Report to the Congress on Ocean Dumping Research

January through December 1976

Public Law 92-532, Title II, Section 201

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
JULY 1977

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Submitted in compliance with Section 201,
Title II of the Marine Protection, Research,
and Sanctuaries Act of 1972
(Public Law 92-532)

July 1977

UNITED STATES
DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

NATIONAL OCEANIC AND
ATMOSPHERIC ADMINISTRATION
Richard A. Frank, Administrator

THE SECRETARY OF COMMERCE
Washington, D.C. 20230

OCT 12 1977

Dear Sirs:

It is my privilege to submit to the Congress this fourth annual report on ocean dumping research.

Under Title II of the Marine Protection, Research, and Sanctuaries Act of 1972, the Congress assigned to the Department of Commerce a responsibility to initiate a program of monitoring and research in order to improve our understanding of the effects of dumping wastes into the ocean. This report is in response to Section 201 of the Act, which specifies that the Secretary shall report on the findings of such research to the Congress at least once a year. The report that follows describes investigations carried out by the National Oceanic and Atmospheric Administration during calendar year 1976.

The NOAA ocean dumping research effort in that year continued the emphasis on the stressed environment of the New York Bight. Our studies of that coastal region are now yielding very practical results that we have used to make timely recommendations to the Environmental Protection Agency to assist that agency in carrying out its regulatory program under the Act. The research that NOAA has conducted in the New York Bight since 1973 has helped us place the problem of ocean disposal in that region in better perspective. For example, it is clear that ocean disposal of wastes can and does have adverse effects on the ecosystem in the vicinity of a dumpsite. However, due to the larger volumes of pollutants entering the region from other sources, ocean dumping contributes a relatively small fraction of the total pollution in the Bight. Enhancement of water quality of that coastal region will require action on a broad front.

The Department of Commerce will continue to fulfill its responsibilities under the law for carrying out research on the effects of ocean disposal wastes to support the regulatory agencies and to improve our understanding of the environmental implications of that practice.

Sincerely,

Juanita M. Kreps

President of the Senate
Speaker of the House of Representatives

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CHAPTER I

INTRODUCTION

BACKGROUND

The Marine Protection, Research, and Sanctuaries Act (MPRSA) was enacted October 23, 1972. The legislation was the result of concern on the part of Congress, the Executive Branch, and the public over the potential harmful effects of continued unregulated ocean waste disposal. The problem of ocean dumping was reviewed by the Council on Environmental Quality (CEQ) in its 1970 report to the President on ocean dumping.[1/] The CEQ report recommended a comprehensive national policy on ocean dumping of wastes to end unregulated ocean dumping and prohibit ocean disposal of any materials harmful to the marine environment. Specific recommendations on the three major categories of dumped waste materials were as follows:

- Dredged material: "Ocean dumping of polluted dredge spoils should be phased out as soon as alternatives can be employed. In the interim, dumping should minimize ecological damage. The current policy of the Corps of Engineers on dredging highly polluted areas only when absolutely necessary should be continued, and even then, navigational benefits should be weighed carefully against damages."

- Sewage sludge: "Ocean dumping of undigested sewage sludge should be stopped as soon as possible and no new sources allowed. Ocean dumping of digested or other stabilized sludge should be phased out and no new sources allowed. In cases in which substantial facilities and/or significant commitments exist, continued ocean dumping may be necessary until alternatives can be developed and implemented. But continued dumping should be considered an interim measure."

- Industrial waste: "Ocean dumping of industrial wastes should be stopped as soon as possible. Ocean dumping of toxic wastes should be terminated immediately, except in those cases in which no alternative offers less harm to man or the environment."

Passage of the Marine Protection, Research, and Sanctuaries Act of 1972 committed the United States on a national basis for the first time to:

> "... regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare or amenities, or marine environment, ecological systems, or economic potentialities."

AGENCY ROLES AND RESPONSIBILITIES

The Marine Protection, Research, and Sanctuaries Act of 1972 is organized into three titles. Title I deals with regulatory aspects of ocean dumping. The Act assigns regulatory authority and involvement to the Environmental Protection Agency (EPA), the Corps of Engineers (COE), and the Coast Guard (USCG). Title II of the Act deals principally with research aspects of ocean dumping that are needed to support the intent of the Act to limit ocean dumping of harmful materials. The research responsibilities described in Title II are to be coordinated by the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), in consultation and coordination with other Federal agencies. Title III of the Act provides for the designation of marine sanctuaries. This Title is administered through the Department of Commerce (NOAA) in consultation with other Federal departments and agencies.

Section 201 of Title II assigns responsibility to the Department of Commerce for a comprehensive and continuing program of monitoring and research regarding the effects of dumping material into ocean waters, coastal waters, and the Great Lakes. The legislation also directs that the Secretary of Commerce will provide to the Congress at least once a year the findings from the monitoring and research program.

SCOPE OF THE 1976 OCEAN DUMPING RESEARCH REPORT

This is the fourth annual report to the Congress prepared by the Department of Commerce pursuant to Section 201 of the legislation. In addition to the Title II research of NOAA, the three previous Department of Commerce reports described the research activities of EPA, COE, and USCG carried out in support of their respective regulatory responsibilities under Title I of MPRSA. Amending legislation in 1976 (P.L. 94-326) directed that those agencies submit to the Congress separate annual reports on their administration of Title I. Therefore, this fourth annual report will describe NOAA research on ocean dumping during calendar year 1976. The EPA report for the same period will include information on interagency coordination, as well as a summary of EPA studies in 1976 on alternatives to ocean dumping.

STATUS OF OCEAN DUMPING

Since April 23, 1973, the effective date of MPRSA, waste dumping in U.S. coastal waters has been regulated by Federal permit. Table 1 lists the amounts of materials dumped during calendar years 1973 through 1976 as reported by EPA and COE.

Table 1.--Comparative levels of ocean dumping activity, 1973-76 (in tons x 10^6)

	1973	1974	1975	1976
Dredged material*	79.8	118.4	105.4	78.6
Municipal waste	4.9	5.0	5.0	5.3
Industrial waste	5.1	4.6	3.4	2.7

* Corresponding figures in millions of cubic yards are: 1973 - 66.5; 1974 - 98.7; 1975 - 87.8; and 1976 - 65.6.

The amount of dredged material dumped in coastal waters in 1976 was less than in 1975. This should not be taken as a trend, because the need to dredge is heavily influenced by natural events such as floods and siltation. A certain proportion of the total dredged material dumped is polluted, particularly spoil excavated from harbors in heavily industrialized areas. It is expected that implementation of the Federal Water Pollution Control Act amendments of 1972 (P.L. 92-500) will eventually lead to a reduction in the levels of untreated wastes entering harbors and other waterways, resulting in a corresponding improvement in the quality of materials dredged from those waters.

The amount of sewage sludge being dumped into the ocean off the Atlantic coast increased slightly in 1976, primarily because of the increase in population in the region and the required secondary treatment of sewage, which yields greater amounts of sludge. The amount of sludge being dumped into the ocean is expected to increase gradually until such dumping is replaced by environmentally acceptable alternative methods of waste disposal. EPA has established December 31, 1981 as a deadline for discontinuing disposal of sewage sludge in the ocean.

The level of industrial waste dumping continues to decline. This trend is the result of several companies adopting other methods of disposal and changes in manufacturing process.

A significant reduction in ocean dumping cannot be achieved until other environmentally suitable methods of disposal are developed and adopted. These methods include, but are not limited to, incineration, pyrolysis, disposal on land, waste recycling, and industrial process changes. For dredged material, some of the options being investigated are: development of habitat through creation of artificial marshes and islands, improved means to confine dredged materials, and various productive uses of dredged material. The EPA and COE reports to the Congress for 1976 describe recent work on alternatives to ocean waste disposal.

CHAPTER II

NOAA OCEAN DUMPING RESEARCH - 1976

During 1976, NOAA research on ocean dumping was focused on sludge dumping in the New York Bight and industrial waste disposal at Deepwater Dumpsite 106 (fig. 1).

OPERATIONS IN THE NEW YORK BIGHT

Waterborne and airborne wastes from the Nation's largest metropolitan complex contaminate waters of the New York Bight. Water quality, particularly in the Bight Apex, has declined over the years. Sites have been designated in the Apex for the disposal of dredged material, cellar dirt, acid wastes, wrecks, and sewage sludge (fig. 2).

The need for information on how pollution affects the New York Bight ecosystem led to the initiation of a major NOAA investigation in 1973 -- the Marine Ecosystems Analysis (MESA) New York Bight Project. The project is designed primarily to determine the sources and distribution of pollutants in the New York Bight and their effects on the ecosystem. A second and broader objective of the project is to understand the major ecological and physical processes in the Bight.

A. Assessment of Contaminant Inputs

During calendar year 1976, studies continued on the relative contributions of natural and man-related inputs to the Bight. Emphasis has been placed on the chemical and mineralogical composition of dredged materials and sewage sludge, especially their transformations as they mix and react with seawater and are dispersed in Bight waters. Many pertinent technical and nontechnical reports have been completed.

Decomposition of Sewage Sludge in Seawater

Decomposition rates of sewage sludge were investigated in 1976. Sediments collected in the area of the sewage sludge dumpsite in the New York Bight Apex contain relatively low concentrations of total organic carbon (0.4 to 5.0 percent dry wt.), despite the continuous dumping of sewage sludge at that location since 1924. Laboratory experiments followed the decomposition processes of the sludge under conditions similar to those found in the dumpsite area. Results showed that the organic fraction of sewage sludge decomposes rapidly under aerobic conditions. Anaerobic conditions, however, are unfavorable for rapid decomposition. Within the temperature range encountered in the Apex, temperature was found to have little effect on the rate of decomposition. Calculations show that aerobic conditions could very well prevail in the

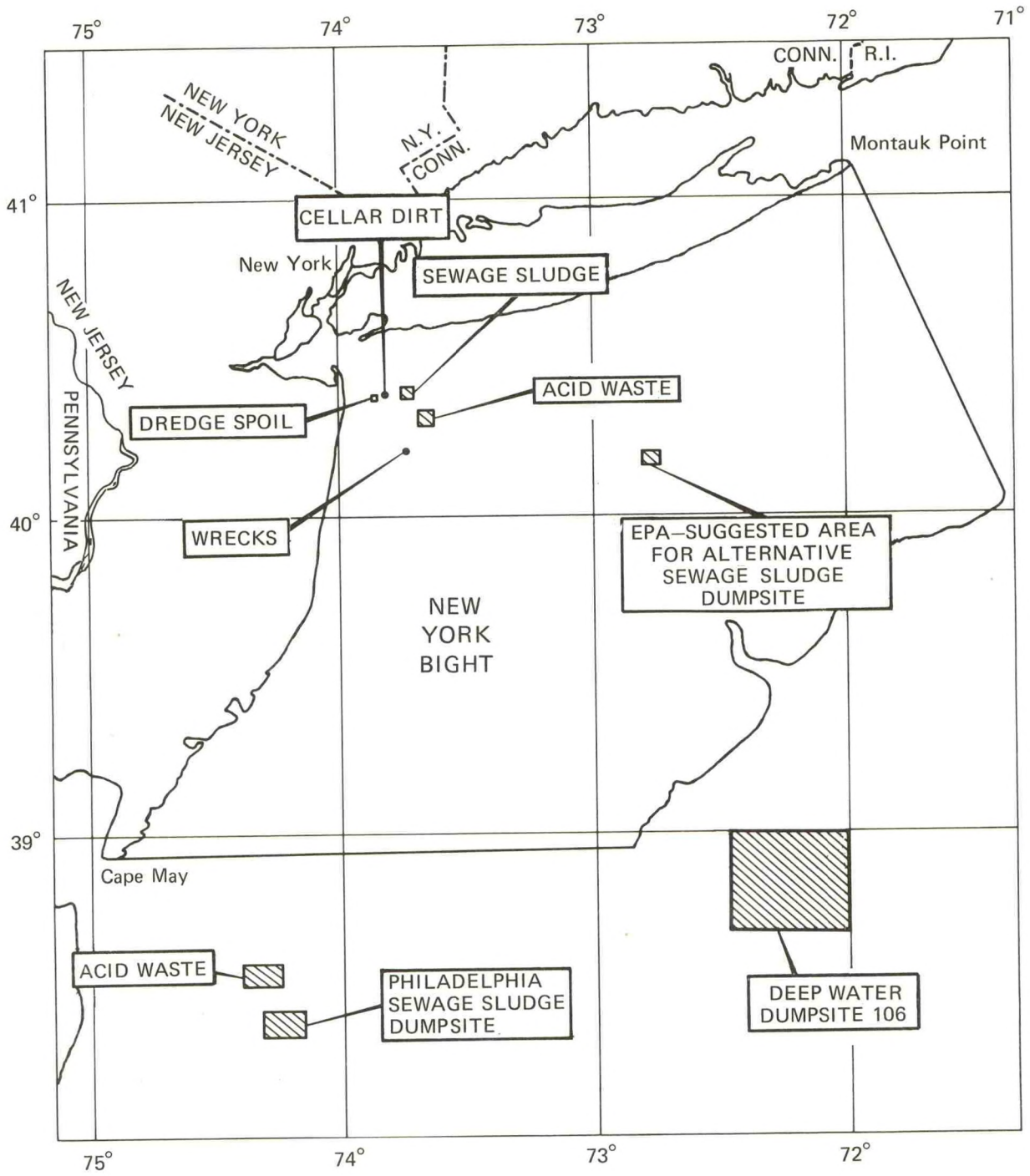


Figure 1.–Middle Atlantic dumpsites.

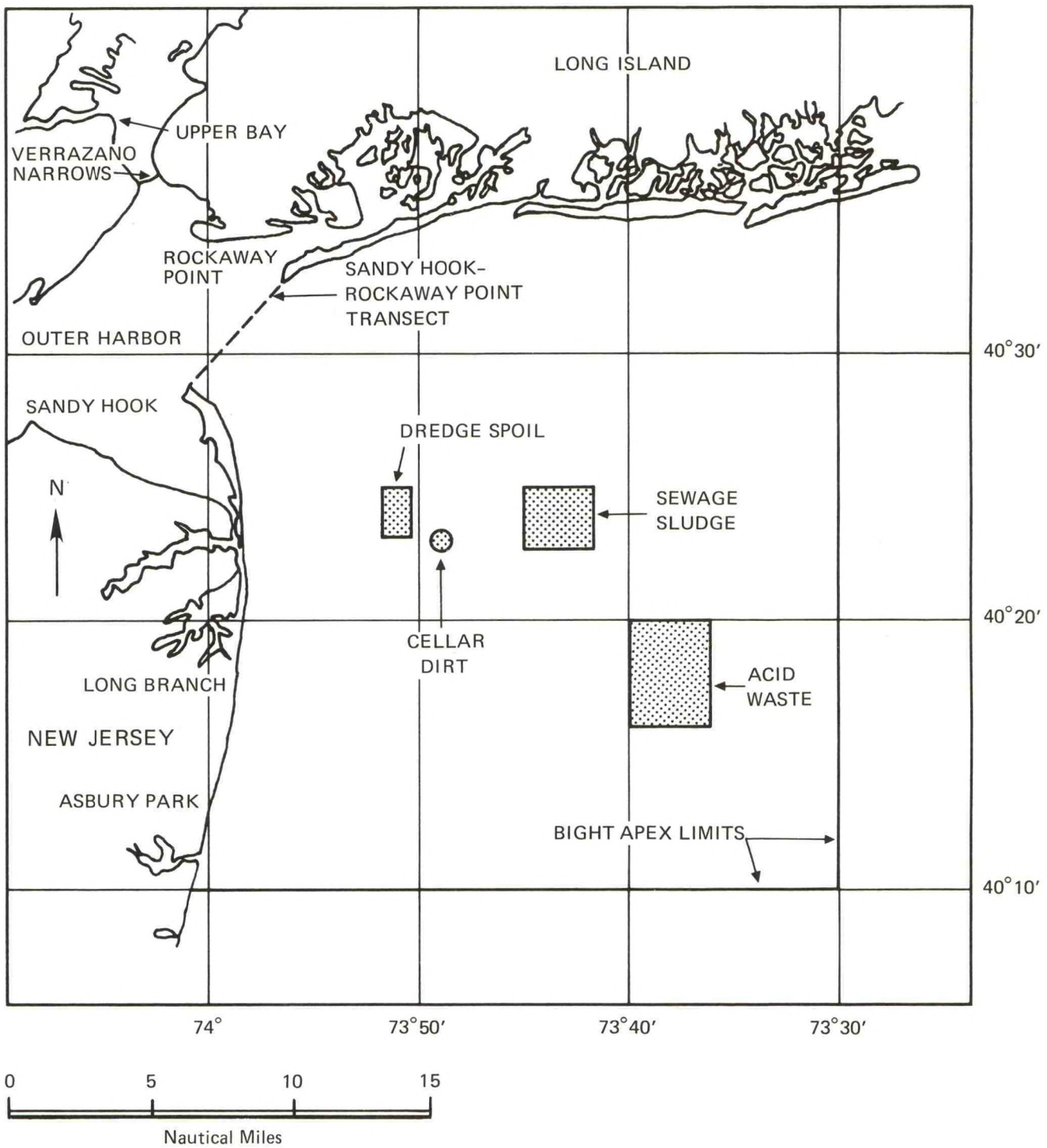


Figure 2.–Existing dumpsites in New York Bight Apex.

dumpsite area, thus promoting rapid decomposition of the sewage sludge, assuming a fairly even distribution of sludge throughout the dumpsite area.[2]

Water Column Perturbations Due to Sewage Sludge Dumping

Water column properties (temperature, salinity, pH, and the concentrations of dissolved oxygen, suspended solids, chlorophyll-a, ammonia, nitrite, nitrate, silicic acid, and phosphate) in the New York Bight Apex were monitored before and for about 2 hours and 40 minutes after a controlled spot dump of 3,000 m^3 of sewage sludge from New York City's Newtown Creek wastewater treatment plant. Ammonia, phosphate, and suspended solids in the discharged sewage sludge dispersion plume caused the greatest perturbations in the water column. The dumping did not significantly affect temperature, salinity, pH, and the concentrations of dissolved oxygen and chlorophyll-a in the water column. Some sewage sludge components reached the bottom (21 m) within 40 minutes after dumping, thus suggesting a relatively rapid descent rate for the particular sewage sludge. Two hours after dumping, the water column above the thermocline (located approximately 17 m below the surface) had nearly returned to its background condition with respect to the variables measured. Below the thermocline, however, concentrations of ammonia, phosphate, and suspended solids remained high for more than 2-1/2 hours. The final report of this study was issued May 1976.[3]

Tracing Contaminants in the Marine Environment

Studies were made to identify any chemical or mineralogical characteristics of sewage sludge that would allow this material to be differentiated from other natural and man-related materials in the Bight. These attempts proved unsuccessful. However, in the case of acid waste material, it was found that the compositional characteristics do provide a means of separating it from either Hudson-Raritan estuarine-derived material or diatom-dominated suspended matter. One of the most profitable results from these studies is that it now appears possible to determine whether most of the material in the nepheloid layer* has settled out of the water column or has been resuspended from the bottom. The chemical-mineralogic differences observed provide an excellent opportunity to examine the resuspension and movement of bottom sediment and suspended materials in the New York Bight. The report on these studies was issued November 1976.[4]

Review of Waste Disposal in the New York Bight

In July 1976 the Project Office published a MESA monograph entitled "Waste Disposal."[5] This monograph reviews the current state of knowledge

* A bottom layer of water, just above the solid sediment, having dense concentrations of particulate material.

of the volumes, sources, and environmental impact of wastes entering the Bight. The report points out that wastes from the New York metropolitan region have been dumped into New York Harbor and the New York Bight for centuries, and as a result, shorelines have been built out, hills on the ocean bottom up to 10 m high have formed, and the head of Hudson Channel has been filled. The waste solids come primarily from rivers (1 million metric tons/yr) and littoral drift of beach sands (1.1 million metric tons/yr), which mix with waste solids discharged by sewers (0.3 million metric tons/yr) and industrial wastes. This material settles in navigation channels where it must be removed by dredging; the material is then dumped into the Bight. Other sources of wastes deposited into the Bight include demolition and construction rubble (0.6 million metric tons/yr), industrial sludges (0.4 million metric tons/yr), and sewage sludge solids from waste treatment plans (0.2 million metric tons/yr). Because of the mixing of riverborne sediments or beach sands with other wastes, the entire sediment load entering the New York Bight from the land must be dredged and handled as a waste.

Contaminant Inputs to the New York Bight

A comprehensive review of the sources and magnitudes of contaminant inputs to the New York Bight was completed in 1976.

Four sources of contaminant inputs were evaluated: barge dumps and atmospheric fallout as direct Bight inputs, and wastewater and runoff as coastal inputs to waters ultimately draining into the Bight. The sources were further subdivided into their various constituents: dredge spoils, sewage sludge, acid wastes, chemical wastes, and rubble from barge dumping; gaged stream flow, urban runoff, and groundwater outflow; and shoreline municipal and industrial wastewater discharges. The wastewater inputs were evaluated only downstream of the gaged stream stations because all inputs above these points are reflected in the gaged runoff values. In addition to flow or volume for each source, 23 separate contaminants were investigated to estimate the inputs of solids, organic matter, nutrients, heavy metals, and microbes.

A large quantity of recent (1970-74) data was obtained from numerous sources, including Federal, State, county, and municipal agencies, and academic institutions. These data were analyzed on a flow-weighted basis to obtain the average mass loads into the New York Bight for each contaminant. A summary of the contribution by source and location was made, as well as an estimate of the annual or seasonal variability for selected sources. To evaluate the significance of the mass loads generated in the study, they were compared to an estimate of the background mass loads entering the Bight as a result of a net current across the ocean boundaries. The study indicates that the quantities of metals, when compared with background levels, are the most significant man-related inputs to the Bight. For example, chromium and lead inputs are approximately 200 percent and 850 percent greater than background levels, respectively. Nutrient inputs via the Hudson-Raritan estuarine complex were identified as potential areas of concern, substantiating previous assessments by MESA.[6/]

B. Sewage Sludge Dumping Investigations

Dispersion of Sewage Sludge in the Marine Environment

During July, a large-scale multidisciplinary investigation of the physical and chemical processes affecting the fate of dumped sewage sludge was conducted. Acoustic devices were used to follow the dispersion and sinking of particulate materials, and to guide the sampling for water and biological samples. The water samples were analyzed for particulate concentration and size distribution, and for chemical transformations between particulate and dissolved phases.

Preliminary results show that most of the dumped sewage sludge proceeds horizontally along the thermocline away from the dumpsite. A portion of the sewage sludge penetrated the thermocline and reached the bottom within minutes after the dump occurred. A minimum speed of descent of 10 cm/sec was observed. The bulk of the sewage sludge settled out or was transported away from the dumpsite within 3 or 4 hours. The finer-grained lighter material, which is predominately organic and contains proportionately much more of the metal and organic contaminants than the more rapidly settling fraction, continued to be examined. The biological element of the sewage sludge tracking experiment is oriented toward the microbiological decomposition of dumped sewage sludge and the associated rates and amounts of oxygen utilization.

Research continued on the origin, extent, and composition of the low-density, high-carbon mud patches that occur seasonally offshore from Long Island. There is some evidence that the positions of these patches vary seasonally, but none that they are moving toward adjacent beaches. There is no compelling evidence that these materials are principally derived from sewage sludge dumped into the Bight. Research on the organic properties of Bight sediments shows that fecal steroids such as coprostanol and 24-β - ethyl coprostanol can be used as tracers of sewage contamination. However, due to the numerous sources of raw and treated sewage to the New York Bight, steroids cannot be used to differentiate the impact on the sediments or suspended matter of any particular source, including dumped sewage sludge. The changes in the size and distribution of the mud patches are being examined by: continuous sidescan sonar recording, grab sampling and analysis of the physical and chemical characteristics of the patches, bottom photography, and direct measurement by divers equipped with graduated rods.

C. Dredged Material Dumping

A review of the impact of dredged material disposal in the New York Bight was undertaken in November 1976. This review assessed the results of New York Bight studies and of other related research, and concluded that:

a. The oxygen demand of the dredged material dumped into the New York Bight is not significant compared to other sources of oxygen demand. It does locally lower the already low oxygen concentrations. The region of such influence will not exceed a few square kilometers, however.

b. The quantity of nutrients released to the water column during dredge spoil disposal is, at most, a minor contributor to nutrient contamination and high summer phytoplankton production in the Bight.

c. The concentrations of some dissolved metals in bottom waters near the dredge spoil dumpsite are above background levels, appear to be persistent, and may extend over a large area of sea floor.

d. The dredged material dumped into the New York Bight is, for a number of elements, the largest input of contaminant trace metals to the area.

e. The concentrations of a number of trace metals are significantly higher in the surface sediments at and around the dumpsite than in any other surface sediments of the Bight. It is not known what proportion of the contaminant trace metals is mobilized to the biota, physically transported away from the mound of dumped dredged material, or permanently buried.

D. Investigations of Effects of Ocean Dumping

Effects on the Bathymetry

A study was done to assess the net bathymetric changes of the Bight Apex between 1936 and 1973, and their implications.[7] The most significant changes occurred in the dredged material dumpsite and the now abandoned dumpsites near Ambrose and Sandy Hook Channels. Dumping at the sewage sludge dumpsite and the acid waste dumpsite has caused no significant changes in water depths at those locations. Approximately 86 percent of the dredged material dumped from 1936 to 1973 is still in place on the bottom. This does not mean, however, that 86 percent of the lighter fraction can be accounted for. It is probable that larger percentages of the heavier materials dumped have remained, and that this percentage decreases as the size fraction decreases. This point is significant because the finer-grained, lighter material is predominantly organic and contains proportionately much more of the contaminants than the more readily accounted for and larger, heavier fraction.

Special Symposium

A Special Symposium on "Middle Atlantic Continental Shelf and the New York Bight" was held in New York City, November 3-5, 1975. The symposium was cosponsored by the American Society of Limnology and Oceanography, Chesapeake Bay Institute of Johns Hopkins University, MESA, and the New York Sea Grant Institute. The session described that marine region in its present state, identified problems, and made recommendations on ways to ameliorate or prevent future environmental damage to that coastal area. The proceedings of the symposium were published in 1976.[8] Summarized in the proceedings are the results of studies focusing on the New York Bight, made generally in conjunction with marine waste disposal

problems. Results from these and other studies were the basis for NOAA recommendations against moving the sewage sludge dumpsite. The symposium summary highlighted several research problems related to ocean dumping which have not yet been solved:

a. Effects of dumping dredged materials or sewage sludge into the Bight cannot easily be separated from the effects of wastes discharged in the estuarine outflows.

b. It is still not possible to distinguish unambiguously the sources of waste products found in the Bight environment.

c. Uncertainty about the possible movements and ultimate fate of dumped materials, due to the variability of natural and man-related events, still constitutes a problem for regulatory agencies at all levels of government in the region.

E. Long Island Beach Pollution

In June 1976, large concentrations of floatable materials washed ashore leading to unprecedented closings of Long Island south shore ocean beaches to swimmers. The seaborne litter included garbage, trash, charred wood, oil, plastics, rubber, and grease (fig. 3). The last three types of floatable material are usually associated with sewage treatment facilities. While there was no confirmation of early claims that raw sewage had washed up on the beaches, analysis of tar and grease balls found among the litter generally did suggest a sewage origin for at least part of the substances included in them. The sewage-related origin of some of the materials led to early reports that the primary source of these floatables was sewage sludge dumped at the Bight dumpsite. An examination of this problem showed that only a maximum of 4 percent of the grease and oil, and 12 percent of the observed plastic tampon applicators could have come from the sewage sludge dumpsite. It can be concluded that sewage sludge dumping in the ocean south of New York was a minor source (less than 12 percent) of the floatable waste materials on the beaches. The major source of these pollutants appears to have been the continuous, high-volume release of floatable wastes to the Hudson-Raritan estuarine system which discharges into the Bight.

This estuarine floatable input was aggravated in May 1976 because of unusually high runoff, which probably flushed more materials than usual from the Hudson-Raritan estuarine system.

Normally the discharge plume from this estuary moves south along the New Jersey coast. In this instance, however, persistent southerly winds forced the plume more toward the east. Thus, there was an unusually large transport of floatables from the Bight toward and onto the Long Island beaches.

MESA studies showed that the oil and grease components of wastewater played a significant role in contaminating the inner Bight via the

Hudson-Raritan estuarine system. Many primary and secondary wastewater discharges reach this estuarine system. In addition, New York City now releases approximately 10.7 m^3/sec (250 x 10^6 gal/day) of raw sewage, together with its floatables load, into the Hudson-Raritan estuary.

A MESA Special Report entitled "Long Island Beach Pollution: June 1976" was released in February 1977.[9] The report concludes that future floatable problems on beaches cannot be prevented until the sources of floatables are clearly identified and their release reduced significantly.

Figure 3.—Typical materials that washed up on Long Island south shore beaches during June 1976.

F. Anoxia Event Off the New Jersey Coast

During the period July to October 1976, extreme oxygen depletion in bottom waters of the western portion of the New York Bight led to mass deaths of many marine species. Mortalities of fish, lobsters, and molluscan shellfish were observed. The sedentary forms -- surf clams, ocean quahogs, and sea scallops -- suffered the greatest mortalities. From surveys, it was estimated that more than one half of the surf clam population off the New Jersey coast -- over 100,000 metric tons -- had

been destroyed by October, with significant but lesser mortalities of ocean quahogs and sea scallops. Lobster catches were reduced by almost 50 percent during the period.

The MESA New York Bight Project and the NOAA Northeast Fisheries Center took the responsibility of examining the causes and effects of the 1976 fish kill off the New Jersey coast. A definitive technical report on the episode is scheduled for September 1977. Results now available indicate that sewage sludge dumping could not have been a significant cause of the problem. First, the area over which the events occurred was too large to be significantly affected by the dumping. Second, the inputs of oxygen-demanding materials from sewage sludge dumping were insufficient to generate such an episode when compared to other man-related and natural inputs. It is also clear that unusual meteorological events contributed to the severity of the oxygen depletion.

G. Remote Surveillance and Monitoring

The MESA New York Bight Project is supporting research and development programs on remote surveillance and monitoring of the effects of ocean dumping on the environment of the Bight.

In April 1973 and 1975, two NASA supported remote sensing experiments were conducted in the New York Bight. In 1976, the MESA New York Bight Project initiated contracts to perform detailed analyses on selected data sets from these experiments, augmenting analysis being conducted independently by NASA. Emphasis is on surface circulation and the determination of chlorophyll-a and suspended particulate distributions. Further, the various sensing systems and interpretive techniques utilizing comparison of data obtained with "sea truth" data taken during experiments is being evaluated. A complete description of the two experiments and an evaluation of the utility of remote sensing methods and data sets for various areas will be produced in 1977. Recommendations for application to future research and monitoring efforts will be included. These reports will:

a. Evaluate ways to correlate computed estimates of surface chlorophyll-a obtained from ocean color scanner data and total particulates determined from surface measurements.

b. Analyze multispectral scanner data and ground-truth data for chlorophyll-a and turbidity, including corrections for overcast conditions.

c. Analyze the utility of photographing dye releases in the New York Bight to determine surface and near-surface circulation.

OPERATIONS AT DEEPWATER DUMPSITE 106

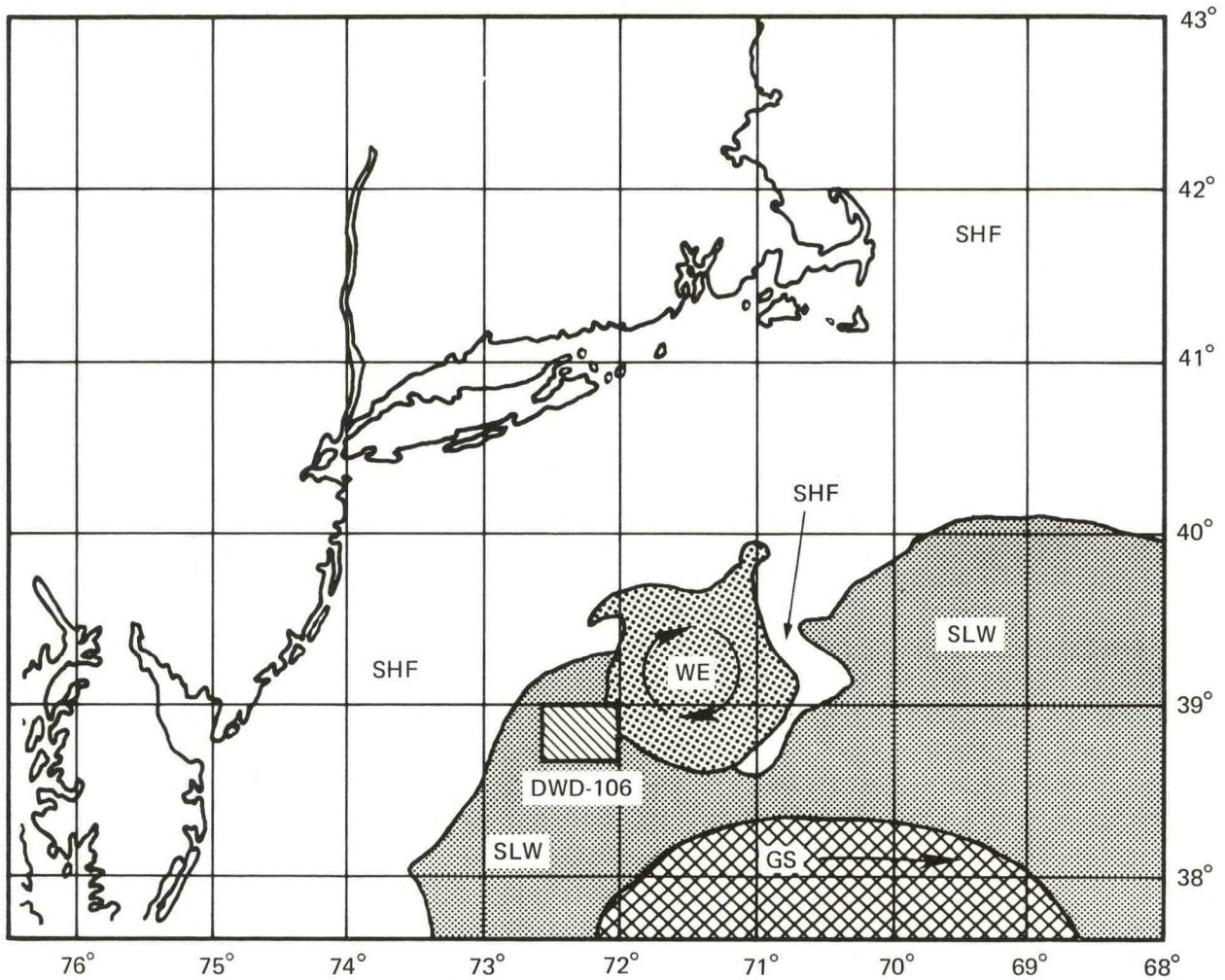
The only active dumpsite located in deep water off the east coast of the United States is Deepwater Dumpsite 106 (DWD-106). The dumpsite is 106 nmi southeast of Ambrose Lightship and 90 nmi due east of Cape Henlopen,

Delaware (fig. 4). The water depths at DWD-106 range from 1750 to 2700 m. In 1976 the dumpsite was utilized by 17 industrial dumpers from the New York-New Jersey area for disposal of various waste products. Wastes are dumped just beneath the sea surface by barges moving at a speed of 3 to 5 kt. Typical waste materials include: hydrochloric acid by-products, inert ore slurry from production of titanium dioxide pigments, residual sludge from galvanizing and plating operations, liquid wastes from production of textile manufacturing and from etching and photographic processes, water solutions of inorganic salts, and similar materials derived from diverse manufacturing processes. Since December 1976 the city of Camden has been dumping primary sewage sludge (65,000 wet tons/yr) at DWD-106 pursuant to permits issued by EPA. This dumping operation is scheduled to cease before the end of 1977.

At the request of EPA, NOAA initiated in 1974 a series of three seasonal investigations of DWD-106 to assess the impact of dumping operations there and to provide a comparative base for future assessments. Because of the nature and volume of materials now being dumped at DWD-106, its potential as an alternative to some of the nearshore dumpsites, and the complex biology and oceanography of the region's waters, the evaluation of impacts of dumping here is of high priority to EPA.

Data from the first NOAA seasonal baseline study in May 1974 were published in 1975.[10/] These data indicate that little if any of the dumped materials reach the bottom in the vicinity of the site. However, this does not imply that pollutants and their effects cannot be transferred by organisms within the ecosystem and through the food chain. A second seasonal baseline study in July 1975 used a research submersible and a surface vessel. The first two seasonal studies focused on the physical oceanographic characteristics of the area of DWD-106. A summary of preliminary results from the 1974-1975 baseline studies is presented here.

Oceanographic conditions in the area of DWD-106 are exceedingly complex, consisting of interactions between three water masses, varying current systems, and long-lasting eddies that break off from Gulf Stream meanders (fig. 4). DWD-106 is located in slope water which lies between fresher shelf water to the west and more saline Gulf Stream water to the east. Strong fronts occur at the boundaries of these water masses. Slope water circulation is generally in a counter-clockwise gyre; near the shelf, currents flow predominately southward; seaward near the Gulf Stream, currents flow northeastward. Abrupt changes in temperature and salinity can occur between shelf and slope water, with shelf water always fresher than slope water and much colder in the winter months. Physical characteristics of the upper 100 to 150 m of water in the dumpsite area are highly variable. The shelf/slope front can lie shoreward or seaward, or pass through the dumpsite. In the winter and spring the shelf/slope front usually is found anywhere from the shelf break (200 m in depth) to about 80 mi seaward of the break. During summer it is found near the shelf break and in the autumn it is usually located shoreward of the break.



LEGEND

- SHF SHELF WATER
- SLW SLOPE WATER
- GS GULF STREAM
- WE WARM EDDY

Figure 4.–Water masses in the vicinity of DWD-106.

Surface shelf water can override slope water as a result of wind-driven advection or as a result of high runoff from the coastal United States. During periods of low runoff, slope water may intrude shelf water. Thus one frequently finds layering of shelf and slope water at DWD-106. Water of Gulf Stream origin invades DWD-106 in the form of clockwise eddies which result from large scale meandering of the Gulf Stream. These eddies, which break off north of the Gulf Stream and entrain warm Sargasso Sea water, can last for months or longer. They migrate in a southwestward direction through slope water until they either dissipate or rejoin the Gulf Stream in the vicinity of Cape Hatteras (fig. 4). In a recent study, Gulf Stream eddies were found to occupy DWD-106, partially or wholly, approximately 20 percent of the time. Research and monitoring in such a dynamic area is, therefore, a major undertaking with many difficulties to be overcome.

The third field effort to collect baseline environmental data in the vicinity of the DWD-106 was accomplished using the NOAA ship OREGON II in February 1976. This winter survey completed efforts begun in 1974 to establish baseline conditions, a requisite to follow-on monitoring. In June 1976, an investigation was mounted with the assistance of the U.S. Coast Guard, using the USCG cutter DALLAS and the Woods Hole Oceanographic Institution submersible ALVIN. Through the cooperation of EPA, a test dump was arranged and studies of waste dispersal were conducted. Additional studies were made on transfer of pollutants to sediments and on effects on living organisms. In August of the same year, an investigation was undertaken using the Woods Hole Ship R/V KNORR. Efforts in this period were devoted to refining dispersal tracking methods (using acoustic equipment) with further test dump operations arranged by EPA.

The three 1976 field investigations were supplemented by laboratory research on reactions of pollutants and on genetic impact of these pollutants. Major sponsored work was with Woods Hole Oceanographic Institution, University of Rhode Island, and laboratories of the National Marine Fisheries Service of NOAA.

A report summarizing NOAA's baseline work through 1976 in the DWD-106 is under preparation. A comprehensive report to EPA addressing both baseline and research results also will be published and will contain specific recommendations concerning dumping at this site. However, preliminary analyses of data have revealed some significant information. These are stated below with tentative conclusions, which are still to be verified by studies continued in 1977.

Characterization of wastes focused on the two major dumpers: duPont (Grasselli Plant) and American Cyanamid. The duPont waste is of high density (1.076 gm/cm^3 average) and is highly caustic (pH 12.5 average). It contains significant amounts (0.05 to 1.50 mg/l) of lead, copper, zinc, chromium, and nickel, along with other metals. Significant organic complexes are also present in the duPont wastes. These materials, clear in appearance, sink rapidly in sea water, forming a precipitate consisting of white flocs. In the laboratory the floc settles out, while at the

dumpsite it tends to form layers on density discontinuity surfaces in the thermocline. The American Cyanamid waste disperses more rapidly; it is of slightly lower density than sea water for this region (1.02 gm/cm^3), and contains significant quantities of arsenic, copper, zinc, chromium, and nickel, as well as large quantities of the water-soluble organophosphate pesticides (Malathion, Cygon, Thimet, Verbex, and Cytroline). These pesticides are hydrolysed within a few hours of dumping and are not believed to be a long-term threat to the environment. The American Cyanamid waste is greenish in color and slightly turbid. Both at sea and in the laboratory, a distinct turbid layer at the top of the water column is formed. The wastes appeared to mix with seawater within a few hours.

Observation of the dumped material shows several possible means of entry into the ecosystem. The duPont wastes produce large quantities of precipitates upon mixing with sea water which might be ingested by filter-feeding organisms. The accumulation of American Cyanamid wastes at the sea surface leads to the temporary formation of a slick of organic materials, which may affect organisms that inhabit or penetrate the sea-air interface.

Attempts to measure actual effects included sampling of biota before and after dumping and collection and examination of fish eggs for possible mutagenic effects. Surface collections of vertically migrating fish revealed more empty nets after the dump, but a not significantly smaller total catch. Depressed chlorophyll levels were noted but could not be attributed to pollutant effects with certainty. The most significant indication of potential dumping effects came from examination of fish eggs. Analysis of fish eggs collected in plankton and neuston nets at and near DWD-106 revealed an unexpectedly high incidence of cellular damage and malfunction of embryos, and absence of embryos in a variety of species sampled. These aberrations cannot be definitely attributed to dumping, as eggs in this region are subject to a variety of natural stresses, but further investigation is clearly required.

Laboratory tests of sensitivity of organisms to small, controlled amounts of wastes concentrated on the effects of the wastes on microbiota and phytoplankton. Aquatic microbial populations, including bacteria and fungi, are among the most highly active components of marine environments, and changes in their metabolic activities can be useful indicators of both lethal and sublethal levels of environmental stress. Results indicate that the principal toxic ingredients in both duPont and American Cyanamid wastes are organic, rather than metallic, and that for natural bacterial populations, duPont waste is about eight times more toxic. Exposure of mixed populations of bacteria to dilutions of both wastes resulted in the isolation of several pure cultures that demonstrated a waste tolerance above that of the control populations. Periodically, extremely low concentrations of either waste had a stimulating effect and initiated glucose uptake at rates which exceeded those of a control sample with no added waste.

Certain diatoms are sensitive to a wide range of organic pollutants and trace metals, as well as to changes in temperature, salinity, and

nutrient concentration. Tests on a variety of laboratory-cultured populations have shown that slope water diatoms are sensitive to duPont wastes in concentrations of less than 10 ppm. Experiments are continuing with a variety of populations from oceanic, slope, and shelf waters.

APPENDIX A

List of References

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APPENDIX B

Title II of "Marine Protection, Research, and Sanctuaries Act of 1972" (P.L. 92-532)--and Amendments

TITLE II—COMPREHENSIVE RESEARCH ON OCEAN DUMPING

Report to Congress.

SEC. 201. The Secretary of Commerce, in coordination with the Secretary of the Department in which the Coast Guard is operating and with the Administrator shall, within six months of the enactment of this Act, initiate a comprehensive and continuing program of monitoring and research regarding the effects of the dumping of material into ocean waters or other coastal waters where the tide ebbs and flows or into the Great Lakes or their connecting waters and shall report from time to time, not less frequently than annually, his findings (including an evaluation of the short-term ecological effects and the social and economic factors involved) to the Congress.

SEC. 202. (a) The Secretary of Commerce, in consultation with other appropriate Federal departments, agencies, and instrumentalities shall, within six months of the enactment of this Act, initiate a comprehensive and continuing program of research with respect to the possible long-range effects of pollution, overfishing, and man-induced changes of ocean ecosystems. In carrying out such research, the Secretary of Commerce shall take into account such factors as existing and proposed international policies affecting oceanic problems, economic considerations involved in both the protection and the use of the oceans, possible alternatives to existing programs, and ways in which the health of the oceans may best be preserved for the benefit of succeeding generations of mankind.

(b) In carrying out his responsibilities under this section, the Secretary of Commerce, under the foreign policy guidance of the President and pursuant to international agreements and treaties made by the President with the advice and consent of the Senate, may act alone or in conjunction with any other nation or group of nations, and shall make known the results of his activities by such channels of communication as may appear appropriate.

Annual report to Congress.

(c) In January of each year, the Secretary of Commerce shall report to the Congress on the results of activities undertaken by him pursuant to this section during the previous fiscal year.

(d) Each department, agency, and independent instrumentality of the Federal Government is authorized and directed to cooperate with the Secretary of Commerce in carrying out the purposes of this section and, to the extent permitted by law, to furnish such information as may be requested.

Inter-agency agreements.

(e) The Secretary of Commerce, in carrying out his responsibilities under this section, shall, to the extent feasible utilize the personnel, services, and facilities of other Federal departments, agencies, and instrumentalities (including those of the Coast Guard for monitoring purposes), and is authorized to enter into appropriate inter-agency agreements to accomplish this action.

Federal-State cooperation.

SEC. 203. The Secretary of Commerce shall conduct and encourage, cooperate with, and render financial and other assistance to appropriate public (whether Federal, State, interstate, or local) authorities, agencies, and institutions, private agencies and institutions, and individuals in the conduct of, and to promote the coordination of, research, investigations, experiments, training, demonstrations, surveys, and studies for the purpose of determining means of minimizing or ending all dumping of materials within five years of the effective date of this Act.

Appropriation.

SEC. 204. There are authorized to be appropriated for the first fiscal year after this Act is enacted and for the next two fiscal years thereafter such sums as may be necessary to carry out this title, but the sums appropriated for any such fiscal year may not exceed $6,000,000.

* *

*Sec. 3(a) of the Act reads: "Administrator" means the Administrator of the Environmental Protection Agency.

**P.L. 94-62, Section 2, amended Section 202(c) of the 1972 Act by striking "January" and inserting "March". Section 3 of P.L. 94-62 amended Section 204 of the 1972 Act by authorizing $1,500,000 for the transition period (July 1 through September 30, 1976). P.L. 94-326, Section 3, amends Section 204 of the 1972 Act by authorizing $5,600,000 for fiscal year 1977.

APPENDIX C

Agency Funding Levels for Ocean Dumping Research

Estimated NOAA Expenditures for Ocean Dumping - Related Research: FY 1975-77
(in millions)

	FY 1975	FY 1976[1/]	FY 1977
New York Bight	$3.20	$5.00	$2.40
Deepwater Dumpsite 106	0.30	0.40	0.65
Gulf dumpsites	--	--	0.40
Total	$3.50	$5.40	$3.45

1/ Includes FY 1976 transition quarter funding of $0.8M for New York Bight and $0.1M for DWD-106.

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