly been exclusively linked to ocean dumping. In spite of a significant difference in fin rot occurrence between fish taken in the Apex and those taken in the outer Bight, the overall percentage occurrence is low (3.8 percent of winter flounder from the Apex, 0.7 percent from the outer Bight). A greater percentage occurrence was observed in samples taken from high-carbon sediment areas (5.1 percent of winter flounder sampled).

Considering the substantial dilution expected at either of the proposed areas and the lack of significant addi-

tional pollutant loadings, fin rot is not expected to occur at a dump site in either of the proposed areas.

3. Plankton

Plankton are defined as those plants (phytoplankton) and animals (zooplankton) which float in the water column (Section IVC).

a. Similar Areas. Ocean dumping practices in the Bight Apex have had no observable effect on phytoplankton productivity. Increased sludge dumping probably would not increase or decrease the rate of primary productivity, but might expand the area of high phytoplankton productivity. Similarly, ocean dumping practices have had no discernible effect on the species composition, abundance, or distribution of zooplankton in the Apex (NOAA-NMFS, 1975b).

Pararas-Carayannis (1973) reported that "no short-term adverse effects have been observed on free-floating or swimming marine organisms in the New York Bight. Specifically, no effects were observed on zooplankton species composition and distribution."

This may indicate the incapacity of present field techniques to detect effects on plankton. Laboratory investigations suggest that there are effects on plankton. However, the applicability of these laboratory investigations to evaluation of an alternate dump site is limited. Barber and Krieger (1970) reported phytoplankton productivity to be inhibited by sewage sludge. This inhibition has not been substantiated. Dunstan

(1975), investigating the effect of sewage effluents on phytoplankton, found the response of phytoplankton quite varied and unpredictable. Although growth was generally enhanced by the addition of nitrogen and phosphorous, the role of minor growth substances (trace metals, vitamins) became paramount in the regulation of phytoplankton productivity, composition, and abundance.

The effects on zooplankton are only slightly less confused. Based on field and laboratory data, NOAA-NMFS (1972) reports that sludge and dredged material cause pathological anomalies in larger crustaceans. It seems likely that smaller crustaceans, such as gammarid amphipods (a common fish food), would be affected in a similar manner.

b. Proposed Areas. Impacts upon plankton in the proposed areas will probably be undiscernible. While the addition of nutrients might favor localized increases in phytoplankton productivity, other factors would tend to decrease productivity. Increased turbidity would lessen the depth of light penetration and, thereby, would result in a localized reduction of productivity. Since primary productivity is limited to the upper layers of the water column (photic zone), high levels of nutrients below this zone will not be utilized in photosynthesis.

Potential impacts on the zooplankton would be more severe at the alternate areas than at the existing dump site. Zooplankton biomass generally is greater in the shelf and transition zone waters, which characterize the two alternate areas,

than in nearshore waters (Section IVC). Thus, adverse effects, such as pathological anomalies and impediments to larval growth, would threaten a larger zooplankton population at a site located in the Northern or Southern Area than at the existing dump site. Furthermore, zooplankton populations at the alternate areas are oceanic in nature and, therefore, are less adapted to environmental stress than zooplankton in the Bight Apex, which are estuarine in nature. No difference could be expected between the alternate areas.

4. Short Dumping

The proposed action may encourage short dumping, that is, dumping before the vessel reaches the designated dump site. Surveillance by USCG radar, shipriders, planes, and vessels, and the use of dump site transponders is expected to prevent illegal short dumping.

a. Emergency Situations. Ocean dumping permits (Appendix A, General Condition 10), allow the master of a vessel to dump at any location or in any manner in order to safeguard life at sea. Dumping of this sort is likely to occur between the Sandy Hook-Rockaway Point transect and any new dump site further offshore.

Rough weather during the late fall, winter, and early spring can cause emergency situations which require short dumping. Other emergency situations which can occur include vessel breakdowns under hazardous conditions and potential collisions at sea with other ships or stationary objects.

The increased number of trips and the greater distance and time to the proposed areas will raise the potential for emergency dumping. The effects of emergency dumping should be mitigated by the dilution and dispersion provided by stormy weather conditions. Moreover, each emergency would be unique in time and place so that sludge would not be continually dumped at the same point under the same wind and weather conditions.

b. Potential Impact. If an alternate dump site were located within the Southern Area, the sludge vessels would likely use the Hudson Canyon Navigational Lane (Figure 5) for much of the distance. The fact that much of this route is over or near the Hudson Shelf Valley will, to some extent, cause minor adverse effects since the Valley will trap short-dumped sludge. The alternate route to the Southern Area, along the Barnegat Navigational Lane (Figure 5), would increase travel time and costs, and thus, probably would not be used. Furthermore, use of this route would present a hazard to New Jersey beaches in the event of a short dump when winds or currents were onshore.

Transporting sludge to the Northern Area does not represent a serious hazard to the Hudson Shelf Valley in that the barges would probably use the Nantucket Navigational Lane (Figure 5), which parallels Long Island. However, use of this route would present a hazard to New York City and Long Island beaches in the event of a short dump when winds or currents were onshore. Following the alternate Hudson Canyon Navigational Lane to the Northern Area would be longer and more costly, and thus

it probably would not be used. If used, it would represent a direct threat to the Hudson Shelf Valley.

The most adverse impacts of short dumping would occur if such dumping were to take place in the Bight Apex. However, the probability is that most short dumping would take place outside of the Apex.

5. Potential for Recovery

The potential for ecosystem recovery at the existing dump site is an important consideration in assessing the impact of moving to an alternate dump site. The recovery potential of both of the proposed areas is about the same.

Studies of repopulation rates following pollution abatement in the Raritan estuary indicate relatively rapid reestablishment by principally freshwater forms in the upper estuary (Dean and Haskin, 1964). However, more recent surveys in western Raritan Bay found an improverished benthos, not indicative of recovery (NOAA-NMFS, 1972). McNulty (1970) found no evidence of increased numbers of commercial or sport fish in Raritan Bay following pollution abatement, and he concluded that long-lasting detrimental effects have resulted from pollution and dredging. The NOAA-NMFS (1972) predicts that after abandonment of the dredged material and sewage sludge dump sites, recovery to former levels of productivity, if it is possible at all, may require years or even decades. The FDA (1975) has found shellfishing areas around these two existing dump sites very degraded and concluded that moving the sites would be of little help to the recovery of the area.

Considering the potential degradation from use of the alternate areas, and the low potential for recovery of the existing dump site, no overall benefit to the benthic ecosystem can be foreseen as a result of moving to an alternate dump site in the Northern or Southern Area.

At this time, no prediction can be made for recovery of an alternate dump site after dumping is phased out.

C. ECONOMIC IMPACTS

The proposed action will increase significantly the cost of ocean dumping sewage sludge in the New York-New Jersey metropolitan area. In addition, it has the potential for conflicting with commercial fisheries, with the development of mineral resources, and with the beneficial use of sludge.

1. Sludge Transportation Costs

The cost of transporting sewage sludge to an alternate dump site in either of the proposed areas was evaluated for two components: capital costs for potential fleet expansion and hauling costs, including operation, maintenance, and repair.

a. Fleet Expansion. Expansion of the existing fleet of fourteen vessels permitted for hauling sludge is unnecessary. These vessels have a combined carrying capacity (Section IIB and Table 7) large enough to transport, at least, 12.6 million cu m (16.5 million cu yd) of sewage sludge annually to any site within the proposed areas (Table 29). The volume of sludge projected for dumping in 1981 is only 10.2 million cu m (13.3 million cu yd). Thus, based on projected volumes, the existing fleet would have a reserve capacity of 2.4 million cu m (3.2 million cu yd). The existing fleet would be more than sufficient to continue dumping sludge at the existing site in the Bight Apex (Table 29).

Besides being unnecessary, fleet expansion costs cannot be justified because land-based disposal alternatives are expected to eventually replace ocean dumping. If, during the interim, there were an unexpected shortage of hauling capacity

TABLE 29

FLEET HAULING CAPACITY

	Existing Dump Site	Northern or Southern Area Minimum	Northern or Southern Area Maximum
One-way Distance[1] in km (n mi)	22 (12)	65 (35)	121(65)
Round-trip Distance[2] in km (n mi)	138 (75)	222(120)	334(180)
Average Speed[3] in km/hr (knots)	13 (7)	13 (7)	13(7)
Round-trip Time[4] in hr	10.6	17.1	25.7
Loading and Docking Time in hr	4.0	4.0	4.0
Total Trip Time[5] in hr	14.6	21.1	29.7
Maximum Trips[6] per year	7,679	5,313	3,775
Required Trips[7] in 1981	3,045	3,045	3,045
Maximum Sludge Hauling Capacity[8] in millions of cu m (cu yd)	25.7 (33.6)	17.8 (23.3)	12.6 (16.5)
1981 Sludge Volume[9] in millions of cu m (cu yd)	10.2 (13.3)	10.2 (13.3)	10.2 (13.3)
Reserve[10] in millions of cu m (cu yd)	15.5 (20.3)	7.6 (10.3)	2.4 (3.2)

[1] One-way distance is from the Sandy Hook-Rockaway Point transect.
[2] Round trip distance includes travel within New York Harbor and waterways.
[3] The average speed is for all fourteen vessels under conservative conditions.
[4] Round trip time equals the round trip distance divided by the average speed.
[5] Total trip time equals round trip time plus loading and docking.
[6] Maximum trips per year equals 8,008 hrs/total trip time x 14 vessels. The 8,008 hours of operations allow one month overhaul (out of service) per vessel per year.
[7] Required trips equals 1981 sludge volume of 10.2 million cu m (13.3 million cu yd)/average vessel capacity of 3,350 cu m (4,380 cu yd).
[8] Sludge hauling capacity equals maximum number of trips times average vessel capacity of 3,350 cu m (4,380 cu yd).
[9] The 1981 sludge volume projected for the Bight (Table 9).
[10] Reserve can be translated as additional transport capacity, extra trips, or greater total trip time. It could also represent the time lost to inclement weather conditions, but not maintence, which was already taken into consideration in the one month overhaul.

in the Bight, additional barges could be brought in from other geographic areas, as required.

b. Hauling Costs. The proposed action would increase total hauling costs during the 1976 to 1981 period by 56 to 69 percent (Table 30). If an alternate dump site were located 65 km (35 n mi) from the Sandy Hook-Rockaway Point transect (Figure 7), the total hauling costs during the 1976 to 1981 period would be 75 million dollars. A distance of 120 km (65 n m) would result in slightly higher total costs of 81 million dollars for the same period. On the other hand, continued use of the existing dump site between 1976 and 1981 would cost 48 million dollars. These conservative estimates were based on unit costs from the current haulers (Table 30, Footnote 1) and on the projected sludge volumes (Table 9). Inflation was taken into consideration after 1979.

The effect of increased distance on unit hauling costs, based on vessel type (barge or tanker) and operation (commercial or municipal), is shown on Figure 41 for the year 1976. It is apparent that Westchester County's barge is not cost-effective at any distance beyond the existing dump site. The cost impacts of increased distance upon commercial haulers are significant when distances are increased from 65 to 120 km (35 to 65 n mi), but appear to become insignificant when distances exceed 120 km (65 n mi).

The cost impacts to New York City will be minor if the distance is extended to 65 km (35 n mi). However, unit costs

TABLE 30

SLUDGE HAULING COSTS

in Millions of Dollars[1]

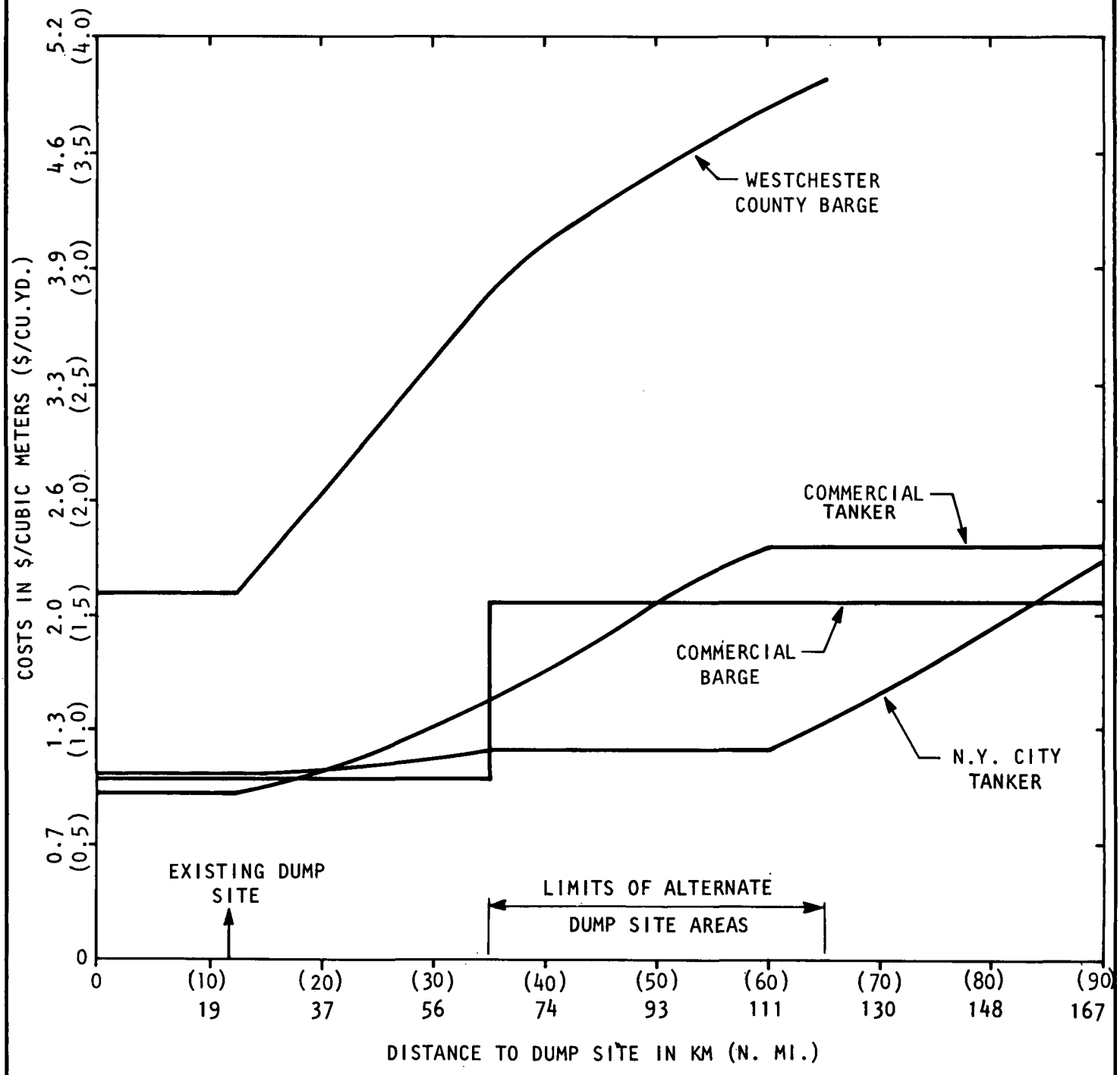
Year[2]	Existing Dump Site	Northern or Southern Area	
		Minimum[3]	Maximum[4]
1976	4.460	6.829	7.509
1977	5.955	9.075	9.917
1978	6.992	10.833	11.749
1979	8.529	13.443	14.459
1980	10.033	15.976	17.096
1981	12.018	18.806	20.180
TOTAL	47.99	74.96	80.91
PERCENT INCREASE	---	56	69

[1]Based on unit costs from Pollution Control Industries (Modern Transportation Company), New York City, and General Marine Transportation Corporation.

[2]Assumes that costs increase by 5 percent annually from 1979 through 1981.

[3]Minimum costs assume a distance of 65 km (35 n mi) from the Sandy Hook-Rockaway Point transect.

[4]Maximum costs assume a distance of 120 km (65 n mi) from the Sandy Hook-Rockaway Point transect.



SLUDGE TRANSPORTATION COSTS

DAMES & MOORE

FIGURE 41

start rising rapidly after 111 km (60 n mi). This may reflect the use of large municipally owned sludge tankers. Total hauling cost will greatly influence New York City's dumping operations, because the city will continue to be the source of more than 50 percent of all sludge dumped (Table 9).

2. Commercial Fishing

The proposed action may adversely affect the harvesting of commercial shellfish at or near an alternate dump site. The commercial harvest of surf clams along the New Jersey shore would be particularly sensitive to sludge dumping at the Southern Area.

a. Southern Area. Dumping sewage sludge within this area probably would damage commercial shellfishing resources. The area adjacent to the New Jersey shore supports significant quantities of commercially valuable surf clams, sea scallops, and ocean quahogs (Figures 17 through 21). As such, it is an important and established fisheries resource. The general dispersion and movement of sludge particles in the water column after dumping at a site located in the Southern Area would appear to be onshore (Section VIA), and thus, over the adjacent shellfishing area.

In December 1975, the State of New Jersey prohibited the taking of surf clams of less than 8.9 cm (3.5 in) in diameter within the 3-mile (5.6 km) limit. This action was precipitated by commercial overfishing in the surf zone (New York Times, on December 31, 1975). While the surf zone is recovering, there will be pressure to develop more abundant areas further offshore.

b. Northern Area. Surf clams are not abundant in this area. Thus, dumping would have a minor effect on commercial harvesting. In addition, the net dispersive flow at the Northern Area appears to be offshore and off the continential shelf (Section IVB).

c. Potential Shellfish Resources. Dumping in either of the proposed areas could reduce the potential for developing ocean quahogs and sea scallops as commercial shellfish resources. Both species appear to be numerous in the proposed areas and undoubtedly would be affected by sludge contamination. Because of their distribution at and near the proposed areas, ocean quahogs and surf clams would appear to be most vulnerable to potential reductions in commercial catches.

In 1973, the commercial shellfish catch in the metropolitan area was worth 20.6 million dollars, as compared with 10.3 million dollars for the commercial fish catch (Table 13). Neither of these figures includes fish or shellfish from the New York Bight that were caught in the Bight and landed in neighboring states (Rhode Island, Connecticut, Delaware, Maryland, and Virginia), or in other countries. Ocean quahogs (11.7 million dollars), American lobster (3.1 million dollars), and surf clams (1.0 million dollars) comprised the most valuable shellfish catch from the Bight in 1973.

At present, the New York Bight may supply at least 50 percent of the edible surf clam meats harvested from U.S. waters (McHugh, 1975). Any damage to or closing of a specific area

within the commercial harvesting zones could result in a significant impact upon the shellfish industries. There is no guarantee that an area closed to shellfishing can be immediately reopened after the cessation of sludge dumping. It should be pointed out, however, that the old Philadelphia sewage sludge dump site off Delaware Bay was reopened by FDA within a year of cessation of sludge dumping. The volume of sludge dumped at this site was one-sixth of that dumped at the New York Bight Apex dump site.

3. Mineral Resource Development

The proposed action may conflict with the potential development of mineral resources in or immediately adjacent to the Southern Area.

a. Sand and Gravel. The designation of a dump site in the Southern Area would apparently conflict with the development of sand and gravel deposits in the western portion of the area (Figure 6). Dumping sewage sludge within this area could contaminate the sand and gravel deposits and limit their onshore uses. Decontamination, in addition to the normal washing practices before construction use, could increase mining costs. However, oil development and pipeline operations at the adjacent OCS (Outer Continental Shelf) Lease Tract #40 may pose a more serious obstacle to mining of these sand and gravel deposits in the Southern Area. Crude oil spills could contaminate the bottom areas. Should this happen during offshore oil development, the sand and gravel deposits would likely be removed from

mining consideration (BLM, November, 1975).

With regard to the potential development of sand and gravel within the Southern Area, initial delineations of the gravel areas were based on widely spaced surficial samples (Section IVD). Preliminary results of recent NOAA-MESA studies (Schlee, 1975) suggest that these gravelly deposits are sandwiched between two clay units in many areas. These deposits may not be as widespread and readily accessible as previously thought.

Sand and gravel deposits also are located at or near the existing sludge dump site (Figure 6). These deposits are much closer to the metropolitan area and, therefore, have more potential as a developable resource than those in the Southern Area. The bottom areas at dump sites in the Bight Apex already have been contaminated by sewage sludge and dredged material dumping. Thus, deposits in these areas may be unusable, or of limited use, without decontamination. In contrast, the sand and gravel deposits within the Southern Area are clean.

b. Oil and Gas. Designation of a dump site in the Southern Area would have a minor adverse impact on the development of oil and gas (Figure 6) off New Jersey (OCS Lease Tract #40). The Northern Area is approximately 111 km (60 n mi) northeast of the tentatively selected tract (Figure 6); use of the Northern Area for sludge dumping could not possibly conflict with the development of this oil and gas lease tract.

Potential conflicts with oil and gas development include:

- Constraints upon pipeline routing because of contaminated bottom sediments. Of course, the pipelines could be routed such that conflicts would not occur.

- Increased difficulty of monitoring and assessing the extent and impact of pollution related solely to oil and gas development.

- Damage to, or elimination of, sport fisheries that could be expected to establish around offshore structures. However, the development of a viable sport fishery 148 km (80 n mi) from the New Jersey coast is difficult to envision at this time.

- Navigation hazards from sludge barging operations (Section VIIB) during drilling, construction, and off-loading operations (BLM, November 1975).

- Increased turbidity from dumping activities that could interfere with maintenance and repair work (BLM, November 1975).

Whether these potential problems will occur depends on the overlap between sludge dumping and offshore oil development. Currently, the BLM intends to lease OCS Tract #40 in May 1976. If an alternate dump site were located in the Southern Area, the two activities could conflict as early as the summer of 1976.

4. Loss of Sewage Sludge as a Potentially Valuable Resource

In theory, the costs of sludge disposal can be significantly reduced by using the material as a soil conditioner,

fertilizer, or energy source (Section VA). Thus, ocean dumping of sewage sludge represents the loss of a potentially valuable resource.

a. Metropolitan Area Sludges. The opportunity for recovering value from sewage sludges generated in the New York-New Jersey metropolitan area appears to be limited to incineration and/or pyrolysis.

On the basis of cost-effectiveness and environmental acceptability, the ISC Phase 1 report clearly favors pyrolysis over the other major land-based alternatives (Section VA). The net cost factors, environmental constraints, and implementation timeframe of the alternatives studied are shown in Table 31.

The Phase 1 report concluded that the sewage sludge produced by most of the treatment facilities in the metropolitan area is unsuitable for use as a soil conditioner or fertilizer because of its high heavy metals, and toxic organics content, and low nutrient content. This is not expected to change in the near future. Only a few sources of sludge, low in heavy metals and toxics, were considered suitable for land application (Section VA).

The ISC's conclusions and recommendations are included in Appendix B.

b. Future Value. As ocean dumping costs increase, the value of sewage sludge as a source of thermal energy will become more important in evaluating the net costs for any alter-

TABLE 31

COMPARISON OF ALTERNATIVE SEWAGE SLUDGE DISPOSAL METHODS FOR THE METROPOLITAN AREA

Disposal Method	Net Cost	Environmental Constraints	Implementation Timeframe
Land Application[1]	$121-132/ metric ton (dry)	Heavy metals and nitrates contamination of ground and surface waters.	2-3 years
Incineration or Pyrolysis[1]	$52/metric ton (dry)	Particulate matter, gases, residues, and odors.	5-10 years
Disposal as a Saleable Product[1] (drying)	$66/metric ton (dry)	Heavy metals and insufficient nutrients (N, P, and K)	4-5 years
Ocean Dumping[2]	$18-40/ metric ton (dry)	Heavy metals, coliforms, nutrients, organics, pesticides	--

Sources:

[1]ISC, 1975.

[2]See Table 9 for projected sludge volumes and Table 30 for sludge hauling costs.

native disposal method. Implicit in EPA's intention to phase out ocean dumping by 1981 is the belief that land-based disposal alternatives will eventually be cost-competitive with ocean dumping.

At present, the ocean dumping of sewage sludge cannot be considered a significant loss of a valuable resource. The future value is dependent upon the costs associated with implementation of the incineration and/or pyrolysis alternative. It is quite possible that this alternative may prove cost-competitive with ocean dumping for most present municipal waste generators.

D. IMPACT WITH RESPECT TO OTHER DUMPING ACTIVITIES IN THE NEW YORK BIGHT

The proposed action should not affect other dumping activities in the foreseeable future. If dredged material is dumped with sewage sludge at an alternate dump site, as requested by EPA (Section IIID), the combined environmental impact will almost certainly be more severe than sludge dumping alone.

1. Dredged Material

At present, it is impossible to predict precisely the environmental impact of dumping both sewage sludge and dredged material at a site within either of the alternate areas. Dredged material dumping was not considered a serious environmental problem until recently. Its effects upon the environment are just now being established.

It is certain that most (90 to 95 percent) dredged material reaches the bottom, based upon historical evidence at the existing dump site. This is in direct contrast to the very small percentage of dumped sewage sludge that reaches the bottom.

2. Wrecks

Relocating the wreck dump site seaward of the Barnegat Navigational Lane (Section IIID) will not environmentally or physically impact upon the proposed action. A potential navigation hazard is most unlikely, since this is the principal reason for relocating the existing dump site. These wrecks might even become a feeding ground for fish and a stimulus to sport fisheries.

3. Other Dumping Activities

Use of the existing acid and chemical wastes dump sites will be phased out with time in favor of land-based disposal methods or process modifications. The cellar dirt dump site will continue to be used as needed, depending upon major construction activity and availability of alternate disposal techniques. At any rate, cellar dirt material is essentially inert and nontoxic to the marine environment.

E. MISCELLANEOUS IMPACTS

The proposed action may result in a number of miscellaneous impacts that are not directly associated with ocean dumping of sewage sludge. These would include potential effects on marine-related recreation (sport fishing, boating, and beach attendance), possible induced population growth in the metropolitan area, and international legal implications.

1. Potential Impact on Marine-Related Recreational Activities

The proposed action is not expected to affect marine-related recreational activities, with the possible exception of sport fishing in the waters at and near an alternate dump site. Sport fishing and pleasure boating in the New York Bight occur mostly in a narrow band, 5 to 20 km (3 to 11 n mi) wide, along the Long Island and New Jersey coasts. Recreational activities within this zone will not be affected by sewage sludge dumping. Sport fish that feed here, and the associated biomass, will be unaffected by the proposed action. Because of the potential for shoreward drift associated with the Southern Area, sport fishing within 46 km (25 n mi) of the New Jersey coast could be impacted by sludge dumping.

Beach attendance, which is critical to Long Island and New Jersey shore resorts, will not be affected by dumping at either of the alternate areas (Section IIG).

2. Effect on Population Growth in the New York-New Jersey Metropolitan Area

The proposed action is not expected to influence population growth in the metropolitan area. This conclusion is

based upon the following observations regarding wastewater treatment and population in the region:

- The decision to provide secondary treatment by 1977 already has been made and is being implemented in the upgrading of existing facilities and the construction of new ones.

- The metropolitan area is receiving sewerage service; the service area is fixed and cannot physically be expanded.

- The population in the metropolitan area is not expected to increase significantly during the next ten years and may even decline. There is no reason to believe that population densities will change in the region.

- The method of sludge disposal does not appear to control, either directly or indirectly, the attractiveness of living in the metropolitan area.

- Increased costs due to the proposed action are insignificant when considering total costs for municipal services.

- Water quality in the metropolitan area should improve as a result of upgrading wastewater treatment. However, this cannot be considered a significant factor in attracting people to the area.

3. International Legal Implications

The proposed action would continue the practice of dumping sewage sludge from the United States in international waters. The United States has established defacto control, based upon and mineral resource development, out to the edge of the continental shelf at the 100 m (328 ft) depth contour and

approximately 85 km (110 n mi) from the Apex. The proposed areas are well within this zone of control.

In February 1976, the United States Senate passed a bill to establish a 200-mile (371 km) fisheries limit. If full legislative action is taken on this bill, it will go into effect in 1977. The UNLOS III Conference may produce similar international controls (Section IIF).

VIII. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSED ACTION BE IMPLEMENTED

The proposed action will adversely affect the benthos at and near an alternate dump site in either the Northern or Southern Area. Sludge dumping will add heavy metals (cadmium, chromium, lead, zinc, and possibly nickel), bacteria (fecal and total coliforms), and organic matter to the marine environment. As the benthic community adapts to these polluted conditions, it will become less diverse, that is, composed of fewer species. Only those species that can tolerate the altered environment at and near the dump site will flourish.

Effects on the benthos will be severe, but localized. Only a small percentage of the sludge solids that are dumped are expected to actually reach the bottom. Most of the sludge will remain suspended in the water column, where it will be subject to degradation by pelagic (free-swimming) organisms.

Sludge dumping will cause bacterial and viral contamination of shellfish (surf clams, ocean quahogs, and sea scallops) at and near the dump site. Benthic organisms, especially shellfish, will also concentrate heavy metals from the sludge in their tissues. To prevent public health hazards from contaminated shellfish, it may be necessary to prohibit shellfishing in the vicinity of the dump site.

Under stormy conditions, sludge particles that have settled on the bottom may be resuspended and transported to adjacent areas. However, sensitive marine resource areas, such

as the Hudson Shelf Valley, are far enough from both the Northern and Southern Areas to remain uncontaminated by transported sludge.

Sludge dumping will produce floatables (oil, grease, and artifacts) in the vicinity of the dump site. None of this material is expected to reach the beaches of Long Island or New Jersey, even under the most extreme weather conditions.

IX. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The proposed action will allow the timely implementation of land-based sludge disposal methods in the New York-New Jersey metropolitan area. At the same time, it will prevent public health hazards and water quality degradation along the shores of Long Island and New Jersey. On the other hand, the proposed action will adversely affect the relatively pristine waters at the alternate dump site. Effects on the benthos will be particularly severe. After sludge dumping is terminated, the alternate dump site area is expected to recover to former levels of productivity and species diversity. However, the time needed for recovery and the extent of recovery will largely depend upon the duration of sludge dumping and the volume of sludge dumped.

Abandoning the existing dump site in the Bight Apex will not insure immediate or even eventual recovery of the area. Contamination of the waters by dredged material dumping, municipal wastewater discharges, combined sewer and stormwater runoff, and other discharges to coastal and harbor waters will continue. The area around the existing dump site will probably remain closed to shellfishing for many years. Although the existing dump site is seriously polluted, its continued use will not endanger public health or welfare or degrade water quality along the shores of Long Island or New Jersey.

Interim use of an alternate dump site in either the Northern or Southern Area will have both short-term and long-term effects on the marine environment. During a dumping operation, dissolved oxygen concentrations in the water column will decrease as soon as sludge is introduced. Shortly after dumping ceases, dissolved oxygen will return to ambient saturation concentrations. Concentrations of dissolved heavy metals in the water column will be slightly elevated during and for a short time after sludge dumping. A long-term effect of sludge dumping will be increased concentrations of heavy metals and organic carbon in sediments.

For the short-term, sludge dumping at a site in the Southern Area may interfere with the potential development of mineral resources (oil and gas, sand and gravel). Gravel deposits at the existing dump site are contaminated and may remain unusable for many years after dumping at the site is terminated.

Certainly for the short-term and possibly for the long-term, sludge dumping at a site in the Southern Area will prohibit the further development of this area's commercially valuable shellfish resources. Whether short-term or long-term closure of the area to shellfishing is necessary will depend on the duration of sludge dumping, the volume of sludge dumped, and the consequent effects.

For the short-term, use of an alternate dump site in either the Northern or Southern Area will pose greater navigation hazards than does use of the existing dump site. The

navigation hazard will increase because more and longer trips to the dump site will be necessary. The highest hazard potential may be expected in the Southern Area if plans to develop the offshore oil and gas resources adjacent to the Southern Area are realized.

X. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The major irreversible and irretrievable resource commitment involved in implementing the proposed action is the cost. Sludge transportation costs will increase by 56 to 69 percent during the interim period (1976 through 1981). Permittees will have to pay an additional 27 to 33 million dollars to use an alternate dump site in either the Northern or Southern Area. These are costs over and above the total transportation costs (48 million dollars) that would be associated with continued use of the existing dump site in the Bight Apex for the same period. Expansion of the existing sludge transportation fleet (Table 6) will not be necessary to implement the proposed action. The total capacity of the existing fleet is sufficient to transport the projected 1981 sludge volumes (Table 9) to either proposed area.

The only other irreversible and irretrievable resource commitment is the sludge itself. The sludge dumped into the ocean during the interim period will be lost to beneficial uses, such as land application and use as fuel. However, the beneficial use of sludge is not immediately implementable, and storing the sludge until it can be used beneficially might be hazardous to the public health.

Use of an alternate dump site in either proposed area will not result in irreversible damage to the area or the as-

sociated marine resources. Sludge dumping will cause short-term impairment of marine productivity at and near the dump site. However, eventual recovery of the area to previous levels of productivity is expected after sludge dumping is terminated.

XI. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY OF GENERAL BACKGROUND

1. The New York Bight (Figure 1) encompasses some extremely valuable marine resources. The Bight currently is used for commercial and sport fishing, navigation, swimming, and recreational boating. It is used for the ultimate disposal of municipal and industrial waste materials, either through ocean dumping or through outfall discharges at the shoreline. In addition, it has the potential for development of mineral resources (oil and gas, sand and gravel), offshore power generating facilities, and deepwater ports.

2. Historically, the New York-New Jersey metropolitan area has used the New York Bight for disposal of its "hard-to-treat" waste materials. For example, in 1975, 4.7 million cu m (6.1 million cu yd) of dredged material, 3.7 million cu m (4.8 million cu yd) of sewage sludge, 2.0 million cu m (2.6 million cu yd) of acid wastes, 130 thousand cu m (170 thousand cu yd) of cellar dirt, and 554 thousand cu m (725 thousand cu yd) of chemical wastes were dumped at sites in and adjacent to the Bight.

3. It is EPA's stated intention to phase out ocean dumping of all municipal and industrial wastes by 1981, provided that the alternative methods of disposal are environmentally acceptable, technically feasible, and economically reasonable. It is EPA's policy not to issue an ocean dumping permit to any municipal or industrial waste generator who is not under a

schedule to develop and implement an acceptable land-based disposal alternative.

4. An EPA-funded study is being conducted by the Interstate Sanitation Commission (ISC) to develop a Regional plan for disposal of municipal sludges which are currently dumped in the ocean. This New York-New Jersey Metropolitan Area Sludge Disposal Management Plan, which is sponsored by the States of New York and New Jersey and by EPA, is scheduled for completion in September 1976. All municipal ocean dumping permittees in the metropolitan area are required either to participate in this plan or to develop and implement their own alternative disposal method.

Phase 1 of the ISC study recommended two basic disposal systems: 1) filter-press dewatering and incineration and/or eventual pyrolysis with maximum energy recovery, and 2) land application where sufficient demand exists for a soil conditioner or fertilizer produced from sludge, and where the application rate amply protects public health and welfare. This Phase 1 study concluded that the pyrolysis system could not be implemented before 1985. However, a less favorable alternative, using multiple hearth incinerators which eventually could be converted to pyrolysis units, could be implemented by 1981 provided that no major legal-institutional problems developed.

Phase 2 of the ISC study is an in-depth investigation of environmental, technical, and economic aspects of the alternatives recommended in Phase 1, and Phase 3 is a study of

legal-institutional problems. The Phase 2 and Phase 3 reports are scheduled for completion in mid-1976; they will be used to prepare the final Sludge Disposal Management Plan.

5. In general, the volume of sludge dumped at the existing sewage sludge dump site has steadily risen since initial designation of the site in 1924. Current projections indicate that, if municipal facilities construction program schedules are maintained, the volume of sludge will increase from approximately 5.1 million cu m (6.7 million cu yd) in 1976 to 10.2 million cu m (13.3 million cu yd) in 1981. This is about a twofold increase.

6. The sludges that are now being dumped in the ocean contain high concentrations of heavy metals (cadmium, lead, mercury, zinc, etc.), which are attributed to the large industrial wastewater contributions to municipal systems in the metropolitan area. The EPA Pretreatment regulations and guidelines, which are aimed at removing industrial pollutants prior to discharge to municipal systems, have not yet been promulgated. A significant reduction in the heavy metals content of municipal sludges is anticipated after these regulations and guidelines are promulgated (expected by 1977) and enforced via municipal National Pollutant Discharge Elimination System (NPDES) permits.

7. The anticipated increase in the volume of sewage sludge to be ocean dumped, its potential adverse environmental impacts, and the timeframe for implementation of land-based al-

ternatives necessitated a study of alternate dump sites. In 1974, EPA and NOAA jointly recommended two mid-shelf areas, the Northern and Southern Areas (Figure 7), as possible locations for an alternate sewage sludge dump site. Oceanographic studies in these areas were conducted by NOAA. These studies were augmented by baseline data collected in a portion of the Northern Area by the Raytheon Company under contract to EPA.

B. COMPARATIVE EVALUATION BETWEEN A NORTHERN OR SOUTHERN ALTERNATE DUMP SITE AND THE EXISTING DUMP SITE

1. Table 32 compares the environmental impacts associated with use of a dump site in the Northern Area, use of a dump site in the Southern Area, and continued use of the existing dump site.

2. Dumping at a site within the Northern Area would result in moderate impacts upon the local marine ecosystem. However, impacts on the benthos (bottom marine organisms) probably would be severe. Closure to shellfishing of the area in and adjacent to the dump site would result in a slight economic loss. Travel time and transportation costs would increase greatly over present time and costs. Threats to the public health or welfare and/or degradation of coastal water quality associated with use of this area would not be expected.

3. Dumping at a site within the Southern Area would result in moderate to severe impacts upon the marine ecosystem. Impacts on the benthos probably would be severe. Closure to

TABLE 32

COMPARATIVE EVALUATION OF A NORTHERN OR SOUTHERN ALTERNATE DUMP SITE AND THE EXISTING DUMP SITE

Affected Component[1]	Northern Area	Southern Area	Existing Dump Site
A. Impacts on Public Health and Water Quality	Very slight potential effects.	Slight potential effects.	Slight potential effects.
1. Swimming	Virtually no potential for pathogen contamination of swimming beaches.	Virtually no potential for pathogen contamination of swimming beaches.	Slight potential for contamination of swimming beaches; no more significant than exists at present.
2. Shellfish	Slight potential for consumption of contaminated shellfish as the area does not have commercially abundant quantities of surf clams or ocean quahogs.	Moderate potential for consumption of contaminated shellfish as the area has commercially abundant quantities of surf clams.	No potential for consumption of contaminated shellfish as the area is closed to shellfishing (Figure 22).
3. Floatables	Very slight potential for floatables reaching beach.	Very slight potential for floatables reaching beach.	Slight potential for floatables reaching beach.
4. Hazards to Navigation	Increased barge traffic, especially through the Precautionary Zone (Figure 5).	Increased barge traffic, especially through the Precautionary Zone (Figure 5). Potential interference with future oil and gas development.	Increased barge traffic, especially through the Precautionary Zone (Figure 5).
B. Impacts on the Ecosystem	Potentially moderate impacts.	Potentially moderate to severe impacts.	Slight impacts.
1. Benthos	A high probability for severe modification of the benthic community.	A high probability for severe modification of the benthic community.	No significant degradation beyond the present state.
2. Fisheries Resources	Slight loss, due to closure, of non-commercial shellfish resources.	Moderate loss, due to closure, of commercially valuable shellfish resources.	Slight impact on shellfish resources, no loss beyond present closure areas.
3. Plankton	Very slight impacts; stimulation of productivity may be offset by toxic effects and turbidity.	Very slight impacts; stimulation of productivity may be offset by toxic effects and turbidity.	Slight impact, if any.
4. Short Dumping	Slight impact upon offshore Long Island waters along the Nantucket Navigational Lane.	Moderate impact upon Hudson Canyon along the Hudson Canyon Navigational Lane.	Very slight impact.
5. Recovery	Moderate potential for recovery of the site following cessation of dumping.	Moderate potential for recovery of the site following cessation of dumping.	Very low potential for recovery if site is moved now or if it is used in the interim.

TABLE 32 (Continued)

COMPARATIVE EVALUATION OF A NORTHERN OR SOUTHERN ALTERNATE DUMP SITE AND THE EXISTING DUMP SITE

Affected Component[1]	Northern Area	Southern Area	Existing Dump Site
C. Economic Impacts	Greatly increased transportation costs.	Greatly increased transportation costs and potential conflicts with commercial shellfishing and mineral resource development.	No significant secondary effects.
1. Sludge Transportation Costs	A 56 to 69 percent increase in sludge transportation costs.	A 56 to 69 percent increase in sludge transportation costs.	No increase in sludge transportation costs besides short-term inflation.
2. Commercial Fishing	Very slight potential for impact upon commercial shellfishing (see A.2 above and Figure 18).	Significant potential for interference with shellfish catches, especially surf clams, shoreward of the area (see A.2 above and Figure 18).	Closed to commercial shellfishing (Figure 22).
3. Mineral Resource Development	No potential resources identified (Figure 6).	Potential conflict with (sand and gravel, oil and gas) resource development (Figure 6).	No effect since sand and gravel deposits are already contaminated.
4. Loss of Sludge as a Resource	No real potential for beneficial use during the short-term future.	No real potential for beneficial use during the short-term future.	No real potential for beneficial use during the short-term future.
D. Impact of Other Dumping Activities	Potentially severe impact if dredged material dumping were to occur.	Potentially severe impact if dredged material dumping were to occur.	Area already contaminated by dredged material.
E. Miscellaneous Impacts	No effect.	No effect.	No effect.
1. Marine Related Recreation	No potential for reaching beaches or near-shore waters.	No potential for reaching beaches or near-shore waters.	Very slight potential for reaching beaches and near-shore waters.
2. Population Growth	No anticipated effect.	No anticipated effect.	No anticipated effect.
3. International Legal Implications	Potential problem in controlling international fishing in the vicinity.	Potential problem in controlling international fishing in the vicinity.	Existing site is within the international 22.2 km (12 n mi) pollution control limit.

[1]The affected components and the effects are discussed in much greater detail in Chapter VII of this EIS. Only the most significant effects are summarized here.

shellfishing of the area in and adjacent to the dump site would result in a severe economic loss. In addition, conflicts would occur with development of mineral resources in and adjacent to this area. Travel time and transportation costs would increase greatly over present time and costs. Threats to the public health or welfare and/or degradation of coastal water quality associated with use of this area would not be expected.

4. Continued dumping of present volumes of sewage sludge at the existing dump site would result in slight additional adverse environmental impact. However, continued dumping of present volumes of sludge would not represent a significant threat to the public health or welfare and/or a degradation of coastal water quality.

C. CONCLUSIONS REGARDING THE CONTINUED USE OF THE EXISTING SEWAGE SLUDGE DUMP SITE

1. Monitoring studies by EPA, NOAA, FDA, and the Town of Hempsted (Section VB) show that sewage sludge dumping at the existing site has not significantly affected the water quality off Long Island or New Jersey beaches. Where contamination of beach quality has occurred, it appears to have been the result of raw and inadequately treated wastewater discharges, combined sewer and stormwater runoff, and other discharges to coastal and harbor waters.

2. Dumping of current volumes of sewage sludge will not have a significant effect on the rather limited benthic community at the existing site. The benthic community would not

recover in the near future if the existing site were abandoned. Furthermore, areas not closed to shellfishing would not be reopened in the near future even if the existing site were abandoned.

3. Continued dumping of present volumes of sewage sludge at the existing site will not have a significant additional effect on water quality in the Bight Apex. Preliminary studies (Mueller and Jeris, unpub.) of pollutant loadings into the Bight Apex indicate that loadings associated with sewage sludge dumping are small (5 percent) in comparison to those associated with dredged material dumping or other pollutant sources (Hudson River input). However, pollutant loadings from dumped sewage sludge are significant and are adversely impacting the benthic community, especially in the vicinity of the dump site.

4. Small quantities of floatables (oil, grease, and artifacts) derived from sewage sludge are present at the existing dump site for short periods immediately after dumping occurs. There is no direct evidence that the washup of floatables on Long Island and New Jersey is attributable to sewage sludge dumping; the probability that these materials result directly from sludge dumping activities is low.

5. Increased volumes of sewage sludge to be ocean dumped represent a potential increase in navigational hazards due to the greater number of trips that will have to be made to the existing dump site, which is located in the Nantucket Navigational Lane.

6. Potential adverse environmental impacts of dumping increased volumes of sewage sludge at the existing site are related to the dispersive characteristics and the assimilative capacity of the Bight Apex waters, which are unknown. Therefore, an expanded program is needed to monitor the impact, especially along the Long Island and New Jersey beaches, and in the Hudson Shelf Valley, of continued dumping at the existing site. Such a monitoring program can be used as a decision-making mechanism for phasing out or abandoning use of the existing dump site to prevent any further significant adverse environmental impacts.

D. CONCLUSIONS REGARDING DUMPING FURTHER OFFSHORE AT EITHER ALTERNATE DUMP SITE AREA

1. Heavy metal, toxic organic, and microbiological contamination of bottom sediment in and near a new dump site will occur after initial use. However, smothering of benthic organisms is not likely to occur, unless dredged material also is dumped there.

2. Dissolved oxygen concentrations in the water column at a new site may undergo short-term decreases following dumping, but these are not likely to significantly affect the ecosystem.

3. The composition of the benthic fauna at a new site may change; the benthic biomass will likely increase in population, but decrease in diversity.

4. Use of a new dump site will result in greatly increased travel time, transportation costs, monitoring costs, and costs associated with U.S. Coast Guard surveillance.

5. Closure by FDA of areas in and near a new dump site to shellfish harvesting, based on potential bacterial contamination, will probably occur.

6. There is an increased probability that short dumping, including emergency dumping, will occur. Increased manpower and equipment will be needed by the U.S. Coast Guard to provide adequate surveillance against illegal dumping.

7. Since the alternate areas lie within international waters, minor problems with regard to legal control of dumping and commercial fishing may arise. Use of a new dump site will increase the potential for human consumption of contaminated shellfish that have been illegally harvested.

8. Increased transportation time in open ocean waters will increase navigation hazards.

9. Sites can be chosen within each alternate area that will mitigate impacts on the living marine resources of the Hudson Shelf Valley. Water column transport of dumped sludge from either area to the Hudson Shelf Valley is possible, but unlikely.

10. Even if greatly increased volumes of sludge are dumped in either area, adverse impacts on coastal water quality are not expected.

11. The water quality of the Bight Apex will not be significantly improved by implementing the proposed action be-

cause the vast majority of pollutants entering the Apex are from other sources: primarily dredged material dumping, inland run-off, and wastewater discharges.

E. CONCLUSIONS REGARDING SELECTION OF A NEW SEWAGE SLUDGE DUMP SITE

1. Designation and use of a site in each of the alternate areas will result in potential adverse impacts (see previous conclusions) in two separate, relatively pristine areas, rather than in one.

2. The comparative evaluation of the alternate areas is summarized in Table 32. The major differences between optimum sites in the Northern and Southern Areas are:

- The Southern Area has greater existing and potential shellfish resources than does the Northern Area. Thus, dumping would have a greater adverse impact if a site were designated in the Southern Area.

- The Southern Area contains or is adjacent to potential mineral resources. Dumping activities in this area could conflict with the development of these resources and could compound the potential impacts on the environment.

3. If an alternate sewage sludge dump site is to be designated, it should be located in the Northern rather than in the Southern Area.

F. RECOMMENDATIONS

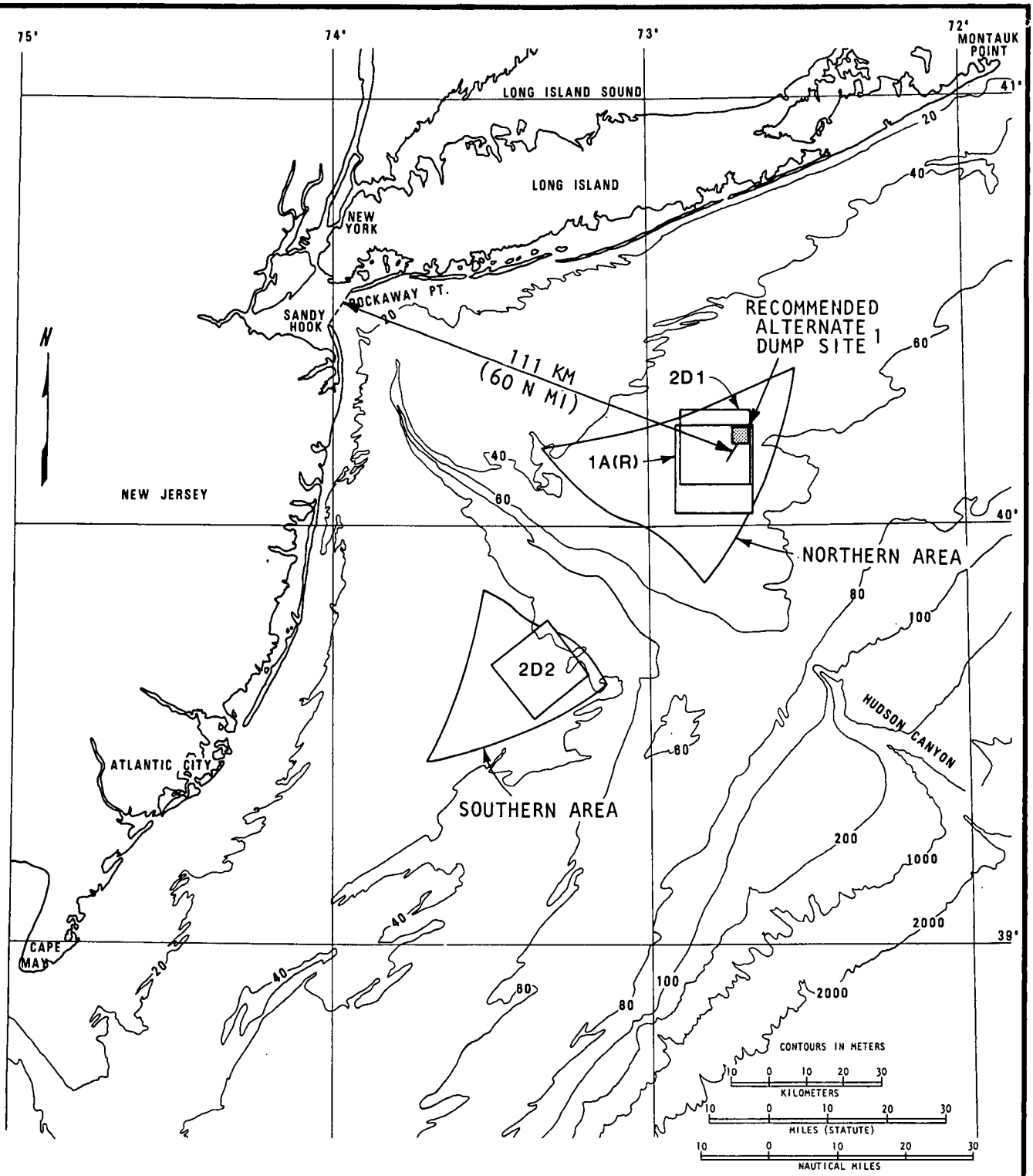
1. The development and implementation of land-based alternatives, which are environmentally acceptable, technically

feasible, and economically reasonable, should be carried forth as expeditiously as possible.

2. The existing sewage sludge dump site should continue to be used.

3. An expanded monitoring program and review process should be developed to determine when and if environmental factors warrant the phasing out or abandonment of the existing dump site. This decision-making process should be directed at the protection of public health and welfare and at the prevention of coastal water quality degradation. In general, the monitoring program should include comprehensive sampling of appropriate parameters upon which a decision to phase out or abandon the existing dump site can be based. In addition, the program should be designed to differentiate between pollutant sources in the Bight Apex.

4. An alternate dump site should be designated in the Northern Area for potential use if and when the existing dump site is abandoned or its use is phased out (Figure 42). This site should be a square, roughly 31 sq km (9 sq n mi) with center coordinates at 72°42' W longitude and 40°12'N latitude, at a depth of 55 m (180 ft). The center of this recommended site is about 61 km (33 n mi) south of Long Island, about 111 km (60 n mi) east of New Jersey, about 45 km (24 n mi) from the Hudson Shelf Valley, and about 111 km (60 n mi) from the Sandy Hook-Rockaway Point transect.



RECOMMENDED ALTERNATE DUMP SITE

[1]CENTER COORDINATES OF RECOMMENDED DUMP SITE ARE 40°12'N, 72°42'W

DAMES & MOORE

FIGURE 42

5. This site offers the following advantages:

- It is located in a deep section. Thus, because of its greater depth, there will be a low potential for resuspension of bottom sediments due to surface and/or internal waves, and wind-driven currents. In addition, nearby deeper troughs of the Long Island Shelf Valley will act as potential traps for sludge contaminants, inhibiting the bottom transport of contaminants into adjacent areas.

- It is distant from the Long Island and New Jersey shorelines and from the Hudson Shelf Valley. The Long Island beaches are located up drift of the prevailing coastal currents. Thus, it is an optimum location with a very low potential for transport of contaminants to either the coastal areas or the Hudson Shelf Valley.

- It has neither significant biological resources (shellfish) nor known potential mineral resources (oil and gas, sand and gravel).

- Oceanographic studies, including those of NOAA and the Raytheon Company, provide a data base for future trend assessments, if the site is actually used.

6. The existing method of ocean dumping, uniform discharge in the transportation vessel's wake, should be continued.

7. Studies of the oceanographic conditions and characteristics of the New York Bight by NOAA should be expanded to bring a clearer understanding of this complex ecosystem. To this end, studies by the NOAA-MESA New York Bight Project should

be supported, especially studies on pollutant loading and the dispersive and assimilative characteristics of Bight waters.

8. The environmental impact of ocean dumping by the COE at the existing dredged material dump site should be studied in detail. Studies of alternatives by the COE should be expedited in order to eliminate the ocean dumping of dredged material as soon as possible.

ABBREVIATIONS USED

BOD	-	biochemical oxygen demand
BLM	-	Bureau of Land Management
cm	-	centimeter
cm/sec	-	centimeter per second
COD	-	chemical oxygen demand
CFR	-	Code of Federal Regulations
cu m	-	cubic meter
cu yd	-	cubic yard
°C	-	degrees Centigrade
°F	-	degrees Fahrenheit
EIS	-	environmental impact statement
FWPCAA	-	Federal Water Pollution Control Act Amendments
ft	-	feet
FDA	-	Food and Drug Administration
in	-	inches
in/sec	-	inches per second
ISC	-	Interstate Sanitation Commission
kg	-	kilogram
kg/day	-	kilogram per day
km	-	kilometer
MPRSA	-	Marine Protection, Research, and Sanctuaries Act of 1972
MPN	-	most probable number
m	-	meters

ABBREVIATIONS (Continued)

ug/kg	-	microgram per kilogram or millionth gram per kilogram
ug/l	-	microgram per liter or millionth gram per liter
μ	-	micron
mg	-	milligram or thousandth gram
mg/l	-	milligram per liter
ml	-	milliliter or thousandth liter
ml/sq m/hr	-	milliliter per square meter per hour
NASA	-	National Aeronautic and Space Administration
NEPA	-	National Environmental Policy Act
NOAA	-	National Oceanic and Atmospheric Administration
NOAA-MESA	-	National Oceanic and Atmospheric Administration-Marine EcoSystems Analysis
NOAA-NMFS	-	National Oceanic and Atmospheric Administration-National Marine Fisheries Service
n mi	-	nautical miles
OCS	-	outer continental shelf
ppm	-	parts per million
PVSC	-	Passaic Valley Sewerage Commissioners
lb/ac/day	-	pounds per acre per day
lb/day	-	pounds per day
sec	-	second
sq	-	square

ABBREVIATIONS (Continued)

SPM	-	suspended particulate matter
SS	-	suspended solids
TCH	-	total carbohydrates
TKN	-	total Kjeldahl nitrogen
TOC	-	total organic carbon
COE	-	U.S. Army Corps of Engineers
USCG	-	U.S. Coast Guard
EPA	-	U.S. Environmental Protection Agency
EPA-Headquarters	-	U.S. Environmental Protection Agency, Headquarters
EPA-Region II	-	U.S. Environmental Protection Agency, Region II
UNLOS	-	United Nations Law of the Sea

METRIC EQUIVALENTS OF ENGLISH UNITS

Metric	English
Centigrade (°C)	Fahrenheit (°F)
centimeter (cm)	inch (in)
centimeters/second (cm/sec)	inches/second (in/sec)
cubic meters (cu m)	cubic yards (cu yd)
cubic meters/day (cu m/day)	million gallons per day (mgd)
kilogram (kg)	pound (lb), ton
kilometer (km)	mile, nautical mile (n mi)
kilometer/hour (km/hr)	knot
liter (l)	gallon(g)
meter (m)	foot (ft)
milliliter/square meter/hour (ml/sq m/hr)	pounds/acre/day (lb/ac/day)
square kilometer (sq km)	square nautical mile (sq n mi)

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APPENDIX A

SAMPLE FORM

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT (OCEAN DUMPING) PERMIT

Source: USEPA, November 15, 1975.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

MARINE PROTECTION, RESEARCH, AND
SANCTUARIES ACT (OCEAN DUMPING) PERMIT

PERMIT NO. AND TYPE: _____

EFFECTIVE DATE: _____

EXPIRATION DATE: _____

REAPPLICATION DATE: _____

APPLICANT: _____

WASTE GENERATOR(S): _____

WASTE GENERATED AT: _____

PORT OF DEPARTURE: _____

WASTE TRANSPORTER(S): _____

and any person owning or operating a towing vessel employed for the purpose authorized herein.

This permit authorizes the transportation and dumping into ocean waters of certain material pursuant to the Marine Protection, Research, and Sanctuaries Act of 1972, 33 U.S.C. 1401-1444, (hereinafter referred to as "the Act"), regulations promulgated thereunder, and the terms and conditions set forth below.

General Conditions:

1. All transportation and dumping authorized herein shall at all times be undertaken in a manner consistent with the terms and conditions of this permit. The applicant, waste generator(s) and waste transporter(s) designated above shall be the permittees liable for compliance with such terms and conditions. The liability of each is set forth in the Special Conditions. Compliance by any permittee with one or more but less than all of the conditions with which such permittee must comply will not constitute a ground or grounds of defense in any proceeding against that permittee for violation of the provisions of this permit.

2. Any person who violates any provision of the Act, the Final Regulations issued thereunder, or any term or condition of this permit shall be liable for a civil penalty of not more than $50,000 for each violation. Additionally, any knowing violation of the Act, Final Regulations, or permit may result in a criminal action being brought with penalties of not more than $50,000 or one year in prison, or both.

3. a. Transportation to, and dumping at any location other than that authorized by this permit shall constitute a violation of the Act and of the terms and conditions of this permit.

b. Transportation and dumping of any material not identified in or significantly in excess of that identified in the application for this permit, unless specifically authorized by a written modification hereto, shall constitute a violation of the Act and of the terms and conditions of this permit.

4. Nothing contained herein shall be deemed to authorize, in any way, the transportation from the United States for the purpose of dumping into the ocean waters, into the territorial sea, or into the contiguous zone, of the following material:

a. High-level radioactive wastes.

b. Materials, in whatever form, produced for radiological, chemical or biological warfare.

c. Persistent synthetic or natural materials which may float or remain in suspension in the ocean.

5. The applicant may not apply for, nor any permittee simultaneously hold, a permit from another EPA Regional Office for any of the material to which this permit is applicable, nor may the applicant or any permittee transfer material from one EPA Region to another if a permit for the transportation or dumping of such material has been denied by one EPA Region.

6. After notice and opportunity for a hearing, this permit may be modified or revoked, in whole or in part, during its term for cause including, but not limited to, the following:

a. Violation of any term or condition of the permit;

b. Misrepresentation, inaccuracy, or failure by the applicant to disclose all relevant facts in the permit application;

c. A change in any condition or material fact upon which this permit is based that requires either a temporary or permanent reduction or elimination of the authorized transportation or dumping including, but not limited to, changes in conditions at the designated dump site, and newly discovered scientific data relative to the granting of this permit.

d. Failure to keep records, to engage in monitoring activities, or to notify appropriate officials in a timely manner of transportation and dumping activities as specified in any condition of this permit.

7. This permit shall be subject to suspension by the Regional Administrator or his delegate if he determines that the permitted dumping has resulted, or is resulting, in imminent and substantial harm to human health or welfare or the marine environment. Such suspension shall be effective subject only to the provisions of 40 C.F.R. 223.2(c).

8. The authority conferred by this permit may, at the discretion of the Regional Administrator or his delegate, be transferred to a waste transporter other than that (those) named herein, provided that a request for such a transfer be made, in writing, by the applicant at least 30 days prior to the requested transfer date.

9. If material which is regulated by this permit is discharged due to an emergency to safeguard life at sea in locations or in a manner not in accordance with the terms of this permit, one of the permittees shall make a full report, in accordance with the provisions of 18 U.S.C. 1001, within 10 days to the Regional Administrator detailing the conditions of this emergency and the actions taken.

10. Unless otherwise provided for herein, all terms used in this permit shall have the meanings assigned to them by the Act or the Final Regulations issued thereunder.

11. The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of rights, nor any infringement of Federal, State or local laws or regulations, nor does it obviate the necessity of obtaining State or local assent required by applicable law for the activity authorized.

12. This permit does not authorize or approve the construction of any onshore physical structures or facilities or, except as authorized by this permit, the undertaking of any work in any navigable water.

13. Each permittee shall at all times maintain in good working order and operate as efficiently as possible all facilities, including vessels, used by such permittee in achieving compliance with the terms and conditions of this permit.

14. This permit, or a true copy thereof, shall be placed in a conspicuous place on the vessel which will be used for the transportation and dumping authorized by this permit. If the dumping vessel is an unmanned barge, the permit or true copy of the permit shall be transferred to the towing vessel or an additional true copy shall be available onboard the towing vessel.

15. In accordance with 33 U.S.C. 445, every scow or boat engaged in the transportation of municipal sludge or industrial wastes shall have its name or number and owner's name painted in letters and numbers at least fourteen inches high on both sides of the scow or boat. These names and numbers shall be kept distinctly legible at all times, and no scow or boat not so marked shall be used to transport or dump any such material.

16. The permittee(s) shall provide telephone notification of sailing to Captain-of-the-Port, (COTP) New York at 212-264-8753 during working hours (8:00 AM to 4:30 PM Monday through Friday) and to 212-264-8770 during the non-working hours, weekends, and holidays not later than two (2) hours prior to the estimated time of departure. The permittee(s) shall immediately notify the COTP upon any changes in the estimated time of departure greater than one hour.

17. The following information shall be provided in the notification of sailing:

a. Name of the towing vessel and barge or tank vessel

b. Name of the transporter

c. Description of the vessel's contents including volume

d. Place of departure

e. Location of the dump site

f. The time of departure

g. Estimated time of arrival at the dump site

h. Estimated time of return to port.

18. The permittee(s) shall maintain and submit Coast Guard Form CCGD 3-278, Monthly Transportation and Dumping Log, to COTP, USCG, c/o New York Station, Governors Island, New York, N.Y. 10004. Permittee(s) shall enter on this form under the column entitled "Dump Site" the latitude and longitude at which the actual dumping occurred. These forms are to be mailed to the Coast Guard during the first week of the succeeding month for which they were prepared. If additional forms are required, they may be obtained by forwarding a written request to Commander (mep), Third Coast Guard District, Governors Island, New York, N.Y. 10004. Copies of these logs will be forwarded on a quarterly basis to: U.S. Environmental Protection Agency, Surveillance and Analysis Division, Edison, N.J. 08817, Attn: Marine Protection Program.

Special Conditions:

1. This permit shall expire at midnight on _____. This permit is nonrenewable. Application for a new permit must be submitted to EPA at least 180 days prior to expiration of this permit.

2. During the term of this permit, the type and quantity of material permitted for transportation for the purpose of ocean dumping shall be in accordance with the following:

_____ gallons of municipal sewage sludge

which shall mean those sludges which result from

primary, secondary, or digestion of municipal

wastes.

3. Disposal Site - Transportation for the purpose of ocean dumping shall terminate at, and waste dumping shall be confined to, the area described below:

Latitude: 40° 22' 30" N to 40° 25' 0" N

Longitude: 73° 41' 30" W to 73° 45' 0" W

4. Method of Disposal - (a) The permittee _____ shall use only the following vessel(s)/barge(s) for transportation and dumping of wastes authorized under this permit:

_____

_____

(b) Waste is to be discharged at a uniform rate over a distance of at least _____ nautical miles within the disposal site designated in Special Condition No. 3. Vessel/barge traverses shall be at least 0.5 nautical mile apart. If two or more vessels/barges are discharging simultaneously, or if any two or more vessel/barge trips are to occur within one hour of each other, a distance of at least 0.5 nautical mile is to be maintained between discharges.

(c) If the waste cannot be uniformly discharged as required above, the permittee _____ shall, within 30 days of issuance of this permit, provide to EPA in writing, detailed technical information, certified by a naval architect or marine engineer, as to why this condition cannot be met. A time period of not more than one year from the date of issuance of this permit will be allowed for the installation of equipment or systems necessary to meet the uniform discharge requirement.

5. Analysis of Authorized Wastes - (a) Analyses shall be conducted monthly on a representative sample of a vessel/barge load for the following parameters:

Bioassay using the organism *Artemia salina* and/or any substitute organism designated to be more appropriate by EPA, Region II.

Mercury (mg/kg), liquid and solid phase

Cadmium (mg/kg), liquid and solid phase

Specific gravity at 20°C

Oil and grease (mg/l), using liquid-liquid extraction with trichlorotrifluorethane.

Petroleum hydrocarbon (mg/l) using tentative IR procedure

Fecal coliform (MPN/100 ml)

Total coliform (MPN/100 ml)

Analyses shall be conducted quarterly on a representative sample of a barge/vessel load for the following parameters:

Bioassay using the organisms *Skeletonema costatum*, *Acartia tonsa* or *Acartia clausii*, *Menidia menidia* and/or any substitute organism designated to be more appropriate by EPA, Region II.

Arsenic (mg/l)	Lead (mg/l)
Copper (mg/l)	Zinc (mg/l)
Vanadium (mg/l)	Chromium (mg/l)
Nickel (mg/l)	Total solids (mg/l)
COD (mg/l)	Suspended solids (mg/l)

(b) Analytical data will be submitted to EPA, Region II, on a monthly basis, with the first report due no later than 30 days following the initial discharge.

(c) All analyses will be conducted according to one of the following:

(1) Specific analytical procedures distributed by EPA, Region II;

(2) Approved test procedures contained in "Guidelines Establishing Test Procedures for Analysis of Pollutants," 40 C.F.R. 136; or

(3) Test procedures selected by the permittee and approved by EPA, Region II.

(d) Within 20 days of effective date, the name and address of the designated laboratory and a description of all analytical test procedures being used shall be provided to the EPA, Region II.

(e) Any laboratory employed for purposes of performing the analyses specified in Special Condition No. 5(a) shall maintain a viable analytical quality control program. This program will include:

(1) Use of EPA-approved analytical test procedures as listed in Special Condition No. 5(c).

(2) Use of the sample preservation techniques and the holding time specified in the analytical method employed or in EPA manual entitled "Methods for Chemical Analysis of Water and Wastes."

(3) Routine use and documentation of intra-laboratory quality control practices as recommended in the EPA manual "Handbook for Analytical Quality Control in Water and Wastewater Laboratories." These practices will include use and documentation of internal quality control samples.

(f) The laboratory facilities, data, records, and quality control records are subject to periodic inspection by EPA, Region II personnel.

(g) EPA may require analysis of quality control samples by any laboratory employed for purposes of compliance with Special Condition 5(a). Upon request, permittee(s) shall provide EPA with the analytical results from such samples.

6. Monitoring - Permittee(s) may be required, during the term of this permit, to conduct or participate in a monitoring program of the impact of the permitted waste disposal on the marine environment at the designated disposal site, pursuant to 40 C.F.R. 223.1(f) (Supp. 1973).

7. Implementation Plan, Schedule, or Alternative - In accordance with 40 C.F.R. 227.4 (Supp. 1973) permittee _____ shall either:

(a) Participate in the EPA's New York-New Jersey Metropolitan Area Sewage Sludge Disposal Management Program, which has a goal of phasing out ocean dumping by 1981, and upon request actively cooperate in the development of such a program; or

(b) No later than nine months from the effective date of this permit, submit a phase A/phase B plan meeting all the requirements of 40 C.F.R. 227.4 (Supp. 1973).

In the event that the permittee chooses alternative (a) above, it shall submit to EPA, Region II, within 20 days of the effective date of this permit, confirmation, in writing, of its intent to participate in the regional sludge management program.

8. Digester Cleanout - The permittees may dispose of "digester cleanout" wastes at the 106-mile chemical waste disposal site (Latitude 38° 40' N to 39° 0' N, Longitude 72° 0' W to 72° 30' W). Conditions to be imposed on the permittees in relation to disposal of "digester cleanout" wastes shall be:

(a) The permittee shall provide telephone notification of sailing to Captain-of-the-Port, (COTP) New York at 212-264-8753 during working hours (8:00 a.m. to 4:30 p.m., Monday through Friday) and to 212-264-8770 during nonworking hours, weekends, and holidays not later than twenty-four (24) hours prior to the estimated time of departure. The permittee shall confirm the exact time of departure within thirty (30) minutes of the actual departure time, and immediately notify the COTP upon any changes in the estimated time of departure greater than one hour. Within two (2) hours after receipt of the initial notification the transporter will be advised as to whether or not a Coast Guard shiprider will be assigned to the voyage.

(b) Surveillance will generally be accomplished by a Coast Guard shiprider who will be on board the towing conveyance for the entire voyage. His quarters and subsistence while on board shall be provided by and shall be at the expense of the permittee. He shall be treated courteously and afforded free and immediate access to all navigational capabilities on the vessel which can provide information on position, course speed, depth of water, bearings, etc. The notification procedures which will permit the timely assignment of a shiprider are specified in Special Condition 8(a). The following information shall be provided in the notification of sailing:

(1) Name of the towing vessel and barge or tank vessel

(2) Name of transporter

(3) Description of the vessel's contents including volume

(4) Place of departure

(5) Location of disposal site

(6) The time of departure

(7) Estimate time of arrival at the disposal site

(8) Estimated time of return to port.

In addition, the permittee shall maintain and submit the information required above in accordance with the provisions of General Condition 18.

(c) A representative sample of the "digester cleanout" material shall be collected and analyzed by the permittee on each barge/vessel load for the following parameters:

Mercury, liquid and solid phase (mg/kg)
Cadmium, liquid and solid phase (mg/kg)
Petroleum hydrocarbon (mg/kg), using IR procedure
Total solids (mg/kg)
Total volatile solids (mg/kg)
Specific gravity at 20°C

Analyses shall be conducted in accordance with Special Condition 5(c) and submitted to EPA, Region II, no later than 30 days following the discharge.

9. Reports and Correspondence - All reports required by General Condition 18 and Special Conditions 5 and 8 shall be submitted to the following address:

U.S. Environmental Protection Agency, Region II
Surveillance and Analysis Division
Edison, New Jersey 08817
Attn: Marine Protection Program

All other material required by this permit to be submitted to EPA, and related correspondence, shall be sent, in duplicate, to:

U.S. Environmental Protection Agency, Region II
Enforcement Division
26 Federal Plaza
New York, New York 10007
Attn: Status of Compliance Branch

10. Liability - (a) The permittees _____ _____ shall be jointly and severally liable for compliance with Special Conditions 2, 5(a)-(g), 6, and 8(c) as well as all applicable General Conditions.

b. The permittee _____ shall be solely liable for compliance with Special Conditions 4(a) and (c).

c. Any person owning or operating a towing vessel employed for purposes of the activities authorized by this permit shall be, for purposes of each discharge, a joint permittee herein who shall be jointly and severally liable together with the permittee _____ for compliance with Special Conditions 3, 4(b), 8(a)-(b), and all applicable General Conditions.

d. The permittee _____ shall be solely liable for compliance with Special Condition 7.

By authority of Gerald M. Hansler, P.E., Regional Administrator, United States Environmental Protection Agency:

Signed this _____ day of _____ 1975.

_____
Meyer Scolnick
Director
Enforcement Division

APPENDIX B

INTERSTATE SANITATION COMMISSION

PHASE 1 REPORT

CHAPTER III. CONCLUSIONS AND RECOMMENDATIONS

Source: ISC, 1975.

III. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The important conclusions arrived at on the basis of environmental considerations, total costs, technical feasibility, and energy usage are as follows. These conclusions form the basis and backup for the recommendations that are made:

1. Sludge Conditioning and Dewatering

The two methods of sludge conditioning ahead of dewatering are by use of chemicals and by heat treatment. The cost of conditioning cannot be dealt with separately, since conditioning influences the costs of dewatering. The cost of chemical conditioning (lime and ferric chloride or polymers) and then dewatering indicates that the combined cost for the different dewatering equipment falls in the range of $30 to $38 per ton of dry solids, including capital and O&M costs. The choice of dewatering method cannot be made only on the basis of these costs, since the moisture content of the sludge cake produced varied from 80 to 60 percent, and the cost of succeeding processing methods determines which method of dewatering is most cost-effective.

The cost of heat treatment to condition the sludge plus dewatering falls in the range of $66 to $72 per ton of the original dry solids precessed. Because this method of treatment affects the total pounds of sludge remaining and its character, a decision as to which conditioning or dewatering method to use depends on the costs of succeeding processing or disposal methods. If the dewatered sludge is to be disposed of as such, then when using filter pressing, the cost of producing the cake with heat treatment is about double that with chemical conditioning.

However, the heat-treated sludge is sterile and there is about 25 percent net less solids to dispose of. Thus, the difference in the dewatered sludge weight or volume, since both can be dewatered to about 40 percent solids, is about 25 percent. To justify using heat treatment, the reduction in hauling and placement costs would have to overcome the 100 percent differential in conditioning and dewatering costs. The net electric power usage for heat treatment plus dewatering is about 360 kwhr per ton compared to 120 kwhr for chemical conditioning and filter press dewatering.

2. Incineration or Pyrolysis

Incineration of sludge or its pyrolysis are both thermal conversion processes that can permit maximum energy recovery from the heat value of the sludge solids. The two processes are compatible as far as requirements for dewatering are concerned. Also, the multiple-hearth incinerator furnaces can be adapted to pyrolysis. The capital and operating costs and energy recovery potential are comparable, with pyrolysis having a distinct advantage as far as air pollution controls are concerned, and is, therefore, the more desirable sludge processing system from the viewpoint of

potential negative environmental impact on the air resources of an area.

Pyrolysis has another advantage over incineration in that the fuels from the pyrolysis reactor, the gas and char, can be stored and thus uniform feed of a steam boiler furnace can be obtained even if the rate of sludge feed to the pyrolysis reactor is variable.

The total capital and O&M costs for a large-size incineration or pyrolysis plant with maximum heat and energy recovery are about $47 per ton of dry solids in the original sludge when processing digested sludge with a heat value of 5,000 Btu per lb. This alternative uses chemical conditioning and filter presses and a sludge of at least 40 percent solids is obtained.

This system incorporates an afterburner for raising the furnace exhaust gas temperature to 1,400 degrees F. Credit has been taken for $22.50 worth of excess electric power produced (evaluated at 5¢ per kwhr). From this credit there is subtracted $4.60 for cost of power generation equipment, leaving $17.90 per ton. Power recovery becomes practical with a large installation having standby equipment. With heat conditioning and filter pressing the total costs are $80 per ton, and there is no power recovered, although the waste heat can be used in the conditioning process. The total power usage with heat treatment and pyrolysis is 415 kwhr per ton, while with chemical conditioning it is 175 kwhr per ton and 260 kwhr are recovered leaving a net gain of 85 kwhr per ton.

If undigested sludge having a Btu value of 6,500 per lb is processed, the energy recovered is increased so that the total cost of conditioning, dewatering, pyrolysis, sidestream treatment, and including all air pollution controls falls to $31 per ton. Moreover, in this case the sidestream is considerably weaker and, therefore, its treatment becomes less costly than when digested sludge is dewatered.

Incineration or pyrolysis with proper air pollution control equipment and treatment of the liquid sidestreams will permit the control of emissions of particulates, odorous vapors, SO_2, NO_x, volatile metals such as mercury and all other heavy metals to well within all federal and local emission standards. In addition, all toxic chlorinated hydrocarbons, including PCB's, will be destroyed.

This alternative for sludge processing, when combined with chemical conditioning of the sludge, produces a liquid sidestream (even when processing digested sludge), which can be readily treated in the activated sludge process to produce an effluent of secondary treatment quality as far as BOD, COD, NH_3, and suspended solids are concerned. The potential negative impact of this liquid sidestream on water is no greater than that of ordinary treated sewage.

3. Wet-Air Oxidation

This process should not be classed with heat treatment for sludge conditioning, since the latter only accomplishes a very small amount of oxidation of the organic solids; that is, 0 to 5 percent COD reduction of the sludge. For true wet-air oxidation, the COD reduction can be as high

as 75 to 85 percent. Such a high amount of oxidation requires very high reactor pressures (1,500 to 2,000 psi), which makes the process very energy-intensive and costly. An intermediate level of oxidation (600 to 800 psi) produces a total volatile solids reduction of about 40 to 50 percent. In that respect, it is about comparable to anaerobic digestion. The total solids reduction is about 30 to 35 percent. These figures are corrected for the increase in the solids to be processed due to regeneration of solids by the biological treatment of the strong liquor that the process produces.

The intermediate wet-air oxidation process has total costs of $98 per ton of dry solids in the original sludge. If the oxidized slurry is dewatered on a vacuum filter, the additional cost is $5.30 per ton. The high-pressure system has costs of $137 per ton for wet-air oxidation and $4.20 per ton for vacuum filtration of the residue. These costs were developed for processing digested sludges. If raw sludges are processed, the cost per ton decreases somewhat, since no auxiliary fuel is required, but the sidestream produced is somewhat stronger in BOD, COD, and NH_3. The total costs remain essentially the same as given above. Thus, for processing undigested sludge the total costs, including dewatering of the residue, but not including disposal of the residue, is $103.30 as compared to $31 for the pyrolysis system, which also does not include the cost of ash disposal. The wet-air oxidation process is very energy-intensive, consuming 800 kwhr per ton for all operations, including sidestream treatment and odor control. If the power costs are less than 5¢ per kwhr, the above-indicated cost difference between wet-air oxidation and pyrolysis will be, of course, somewhat less. For example, if power costs are 3¢ per kwhr, the wet oxidation costs drop to $87 per ton and the net cost of the pyrolysis system rises to $36.50.

Wet-air oxidation generates a liquid sidestream having a BOD_5 of up to 10,000 mg/l, a COD of 20,000 mg/l, and NH_3 of 1,200 mg/l. A large portion of the COD is not biodegradable, and consists of various unknown organic complexes. This liquid sidestream presents a very serious potential negative environmental impact on our surface water resources. This sidestream also is odorous and the vapors from it must be put through odor control equipment. Also, the handling and treating of this sidestream will produce nonpoint odor sources which are difficult to control. The environmental assessment of this sludge processing system (including both the Zimpro and Barber Colman designs) indicates serious potential negative impacts on air and water resources of the area.

Other negative features of wet-air oxidation are the safety hazards associated with high-pressure reactors and serious corrosion-erosion-deposition problems in piping and heat exchangers (Department of Defense, 1973).

4. Oil-Medium Dehydration and Combustion (Carver-Greenfield System)

This system accomplishes dewatering of the liquid sludge by mixing it with No. 2 or No. 4 fuel oil in proportions of 1 part of solids to 6 - 10 parts of oil, evaporating the water in a multi-effect evaporator, and then separating the oil from the solids in a centrifuge. The use of waste oils and fat skimmings from sewage treatment plants could replace some of the fuel oil, but evaluation of this was too indefinite and was

considered not a sufficiently reliable source of oil for carrying on the process. The solids are then incinerated (or pyrolyzed) to produce the steam and power needed to run the system. This system has been used to dewater varicus homogeneous slurries in industrial processes. Some laboratory scale tests made on a heterogeneous sewage sludge (primary and waste activated) indicated that the evaporated and condensed water (liquid sidestream) contained ammonia concentrations up to 3,000 mg/l and total carbon up to 9,000 mg/l. The BOD was estimated as being up to 12,000 mg/l. It was assumed that treatment of this sidestream would have total costs and power consumption similar to that for the sidestream generated by heat treatment of sludge.

Total capital and O&M costs were estimated on basis of information supplied by the manufacturer. Total costs, including sidestream treatment and odor controls, were $106 per ton of dry solids. Information obtained on operation of multi-effect evaporators, with the associated pumps and valves, indicated very high maintenance costs. The system uses up fuel oil in order to produce sufficient steam and power for the process. Power for treatment of the high-strength sidestream must be purchased or additional fuel burned in the boiler and additional power generated for this purpose.

This process produces several negative environmental impacts. The high-strength sidestream has organics not common to domestic sewage. The condensed water (distillate) when exposed to air emits odorous vapors. The large amount of exposed fuel oil in agitated tanks into which the sludge is added produces hydrocarbon-type odors and also does present a fire hazard.

There are no installations of this system processing a heterogeneous sludge mixture. For cost, environmental, and experience reasons, this system cannot be recommended.

5. Land Application

An investigation was made of the cost of applying liquid stabilized (digested) sludge to strip-mine areas in Pennsylvania, about 100 miles from the study area. Even if the heavy metals did not limit the rate of sludge application, and using a rate of 10 tons (dry solids) per acre per year, on the basis of nitrogen limitation, the total costs for applying the area's sludge, including acquisition of land, was between $110 and $120 per ton. The application of 1,000 tons per day, that is, 50 percent of the study area sludge, would require 36,500 acres.

The present heavy metal concentration would limit the safe application rate on agricultural land to 1 to 2 tons per acre per year. If reductions in heavy metal content to one-half of present values could be achieved by enforcement of pretreatment regulations, the application rate could go up to 5 tons per acre per year. This would require double the land area previously indicated and increase the costs to $185 to $195 per ton of dry solids.

Application of either liquid or dewatered sludge to land in the study area and in southern New Jersey is severely limited due to the sandy soil

and the very real hazard of polluting the extensive groundwater resources of the area and in New Jersey. An EPA funded study being carried out by Rutgers University in Ocean County shows that longer-term breakthrough of nitrates can occur with resultant groundwater contamination (Kaplovsky, 1975). Limited quantities of dewatered and stabilized sludge could find use along roadways, grass strips in park areas, on golf courses, etc.

The conclusion arrived at is that direct application to land of a large portion of the study area's sludge is not economical and the cost would be about triple that of the incineration or pyrolysis alternative. The potential hazard of contamination of underground and surface waters with heavy metals is a serious negative environmental impact of such disposal of the study area's sludge. Sewage sludges from modern urban-industrial areas contain many materials that are not "natural" to soils, and hazardous contamination of our land resources with serious long-term effects is possible by uncontrolled and indiscriminate application of such sewage sludges to land.

6. Drying to Produce a Product as a Source for Plant Nutrients

The disposal of the study area's sludge by drying and selling the product to the organic fertilizer and soil conditioner market was given intensive consideration and study. The constraints mentioned under land application in regard to the toxic heavy metals also apply to the dried product. The total cost of drying, including dewatering after chemical conditioning is in the range of $100 to $120 per ton of dry solids, the higher cost being that of a granulated product suitable for bagging. If the product is to have a nitrogen content higher than in normal mixed primary and activated sludge (2 to 4 percent), the cost of fortifying it with, say, urea, must be added.

In comparing this alternative for sludge disposal with incineration or pyrolysis, the costs for the drying operation only should be determined since dewatering and sidestream treatment is common to both alternatives. These costs, including all air pollution controls, are at least $75 per ton of dry solids. The power and fuel costs are those used in all evaluations in this Report. The cost of incineration or pyrolysis is $30.85 per ton, including equipment for energy recovery. The value of the electrical energy recovered is $22.50 for a 5,000 Btu per lb sludge and $32 for a 6,500 Btu per lb sludge. Thus, the incineration or pyrolysis process actually costs only about 0 to $8 per ton of dry solids, or about $5 to $12 per ton of sludge processed when ash disposal is included.

On the basis of the above costs study, in order to justify drying of the sludge for disposal as a soil fertilizer-conditioner, it is necessary that the product be sold for at least $65 per ton at the sludge processing plant. On the basis of present prices for N and P in commercial fertilizers, the value of a 4-5-0-sludge is about $30 - $35 per ton, which values agree with rates presently quoted for dried sludge. Obviously, the drying of the sludge and disposing of the product as indicated is not an economical alternative.

7. Composting to Produce a Product as Source for Plant Nutrients

Composting of sludge stabilizes it by reducing the volatile solids by about 20 to 40 percent, depending on whether digested or raw primary and waste activated sludge are used. During composting a considerable amount of nigrogen is evolved as ammonia. Therefore, a compost from raw sewage sludge will never have more than about 2.2 percent nitrogen. For digested sludge, the compost nitrogen is less than 1 percent.

Composting has been cost estimated on the basis that the operation will be carried on using roofed areas such as not to be affected by the weather, and that artificial aeration will be used to control odors and prevent anaerobic conditions from developing. Composting uses less fuel and power than any other type of sludge processing except anaerobic digestion. However, it requires large land areas and has high labor costs. A large composting facility needs about 0.5 acres per ton of dry solids processed, or a 1,000-ton per day plant will require 500 acres of flat land area.

If the liquid sludge could be transported by barge or pipeline to the composting facility, the high costs of hauling a sludge cake could be avoided.

Using the above criteria, the total costs, not including the cost of land and transportation, are about $75 per ton. This includes all costs associated with dewatering and sidestream treatment. If the costs of dewatering are subtracted, the cost is about $45 per ton. This can be compared with the cost of incineration or pyrolysis with energy recovery, which was about $5 to $12 per ton, including ash disposal, as indicated in the conclusions relating to drying. Thus, to justify composting it is necessary to sell the product for at least $35 per ton. Because compost is low in nitrogen, it would require considerable fortification. If sold as produced, it is doubtful if more than $10 to $15 per ton could be obtained. The inert matter in compost will be between 40 and 50 percent. However, the product is a good conditioner for sandy soils and improves their water-holding capacity. Certainly a small portion of the study area's sludge, particularly that having lower heavy metal content, could be composted and the product used along highways, on lawns, park areas, etc.

This processing method cannot be recommended for handling the major protion of the study area's sludge because of its relative cost and the uncertainty of disposing of a large quantity of the product. Except for possible odors, the process does not generate any negative environmental impacts on air or water.

8. Anaerobic and Aerobic Digestion

Most of the New York City wastewater treatment plants have anaerobic digestion. The purpose of digestion is to reduce the total amount of solids, stabilize the solids, reduce pathogens, and produce a gas that can be burned to generate heat or power. In regard to the incineration and pyrolysis alternatives, it is noted that the cost-effectiveness is

dependent on the heat energy that can be extracted. The volatile solids that are destroyed and converted to methane and CO_2 in the anaerobic digester have a heat value of about 10,000 Btu per lb. To obtain maximum efficiency, a digester must be heated to about 90 degrees F, which is done by burning the gas produced. Also, energy for mixing is required.

The cost analysis showed that the energy recovered from the methane produced, when converted to electrical power, will pay for the costs associated with digestion. Also, analyses showed that if the volatile solids destroyed in the digestion process were pyrolyzed, since their Btu value is 10,000 per lb, the resultant energy recovered will more than pay for all costs associated with dewatering and processing these solids in a pyrolysis system. Therefore, either the digestion and pyrolysis systems, with maximum energy recovery, can pay for their processing costs as far as destruction of volatile solids is concerned.

Therefore, if incineration or pyrolysis is practiced, digestion plants probably should not be expanded or any new ones built. A further advantage is obtained if digestion is not expanded, and that is the considerable decrease in the BOD and ammonia content of the sidestream with resultant reduced costs of treatment.

Aerobic digestion did not receive serious consideration in this study because it is very energy-intensive. The power required to reduce the volatile solids by about 40 percent, using aerobic digestion, is in the range of 35 to 50 percent of that used in the activated sludge process that generated the waste activated sludge. On an average the power consumption will be about 250 kwhr per ton of solids per day , or at 5¢ per kwhr, $12.50 per ton of dry solids processed. The equipment and construction cost for a large plant is about $10 per ton (EPA Process Design Manual, Sludge Treatment and Disposal, 1974). The total cost of aerobic digestion is about $25 per ton of solids, or about twice that of anaerobic digestion when credit is taken for energy recovery from the generated gas.

9. Incineration or Pyrolysis with Solid Wastes

The benefits associated with heat-energy recovery by dewatering chemically conditioned sludge to 40 percent solids with filter presses can be also realized by incineration or pyrolysis in combination with the combustibles in solid wastes. How the sludge is to be fed with the shredded solid wastes into a solid wastes incinerator or pyrolysis unit depends on the type of furnace or reactor and the general design. It may be desirable to dry the sludge cake with heat from the solid wastes combustion, so as to permit a furnace design without providing for evaporation of the remaining water in the sludge cake. The heat-dried sludge could be blown into the furnace separately or mixed with the shredded solids waste material.

Whether this alternative would be attractive economically, over the incineration or pyrolysis of the sludge separately, depends to a large degree on whether the sludge could be dewatered and the sidestream treated at the solid waste processing facility. The hauling of sludge cake over an appreciable distance to the solid wastes facility is expensive and may not be desirable from operational and environmental considerations.

10. Miscellaneous Processing and Disposal Systems Considered

The following sludge processing and disposal systems were considered and evaluated relating to technical feasibility, costs, energy usage, and potential negative environmental impact on land, water, and air. They were considered unsuited for handling the major portion of the sludge produced in the study area for one, some, or all of the above reasons. In some cases, the environmental impact was indeterminate, but feasibility and costs made the proposed systems unsuitable.

1. Landfill of dewatered sludge cake

2. Chemical solidification and disposal in landfill

3. High chlorine stabilization and disposal on land

4. Solvent (amine) extraction and dehydration process

5. Shipping overseas of liquid or dried sludge to desert countries

6. Combustion of sludge on board ships in open seas

7. Mixing sludge with pulverized rock to produce a topsoil (Goordman system)

B. RECOMMENDATIONS FOR FURTHER STUDY

On the basis of the cost studies, technical feasibility, energy considerations, and environmental acceptability, the basic sludge disposal system recommended for the study area is pyrolysis of the sludge solids with maximum recovery of energy. Specifically, the sludge processing system would consist of:

1. Chemical conditioning with lime and ferric chloride.

2. Dewatering using filter presses to obtain a sludge cake of at least 40 percent solids.

3. Pyrolysis of sludge cake in an oxygen-deficient atmosphere to produce combustible gases and a residual char.

4. Recovery of heat energy from exhaust gases and char with a steam boiler and electric power generator.

5. Air pollution controlled by use of a high-energy water scrubber.

6. Treatment of all liquid sidestreams so that before discharge into a receiving water they will be of secondary treatment quality.

Pyrolysis equipment is compatible with incineration; however, it offers some significant advantages in reducing emissions and simplifying air pollution controls. Also, it has better overall economics. Pyrolysis plants have been built for solid wastes; nevertheless, studies should be carried on to develop design parameters specifically for sewage

sludge pyrolysis. Studies to date indicate that a multiple-hearth furnace can, with relatively simple modifications, be converted to a pyrolysis reactor.

It is estimated that it will take about one year to make the necessary small scale plant studies. After that a full-scale demonstration plant appears to be indicated, and its design, construction, and operation will take another 2 - 3 years. After about 4 years the design of actual processing facilities could be started, and they can be placed in operation in about 8 - 10 years after the initial studies are begun. It is recommended that small scale plant studies be started immediately with an equipment manufacturer who is familiar with pyrolysis technology and who builds multiple-hearth furnaces. It is recommended that such studies be funded and carried out concurrently during the Phase II program. Funding sources are being investigated by ISC and EPA.

An incinerator facility design could be started immediately if this seems desirable and pyrolysis units could be added during later expansions, or any existing multiple-hearth incinerators could be converted to pyrolysis units. Sludge dewatering, air pollution control, and energy recovery equipment, with incineration would be compatible with pyrolysis reactors.

In-depth studies in Phase II of the study program should include, in addition to the pyrolysis investigations, the following:

1. For the selected sites, problems relating to sludge transport, transfer, storage, and pumping should be more thoroughly studied. Also, the transport and disposal of residual ash must be investigated, including disposal and its possible beneficial uses.

2. Availability of fresh makeup water at the processing site.

3. On the basis of the projected sludge handling capacity at the planned sites, the total mount of pollutants of concern that will be emitted into the atmosphere per unit time by the facility should be determined and their dispersion indicated.

4. The required treatment of the dewatering and scrubber water sidestreams should be definitely established, including amount of such treated sidestreams that can be recycled. The integration of these treatment facilities with the sludge processing facility should be clearly established.

5. The complete materials handling logistics at the sludge processing facility should be worked out.

1. Incineration or Pyrolysis with Solid Wastes

The possibility of combined incineration whould be investigated in conjunction with the on-going solid wastes study for New York City, and any such resource recovery projects in New Jersey. The use of pyrolysis for heat conversion of solid wastes should be studied at the 1,000 ton per day plant that is being started up at Baltimore and the multiple-hearth furnace being studied in Contra Costa County, California.

If resource recovery systems are to be established for handling the solid wastes, the burning of the shredded combustibles with disintegrated sludge cake or with heat-dried sludge in a boiler-furnace for power production should be investigated. Answers to questions regarding how sewage sludge and solid waste combustibles could be best combined for burning with maximum energy recovery should be forthcoming from work now in progress at public power plants and industrial plants.

In considering heat conversion for energy recovery from solid wastes and sewage sludge, the incineration or pyrolysis site location with respect to the wastewater treatment plants is of considerable importance in connection with the overall economics. In studying the siting for such joint disposal, investigations should be made regarding the location of sludge dewatering facilities, as truck transport and handling of sludge cake is costly.

Obviously, any study of joint disposal of sewage sludge with solid wastes must be closely integrated with the studies relating to solid wastes. The maximum benefits of such disposal, including maximum costs recovery from power generation, will be obtained if, other things being equal, the costs of sludge dewatering, treatment of resulting sidestreams, and transport can be minimized.

2. Land Application for Limited Quantities of Sludge

In the study area there are several wastewater treatment plants that produce sludges that are more suited for land application, especially in regard to heavy metals, than the major portion of the area's sludge. These sludges should be identified and consideration given to use of such sludges, after stabilization (digestion, composting, or high lime treatment), and dewatering, on various suitable land areas such as parks, golf courses, grass strips along highways, etc. Also, it could be used to improve sandy soils where it is desirable to increase growth of natural vegetation.

Such processing of sludges from smaller treatment plants, located near the periphery of the study area, could be more economical than the transport of the sludge to a large processing facility. Proper land disposal, if done with some judgment, should not create any potential environmental hazards.

3. Drying and Composting for Use on Land

It is recommended that some additional verificaiton be obtained in regard to the marketing possibilities, with projections for at least the next 25 years, for dried sludge and also composted sludge for use as soil conditioners and as source of plant nutrients. Limited studies in regard to the costs for producing these products and their selling price at the sludge processing plant, indicate these sludge disposal methods would have net costs considerably higher than incineration or pyrolysis with energy recovery.

Any planned widespread use of the sludge produced in the study area on land, and especially on agricultural land, is contingent on the reduction, by pretreatment and other control measures, of the heavy metal content by at least one-half of present values, and the cadmium to about one-

fifth of its present average value. If this is not possible or practical, then no large-scale and long-term plans for processing this sludge for disposal on land should be made, irrespective of cost considerations.

4. Siting and Transportation

The sites identified in Chapter VI as having potential for serving as the location of sludge processing facilities should be further investigated. Considerations should include:

1. Existing plans for the site and availability
2. Access for materials and personnel
3. Effects on air and on surface and ground waters
4. Effects on neighborhoods
5. Building conditions, including topography and foundation conditions
6. Effects on natural preserves and on recreational areas

Transportation should be further investigated to refine merits of barging versus pumping.

APPENDIX C

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

MARINE ECOSYSTEMS ANALYSIS

DRAFT REPORT

CHAPTER I. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Source: NOAA-MESA, November 1975.

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I. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This section summarizes significant features of the New York Bight's midshelf environment and alternative sewage sludge dumpsite areas 1-A and 2-A (fig. 1), draws applicable conclusions about the effects of dumping sewage sludge at any interim dumpsite in this environment, and presents specific recommendations relative to dumping operations and monitoring activities.

A. Characteristics of the Environment

Features of the Bight's physical environment and biota that relate to the dumping of sewage sludge in the alternative dumpsite areas are summarized by disciplinary category.

Geological oceanography: Field studies within the northern alternative dumpsite area 1-A and the southern alternative dumpsite area 2-A indicate the following:

Seafloor sediments in both areas are predominantly clean sands of medium grain size (1/4 to 1/2 mm), but contain small areas with over 20 percent gravel. The absence of mud deposits indicates thorough reworking of the substrate by storms, which resuspend fine sediment particles and remove them from the studied areas.

Sediment grain-size and bedform data for special survey grid-area/2D1 in northern area 1-A and special survey grid area 2D2 in southern area 2-A (fig. 2) suggest a general transport of sand-sized sediment to the southwest during seasonal storms--"northeasters," which usually occur in winter, but sometimes occur in summer. Data for northern grid-area 2D1 indicate a moderate

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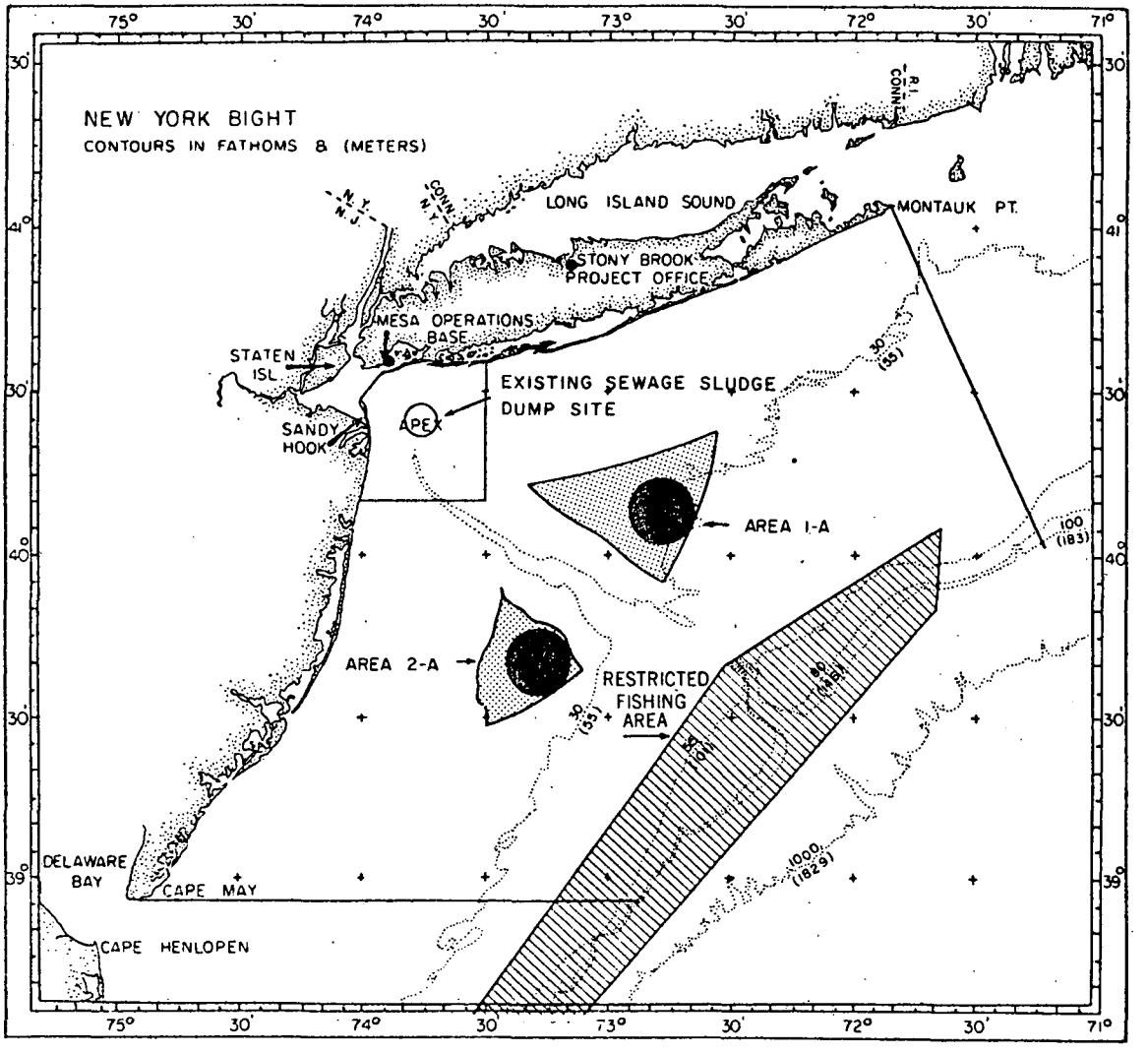

Fig. 1 Existing and proposed alternative sewage dump site area (Area 1-A and Area 2-A). The shaded area along the continental shelf is a no-fishing area established by international bilateral agreements.

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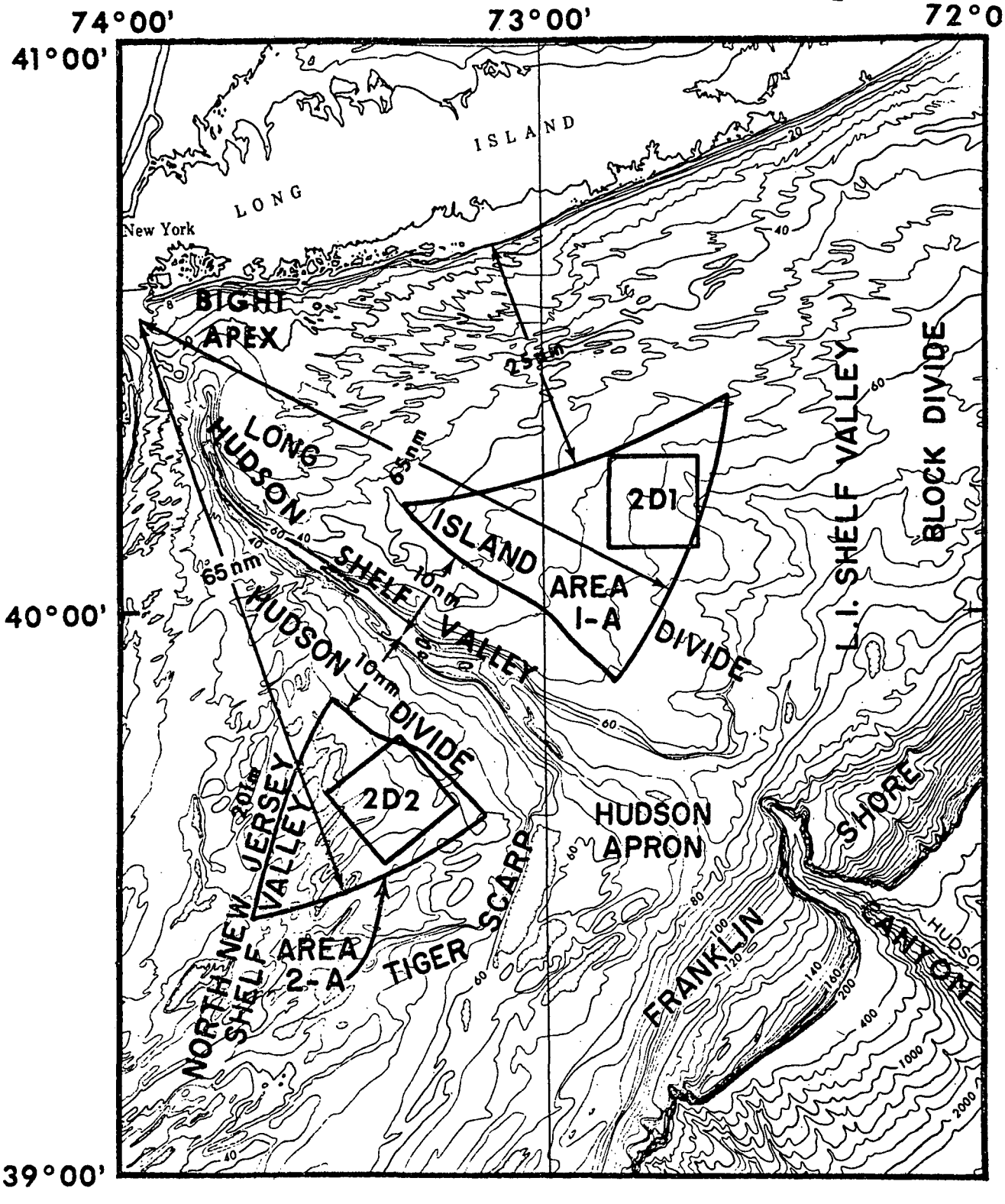

Fig. 2 Proposed alternative dumping area location criteria, New York Bight.

rate of southwest sediment transport over broad, low-gradient, preexisting valleys. Data for southern grid-area 2D2 suggest more intense southwes+ sediment transport. The Hudson Shelf Valley (Fig.2) functions to some extent as a conduit for materials dumped in the Bight Apex.

Physical oceanography: Water-column characteristics and water movements over the midshelf region of the alternative dumpsite areas are predictable, in a general manner. However, sudden climatic events can disrupt general seasonal cycles, cause changes in structure of the water column, and modify the fractionation, settling, and transport of dumped sewage sludge.

The density difference associated with the "cold bubble" that occurs in midshelf waters over the alternative dump-site areas during summer may cause increased amounts of dumped material to reside in the surface water layer. The potential for shoreward transport of material in this surface layer, at the air-sea interface, is greater during summer. In winter, shoreward transport in the surface layer is less.

The flow of shelf waters, below the wind-driven surface layer, is generally southwestward, along depth contours. This flow is highly variable and subject to intense meteorological events, particularly in winter. Midshelf water mixes

with water in the Bight Apex, where currents are also variable. Apex currents are dominated by tidal and meteorological forcing. Wind events sometimes cause varying flow patterns of the order of several days. The previously hypothesized, long-term clockwise eddy motion (gyre) in the Apex has been confirmed for the intermediate-water layer. The near-bottom flow and surface flow in the Apex do not, however, always coincide with the flow in the intermediate water layer or with each other. Short-term current-meter records of near-bottom flow indicate that the gyre may extend to the bottom during the winter season.

Hudson Shelf Valley water, at least beneath rim depth, flows both up and down the Shelf Valley; but, long-term water flow is distinctly up-valley. This up-valley flow and the predominate southwestward flow in upper midshelf waters increase the potential for shoreward transport of sewage sludge that would be dumped in the northern area (northeast of the Hudson Shelf Valley).

There is a subtle shoreward movement of bottom water flow relative to the flow higher in the water column, as shown by current meter records throughout the Bight. Though not fully understood, this movement may be caused by estuarine influences, compensation for offshore surface wind transport, and formation of a boundary layer due to friction.

Chemical oceanography: In the Bight Apex sewage sludge dumping adversely affects the trace metal and organic contaminant loading of sediments, and, to a lesser extent, the water column.

It also adversely affects, to a lesser extent, the oxygen levels in the Apex water mass. The total influence, however, of sewage sludge dumping upon the sediment and water-column is less than the influence of contaminants from other sources.

In the alternative dumpsite areas, sewage sludge dumping could increase chemical species in the water column at the point of introduction. However, rates of dispersal should be sufficient to reduce this effect, except in the immediate discharge plume. There is little contamination of the midshelf region, at least within the limits of the alternative dumpsite areas.

Dilution and dispersion of sewage sludge at the present dumpsite, however, are not sufficient to avoid some influences on the chemistry of the ecosystem. Dilution and dispersion of sewage sludge at either alternative dumpsite area would be greater than at the present site, and would probably result in only local and temporary changes in water chemistry.

Biological oceanography: Outer and mid-portions of the Bight appear relatively pristine insofar as they have been studied. General conclusions follow.

Living marine resources in the midshelf region of the alternative dumpsite areas are typical of those along the Middle Atlantic and New England continental shelf. Benthic assemblages are an essential food supply for most demersal

fishes. They would be altered unpredictably, prehaps only minimally, by the dumping of sewage sludge. These assemblages are distributed fairly homogeneously, on a large scale, in response to the natural features of the region, such as sediment type and bottom relief.

Potential biological impacts of sewage sludge dumped in the alternative areas, based on field investigations and studies in the Bight Apex, include:

1. An increase in the incidence of fin rot.
2. Contamination of sediments and overlying waters by pathogens of man, fish, and shellfish, some of which are resistant to certain antibiotics and heavy metals.
3. Alterations in migratory patterns of bottom-living fishes.
4. Increased concentrations of several heavy metals in fish and shellfish, which are significantly higher than concentrations in these organisms under existing conditions.
5. Modifications of food webs through introductions of detritus and bacteria; and short-term, localized effects on plankton through nutrient enrichment.

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B. Selection of Area, Site, and Disposal Procedure

Certain observed phenomena that will affect the impact of dumped sewage sludge are discussed relative to choice of dumpsite and method of dumping. The following discussion is predicated on the assumption that a clear and definite need for moving the existing sewage sludge dumpsite has been demonstrated, a need which has not yet been demonstrated. NOAA's advice and policy on continued use of the existing dumpsite is contained in letters from David H. Wallace, NOAA's Associate Administrator for Marine Resources, to Gerald R. Hansler, Administrator of Environmental Protection Agency, Region II, dated 17 September 1974 and 6 October 1975. Copies of these letters in Appendix

Selection of alternative dumpsite area: In selecting any dumpsite area, the Hudson Shelf Valley must be considered because: a) it serves as a migration path for certain fishes and shellfish, b) fisheries are now present in and near the Valley, and c) the deeper portion of the Valley is a winter aggregation zone for certain species. Further, water flow in the Shelf Valley is extremely complex, reverses at times, and is difficult to predict.

Current flow on the open shelf of the Bight generally is to the southwest. Variations in this mean flow sometimes show an onshore component. Dissolved and suspended fractions

of dumped material can be expected to move with this prevailing flow, and, at times, move shoreward.

The Hudson Shelf Valley is a sink for a large portion of fine particles that reach it. Material dumped in northern area 1-A is likely to contaminate the Shelf Valley to a greater degree than material dumped in southern area 2-A. Because of the Shelf Valley's importance to living resources, southern area 2-A is more acceptable for disposal of sewage sludge than northern area 1-A.

Selection of specific dumpsite location: It is recommended that any new sewage sludge dumpsite be located within a small portion of the southern alternative dumpsite area 2-A. Specifically, the site should include an area no more than approximately 12 nmi^2 (41 km^2), centered at latitude 39°40'N - longitude 73°18'W, where depths are approximately 40 m (22 fm). Reasons for recommending this location include projected environmental effects, development of an effective monitoring program, and, to a lesser degree, the method and economy of the sewage sludge disposal operations. This site minimizes the possibility of material being dispersed toward and into the Hudson Shelf Valley.

Selection of disposal procedure: There has been much discussion about the merits of containing vs. dispersing of wastes as they are disposed in the marine environment. Dilution over a large area has been advocated by some to minimize environmental problems, while containment of wastes within

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a small area has been advocated by others to preserve the remainder of the environment. In the midshelf region the argument is academic. Sewage sludge will be naturally dispersed and widely distributed, even when dumped at a point source. Dumping over a large area increases costs of dumping operations. Also, development of a system to monitor effects of disposal over a large region will introduce a logistic problem that will be exceedingly expensive to solve.

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C. Monitoring New Interim Dumpsites

Development of a sound monitoring program at any new sewage sludge disposal site is essential to understanding the effects of the dumping. It is recommended that an adequately-funded monitoring program be established. Initial surveys at a new sewage sludge dumpsite must examine the type of waste material to be disposed in context with the rationale for dumping, and the desired ultimate fate of the waste. Knowledge of the proposed site, in the context of regional oceanographic processes, and of the interaction of the injected material with the environment is required. Ideally, the proposed dumping situation should be modeled and independently verified. Once dumping begins at the site, the oceanographic processes and fate of dumped materials, which were hypotheized and modeled, should be verified through a monitoring effort which should include detailed investigations of the dispersive, advective, and density fields, particularly as a function of the oceanographic climatology. If initial assumptions prove valid, then monitoring should continue routinely, utilizing only a few key parameters to check the probabilistic nature of the original predictions. These parameters should be selected on the basis of their usefulness, sensitivity, and ease and rapidity of sampling and analysis. The monitoring program should be designed to be economically reasonable. The objective

of the monitoring should be a biological and chemical assessment of the capacity and growth of the site, the health of the biological community in and around the site, and the extent of movement of material away from the site. If initial assumptions concerning the oceanography in the vicinity of the site fail to withstand the rigors of the field investigations, then the new knowledge should be used immediately to identify and resolve discrepancies, and to make appropriate adjustments in dumping practices, if warranted.

Following is a list of parameters which should be part of the monitoring effort. It should be emphasized that there is no unique tag for measuring the fate or effect of dumped sewage sludge in the marine environment.

Total and fecal coliforms: The distribution and abundance of these organisms in the water column, sediments, and shellfish should be measured. Regardless of weaknesses associated with utilizing coliforms as indicators, they remain the only acceptable standard, and they are indicators of pathogens.

Turbidity: Some measure of turbidity of the water column is useful as a general measure of the advection and dispersion of dumped sewage sludge. Long-term persistence and growth of turbidity in what is now a rather pristine area would be excellent indicators of

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environmental degradation.

Ocean color: Remotely-sensed ocean color information should be considered as a potential indicator of materials from dumped sewage sludge at and near the air/sea interface. Utilization of existing technology and either satellite or high altitude imagery should provide considerable insight into the transport and dispersion of these materials.

Characteristic materials found in sewage sludge: There are a number of byproducts representative of human, animal and industrial wastes in sewage sludge. Physical examination of suspended material and of bottom surficial sediment samples should give, perhaps, the first indication of contamination. Examination of samples for tomato and melon seeds, human hair, fragments of rubber and plastic, and cellulose fibers is suggested.

Dissolved oxygen: Dissolved oxygen in the water column is one of the most critical parameters to monitor. The general health of the environment depends on a sufficient supply of oxygen relative to its utilization to support life and oxidize man-related and natural materials. Close examination of oxygen content is recommended.

Metals in sediments: The distribution and abundance of selected heavy metals in surficial sediments should be monitored at both sites. Atypical metals concentrations are general indicators of a degraded environment.

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Benthic invertebrates: These organisms serve as long term integrators of marine environmental contamination. It is recommended that abundance of selected species be determined. In addition coliform and heavy metal determination should be made in selected shellfish.

Time and space scales, and methods of sampling are not defined at this time. Environmental parameters that require complex instrumentation systems, or massive data collection programs, should be avoided.