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FEDERAL ACTION PLAN FOR OCEAN DUMPING RESEARCH AND MONITORING: MUNICIPAL AND INDUSTRIAL WASTES

NOAA

NATIONAL MARINE POLLUTION

PROGRAM OFFICE

FEDERAL ACTION PLAN

FOR OCEAN DUMPING RESEARCH AND MONITORING:

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August 8, 1986

Prepared by the

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PREFACE

The National Ocean Pollution Planning Act of 1978, P.L. 95-273 (as amended), calls for the establishment of a comprehensive, coordinated, and effective Federal program for ocean pollution research, development, and monitoring. The Act directs the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), in consultation with other agencies, to prepare triennially a five-year Federal Plan for the National Marine Pollution Program. The Plan is to include an inventory of existing Federal programs, an analysis of the extent to which existing programs assist in meeting priorities, recommendations for changes in the overall Federal effort where necessary, and a report on budget coordination efforts.

NOAA established the National Marine Pollution Program Office (NMPPO) to provide a focal point for coordinating Federal efforts on a day-to-day basis. This office is responsible for updating the five-year Plan and coordinating implementation of the recommendations of the Plan. An interagency task force provides agency representation to NMPPO in plan preparation and implementation. Three plans have been produced, the most recent of which was released in November 1985.

The Federal Plans consider all aspects of marine pollution research, development, and monitoring. Therefore, in the Federal Plan, it is necessary to present relatively general discussions of important issues. To meet more fully the intent of P.L. 95-273, action plans which focus on specific areas in greater detail are formulated when required, and as resources permit. Each action plan considers the existing and potential problems in the area under consideration, the needs for scientific information to aid resource managers in solving these problems, and the development of a research and monitoring strategy to acquire this information. These action plans do not attempt to present a comprehensive summary of all aspects of the problem areas under consideration. Instead they provide summaries of the overall status, needs, and plans and include references where detailed information on the various aspects can be obtained.

The present document focuses on the issue of ocean dumping of municipal and industrial wastes. This plan was developed under the guidance of an interagency working groups established by the interagency Committee on Ocean Pollution Research, Development, and Monitoring (COPRDM) specifically for this purpose. COPRDM was replaced by the National Ocean Pollution Policy Board during the course of this project. The agencies represented on the working group were the Army Corps of Engineers, the Department of Energy, the Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Department of Agriculture, and the Office of Technology Assessment as an observer. The individual members of this working group are listed in Appendix I.

CHAPTER 1

INTRODUCTION

Rationale for an Ocean Dumping Action Plan

The ocean dumping of municipal and industrial wastes is regulated by a complex set of Federal rules that require the consideration of a number of scientific issues. There are four major departments or agencies which have regulatory and/or research responsibilities related to ocean dumping: Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), the Department of Defense (Army Corps of Engineers), and the Department of Health and Human Services (Shellfish Sanitation Program). This issue maintains a high degree of visibility and draws considerable public and Congressional concern. Therefore, a strong need exists for coordination between the involved government groups based on management information needs that may be addressed by research and monitoring efforts. The limited resources available for ocean dumping studies require that research needs be prioritized to ensure that the most critical questions are answered first, to avoid any duplication of effort, and to maximize benefits through cooperation between agencies.

The Action Plan Process

The concept of the Ocean Dumping Action Plan (ODAP) was conceived by the National Marine Pollution Program Office (NMPPO) of NOAA and developed under the Interagency Committee on Ocean Pollution Research, Development, and Monitoring. This project was initiated because of the need for coordination of research and monitoring activities concerned with ocean dumping of municipal and industrial wastes. The first step in the creation of the ODAP was to establish a working group under COPRDM including representatives of EPA, NOAA, the Army Corps of Engineers (COE), the Department of Agriculture, the Department of Energy, and the Office of Technology Assessment. This group established the general approach for ODAP which included the consideration of:

1) Magnitude of potential future requirements for ocean dumping of municipal industrial wastes;

2) Information needed by managers and others to aid in the decision making process for the regulation of such disposal;

3) Scientific strategies and research studies that would most efficiently and effectively acquire the required information;

4) Responsibilities for specific agencies to carry out the individual components of the scientific strategy; and

5) Activities required to implement the Action Plan to ensure future interagency coordination of Federal research in this area.

During the initial consideration of the scope for the action plan, ocean incineration was discussed for possible inclusion, especially since ocean incineration is regulated under the Ocean Dumping Act. However, it was agreed by most members that the research issues and management questions surrounding ocean incineration were likely to be reasonably distinct from those concerning ocean dumping. If deemed necessary by COPRDM, ocean incineration may be examined for analysis by the action plan approach as a separate issue. Ocean dumping of dredged material was also excluded from consideration since it was generally believed that most of the scientific and public concern from ocean dumping centered around municipal and industrial wastes.

Under contract to NMPPO, EG&G (1985) prepared a study to investigate item 1 above entitled "Projected Ocean Dumping Rates for Municipal and Industrial Wastes in the Year 2000." This study showed the current and potential use of ocean dumping of these wastes by presenting information on current and estimated future waste inputs at ocean disposal sites. Special attention was devoted to projecting the influence on ocean dumping due to changes in technology or emerging high volume wastes potentially suitable for ocean disposal. In general, the results indicated that ocean dumping will likely continue to be an environmental issue due to the high potential demand for this disposal medium.

The second major consideration of ODAP identified above was studied under a separate NMPPO contract to Mitre (1984). The final report, "Management Information Needs Related to Ocean Disposal of Sewage and Industrial Wastes," identified the major information needs by directly interviewing managers in the area of ocean dumping. Primarily, these needs fell into the general categories of site designation for ocean dumping, permit review, dumpsite management, and problems with determining and evaluating the environmental effects of ocean dumping.

The next step in the development of ODAP was to meet with a group of technical experts in EPA and NOAA (December, 1985) who work with the issue and problems of ocean dumping on a frequent basis. This group met to discuss the information needs which emerged from the Mitre (1984) study, recommend specific studies to meet these information needs, and prioritize these studies as to their ability to meet the objectivies of the information needs.

The Ocean Dumping Action Plan summarizes the results of the contractor studies and technical expert recommendations, synthesizes this information to identify research information which is needed to improve the management of ocean dumping, and presents an overall approach to implementing the elements of this Action Plan to facilitate future interagency coordination.

Organization of the Action Plan

The organization of the Ocean Dumping Action Plan parallels the process which went into developing the elements of the Plan. Following this introduction, Chapter 2 provides a brief legal, regulatory, and technical background on ocean dumping. A major part of the information in this section is a summary of the contractor study which estimated existing and projected

rates of ocean dumping of municipal and industrial wastes (EG&G, 1985). Chapter 3 develops and briefly discusses the information needs of managers of ocean dumping, basing most of these needs on the results of interviews with individuals directly involved with the day-to-day operations of ocean dumping (Mitre, 1984). These information needs are organized within four overall management objectives for ocean dumping. Chapter 4 discusses in detail each of the information needs within the separate management objectives and identifies research studies which would be useful in addressing these management needs. These specific recommendations for research studies are based on the results of the meeting with ocean dumping technical experts in December, 1985. During this meeting, each information need was discussed individually to identify ongoing and future priority research studies. The scope of this effort does not include the development of specific research plans for each recommended research area with specific endpoints to be used in the regulatory and management process. The recommended research areas were developed at a lower scale of resolution and respond to generally perceived needs for research in certain of ocean dumping. Detailed endpoints for each of these research areas would need to be developed.

Chapter 5 is also based on the results of the meeting of technical experts. This chapter assigns priorities to the various proposed research studies to support the research areas of greatest and most immediate value to the identified management objectivies. Priorities do not specifically relate to the most immediate needs of the ongoing regulatory process because the likelihood of research success was one of the major components of the prioritiziation. However, there should be considerable overlap because the management objectives identifed in this plan tend to reflect regulatory priorities. This chapter also identifies the agencies which are capable of performing these studies and whose mandates and responsibilities are most compatible with the recommended research. Finally, Chapter 5 summarizes ongoing research efforts EPA and NOAA which supports some of the identified research areas and makes final recommendations for action beyond this plan.

Implementation

The Ocean Dumping Action Plan was created by an interagency working group established under the Interagency Committee on Ocean Pollution Reseach, Development and Monitoring (COPRDM) and has been reviewed and approved by COPRDM. Technical experts within COPRDM member agencies provided the specific recommendations for needed research studies. This process tends to ensure compatibility between the Action Plan and the individual mandates of each agency in order to facilitate implementation. Decisions on areas of ocean dumping research emphasis within each agency are made through competition among agency-viewed priority areas as related to agency missions. This Action Plan is not intended to interfere with these agency responsibilities and mandates. However, this plan helps to ensure the development of a more responsive and efficient Federal program of research in support of ocean dumping mangement by identifying critical research areas, opportunities for cooperative research between agencies, and preventing duplication of efforts.

CHAPTER 2

SCOPE OF THE PROBLEM

The Regulatory Environment

The historical view of the oceans as virtually limitless receptacles for societal wastes has resulted in centuries of degradation of rivers and estuaries and ultimately of coastal inshore waters (Soule and Walsh, 1983). Disposal of the various types of wastes generated by the densely populated and industrial coastal regions of the United States has created economic, environmental, and political conflicts. Concern over the pollution of coastal waters in the U.S. precipitated the enactment of legislation aimed at improving the quality and preventing further degradation of the marine environment. Federal mandates related to ocean dumping of wastes are described in the Marine Protection, Research, and Santuaries Act (PL 92-532, as amended) (MPRSA), also known as the "Ocean Dumping Act."

Title I of the MPRSA provides for the regulation of ocean dumping, while Title II gives the mandates for conducting research on ocean dumping. Regulations controlling the transportation and dumping of substances in the ocean, seaward of the baseline from which the territorial sea is measured, are promulgated under the MPRSA.

In addition to the MPRSA, other major pieces of legislation indirectly affect ocean dumping and the quantities of wastes that require disposal primarily by regulating the disposal of wastes by other means. The Federal Water Pollution Control Act (the Clean Water Act) controls the discharge of pollutants from point sources (pipelines). Implementation of the National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act has improved the quality of pipeline discharges but has resulted in the increased production of treatment sludges. These sludges are primarily being disposed of in landfills, incinerated, or applied as fertilizer on land. The Resource Conservation and Recovery Act (RCRA) places Federal controls on the generation, transport, treatment, storage, and disposal of material classified as hazardous wastes. The effect of this law has been the identification of increasing amounts of hazardous wastes and, because of the lack of suitable disposal sites, has resulted in pressure on states to identify and develop proper hazardous waste disposal sites.

NACOA (1981) indicated that an integrated approach of waste management was needed to minimize risk to human health and the environment, rather than the ongoing medium-by-medium approach. Consistent with this recognition, NACOA recommended that the Environmental Protection Agency (EPA) revise its policy that no ocean dumping permit be issued when any land-based alternative exists. This report also recognized that each region of the country has its own unique set of oceanographic, hydrologic, geologic, and atmospheric properties which must be considered when deciding upon a waste management strategy. NACOA recommended that 1) sewage sludge dumping be allowed, under appropriate conditions and with adequate

monitoring safeguards, in those areas where no unreasonable degradation of the environment would result, and 2) ocean disposal of industrial wastes continue at sites where evidence indicates no unreasonable degradation of the environment and when human health, environmental, and economic considerations indicate that this is the preferable option.

Events subsequent to publication of the NACOA report gave further impetus to reconsideration of the role of the oceans in waste management strategies. Amendments to MPRSA statutorily adopted a phaseout date of December 1981 for the ocean dumping of sewage sludge and industrial wastes "which may unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, and economic potentialities" (Sec. 101 d). Court suit brought by New York City and several other municipalities against EPA resulted in a decision by Federal District Court Judge Sofaer that EPA must consider the availability and impact of land-based alternatives to ocean dumping when making an ocean dumping permit decision [City of NY v. EPA 543 F. Supp. 1084 (S.D.N.Y. 1981)]. EPA did not appeal the decision and is now presently revising the ocean dumping regulations.

EPA may issue ocean dumping permits for sewage sludge and industrial wastes if they meet specific regulatory criteria. No permits may be issued for radiological, chemical, biological warfare agents, and high-level radioactive waste. Permits for the ocean dumping of dredged material are issued by the Secretary of the Army in consultation with the Administrator. The MPRSA requires the Administrator to establish and apply criteria for reviewing and evaluating such permit applications. In establishing or revising such criteria, the Administrator is required to consider the following.

(a) The need for the proposed dumping.

(b) The effect of such dumping on human health and welfare, including economics, esthetic, and recreational values.

(c) The effect of such dumping on fisheries resources, plankton, fish, shellfish, wildlife, shore lines and beaches.

(d) The effect of such dumping on marine ecosystems, particularly with respect to

(i) the transfer, concentration, and dispersion of such material and its byproducts through biological, physical, and chemical processes,

(ii) potential changes in marine ecosystem diversity, productivity, and stability, and

(iii) species and community population dynamics.

(e) The persistence and permanence of the effects of the dumping.

(f) The effect of dumping particular volumes and concentrations of such materials.

(g) Appropriate locations and methods of disposal or recycling, including land-based alternatives and the probable impact requiring use of such alternate locations or methods upon considerations affecting the public interest.

(h) The effect on alternate uses of oceans, such as scientific study, fishing, and other living resource exploitation, and nonliving resource exploitation.

(i) In designating recommended sites, the Administrator shall utilize wherever feasible locations beyond the edge of the Continental Shelf. (MPRSA Sec. 102(a))

Regulations

EPA authority under Title I or MPRSA includes 1) the designation and management of dump sites; 2) the development of criteria to evaluate ocean dumping permit applications; and 3) the review, award, and enforcement of ocean dumping permits. On the basis of the nine statutory factors listed above, EPA has promulgated implementing regulations which provide criteria for the designation and management of approved sites for ocean dumping (40 CFR Part 228). The general criteria for site selection (sec. 228.5) are that sites be chosen to "minimize the interference with other activities in the marine environment" and be located in areas where the "temporary perturbations in water quality or other environmental conditions... can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery." Sites off the continental shelf or of historic use are to be given preference. Specific site selection criteria set forth under Sec. 228.6 include EPA's consideration of 1) geographic features of the site, especially in relation to biological resources or human recreational areas; 2) the types, quantities, and mechanisms for disposal of the wastes; 3) physical and hydrographic properties of the site; 4) existing water quality and ecology of the site and effects of current or previous discharges or dumping to the area; 5) potential for development of nuisance species at the disposal site; and 6) feasibility of surveillance and monitoring.

Unlike the designation of dumpsites for dredged material, there has been little application of the ocean dumpsite designation criteria for the disposal of municipal sewage sludge. EPA designated separate portions of the 106-Mile Site (about 120 nmi SE of New York Harbor) for the disposal of sewage sludge and industrial wastes (49 Federal Register pp. 19005-19012; May 4, 1984). In this designation, EPA addressed the statutory and regulatory requirements for site designation (Sec. 228.5 and 228.6). At this same time the 106-Mile Site was designated, EPA issued a tentative

denial of petitions to redesignate the 12-Mile Site in the New York Bight for the continued disposal of sewage sludge (49 Federal Register pp. 19042-19048, May 4, 1984). Final denial of the 12-Mile Site redesignation was announced on April 1, 1985. Under agreement between EPA and New York and New Jersey municipal and county authorities, all ocean dumping at the 12-Mile Site will be completely transferred to the 106-Mile Site by the end of 1987.

Under EPA's ocean dumping regulations, permits are issued in accordance with the criteria of 40 CFR Part 227 which include specific limitations on the type and quantities of certain materials which may be dumped, an assessment of the need for ocean dumping, the availability of alternatives to ocean dumping, and an assessment of the impact of the proposed dumping on aesthetic, recreational, and economic values and other uses of the ocean. Under the regulations, EPA may issue five different types of permits for ocean dumping.

At present, ocean dumping of sewage sludge at the 12-Mile Site and 106-Mile Site is continuing under court decree in the "City of New York vs. EPA" case [543 F. Supp. 1084 (S.D.N.Y. 1981)]. EPA is in the process of developing permit requirements, and New York City is expected to submit a special permit application for continued disposal of sewage sludge at the 106-Mile Site. It is expected that requirements for permit applications will be issued at the end of 1987 to coincide with the complete transfer of ocean dumping of sewage sludge to the 106-Mile Site.

The applicants for a special permit must establish that they meet the limiting permissible concentrations (LPC) criteria and must conduct bioassay tests following specific guidelines (Sec. 227.27 (G)). The ocean dumped material would not be allowed to exceed the LPC which is defined as that concentration of a constituent which, after allowing for initial mixing (within 4 hours), does not exceed applicable marine water quality standards or does not exceed a level of 0.01 times the acute toxicity threshold as determined in bioassay tests. The environmental impact criteria require that the candidate material pass two bioassay tests: a test for toxicity of the liquid, suspended particulate, and solid phases, and a bioaccumulation test. Failure of either test results in permit denial.

Projected Ocean Dumping Activities

As part of the process of developing background information for the Ocean Dumping Action Plan, a study was performed on "Projected Ocean Dumping Rates for Municipal and Industrial Wastes in the Year 2000" (EG&G, 1985). Currently, Boston, Massachusetts is seeking to use ocean dumping for the disposal of sewage sludge. Orange County, California, is seeking permission to conduct a research program using pipeline discharge of sewage sludge at deep ocean depths. However, the probability of obtaining the necessary permits is difficult to predict. Considering the somewhat uncertain nature of the regulatory environment, especially until EPA revises the ocean dumping regulations, the estimates of annual ocean

dumping rates in the year 2000 were developed using the following three regulatory scenarios. These scenarios represent broad extremes, but not realistic predictions.

Scenario I assumes an extension of the current regulatory environment to the year 2000 and that only currently active permit holders would be dumping in the oceans in the year 2000. At present, ocean dumping of sewage sludge and industrial wastes is relatively limited from a national perspective. The City of New York and several area municipalities and county authorities continue to dump sludge at the 12-mile site, and will soon begin disposal at the 106-Mile Site. There is currently only one active industrial dumper on the Atlantic coast and the waste is disposed at the 106-Mile Site. In the Pacific, industrial waste dumping is now limited to a single site offshore of American Samoa where seafood processing wastes are dumped.

Scenario II represents a situation where wastes in the year 2000 would be generated at the rates projected in the EG&G report. Regulations, although more relaxed, will conform to the factors laid down by the court and will adhere to the London Dumping Convention. In particular, it is assumed that dumping of sewage sludge, industrial wastes, and coal ash or flue gas desulfurization (FGD) sludge would occur when evidence indicates no unreasonable environmental degradation would result and when human health, environmental and economic considerations indicate that this is the preferred option. Determining the preferred option under the constraints of finding the best alternative when considering human health, environmental and economic considerations requires local and geographic specific knowledge as suggested by the NACOA report. Under these conditions, the characteristics of the waste itself will not be the only factors determining the preferred option. For example, in some instances, although disposal of a waste may not result in unreasonable environmental degradation if ocean dumped, the availability of suitable land or technology with their accompanying economic impacts may dictate disposal methods. The geographic region where a waste is generated can often determine the method of disposal. These analyses consider recycling and multi-media approaches wherever possible for all wastes.

Scenario III assumes that the selection of a waste disposal alternative would be based exclusively on economic considerations with no concern for environmental effects. Only the coastal EPA regions and the near-coast areas within these regions were considered.

Using these scenarios, projections were made for future ocean dumping rates that might occur for the following wastes: sewage sludge, coal ash and flue gas desulfurization sludge, hazardous industrial wastes, and seafood processing wastes. Projections were primarily based on waste generation rates predicted for the year 2000 and an assessment of the likelihood of ocean dumping under each scenario for the EPA regions of concern (Fig. 2-1).

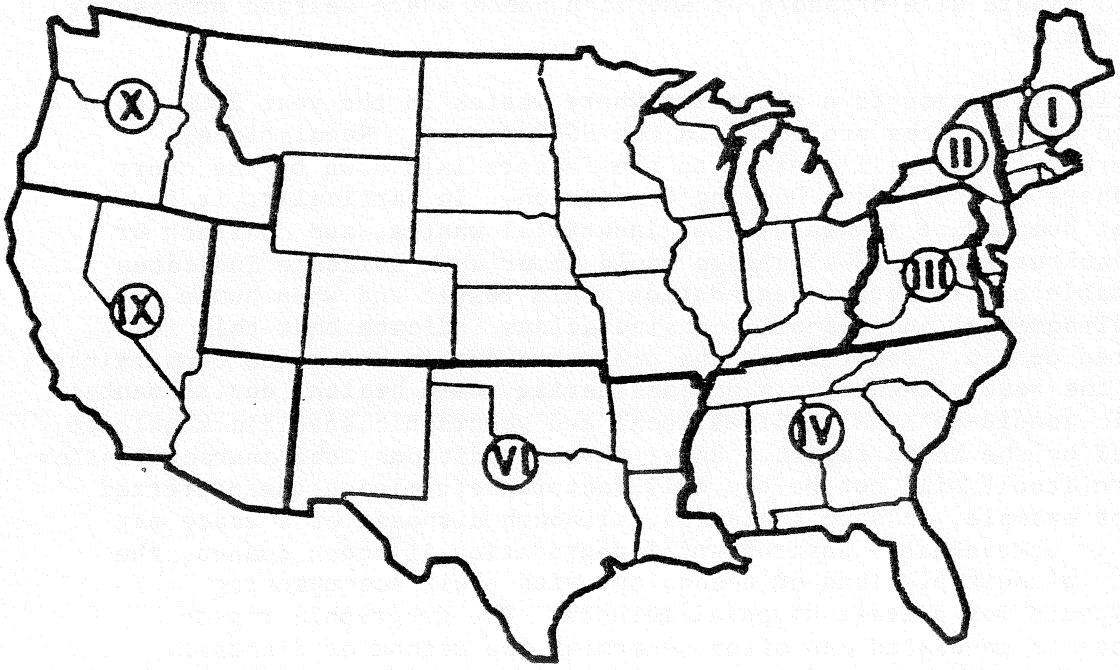

Figure 2-1 Map of EPA Regions

Coal Wastes and FGD Sludge: Projected Rates of Ocean Dumping in the Year 2000

Coal ash is a relatively high volume waste which derives from coal burning in electric utility and industry coal-fired boilers. The ash volumes generated in the processes are, to a large measure, a function of the source (i.e., type) of the coal. The ash is characterized as either fly ash, a powdery particulate entrained in the flue gas exiting the boiler, or as bottom ash, a non-combustible material which is too dense to escape from the boiler in the flue gas stream. Flue gas desulfurization (FGD) sludges also derive from coal burning in electric utility and industry boilers. They are a product of pollution abatement technologies designed to remove sulfur, a contributor to acid rain, from the flue gas. Both of these wastes are considered high volume wastes (USWAG, 1982). The major chemical constituents of coal ash (the salts of silicon, aluminum, potassium, and titanium) do not present any major problems associated with ocean dumping since these are low toxicity pollutants. The minor constituents of coal ash and FGD sludge, trace metals, may have potential ecological effects (EG&G, 1983).

There is general agreement among government and industry sources that the generation rates of ash and FGD sludge will continue to increase over the next two decades. Forecasts of ash generation (USWAG, 1982), and forecasts of FGD sludge by DOE, predict 169.5 million tons of total ash (fly ash + bottom ash) and 56.7 million tons of FGD sludge to be produced in the U.S in the year 2000, which is approximately twice the amount of the wastes estimated to be generated in 1985. An important point is that neither ash nor FGD sludge are degradable. Therefore, utlities and communities face the problem of finding new landfills or other means of disposal.

Ranges for estimates of projected ash and FGD sludge wastes under the three scenarios previously described are presented in Table 2-1. EPA regions II, III, and IV are predicted to have the greatest amounts of coal ash generated for possible ocean dumping, while regions I, II, and IV are targeted for the highest concentrations of FGD sludge for dumping. Other studies (Tobin, 1982; Kurgan et al., 1984) have similarly indicated that the eastern seaboard from Pennsylvania to Florida and Gulf states of Florida, Alabama, and Louisiana are major producers of coal ash and FGD sludge.

TABLE 2-1. Estimated coal ash and flue gas desulfurization sludge to be ocean dumped in the year 2000 (EG&G, 1985).

REGION	million tons per year			
	COAL ASH		FGD SLUDGE	
	Scenario II	Scenario III	Scenario II	Scenario III
I	1.5	2.0	3.2	3.2
II	1.6	4.6	2.0	4.9
III	2.2	4.7	1.0	1.0
IV	0	4.5	0	4.0
VI	0	1.5	0	0.1
IX	0.3	0.3	0.3	0.3
X	0.2	0.2	0.1	0.1
totals	5.8	19.3	6.6	14.6

* No coal ash or FGD sludge would be ocean dumped under Scenario I.

Sewage Sludge: Projected Rates of Ocean Dumping in the Year 2000

Sewage sludge is the semi-solid residue that results from the treatment of municipal wastewater. Particulate, solids, and associated contaminants present in the wastewater are concentrated into the sludge. Both domestic and industrial wastes may be discharged into sewer systems and are frequently present in municipal wastes. Contaminants of concern in sewage sludge include microbial pathogens, trace metals, and toxic organic compounds.

For 1980, generation of municipal sewage sludge for the nation as a whole was estimated at approximately 7 million dry tons per year (EPA, 1980; EG&G, 1983). It is expected that this total will increase substantially by 1990, as a result of the goal of providing secondary treatment for nearly all municipal wastewater discharges. The potential ocean dumping of sewage sludge will probably be limited to coastal municipalities. Only sources from coastal treatment plants were considered in this study.

Estimates of future generation rates are presented in Table 2-2 for each EPA coastal region based on the work of Basta et al. (1982) and the previously described scenarios.

TABLE 2-2. Projected waste levels for ocean dumping of sewage sludge under the various scenarios. (thousands or dry tons per year)

REGION	DISPOSAL SCENARIOS		
	I	II	III
I	0	175	200
II	265	850	1000
III	0	600	650
IV	0	100	250
VI	0	0	40
IX *	117	600	800
X	0	0	40
totals	382	2325	2980

* Current discharge by pipeline.

Under Scenario II it is assumed that the major urban centers, especially along the east coast, will find land-based disposal alternatives to be environmentally objectionable and/or a source of significant human health risks. It is likely that land-based disposal of sewage sludge will encounter controversy and public opposition whenever it must compete with more desirable alternatives.

It is also realistic to assume that smaller communities in areas devoted to more rural land use patterns where the competition is less intense will continue to have access to land-base disposal and will not resort to ocean dumping. The projections under Scenario II have accounted for both assumptions. Regions II, III, and IX have large metropolitan areas and accessibility to the oceans for dumping. Thus, these are the leading areas predicted to produce the largest amounts of sewage sludge for ocean dumping (Table 2-2). Regions IV and VI wer not predicted to use ocean udmping for the disposal of sewage sludge since land disposal alternatives have been easily available in the past. The predicted rates under Scenario III were formulated considering only the economic advantages and disadvantages (i.e., transportation costs) for each region. Under this Scenario all regions of interest were predicted to produce sewage sludge for ocean dumping with regions II, III, and IX generating the most.

Hazardous and Industrial Wastes: Projected Rates of Ocean Dumping in the Year 2000

For the purpose of this study, industrial wastes are defined as potentially harmful wastes which are produced from industrial manufacturing processes. These wastes are made up of waste streams from many different sources and, therefore, this category is extremely complex. Data on the quantities of hazardous wastes generated in this country are emerging, but it is acknowledged that the existing data base is inadequate and should be improved.

EPA has established a hazardous waste identification system which provides a useful framework for classifying wastes. Wastes can be classified by their basic characteristics (e.g., ignitable, corrosive, reactive, or extraction process (EP) toxic with respect to specific contaminants such as particular metals or organics). In addition, there are several other general categories of wastes, including generic solvents and sludges, wastes from specific industries, and discarded commercial products.

The most likely candidates for ocean disposal of the above wastes are the acids and alkalis which have corrosive characteristics. Ocean disposal is attractive for corrosive wastes because the ocean can provide a buffering medium for treatment of these wastes. Hazardous wastes contain a variety of chemicals. Corrosive acids and alkalis may be hazardous strictly based on these characteristics, or may contain metals and organics. The fate and effect of these contaminants must be considered in determining possible environmental implications of disposal options. The kinds and quantities of chemical contaminants will depend on the nature of the manufacturing or chemical processes which generate the waste. Some acid or alkali wastes may be listed as EP toxic or as generic hazardous wastes because of high concentrations of metals, organics, or solids.

Several estimates have been made on total hazardous waste generation in the United States. Approximately 41-43 million wet metric tons of hazardous wastes were generated between 1980 and 1981, and approximately 9.7 million tons (23%) were disposed of off-site (Booz-Allen, 1980). A more recent survey (Westat, 1981) has estimated that a much larger quantity of hazardous waste is generated (264 million metric tons) and that only about 4% of this (approximately 10.4 million metric tons) was shipped off-site for treatment and/or disposal. While the estimates for total generation of wastes differ by a factor of six for these studies, their estimates for quantities disposed of off-site are close (9.7-10.4 million metric tons). EG&G (1985) concluded that it is not possible to predict future hazardous waste generation rates based upon available data. Therefore, the somewhat unrealistic assumption was made that industrial/hazardous waste generation rates were the same for the years 1980 and 2000. The different ocean dumping estimates in Figure 2-2 reflect only the results of varying disposal rates under the different scenarios.

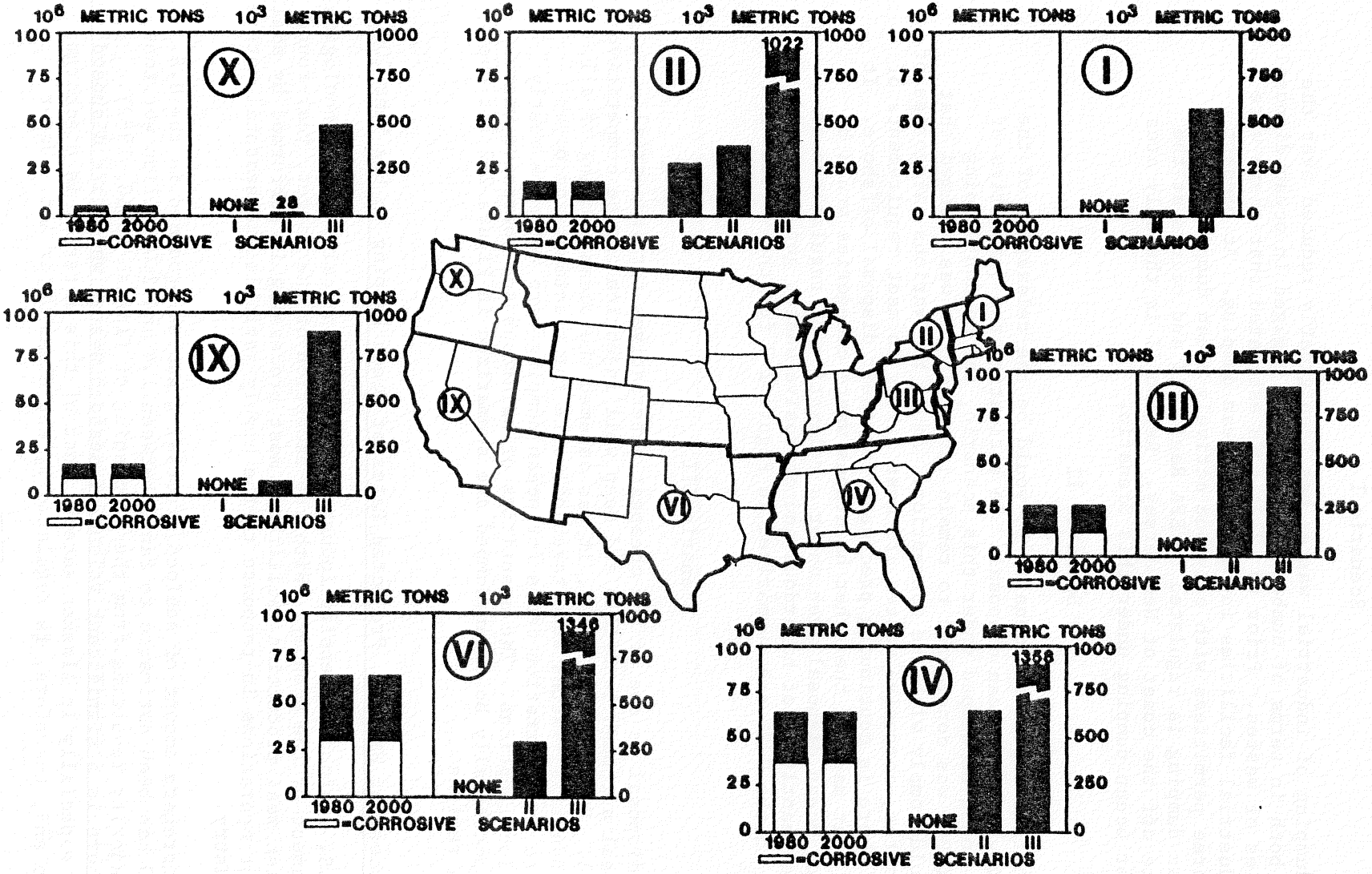

Figure 2-2 Present (1980) and projected (2000) generation rates (10^6 tons/year) for industrial/hazardous wastes and ocean dumping rates (10^3 tons/year) under the three scenarios by EPA region. NOTE: 1980 and 2000 corrosives are depicted as open histogram. Scenario I wastes are from present dumpers only. Scenario II represents only corrosive wastes taken off site and Scenario III represents all industrial hazardous wastes taken off site for disposal.

Scenario I

Ocean dumping of industrial wastes has been greatly reduced over the past decade both in terms of number of permittees engaged in ocean disposal and quantities of wastes. Prior to 1973 it is estimated that there were over 300 industrial facilities involved in ocean dumping. At present there are three permittees with only one actively ocean dumping. All current ocean dumping is regulated by EPA Region II and occurs at the 106-Mile Site off the coast of New Jersey. Region II is the only area scheduled for ocean dumping under this Scenario.

Scenario II

An important aspect of Scenario II would be the relaxation of the current policy toward ocean disposal. In estimating the quantities of wastes that could be dumped under this scenario, the London Dumping Convention (LDC) was considered to remain intact and it was assumed that the U.S. would comply with the Convention. Among the various categories of hazardous wastes, corrosive wastes are most likely to meet requirements of the LDC and there is continuing precedent for their disposal offshore. It is unlikely that many of the other hazardous waste categories would be permitted for ocean disposal even under a relaxation of regulations or policy. The quantities of hazardous and corrosive wastes generated under Scenario II in the U.S. are summarized in Figure 2-2 for the various EPA regions.

Scenario III

Ocean disposal is one of the cheapest alternatives for industrial waste disposal although landfills and deep well injection can be competitive (EG&G, 1983). Under Scenario III, it was assumed the ocean dumping of all hazardous/industrial wastes were taken off-site for treatment and ocean dumping where transportation costs for ocean dumping were not more costly than other local options. The quantities of hazardous and corrosive wastes that might potentially be ocean dumped are summarized in Figure 2-2 for the various EPA regions.

Seafood Processing Wastes: Projected Rates of Ocean Dumping in the Year 2000

The U.S. seafood processing industry is a geographically and technologically diverse segment of the economy. With the exception of the larger, year-round tuna and fish meal production facilities, most processing is performed by small, intermittent operations in response to the highly variable and seasonal nature of the industry.

The aggregate amount of seafood processing wastes produced in the U.S. during 1980 has been estimated to range between 1.4 and 2.0 million wet tons, with the majority resulting from the processing of finfish (EG&G, 1983). Although there is a significant volume of seafood wastes which are disposed of at sea, especially in Alaskan waters, most of this material is discharged by pipeline and, therefore, is regulated by the Clean Water Act. Under

ocean dumping regulations, fish wastes do not require a permit unless the dumping occurs in "harbors or other protected or enclosed coastal waters," or the EPA determines that such dumping "may endanger health, the environment or ecological systems" (40 CFR Sec 220.1 (c)). The ocean dumping of fish wastes is presently limited to a single instance offshore American Samoa.

In the future, there may be a need for ocean disposal of dissolved air flotation (DAF) sludge from the primary treatment of process wastewaters. This system generally requires the use of coagulants which contaminate the sludge so that it is no longer eligible for an exclusion from ocean dumping regulations. The quantities involved are difficult to estimate accurately, but are negligible in comparison with the other categories of waste which have been considered.

CHAPTER 3

MANAGEMENT INFORMATION NEEDS

Ocean dumping research and monitoring programs should address objectives that are based on the information needed by environmental managers and decisionmakers who develop and implement ocean dumping regulatory policies. For example, scientific understanding may contribute to the following aspects of ocean dumping policy development and implementation.

- o Lawmaking - Approaches, limitations and definitions used in legislation should have a solid technical foundation so that legislation can be effectively implemented to produce the results intended by the Congress.

- o Rulemaking - Rationales, definitions, and terms used in writing regulations should have a sound scientific basis so that the regulations have realistic assumptions and achievable results, and so that they may be interpreted and implemented in a consistent and effective manner.

- o Dumpsite Designation - Research and monitoring experience can contribute to the development of dumpsite designation protocols. (What information is required on each candidate dumpsite? How is the best site chosen?)

- o Review of Applications for Dumping Permits - Research and monitoring can assist in predicting the environmental implications of proposed dumping actions, and in developing protocols for screening wastes that are under consideration for ocean dumping.

- o Dumpsite Management - Monitoring in or near the dumpsite may be used to ensure that dumpers comply with permit stipulations and to check accuracy of predictions for fate and effects made during the dumpsite designation and permit review processes. Procedures for conducting such monitoring should have a sound scientific basis.

This section begins with a dicussion of ocean dumping information needs as perceived by environmental decisionmakers, and ends with a presentation of ocean dumping research and monitoring objectives based on those needs which can be addressed by scientific study, or by applying the results of scientific study.

To identify information needs and issues related to ocean dumping of sewage sludge and industrial wastes, a series of interviews were conducted with selected representatives of the ocean community (Mitre, 1984). These representatives were from:

1) the EPA Office of Water (writers of ocean dumping regulations),

2) EPA Regions II and III (involved in ocean dumping regulation implementation),

3) the National Marine Fisheries Service (fishery stock managers),

4) the National Wildlife Federation (an environmental group), and

5) the Association of Metropolitan Sewerage Agencies (organization of major publically owned treatment works which includes about one-half of the U.S. sewered population).

Each interview consisted of a discussion of three aspects of the ocean dumping regulatory process: dumpsite designation, review of applications for permits to ocean dump, and overall dumpsite management. Table 3-1 presents a summary of the information needs identified by this study that might be addressed by research or monitoring. A total of 35 information needs are presented in the Table: 8 for Dumpsite Designation, 15 for Permit Review, and 12 for Dumpsite Management. Some information needs are listed more than once. For example, the need to define "unreasonable degradation" appears under Permit Review and Dumpsite Management.

TABLE 3-1. Results of Interviews on Management Information Needs Related to Ocean Dumping

Information Needs	National Wildlife Federation	Assn. of Metropolitan Sewage Agencies	EPA-Hq.	EPA Regions II & III	National Marine Fisheries Service
A. Dumpsite Designation					
(1) Future demand for ocean dumping sites	X			X	
(2) What constitutes dispersive vs. containment sites?	X	X	X	X	X
(3) What are the environmental threats of dispersive vs. containment sites?			X		
(4) Is the 106-mile site more dispersive than the 12-mile site?		X			
(5) How do you maximize dispersion at a site?		X			
(6) What are the relationships between site design, disposal method, and dispersal?		X			
(7) What information is required to consider a site for designation? (e.g., baseline environmental characterization)			X	X	X
(8) Do the biota of inner and outer shelf ecosystems differ in their resistance to ocean dumping effects?		X			
B. Permit Review					
(1) What constitutes "unreasonable degradation"?	X	X	X	X	X
(2) What constitutes "trace amounts" as used in the London Dumping Convention?				X	
(3) What set of information requires denial of a permit?			X		
(4) What information on the site and on potential effects is sufficient for application review?			X	X	
(5) What is the relationship between concentrations in the barge and effects in the environment?				X	
(6) What ecosystem impact test could replace the bioassay test?	X				X

TABLE 3-1. Results of Interviews on Management Information Needs Related to Ocean Dumping (Continued)

Information Needs	National Wildlife Federation	Assn. of Metropolitan Sewage Agencies	EPA-Hq.	EPA Regions II & III	National Marine Fisheries Service
B. Permit Review (continued)					
(7) What are the real risks associated with ingestion of sludge-derived pathogens with seafood?		X			
(8) What is the relationship between changes in benthic communities and fish stocks?					X
(9) What are the habitat requirements for different fish species?					X
(10) What long-term uses of the oceans might be affected by ocean dumping?					X
(11) What is the best method to use as a standard for calculating mixing zone?	X				
(12) What are the best protocols to standardize for permit review (dispersion modeling, assessing risk, etc.)			X		
(13) What is the appropriate term for a permit?	X				
(14) What protocols should be used for comparing disposal alternatives across media?	X	X	X	X	
(15) Development of innovative disposal technologies	X			X	X
C. Dumpsite Management					
(1) What is the best way to sample (spot check) barge contents?				X	
(2) What is the best way to monitor to ensure adequate dilution is being achieved in the field?				X	
(3) Need the results of a broad-based environmental monitoring program as a context for dumpsite monitoring	X				
(4) What safety margin should be built into the ocean dumping decision framework to account for uncertainty inherent in the ocean environment?	X				

TABLE 3-1. Results of Interviews on Management Information Needs Related to Ocean Dumping

Information Needs	National Wildlife Federation	Assn. of Metropolitan Sewage Agencies	EPA-Hq.	EPA Regions II & III	National Marine Fisheries Service
C. Dumpsite Management (continued)					
(5) To what extent are multiple stresses affecting the environment?		X	X	X	X
(6) Can changes observed in the environment be linked to ocean dumping activities?		X	X	X	X
(7) What are the other sources of contaminants of the dumpsite?		X	X	X	X
(8) How significant a problem is eutrophication in the marine environment?					X
(9) How can we determine the life expectancy of a site?	X	X			
(10) What constitutes unreasonable" degradation"?	X	X	X	X	X
(11) What indices could be used to detect "unreasonable degradation"?			X	X	X
(12) Should "unreasonable degradation" indices be generic or site-specific?					X

Table 3-1 illustrates some of the special concerns held by the individual sectors of the ocean community that were interviewed. For example, a consultant representing the Association of Metropolitan Sewerage Agencies was especially concerned with directly linking sludge dumping to specific effects in the environment, objectively assessing the real risks associated with sludge dumping, and with several practical issues directly related to mitigating the effects of ocean dumping. Representatives from the EPA were especially interested in the development of standard methods and protocols needed to regulate ocean dumping activities. Representatives from the National Wildlife Federation posed questions related to the need for ocean dumping, methods and protocols, and the effects of ocean dumping in the context of other environmental disturbances. Many of the needs identified by the representative from the National Marine Fisheries Service related to general effects on the marine ecosystems which might affect fisheries stocks, and ocean to dumping as one of many multiple stresses.

In addition, the following needs were identified by at least four of the five groups interviewed:

-- What constitutes dispersive vs. containment sites?

-- What constitutes "unreasonable degradation"?

-- What protocols should be used for comparing disposal alternatives across media?

-- To what extent are multiple stresses affecting by the environment?

-- Can changes in the environment be directly and exclusively linked to ocean dumping activities?

Since these needs were of common concern to all, or nearly all, of the persons interviewed, they should be among the issues seriously considered as potential targets for ocean dumping research and monitoring efforts.

It is uncertain whether these or other needs would have resulted if different, or more, people had been interviewed. Therefore, the Interagency Working Group has used the needs listed in Table 3-1 only as a starting point and has made additions and elaborations, as required, in developing the objectives presented in the next section.

Ocean Dumping Research and Monitoring Objectives

There appear to be two general types of information needs presented in the previous Table 3-1. The first general type consists of needs that directly and closely support the regulatory process. For example, development of protocols for dumpsite designation and development of a scientific definition of "unreasonable degradation" are included in this general type of need. Some of these needs have a significant policy component in addition to the scientific dimension. Needs of this type may be grouped by the regulatory functions that they support: dumpsite designation, review of specific proposals for dumping, and general dumpsite management.

The second general type of need results from the requirement to understand more fully the overall effects of ocean dumping actions in the context of ecosystem changes and other sources of disturbance to marine ecosystems. For example, needs related to linking benthic effects to fisheries resources, or evaluating the significance of observed environmental effects would fall into this category. These needs were expressed under all three portions of the interview. However, for the purpose of planning research and monitoring activities, it is useful to group all of these types of needs together so that a more unified approach can be taken.

Based on these considerations, the following four major objectives have been chosen for the purpose of coordinating ocean dumping research and monitoring activities across agencies:

1. Provide protocols for dumpsite designation

2. Provide methods for assessing effects of specific proposed ocean dumping actions (e.g., review of permit applications)

3. Prescribe procedures for dumpsite monitoring and management

4. Determine and evaluate the environmental effects of ocean dumping.

These four objectives form the skeleton of Table 3-2. Sub-objectives are developed for each objective and the specific information needs are listed within. Each sub-objective is evaluated in Section 3 of the Action Plan to determine whether additional research and monitoring is required, and, if required, what general type of research would be most productive.

TABLE 3-2. Ocean Dumping Research and Monitoring Objectives and Information Needs

OBJECTIVE 1. Provide protocols for dumpsite designation

A. Develop a scientific protocol for dumpsite designation.

(1) Which geographical areas are likely to require dumpsites in the future?

(2) How much and what kinds of sewage sludge and industrial wastes are likely to be ocean dumped in the future?

(3) What specific types of information should be collected about potential dumpsites?

(4) What other sources of pollutants may have an effect in the area of the dumpsite?

(5) What constitutes a dispersive site as compared to a containment site? (e.g., Which is more dispersive, the 106-mile or the 12-mile site?) Which is preferable for which types of waste and conditions.

OJBECTIVE 2. Provide methods for assessing effects of specific proposed ocean dumping actions. (i.e., review of permit applications)

A. Develop hazard assessment protocols to evaluate ocean disposal impacts (exposure and effects assessment)

(1) What information is required to conduct a hazard assessment?

(2) What standard procedures should be used to calculate mixing zones?

(3) What level and duration of exposure are expected to result from specific dumping actions?

(4) For principal contaminants, what effects (lethal and sublethal) result from exposure (concentration and duration) that is expected to occur in and around the dumpsite?

(5) What levels of short-term exposure are considered to be acceptable?

(6) What safety margin should be built into a hazard assessment protocol to account for uncertainties inherent in the ocean environment?

(7) How can we verify hazard assessments in the field?

(8) What constitutes "unreasonable degradation"? How can it be measured?

B. Develop methods for comparing disposal alternatives

(1) Can valid comparisons be made for the different alternatives? How?

(2) Are we considering all feasible alternatives to ocean dumping?

(3) What are the relative costs of monitoring in various media?

C. Develop new procedures or improve existing procedures for evaluating or screening wastes proposed for ocean dumping (physical, chemical, biological characterization or screening protocols).

(1) What information is needed to adequately characterize a waste for the purpose of permit application review?

(2) What indications are sufficient to require denial of a permit application?

(3) What would be a better prediction or indicator of ecological effects than the bioassay procedure?

OBJECTIVE 3. Prescribe procedures for dumpsite monitoring and management

A. Develop procedures for permit compliance monitoring

(1) What parameters should be monitored? Where? How often?

(2) What is the best way to get a valid sample of the contents of a barge?

(3) How can we identify unexpected problems that arise as a result of ocean dumping?

(4) Can a protocol for cost-effective compliance monitoring be devised?

B. Develop procedures for monitoring ecological trends in and near dumpsites

(1) From the perspective of detecting long-term trends in environmental status, what constitutes adequate baseline data for a dumpsite?

(2) What parameters should be monitored for the purpose of ecological trend assessment in and around dumpsites?

(3) Should sublethal effects be monitored? How?

(4) Can trend assessment monitoring be designed in a cost-effective manner?

C. Develop and evaluate site management options

(1) What methods are available to maximize dispersion at a site, or to otherwise mitigate impacts?

(2) What should be the duration of an ocean dumping permit?

(3) How long should a dumpsite remain active?

OBJECTIVE 4. Determine and evaluate the environmental effects of ocean dumping

A. Determine fate of contaminants (water column, sediments, biota) in short- and long-term

(1) What is the short-term fate of contaminants?

(2) What concentrations of contaminants are likely to occur in the water column and sediments as a direct consequence of ocean dumping?

(3) What is the long-term fate of contaminants that are dumped in the ocean?

(4) What is the area of influence of a typical dumpsite? How far do significant effects range?

(5) In what concentrations and forms are contaminants that are ocean dumped likely to occur in marine organisms (including human food resources)?

B. Determine effects of dumping activities and evaluate significance to human health, living marine resources, and integrity of marine ecosystems

(1) What are the concentrations in the water column, sediments, and tissues of marine organisms at which we need to take regulatory steps to limit or eliminate inputs?

(2) How severe is the risk to human health from ingestion of ocean-dumped contaminants and pathogens?

(3) What will be the effects of ocean dumping on fisheries stocks?

(4) Where might ocean dumping affect critical habitats of living marine resources?

(5) What is the environmental status of marine ecosystems? What trends are occurring in environmental status? What are the effects of ocean dumping as distinct from the effects of other sources of pollution and changes due to natural phenomena?

(6) How much ocean dumping has occurred, is occurring, and is likely to occur in the future on a regional, and national level? How significant are any long-term regional or national consequences of ocean dumping likely to be? (e.g., eutrophication)

(7) Are inner- or outer-shelf ecosystems inherently more sensitive to the effects of ocean dumping?

CHAPTER 4

TECHNICAL ISSUES AND RESEARCH NEEDS

This chapter takes the management objectives and information needs developed in Chapter 3 and discusses the general state of scientific knowledge, ongoing research and new research areas that should be studied for each information need. The thoughts, discussion, and research ideas developed in this Chapter have been derived in large part from a meeting of technical experts on ocean dumping[1]. For this meeting, the following questions were addressed for each of the information needs.

1) Can the information need be addressed by scientific research or is it strictly a policy question?

2) Does existing technical information exist to adequately address this need or major components of this need?

3) Are ongoing research efforts adequate to address this need?

4) What further studies are needed to address this information need?

From the discussion, a list of recommended research areas was generated. The study areas were ranked by meeting participants according to several criteria. The ranking process and the overall research priorities are presented in Chapter 5. Table 4-2 (at the end of this chapter) lists all research recommendations by objective.

The ultimate purpose of the recommended research and monitoring is to provide the technical basis and scientific understanding required to improve the mangement of ocean dumping activities. The objectives and information needs developed in the previous chapter form the structure for addressing and organizing the research recommendations.

During the past 15 years, considerable research has been conducted on the ocean dumping of various materials by EPA, NOAA, the Army Corps of Engineers, and private researchers. Major studies on the fates and effects of ocean dumping have been conducted at the 12-Mile Site, the 106-Mile Site, and the now closed Philadelphia dumpsite off Delaware Bay. Although this research may not be referred to specifically throughout this chapter, the process of the meeting of technical experts included the assessment of the adequacy of the existing body of research knowledge.

It is readily apparent that a number of the recommended research areas in this chapter are applicable to more than one information need or objective. Similarly, different research recommendations often complement one another and would contribute to existing data bases on the environmental implications of ocean dumping of wastes. As appropriate, these relationships will be mentioned in this chapter.

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[1]Conference held December 3-4, 1985, in Narragansett, Rhode Island. See Appendix 1 for participants.

OBJECTIVE 1. Provide Protocols for Dumpsite Designation

OBJECTIVE 1.A Develop a scientific protocol for dumpsite designation

Information Needs:

(1) Which geographical areas are likely to require dumpsites in the future?

(2) How much and what kinds of sewage sludge and industrial wastes are likely to be ocean-dumped in the future?

(3) What specific types of information should be collected about potential dumpsites?

(4) What other sources of pollutants may have an effect in the area of the dumpsite?

(5) What constitutes a "dispersive" site compared to a "containment" site? Which is preferable for which types of waste?

Evaluation:

Information Needs 1 and 2 relate to future dumping requirements and may be answered by a projection of existing information (Chapter 2). They are not questions that could be addressed by scientific research.

Information Need 3 addresses the specific types of research or scientific information necessary to support the site-designation process. Considerable progress has been made already in developing a dumpsite designation protocol, and no additional research is considered to be necessary. Current regulations (40 CFR 228.6) specify technical and site-specific characteristics that must be considered in assessing a potential site (Table 4-1). Methods to collect that required information are well-known, and are adequate for environmental characterization.

Information Need 3 is also linked to Information Needs 4 and 5, since information gathered for site designation would indicate other sources of pollutants to a dumpsite area and give information on the dispersive characteristics of the site. In addition, information gathered as part of the site-designation process provides information that aids in the evaluation of specific permit applications for disposal, including the determination of waste load allocations.

In February 1983, the Environmental Protection Agency sponsored a "Workshop for the Development of a Scientific Protocol for Ocean Dump Site Designation." The workshop report presents the scientific basis for a "straw man" protocol that includes the following stages (EPA, 1983):

1. Preliminary site evaluation

2. Waste profile and loading characterization

3. Transport mapping and resuspension estimation

Table 4-1

Specific Criteria for Ocean Dumping Site Selection
(40 CFR 228.6)

(1) Geographic position, depth of water, bottom topography and distance from coast

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases

(3) Location in relation to beaches and other amenity areas

(4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any

(5) Feasibility of surveillance and monitoring

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any

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

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

(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys

(10) Potentiality for the development or recruitment of nuisance species in the disposal site

(11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance

4. Initial mixing and source-strength calculations

5. EPA water quality comparisons

6. Estimation of hypoxic potential

7. Species-specific assessments

The protocol is now being modified and implemented jointly by EPA and the Corps of Engineers, and employs a "hazard assessment" approach similar to that found in Objective 2.A.

Information Need 4, regarding the sources of pollutants in the area of a dumpsite, may require some scientific knowledge to answer adequately, especially to determine if contaminants from other sources contribute to degradation or environmental effects in the area of the dumpsite. For the purposes of dumpsite designation, however, existing knowledge is probably sufficient to determine if such sources exist. No further research is necessary.

Information Need 5 appears to have emerged from the lack of understanding of the short term fate of ocean dumped materals. Although dumpsites are designated at specific locations, wastes such as sewage sludge and other slurries are dispersed over a wide region, the size of which varies with local hydrographic conditions and the dumping techniques employed.

In the oceanic environment, a true "containment" site of the type implied by Information Need 5 does not exist[2], although certain dense wastes such as some types of dredged material have a greater tendency to remain in a given area. There are large differences between sites in the local residence times for settling particles and associated contaminants. These differences are a factor of oceanographic conditions, water depth, and episodic events such as storms that may pass through a site.

Neither complete containment nor maximum dispersion are reasonable objectives since the former is unrealistic (except for containerized wastes), and dispersion of wastes beyond threshold levels of adverse environmental effect is inefficient and unnecessary. In addition, by manipulating the dispersion rates of wastes such as sewage sludge, it may be possible to achieve some beneficial enhancement of productivity while incurring no negative impacts.

Current techniques would enable the quantification of relative dispersion rates or residence times, given known characteristics of the waste and the receiving environment. However, waste management practices (such as dewatering of sewage sludge) or the ocean dumping of other types of wastes (such as coal ash or scrubber sludge) may considerably affect known dispersion characteristics of wastes. Additional research is needed to be able to relate these waste management practices to dispersion parameters, and is considered under Objective 2.C.

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[2]With the limited exception of the disposal of containerized wastes--a disposal method not practicable for the municipal and industrial wastes considered here and not currently used as a method of disposal in ocean dumping.

Research Recommendations:

There are no specific research recommendations for this management objective. However, many of the issues important to site designation are equally important to permitting decisions (Objective 2) and site management (Objective 3), and will be discussed in those sections. Research on hazard assessment protocols, which will provide complementary information to EPA and the Corps of Engineers in ongoing revision and implementation of dumpsite designation protocols, are discussed under the next objective. Waste characterization studies such as the effect of dewatering of sludge on dispersion characteristics and the dispersion characteristics of potential new types of waste for ocean dumping (such as coal ash and scrubber sludge) are identified under Objective 2.C.

OBJECTIVE 2. Provide Methods for Assessing Effects of Specific Proposed Ocean Dumping Actions (e.g., review of permit applications)

OBJECTIVE 2.A Develop Hazard Assessment Protocols to Evaluate Ocean Disposal Impacts (Exposure and Effects Assessment)

Information Needs:

(1) What information is required to conduct a hazard assessment?

(2) What standard procedures should be used to calculate mixing zones?

(3) What level and duration of exposure are expected to result from specific dumping actions?

(4) For principal contaminants, what effects (lethal and sublethal) result from exposure (concentration and duration) that is expected to occur in and around the dumpsite?

(5) What levels of short-term exposure are considered acceptable?

(6) what safety margin should be built into a hazard assessment protocol to account for uncertainties inherent in the ocean environment?

(7) How can we verify hazard assessments in the field?

(8) What constitutes "unreasonable degradation"? How can it be measured?

Evaluation:

This sub-objective deals with the information required to regulate specific permit applications for ocean dumping at an existing site that already has been characterized during the site designation process.

Hazard assessment is a critical part of the permit approval process and requires specific types of scientific information. In this process, the risk (probability) of potential adverse effects is estimated. Any hazard assessment for ocean dumping requires three primary elements:

(1) Source Characterization, the identification and quantification of the input of wastes or specific contaminants to the environment;

(2) Exposure Assessment, determining the distribution and fate of contaminants in the environment, and their availability to organisms of concern;

(3) Effects Assessment, determining the likely effect of contaminants on humans and biota as a function of exposure.

Over the past several years, EPA has put considerable effort into developing procedures conducting hazard assessmnets. Although existing procedures and knowledge to conduct hazard assessments satisfy some of the most immediate management and regulatory needs, technical experts identified several research areas which should be furhter studied to improve the assessment process.

Information Need 1, regarding the information necessary to conduct a hazard assessment, is primarily a scientific question. The specific information needed depends, in part, on site-specific knowledge of the dumpsite and the particular resources at risk. In general, the scientific information necessary to conduct a hazard assessment is known, but we are not necessarily able to measure all of the variables involved. No additional research is needed on identifying the information necessary to conduct a hazard assessment. Ongoing research is directed towards developing methods to measure these unknown parameters.

Information Needs 2 through 7 deal with the specific elements of hazard assessments. While Information Need 2 on procedures to estimate "mixing zones" is a technical question, the "mixing zone", for the purposes of ocean dumping, is defined by regulation (40 CFR 227.29). A number of mathematical models for turbulent mixing exist, but they all give essentially the same result for neutrally buoyant materials such as municipal and industrial wastes. Models and field verification information also exists for negatively buoyant materials based on studies of dredged material. Therefore, the selection of one or several of these models may be done using existing knowledge.

Information Need 3 relates to exposure of humans and biota to ocean-dumped contaminants. It is convenient to distinguish between "near-field" exposures and "far-field" environmental exposures, the latter being beyond the area of the designated dumpsite. The regulations on the limiting permissible concentrations of ocean-dumped pollutants (40 CFR 227.27) deal only with the near field. Also, the methods for determining far-field exposures are quite different than those required for near-field assessments. Methods for near-field exposures are quite well developed and part of some ongoing research programs, but far-field exposure methods development is in need of further research. There are also research recommendations pertinent to these needs discussed under Objective 4.A.

Information Need 5 is also concerned with the exposure of biota to ocean-dumped contaminants, but asks only for an "acceptable" level of exposure. The determination of acceptable risk is strictly a policy question, although science can present estimates of risk for a variety of exposure levels.

Information Need 4 relates to determining the toxicity of wastes upon humans or the biota in order to evaluate the significance of a particular dumping action. Because laboratory measures of lethal effects are reasonably well developed, future research should focus on chronic or sub-lethal effects upon a population (e.g., growth and reproduction) or contamination of biotic resources consumed by humans. Current practices, embodied in regulations, focus on testing for standard principal contaminants. With the identification of new toxicants, new methods may need to be developed. However, for the purposes of regulating ocean dumping, bio-assay methods may be used to determine effects of total-wastes, but do not link effects to a particular toxicant. Exposure and effects assessment methods based on laboratory studies require intensive case-studies in order to iteratively test and improve them. While existing methods are reasonably adequate for currently dumped wastes--from the perspective of total-waste toxicity--a number of research questions remain on the linkage between laboratory measurements of toxicity and effects observed in the actual environment at the population or community level. Measures or indices of responses to environmental contamination by populations or communities need to be developed and validated. Research is also needed to help identify the effects of particle adsorption on the toxicity of contaminants in ocean-dumped wastes. A number of recommendations for addressing these questions are also discussed under Objective 4.B.

Information Need 6, regarding the safety margin built into hazard assessments, is in part a scientific question since it relates to "uncertainties" in the marine environment. However, the determination of a "safety margin" is a policy issue, not science. Uncertainty in hazard assessments may arise from several sources: analytical error; uncertainty due to natural environmental variability and biological cycles; sampling variability and handling error; and uncertainty in extrapolating laboratory research results to the environment. The question really addresses the combination of all of these sources of uncertainty. As a practical matter, the "safety margin" is usually a straight percentage of toxicant concentrations that produce adverse effects in laboratory bioassays. As long as exposure levels do not approach threshold concentrations, errors tend not to be significant, so safety margins on the order of 10-100 times lower than toxic concentrations typically have been used. These safety margins, in effect, allow for some probable, but unknown, analytical error.

In translating laboratory-derived values to the field, analytical uncertainty may or may not be as significant as natural variability. The closer the ambient concentrations are to toxic effect levels, the more significant is the effect of environmental variability.

No additional research related to analytical errors or sampling is considered necessary, but research is needed both in the area of environmental variability and combined (overall) uncertainties. Methods to determine

environmental probability distributions, such as Monte Carlo simulations, are mathematically well-developed and can be applied to ocean-dumping. Determining the overall uncertainty within a hazard assessment requires, finally, the statistical combination of exposure values and effect probabilities into a unified hazard assessment. Mathematical methods are available, but they have not yet been used to any extent in ocean pollution.

Information Need 7 relates to the scientific question of monitoring of post-dumping conditions in the field to verify predictions from hazard assessment. For the near field, existing knowledge is probably adequate but not enough is known to adequately monitor far-field effects. This issue is also related to the information needs for monitoring discussed under Objective 3. Because monitoring for effects in the far-field is likely to be very expensive, the type of monitoring performed may be limited more by resource constraints than scientific capability. Given a small likelihood of far-field effects, the priorities for this type of monitoring are expected to be low. However, improved capability for hazard assessment of far-field effects is still needed to better predict environmental effects. The case-studies recommended under Objective 3.B. also would be useful in determining far-field effects.

The last information need (8) seeks a scientific basis for the statutory concept of "unreasonable degradation." While environmental degradation may be indicated by the use of various environmental indices, the determination of what level of change becomes "unreasonable" is primarily a policy decision. While additional research cannot contribute to that policy decision, additional studies to measure or evaluate environmental degradation are needed, especially in the areas of effects on population structure and ecosystem health.

Research Recommendations:

(1) Apply existing exposure and effects estimating procedures to hazard assessments and revise procedures based upon results[3]

(2) Develop methodology to accurately predict environmental and ecological responses in the field based on laboratory data

(3) Develop methodology to predict population and community responses from single-species tests[4]

(4) Evaluate the toxicity of particle-bound contaminants in the water column[5]

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[3]This topic could equally be listed under Objective 1.A.

[4]This study is also recommended as the third recommendation under Objective 2.C.

[5]This topic is closely related to the third recommendation under Objective 4.A, which deals with the phase-partitioning of contaminants as a function of particle size.

(5) Study the effects of environmental/oceanic variability on the exposure of organisms to ocean-dumped contaminants

(6) Develop methods for analyzing uncertainties in measuring effects

(7) Evaluate uncertainty levels in hazard assessment protocols that use exposure and effects data

(8) Develop measures of ecosystem-level response to environmental contamination[6]

(9) Develop methods to conduct hazard assessments for far-field impacts[7]

OBJECTIVE 2.B. Develop Methods for Comparing Disposal Alternatives

Information Needs:

(1) Can valid cross-media comparisons be made for the different alternatives? How?

(2) Are we considering all feasible alternatives to ocean dumping?

(3) What are the relative costs of monitoring in various media?

Evaluation:

Information Need 1 of this sub-objective relates to the comparison of air, land and water waste-disposal alternatives, including ocean dumping. Variables such as human health, environmental effects, economic and social costs are possible elements for comparison. Air disposal of municipal and industrial wastes means incineration, and is the most dispersive disposal alternative for certain contaminants. Exposure to contaminated air can potentially lead to direct effects on humans and biotic resources. This alternative also produces incombustible solid residues (e.g., ash and scrubber sludge) that still must be disposed elsewhere.

The basic concept behind land disposal of wastes is containment which may require that designated disposal sites be withdrawn from alternative use for long periods of time. The use of sewage sludge as fertilizer avoids this commitment of land resources, although the loading rates for certain contaminants (e.g., trace metals) must be closely monitored. In general, waste disposal on land is easier to monitor for both short- and long-term effects than in the marine environment. Conversely, disposal of wastes in the marine environment, as with incineration, leads to dispersal of the wastes and possible far-field effects. For these and other reasons, land disposal of waste generally considers risk to human health as the primary

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[6]This recommendation parallels the fourth recommendation under Objective 3.B.

[7]This study is very similar to the fourth recommendation under Objective 4.A.

objective in assessing risks, in contrast to the strong additional concern with ecosystem degradation in the coastal and marine environment.

The State of New York, in its application for an ocean dumping permit, compared cross-media disposal alternatives according to four priorities: public health; ecological effects; public perception and environmental concern; and economic cost (NYC, 1983). EPA's hazard assessment approach (source and site characterization, exposure and effects assessments, and risk assessment) may serve a similar framework for comparison of alternatives. The greatest difficulty lies with designing studies to give equivalent measures of risk for the different media.[8]

EPA's Office of Policy, Planning and Evaluation and Office of Water are conducting an intermedia comparison of the ocean versus land disposal of sewage sludge, but the land disposal evaluation is largely focused on and Liability Act (Superfund) is a good example of this difficulty. human health risk, and does not include effects on the components of the environment. These and other generic studies are limited in what they tell us about specific regional alternatives, and there is a pressing need for regional case studies and demonstrations that compare ecological effects as well as public health objectives between land and ocean disposal options. Unfortunately, intermedia comparisons of effects using existing information may be hindered by the lack of compatibility in their data between studies. In fact, many of the early studies lack the data to apply modern hazard assessments even within the waste disposal medium for which they were designed.

Information Need 2 refers to the related issue of an adequate evaluation of various alternatives within the scope of marine disposal. Questions related to site selection for ocean dumping (for a given permit applicant), area-wide management, consolidation/separation of waste-dumping actions, disposal by deep-ocean pipeline, modification of discharge rates, periodic use of alternate sites, and other issues have been inadequately addressed. An excellent opportunity for a case study would be a rigorous analysis of New York City's sewage-sludge disposal options following the closure of the 12-Mile Site. Both of these aspects would also benefit from an evaluation of alternatives designed to minimize negative effects and possibly increase productivity.

For Information Need 3, it was determined that the question is science related because the design of a monitoring program determines the cost. However, no new research is necessary to adequately address this area.

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[8]A number of attempts have been made to establish environmental and ecological "values" of specific resources. These attempts have had limited success due to the tremendous difficulty in defining a reasonable "currency" for natural resource values and for scaling values from single entities (e.g., organisms) to large numbers of organisms. The current long-running attempt to define "Natural Resource Damage Functions" under Section 301(c)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) is a good example of this difficulty.

Research Recommendations:

(10) Conduct a regional demonstration study to evaluate the ability to compare environmental effects among different ocean disposal options

(11) Conduct a regional demonstration study to evaluate the ability to compare environmental effects across media

OBJECTIVE 2.C. Develop New Procedures or Improve Existing Procedures for Evaluating or Screening Wastes Proposed for Ocean Dumping (Physical, Chemical, Biological Characterization or Screening Protocols)

Information Needs:

(1) What information is needed to characterize adequately a waste for the purpose of permit application review?

(2) What indications are sufficient to require denial of a permit application?

(3) What would be a better predictor or indicator of ecological effects than the bioassay procedure?

Evaluation:

Information Needs 1 and 3 relate to improved standard methods for physical and biological characterizations of wastes during the permit review process. Existing analytical methods for the chemical characterization of wastes are very well-developed. Similarly, laboratory measures of toxicity and other biological effects are reasonably sufficient for current wastes. However, the ability to extrapolate laboratory bioassay data to field conditions and population and community levels requires research. Single-chemical analyses are frequently performed to determine the presence of certain key compounds in the waste. The fundamental assumption is that biological effects are somehow related to the presence of these key chemicals, but there is no adequate means to relate single-chemical analyses to environmental or public health effects.

With whole-waste bioassays, it is not necessary to attribute effects to particular constituents in order to regulate the discharge of that waste. However, the assumption is made that the waste constituents causing toxic effects are always present in the waste at the same concentrations. It has been suggested that bioassays employ offshore zooplankton or other species that would be more representative of dumpsite biota. Bioassays using certain offshore zooplankton (copepods) would be far more sensitive than current protocols. However, it is possible that certain species could be too sensitive to use successfully in routine tests and more sensitive than necessary to determine public health or environmental standards. Because wastes are being dumped further offshore, the difference in sensitivity between near-shore and offshore species needs to be studied.

Physical characterization of wastes is generally adequate, with the exception that waste settling and dispersive properties, especially for new wastes, are not well characterized. There are no good criteria for predicting settling velocity (and hence, residence time) of sludge under various ambient conditions. This uncertainty concerning sedimentation behavior affects information needs in virtually every objective. Related research recommendations are further discussed under Objectives 2.A, 3.C, 4.A and 4.B.

Information Need 3 directly addresses the inability to adequately identify environmental effects in the field using laboratory (chemical or biological) tests. Laboratory biological test protocols are based largely on single-species bioassays, and it is possible that the development of multi-species bioassays will better reflect natural conditions. Ongoing microcosm/mesocosm research by the NOAA, EPA and others have used complex mixtures (whole wastes) to predict effects. There is no proof, however, that the development of multi-species bioassays will improve the ability to predict field effects over single-species tests. While a valuable research topic (it is the final recommendation under Objective 4.B.), multi-species bioassays are probably not a practical or cost-effective tool in the foreseeable future for the routine screening of wastes.

There is an immediate need for rapid and cost-effective techniques for determining relative toxicity of ocean-dumped pollutants and identifying their possible chronic or sub-lethal effects. A number of sub-organism tests (i.e., biochemical, histopathological, molecular, cellular) show promise for measuring ecological stress. These methods are extremely early in their research and development at the present time and still must be linked to population factors such as reproduction and growth. These issues are further discussed under Objective 4.B, dealing with long-term effects.

Information Need 2 relates to the policy judgment of permit denial. This question is similar to the concept of "unacceptable degradation" raised in Information Need 8 under Objective 2.A. While the best available scientific information should be used to develop criteria for permit denial, the establishment of such criteria is part of the policy process in government.

Research Recommendations:

(12) Determine the settling rates of sewage sludge as a function of initial sludge conditions and discharge technique[9]

(13) Determine the dispersive characteristics of potential new ocean-dumped wastes (e.g., coal ash, scrubber sludge)[9]

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[9]This recommendation also provides waste-characterization information related to Objective 1.A.

(14) Develop methodology to predict population and community responses from single-species tests[10]

(15) Determine the difference in sensitivity between near-shore and offshore species used in sewage-sludge bioassays[11]

(16) Demonstrate rapid, cost-effective screening tools for ranking relative toxicity of ocean-dumped pollutants

(17) Develop rapid test measures to identify chronic effects (e.g., growth, reproduction) due to ocean-dumping

(18) Investigation of sub-organism responses (e.g., histopathology, "stress proteins," enzymatic responses) of organisms to ocean-dumped pollutants

OBJECTIVE 3. Prescribe Procedures for Dumpsite Monitoring and Management

OBJECTIVE 3.A. Develop Procedures for Permit Compliance Monitoring

Information Needs:

(1) What parameters should be monitored? Where? How often?

(2) What is the best way to get a valid sample of the contents of a barge?

(3) How can we identify unexpected problems that arise as a result of ocean dumping?

(4) Can a protocol for cost-effective compliance monitoring be devised?

Evaluation:

This sub-objective addresses the need to develop well-designed monitoring procedures to be performed by the holder of an ocean dumping permit. The first and second Information Needs reflect management concern with ensuring that individual dumping events are conducted as prescribed and that predicted effects are not exceeded. Given knowledge of the waste constituents, standard chemical constituents and physical properties can be readily monitored. Therefore, existing scientific knowledge is sufficient to design an effective monitoring program. A monitoring program for the disposal of sewage sludge at the 106-Mile Site is currently being designed.

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[10]This study is also listed as the third topic under Objective 2.A.

[11]This topic is directly related to the sixth study recommended under Objective 4.B, dealing with nearshore/offshore sensitivity.

Information Need 3 relates to the fact that not every chemical compound is measured in waste material, not every potentially affected population can be monitored, and not every environmental response can be predicted. The best possible hazard assessment, within reasonable bounds of time and resources, cannot absolutely ensure the detection of all possible effects. However, a well-designed monitoring program that includes measures of ecosystem and population health will provide some ability to detect unexpected effects. While additional research is not required for this information need, Objectives 2.A, 3.B and 4.B (and some of the research recommendations under these Objectives) address the measurement of ecosystem and population-level effects.

The final Information Need, cost-effective compliance monitoring, is really a design problem. Scientists can suggest monitoring program options with their associated costs, but the choice among these options for the desired level of effectiveness is a policy decision. Increased scientific knowledge may improve this process, for example by providing additional data to give a statistical basis for reduced sampling.

Research Recommendations:

No specific research is required to address the needs of this objective. However, the recommendations discussed under Objective 2.C would provide additional tools for use in compliance monitoring.

OBJECTIVE 3.B. Develop Procedures for Monitoring Ecological Trends in and Near Dumpsites

Information Needs:

(1) From the perspective of detecting long-term trends in environmental status, what constitutes adequate baseline data for a dumpsite?

(2) What parameters should be monitored for the purpose of ecological trend assessment in and around dumpsites?

(3) Should sublethal effects be monitored? How?

(4) Can trend-assessment monitoring be designed in a cost-effective manner?

Evaluation:

The first three information needs of this sub-objective deal primarily with the development of a monitoring program for long-term or far-field fate and effects of ocean-dumped material. Such monitoring frequently develops baseline data representing the natural or pre-dumping conditions of the site.

The first Information Need relates to the initial ambient conditions with which changes in the measured parameters may be compared. Current methods for far-field monitoring at ambient marine concentrations are relatively poor compared with those for the near-field. There is a scarcity of meaningful baseline data available that relates to ocean dumping. In fact, there is no adequate criterion by which to judge the adequacy of baseline data given our poor understanding of natural variability. This concern parallels the need to better understand the statistical uncertainties surrounding assessment protocols discussed under Objective 2.A.

The International Council for the Exploration of the Sea (ICES) program has been conducting trend-monitoring in fish, for organic and metal contaminants over an extended period. The Outer Continental Shelf (OCS) oil and gas leasing program and the monitoring programs conducted for effluent discharges (i.e., NPDES and 301(h) compliance monitoring) have extensive environmental baseline and monitoring data for several regions. The Northeast Monitoring Program of NOAA has accumulated a large quantity of samples and data in the waters and sediments of the continental shelf off the Northeastern United States. These data sets should be examined to determine if the information can be used to help improve ocean-dumping monitoring in the selection of parameters or design of sampling programs.

More research is required under field conditions to refine the methods, study-durations, parameters, and protocols for the detection of long-term ecological trends. Case-studies will be required to investigate these questions, and to determine whether long-term trends may even be detected and distinguished from natural cycles. One of the most promising avenues appears to be retrospective monitoring of recovery at abandoned dumpsites such as the 12-Mile Site (See discussion under Objective 4.B.). Case studies conducted at the 12-Mile Site would be particularly useful because of the extensive history of research studies conducted in the New York Bight area on the biological, chemical and physical parameters and contaminant inputs to the region. In addition, a case-study initiated at the 106-Mile Site would afford an excellent opportunity to monitor environmental trends, especially since NMFS and university scientists have already conducted long-term studies in the general area. A monitoring program for the 106-Mile Site is in the process of development by EPA with the input and cooperation of NOAA.

Information Needs 2 and 3, similar to Information Need 1 of Objective 3.A, concern the choice of parameters used to detect possible adverse effects. Existing scientific information is probably sufficient to make a selection among known parameters. However, techniques that measure sublethal effects (e.g., effects on growth or reproduction) and environmental degradation at the ecosystem level are not well developed. Research should be strengthened so that these techniques may be included in a monitoring program. Introduced species (transplants) such as caged mussels could be a useful technique to measure a variety of parameters and to detect temporal trends. Considerable work on this technique has already been done under the existing Mussel Watch programs. Preliminary studies have been made at the 12-Mile Site in the New York Bight, and this type of research should be continued and expanded.

Considerable research has been done on the measures of chronic effects of environmental contaminants on individual species. However, not enough is known concerning ecosystem responses or how to recognize them. Ongoing research is concentrating on the development of ecological indices, and this should be encouraged. As discussed under Objectives 2.A, 2.C and 4.B, the methods are not yet entirely adequate. Research activities such as topics 6 and 7 under Objective 2.C, dealing with the development of rapid screening tools, are necessary to address the concerns of this section as well.

The final Information Need, similar to Information Need 4 under Objective 3.A, concerns cost-effective trend monitoring. As previously discussed, scientists can present different monitoring schemes or options, but the selection among them, balancing cost and effectiveness, is a policy decision.

Research Recommendations:

(19) Conduct case-studies at new and closed dumpsites to determine requirements (parameters, frequency, duration) for the detection of long-term ecological trends[12]

(20) Improve and employ transplant techniques (e.g., caged mussels) as a substitute for baseline data, using control sites to determine environmental effects

(21) Develop measures of sublethal effects to detect environmental change at ocean dumpsites[13]

(22) Develop measures of environmental degradation and interpret what they mean at the ecosystem level[14]

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[12]This topic is the highest-ranking recommendation across all objectives. It is also directly related to the fifth study recommended under Objective 4.B.

[13]This topic is closely related to recommendations 6 and 7 under Objective 2.C. and the second study recommended under Objective 4.B.

[14]This topic is directly related to the eighth recommendation under Objective 2.A.

OBJECTIVE 3.C. Develop and Evaluate Site Management Options

Information Needs:

(1) What methods are available to maximize dispersion at a site, or to otherwise mitigate impacts?

(2) What should be the duration of an ocean dumping permit?

(3) How long should a dumpsite remain active?

Evaluation:

The first Information Need is similar to the fifth Information Need under Objective 1.A, concerning the relative merits of dispersion versus containment. As was discussed there, initial dispersion is a function of the physical parameters of the waste (particle size and water content being the principal ones), the actual dumping method and pattern used, and the immediate physical oceanographic conditions at the dumpsite. By combinations of engineering innovations, chemical peptizing agents and the use of certain dumping patterns (e.g., speed and path of vessel), the dispersion of particulate wastes and the degree of flocculation may be modified during the initial mixing period. Considerable research has already been conducted in this area under the dredged material research program and may be applicable to municipal and industrial wastes. Additional research in chemical engineering, mechanical engineering and colloidal chemistry would be valuable to develop means to actually control dispersion rates for various types of waste. Sedimentation behavior and settling rates are also discussed under Objectives 2.A, 2.B, 4.A and 4.B.

Operational decisions on ocean dumping should also take into account the synoptic physical oceanographic conditions of the receiving waters because changes in site conditions can alter the possibility of risk to the environment and human health. Ongoing research sponsored by NOAA, the Office of Naval Research, the National Science Foundation and NASA, using remote sensing technologies for real-time identification of short-term oceanographic conditions (such as Gulf Stream rings) may prove to be very valuable in addressing this issue, but additional research would be needed to optimize decisions based on these data.

The second part of the first Information Need, dealing with the mitigation of impacts, touches on an area commonly investigated in connection with land disposal, but usually overlooked in ocean dumping: the potential beneficial aspects to enhanced productivity and fisheries from sewage-sludge disposal. As written, the question implies that maximum dispersion is most desirable. This may be true for certain wastes, but for sewage sludge, it is possible that certain application rates might yield positive effects.[15] Very little has been done regarding its potential beneficial influences

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[15]Sewage sludge is being used increasingly in agriculture as a fertilizer.

in the marine environment. Additional research would also help address the issues related to dumpsite selection discussed under Objective 1.A and the intermedia and ocean-dumping alternatives considered under Objective 2.B.

Information Needs 2 and 3 relate to management concern over the effective capacity of a given dumpsite. Since ocean-dumping sites are dispersive, they do not "fill up," but reach a quasi-steady-state equilibrium that is a function of the application rate. Because of this, Information Need 2 is not really a research question. Permits are generally written for a specified period (usually five years), but EPA has the authority to cancel them or deny renewal should the permits be violated or if environmental monitoring detects unanticipated degradation.

In theory, a dumpsite can remain active indefinitely, as long as the rate of ocean dumping does not exceed the ability of the site to disperse, assimilate, or otherwise neutralize the wastes. This Information Need might be rephrased, "What is the maximum periodic load of ocean-dumped material that will not exceed the loading capacity of the site?" That capacity should be estimated optimally at the dumpsite-designation stage, and monitoring should be used to continuously refine that estimate. Therefore, this is equally a site management and site designation issue. However, there is no existing methodology developed to calculate or predict the capacity of a dumpsite, and further research is necessary. A case-study approach to develop maximum loading rates was recommended.

Research Recommendations:

(23) Develop methods to optimize dispersion of wastes using engineering technologies, dispersion protocols, or control of sedimentation rates

(24) Develop methods to determine dumpsite capacity in terms of maximum periodic load

(25) Evaluate beneficial effects of alternative sewage-sludge dumpsite management options designed to increase productivity and enhance fisheries[16]

(26) Develop methods to identify large-scale water mass characteristics for use in real-time dumpsite management

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[16]This topic would also address related information needs under Objectives 1.A (dumpsite selection and waste characterization) and 2.B (ocean-dumping alternatives).

OBJECTIVE 4. Determine and Evaluate the Environmental Fate and Effects of Ocean Dumping

OBJECTIVE 4.A. Determine Fate of Contaminants (Water Column, Sediments, Biota) in Near- and Far-Field

Information Needs:

(1) What is the short-term fate of contaminants that are dumped in the ocean?

(2) What concentrations of contaminants are likely to occur in the water column and sediments as a direct result of ocean dumping?

(3) What is the long-term fate of contaminants that are dumped in the ocean?

(4) What is the area of influence of a typical dumpsite? How far do significant effects range?

(5) In what concentrations and forms are contaminants that are ocean-dumped likely to occur in marine organisms (including human food resources)?

Evaluation:

Rather than focus on the temporal distinction implied by "short-" and "long-term," it was decided that it was more appropriate to speak of the "near field" and "far field" when discussing the fates of ocean dumping contaminants. Physical and biological processes occur at widely varying rates, so the use of time scales in describing the kinetics of pollutant transport and fate may be misleading. The near field implies fates in the immediate environment of the dumpsite; the far field occupies an extended region.

Information Needs 1 and 2 relate to the behavior of materials directly after dumping. The key issue pertaining to oceanic fate of dumped pollutants is the accumulation of contaminants in environmental compartments to levels at which negative effects are caused. This primarily includes the uptake of key components of the material into the food web or the accumulation of organic materials below the thermocline and the formation of anoxic conditions. The uptake of contaminants by organisms occurs both by physical assimilation--a function of ambient bioavailability--and by the longer-term process of food-web transport. The residence time of the dumped material in the water column is a factor of dispersive hydrodynamic forces and sedimentation rate. Theoretical settling velocities of particulates are greatly affected by a number of variables including local salinity and temperature conditions and density gradients, the specific makeup (and water content) of the sludge, the disposal rate and technique used by the barge, and the rate of uptake by biota (and fecal pellet formation by zooplankton). Physical and chemical conditions also affect the flocculation of suspended particles, (and therefore the residence time) and phase partitioning of the pollutants. As a result, more research

should be directed towards both the biological and physical/chemical factors that affect the particle size distribution of dumped materials, and existing models that describe the settling of particles should be refined and validated for conditions associated with ocean dumping events.

Different particle types and sizes have different affinities for binding chemical contaminants. For example, very fine particulates and colloids tend to have surface electrical properties conducive to organic bonding. Thus, physical partitioning of chemical contaminants, residence times of various constituents, and fate are closely affected by particle type and size after initial mixing. Additional research is therefore necessary on the phase partitioning of ocean-dumped contaminants as a function of particle size and type. This area is similar to the research needs identified under the Objective 2.A. dealing with the toxicity of particle-bound contaminants.

In addition, contaminants are not necessarily stable in the environment or after uptake by organisms. Contaminants may be transformed to related compounds of either greater or lesser toxicity. The transformation of contaminants in the marine environment needs greater study since contaminant fate may be greatly affected by these processes.

Information Need 3 refers to the far-field fate of ocean-dumped contaminants, beyond the immediate boundaries of the dumpsite. Far-field fate is affected by the distribution of the wastes and contaminants. Contaminants resuspended in the water column are continually transported to other areas while being diluted, and are available for biological uptake. Contaminated sediments are available to the benthos or may be resuspended by physical or biological events. Relatively little is understood of these factors. In addition, current, relatively crude models that describe far-field fate have never been adequately validated. Additional research is needed on <u>in situ</u> waste degradation and the effect of sediment resuspension and bioturbation on contaminant distribution and bioavailability. Research into the uptake of contaminants into the food web, of significant importance to this question, is discussed under Information Need 5.

Regulatory standards, water quality criteria, and Limiting Permissible Concentrations deal with the near-field. Concentrations of contaminants in the water column are not likely to be greater than the initial conditions at dumping, so water-column concentration-based criteria met in the near field would not be violated in the far field even though certain sediments beyond dump-site boundaries could possibly accumulate contaminants to significantly elevated levels. Information Need 4, though, questions if one can be in short-term compliance and still create long-term effects outside the dumpsite. This is really an issue of effects assessment (dealing with bioaccumulation in benthic organisms) rather than exposure, and is considered in the next section. The "area of influence" and the concept of "significant effects" are policy decisions, not science questions, although science provides the technical information necessary to make such decisions.

Information Need 5 also addresses the uptake of contaminants into the food web and human food resources. There is no reliable way to predict concentrations that will occur in marine organisms as a result of concentrations in the environment. Food-web, or trophic-level, transport of pollutants is both a near-field issue (affected by the bioavailability of the toxicants in the water column or sediment) and a far-field issue (associated with uptake from prey species as well as the water column or sediments). For high-molecular-weight hydrocarbons at equilibrium, it is theoretically possible to calculate some equilibruim value between tissue residues and water concentration knowing the physiochemistry of the compounds revealed in their octanol-water coefficients. This, however, has not been well verified in the field. The assumption of equilibrium is not necessarily valid in ambient conditions (e.g., depuration kinetics may not be able to keep pace with uptake kinetics). Validation of existing and developing models is probably the single most pressing need for this Information Need. Tissue residues should be monitored in resident benthic or demersal organisms. Current plans for a 106-Mile Site monitoring program include the study of tissue residues in the tile fish, Lopholatilus chamaeleonticeps. The earlier recommendations under Objectives 2.B. and 3.B. relating to case-studies at the 106-Mile Site and other areas would directly benefit this information need, as would the recommendations in Objective 4.B. dealing with population-level effects.

Research Recommendations:

27a) Investigate the effects on particle settling rates by biological processes (e.g., zooplankton grazing and formation of fecal pellets)

27b) Investigate the effects on particle settling rates by physical and chemical processes associated with ocean dumping (e.g., flocculation, salinity, density gradients)

(28) Investigate the phase-partitioning of contaminants as a function of particle type and size[17]

(29) Develop and validate models to predict far-field transport, transformation and fate of pollutants[18]

(30) Investigate the long-term biological fate of ocean-dumped pollutants and the movement and transformation of contaminants through the food web (e.g., bioavailability, bioconcentration and biomagnification)

(31) Investigate the effects of resuspension and bioturbation on the long-term fate of contaminated sediments

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[17]This topic is directly related to the fourth recommendation under Objective 2.A., which deals with the toxicity of particle-bound contaminants.

[18]This study is closely related to the ninth topic recommended under Objective 2.A.

OBJECTIVE 4.B. Determine Effects of Dumping Activities and Evaluate Significance to Human Health, Living Marine Resources, and Integrity of Marine Ecosystems

Information Needs:

(1) What are the concentrations in the water column, sediments, and tissues of marine organisms at which we need to take regulatory steps to limit or eliminate inputs?

(2) How severe is the risk to human health from ingestion or assimilation of ocean-dumped contaminants and pathogens?

(3) What will be the effects of ocean dumping on fisheries stocks?

(4) Where might ocean dumping affect critical habitats of living marine resources?

(5) What is the environmental status of marine ecosystems? What trends are occurring in environmental status? What are the effects of ocean-dumping as distinct from other sources of pollution and changes due to natural phenomena?

(6) How much ocean dumping has occurred, is occurring, and is likely to occur in the future on a regional and national level? How significant are any long-term regional or national consequences of ocean dumping likely to be?

(7) Are inner- or outer-shelf ecosystems inherently more sensitive to the effects of ocean dumping?

Evaluation:

Information Needs 1 and 2 relate to the determination of contaminant concentrations at which regulators should become concerned about effects. While the point at which action should be taken is strictly a policy determination, science can provide the information necessary to make such a decision.

To some extent, Information Need 1 can be addressed by acute and chronic toxicity studies that determine the contaminant concentrations in water, sediments or tissues at which effects can be expected. To apply this information to the field, contaminant concentrations must be determined in the environment. However, this approach lacks adequate scientific evidence linking contaminant concentration with effects on various species in the environment. Research is also needed on the rate of transfer of contaminants between water, sediments and biota, since such transfers would affect the level of contamination to which the organisms are exposed.

Considerable research is already underway investigating links between sediment concentrations and biological effects, to develop a basis for

establishing sediment quality criteria. These concerns are directly related to the information needs and research recommendations discussed under Objective 3.B.

Information Need 2 specifically addresses the threat to public health from the human food web. Existing knowledge is probably adequate only for a first-order estimate. While predictive models exist, they remain unvalidated because of the difficulties involved in distinguishing human health effects due solely to exposure to ocean-dumped contaminants. Factors such as levels of tissue residues in important food fish and consumption (dose) rates are highly variable and it is difficult to estimate the amount of contamination due to ocean dumping. NOAA is presently funding research on the West Coast to determine the kinds and amounts of fish that are regularly consumed by segments of the population. Similar studies have been made in southern California. Research recommendations regarding the actual risk to humans from the consumption of contaminated fish and shellfish is beyond the scope of this Action Plan, but research should be continued to estimate the potential human dosage (exposure) from ocean-dumped contaminants.

Information Needs 3 and 4 relate to the impact of contamination on valuable living marine resources, such as commercial fisheries and endangered species. Population effects may result from contaminants or habitat disruption. However, given the assumption that dumpsites are selected to avoid important population, migration and spawning areas, there is less concern that habitat disruption will have a significant effect. Research into long-term population changes due to specific and continuous losses of eggs, larvae and juveniles is needed for regulation of ocean waste disposal as well as other activities. However, as discussed previously, the linkage between contaminant levels and observable population effects is an extremely difficult task. In fact, the effects of ocean dumping on all fisheries stocks may be impossible to estimate. The National Marine Fisheries Service has collected some distributional information on tilefish[19] (Lopholatilus chamaeleonticeps) in the general region of 106-Mile Site. The tilefish is a long-lived, bottom-dwelling stationary animal. These characteristics combined with several years' population and catch data make this a valuable long-term monitoring tool. This monitoring should be intensified and extended more directly into the impact area. NMFS is also monitoring the planktonic larval stages of several commercially important fish on the inner shelf, but it is extremely difficult to identify population effects, short of catastrophic declines. Support should be provided for NMFS to extend ichthyoplankton monitoring out to the 106-Mile Site.

There is negligible information on the decline in commercial quality of demersal fish due to diseases, tumors or other aberrations that might be attributed to ocean dumping. While no additional research is recommended in this area, the issue is tied directly to potential effects on reproduction and growth raised under Objectives 2.C and 3.B and indirectly to the public health issues discussed above.

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[19]The tile fish is presently the most valuable commercial landing in New Jersey.

Information Need 4 focuses on the identification of areas where ocean dumping might have negative impact on the critical habitats of marine organisms. By statute, no ocean dumping is permitted at critical habitats. The U.S. Fish and Wildlife Service and the NMFS have data that are sufficient to map the gross distribution of many resource and non-resource organisms on the inner shelves and for most potential dumpsites. The existence of geographically defined critical habitats for most of the species is not known. Additional research in this area would likely be of limited value.

Information Need 5 deals with the overall status of the marine environment and the effect that ocean dumping might be having. At a regional level, the ability to differentiate sources of anthropogenic pollution depends on the number and type of inputs to an area. On the inner shelf and in estuaries with multiple sources of pollutants, identification of the particular municipal and industrial waste source is difficult or impossible. Further, it is extremely difficult to associate observed biological or ecological change with dumping. As long as ocean dumping is confined to a relatively few, widely separated sites, associations between dumping and effects might be detected (albeit with a highly sophisticated and expensive sampling program) as a function of concentration gradient. However, closely spaced dumpsites could make these studies difficult. A case study of recovery of the 12-Mile Site following the cessation of ocean dumping was strongly recommended to help address this Information Need. The establishment of a far-field monitoring program for active dumpsites would also be needed to determine the long-term regional or national consequences of ocean dumping. Many of these issues are also directly related to those discussed under Objective 3.B, dealing with the development of improved capabilities for identifying such linkages.

Information Need 6 focuses on determining future trends in ocean dumping, and thereby predicting the possible need for environmental regulation. In general, long-term knowledge in this area is poor and any predictions are difficult. It is unlikely that further research would greatly aid this Information Need.

The final Information Need addresses the relative sensitivity in marine ecosystems between the inner and outer continental shelf. The Ocean Dumping Act specifies preference for sites off the continental shelf[20], making the presumption that offshore areas are either less valuable or less sensitive. Conventional wisdom would suggest that offshore species are more sensitive to local environmental stress than near-shore populations, but many species are also fairly adaptable. Additional research would be necessary to address this information need.

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[20]Section 102(b)(I) states, "In designating recommended sites, the Administrator shall utilize wherever feasible locations beyond the edge of the Continental Shelf."

Research Recommendations:

(32) Investigate the kinetics of tissue/sediment/water-column pollutant transfer[21]

(33) Determine the linkage between tissue residues and effects (growth, reproduction) in selected biota[22]

(34) Determine the linkage between sediment concentrations and effects of pollutants on biota, and develop appropriate sediment quality criteria

(35) Conduct laboratory and field studies of pollutant effects on contamination, survival and reproductive success of selected living marine resources within the dumpsite area

(36) Monitor post-dumping ecological recovery at the 12-Mile Site and other areas of opportunity[23]

(37) Evaluate the sensitivity of off-shore species to ocean-dumped pollutants[24]

(38) Develop multispecies techniques (e.g., microcosms/mesocosms) to study the effects of ocean-dumping of specific wastes

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[21]This topic is closely related to the fourth recommendation under Objective 2.A, which deals with the toxicity of particle-bound sediments.

[22]This recommendation (as well as the next one) is related to the sixth and seventh recommendations under Objective 2.C and the third and fourth studies under 3.B, all dealing with chronic-effects detection and measurement.

[23]This recommendation is closely related to the first priority recommendation under Objective 3.B.

[24]This topic is closely related to the fourth recommendation under Objective 2.C.

Table 4-2
Recommended Research and Monitoring
by Information Need Objective

Number	Description	Related Objectives	Overall Rank
Objective 2.A:	Develop hazard assessment protocols to evaluate ocean disposal impacts (exposure and effects assessment)		
1	Apply existing exposure and effects estimating procedures to hazard assessments and revise procedures based upon results	1a	6
2	Develop methodology to accurately predict environmental and ecological responses in the field based on laboratory data		9
3	Develop methodology to predict population and community responses from single species tests	2c	17
4	Evaluate the toxicity of particle-bound contaminants in the water-column	4a	33
5	Study the effects of environmental/ oceanic variability on the exposure of organisms to ocean-dumped contaminants		34
6	Develop methods for analyzing uncertainties in measuring effects		24
7	Evaluate uncertainty levels in hazard assessment protocols that use exposure and effects data		13
8	Develop measures of ecosystem-level response to environmental contamination	3b	37
9	Develop methods to conduct hazard assessments for far-field impacts	4a	2
Objective 2.B:	Develop methods for comparing ocean disposal alternatives		
1	Conduct regional demonstration study to evaluate the ability to compare environmental effects among different ocean-disposal options		28
2	Conduct regional demonstration study to evaluate the ability to compare environmental effects across media		15

Table 4-2 (Continued)
Recommended Research and Monitoring
by Information Need Objective

Number	Description	Related Objectives	Overall Rank
Objective 2.C:	Develop new procedures or improve existing procedures for evaluating or screening wastes proposed for ocean dumping		
1	Determine settling rates of sewage sludge as function of initial sludge conditions and discharge techniques	1a	18
2	Determine the dispersive characteristics of potential new ocean-dumped wastes (e.g., coal ash, scrubber sludge)	1a	32
3	Develop methodology to predict population and community responses from single species tests	2a	23
4	Determine the difference in sensitivity between near-shore and offshore species used in sewage-sludge bioassays	3b, 4b	10
5	Demonstrate rapid, cost-effective screening tools for ranking relative toxicity of ocean-dumped pollutants		4
6	Develop rapid test measures to identify chronic effects (e.g., growth, reproduction) due to ocean dumping		7
7	Investigate sub-organism responses (e.g., histopathology, "stress proteins," enzymatic responses) of organisms to ocean-dumped pollutants		25

Table 4-2 (Continued)
Recommended Research and Monitoring
by Information Need Objective

Number	Description	Related Objectives	Overall Rank
Objective 3.B:	Develop procedures for monitoring ecological trends in and near dumpsites		
1	Conduct case-studies at new and closed dumpsites to determine requirements (parameters, frequency, duration) for the detection of long-term ecological trends	4b	1
2	Improve and employ transplant techniques (e.g., caged mussels), as a substitute for baseline data, using control sites to determine environmental effects		30
3	Develop measures of sublethal effects to detect environmental change at ocean dumpsites	2c 4b	22
4	Develop measures of environmental degradation and interpret what they mean at the ecosystem level	2a	20
Objective 3.C	Develop and evaluate site management options		
1	Develop methods to optimize dispersion of wastes using engineering technologies, dispersion protocols, or control of sedimentation rates		29
2	Develop methods to determine dumpsite capacity in terms of maximum daily load		5
3	Evaluate beneficial effects of alternative dumpsite management options designed to increase productivity and enhance fisheries	1a, 2b	39
4	Develop methods to identify large-scale water mass characteristics for use in real-time dumpsite management		35

Table 4-2 (Continued)
Recommended Research and Monitoring
by Information Need Objective

Number	Description	Related Objectives	Overall Rank
Objective 4.A:	Determine fate of contaminants (water column, sediments, biota) in near- and far-field		
1	Investigate the effects on particle settling rates by biological processes (e.g., zooplankton grazing and formation of fecal pellets)		26
2	Investigate the effects on particle settling rates by physical and chemical processes associated with ocean dumping (e.g., flocculation, salinity, density gradients)		16
3	Investigate the phase-partitioning of contaminants as a function of particle type and size	2a	27
4	Develop and validate models to predict far-field transport, transformation and fate of pollutants	2a	14
5	Investigate the long-term biological fate of ocean-dumped pollutants and the movement and transformation of contaminants through the food web (e.g., bioavailability, bioconcentration and biomagnification)		12
6	Investigate the effects of resuspension and bioturbation on the long-term fate of contaminated sediments		36

Table 4-2 (Continued)
Recommended Research and Monitoring
by Information Need Objective

Number	Description	Related Objectives	Overall Rank
Objective 4.B:	Determine effects of dumping activities and evaluate significance to human health, living marine resources, and integrity of marine ecosystems		
1	Investigate the kinetics of tissue/sediment/water-column pollutant transfer	2a	31
2	Determine linkage between tissue residues and effects (growth, reproduction) in selected biota	2c 3b	3
3	Determine the linkage between sediment concentrations and effects of pollutants on biota, and develop appropriate sediment quality criteria		8
4	Conduct laboratory and field studies of pollutant effects on contamination, survival and reproductive success of selected living marine resources within the dumpsite area		11
5	Monitor post-dumping ecological recovery at the 12-Mile site and other areas of opportunity	3b	19
6	Evaluate the sensitivity of offshore species to ocean dumped pollutants	2c 3b	21
7	Develop multispecies techniques (e.g., microcosms/mesocosms) to study the effects of ocean dumping of specific wastes		38

CHAPTER 5

ACTION PLAN RECOMMENDATIONS AND CONCLUSIONS

The previous chapter developed research recommendations to address information needs of environmental managers. This chapter prioritizes the specific recommendations for research and identifies the general research areas needing increase attention based, in part, upon the recommendations of the technical-expert panel.

Table 5-1 lists all recommendations in order of overall priority within each objective, identifies related information objectives and displays a "cost index" for each study[1]. The rank score (1-10) is a composite of two criteria estimated by each member of the technical-expert panel: (1) the relative importance a study has to its specific management objective; and (2) the relative "certainty" of obtaining useful results in the near future. Scores in this category ranged from 4 to 9. The overall rank gives the relative priority, determined separately by the technical-expert panel, for all research recommendations regardless of objective. The overall rank was essentially identical to the ranks assigned within the objectives. The priorities developed by these methods do not assess the relative importance relative to the most immediate regulatory needs except to the extent that regulatory needs relate to the identified management information needs. Table 5-1 also lists agencies which have ongoing studies closely related to the research recommendations. The identification of lead agency suggests the agency whose mandates and existing programs best coincides with the recommended research.

In total, the technical experts meeting resulted in the suggestion of nearly 40 specific research areas deserving of study if management information needs are to be met. Most of these studies can be grouped into four basic categories each with research recommendations emerging from Objectives 2, 3, and 4.

1) studies which relate directly to hazard assessments,

2) the measurement or prediction of ecosystem, community, and population effects in the field,

3) the measurement of effects on individual organisms, and

4) the influence of particles on pollutant fate and effects.

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[1]"Cost" is indexed on a scale from 2.0 (least expensive) to 0.0 (most expensive). A middle score of 1.0 would approximate an "average" cost for a research study in that particular field. No absolute dollar amounts could be estimated accurately because of the wide variability in possible methods.

Studies Relating to Hazard Assessments: Several study areas were recommended which directly relate or provide the information necessary to conduct hazard assessments. While it appears that methodology exists to conduct hazard assessments to predict many near-field effects, research is needed to develop methods to predict far-field fate and effects. However, all hazard assessments suffer from some common weaknesses. The kinetics of pollutant transfer between water, sediment, and tissue are poorly known for most contaminnats. In addition, uncertainty or variability in laboratory measurements, environmental sampling, and the ecosystem is poorly accounted for in hazard assessments. There is a need to verify and test existing hazard assessments and revise the protocols as needed. Case studies to be conducted at new or closing ocean dump sites emerged as two separate recommendations. One recommended that case-studies be used to better determine the requirements (i.e., the parameters to be measured, the frequency and duration of sampling) for the detection of long-term trends emerged as the highest ranked recommendation. A somewhat similar recommendation to monitor ecological recovery at the 12-Mile Site and possibly other areas received a moderate rank of "19" presumably because post-dumping recovery was thought to be a less critical concern. Considerable research has already been conducted in the area of the 12-Mile Site in the New York Bight, at the closed Phaladelphia dumpsite, and at the 106-Mile Site. Further case-studies could make extensive use of this information to help identify methods for detecting long-term trends in the marine environment and for the monitoring of dumpsite recovery. A case study employing multi-medium assessment, with hazard assessment as a dominant component, was also strongly recommended. Successful research in these areas would provide a mechanism for calculating the maximum periodic load of waste which could be safely disposed of at a particular dump site.

Measurement/Prediction of Effects in the Field: Generally, our ability to measure or predict ecosystem, community, or population level effects is seen to be extremely weak. Specific recommendations for research areas included studies to link laboratory measured species effects, tissue residues, and sediment concentrations to possible effects at the community or population level. In addition, studies are needed to develop methodologies to directly measure effects and environmental degradation in the field. All of these studies further would aid in the improvement of hazard assessment.

Measurement of Effects on Individual Organisms: Several study areas which were recommended related to the measurement of effects on individual organisms. There was seen to be a need to develop rapid tests to determine toxicity and chronic effects. Emphasis is also needed in the detection of sub-organism responses (e.g., biochemical/enzymatic, cellular, and tissue level changes) to pollutant stress and the need to measure such effects in the laboratory and field. It was also suggested that the difference in sensitivity between nearshore and offshore species be studied. Multispecies techniques employing microcosms and mesocosms were recommended as potentially useful study areas for effects studies.

For the detection of effects in the field, it was recommended that organism transplant techniques (e.g., mussels and other filter feeders) be further developed and studied.

Influence of Particles on Pollutant Fates and Effects: This last category emerged as a general research area where scientific understanding is poor for both the fate and effects of particle-associated contaminants. Specific research areas recommended included study of the toxicity of contaminants associated with particles, the association and affinities of contaminants in wastes with particulates, and the study of the settling rates and dispersion of particulate wastes (including new wastes such as coal ash or dewatered sludge) under different conditions of disposal. Other needed research areas include studies on the resuspension of contaminated sediment and techniques to optimize dispersion of ocean dumped wastes.

Ongoing Research Programs within the Agencies

Presently, both NOAA and EPA have significant ongoing research efforts which relate to ocean dumping, and many of these directly or indirectly address the recommended research areas (see Appendix II). Previous research studies are not discussed because the knowledge gained from such studies was used to develop the recomendations for future research. However, ongoing or emerging studies were not used as a determining basis for future research. The following is a summary of current research activities in NOAA and EPA related to ocean dumping.

NOAA: NOAA has several research studies addressing the role of particulates, sediments and colloids in transporting contaminants including PAHs, PCBs, organometallics, and heavy metals. One of these studies specifically looks at sewage sludge particle formation (aggregation) in sea water, the segregation of toxic substances, and settling rates. Another study examines the sorption, desorption, and bioavailability of toxic organics on particles. NOAA also has studies which examine the fate, effects, bioavailability, and toxicity of contaminants in the sediments. NOAA is also in the process of developing techniques and indices to measure degradation in the benthos and other components of the New York Bight.

NOAA is currently assessing variability in monitoring data by measuring contaminant body burdens in organisms in the New York Bight region, and assessing variability in monitoring data for several parameters. Other NOAA monitoring and baseline related studies applicable to ocean dumping include the Northeast Environmental Monitoring Program (NEMP), water chemistry and phytoplankton studies in the Mid-Atlantic Bight region, and a study developing trace metal analysis of sediments as a tracer of waste inputs to the marine environment. NOAA is also presently using satellite monitoring data to help establish baseline information for the 106-Mile Site. A number of NOAA studies also relate to the distribution and abundance of fish and marine mammals in coastal waters.

NOAA is also presently studying the fates and effects of sewage sludge at the 12-Mile Site in the New York Bight to establish a baseline prior to the cessation of dumping in late 1987. This includes the monitoring of seabed metabolism as a mechanism of measuring change. Other techniques being developed which may be of value in monitoring ocean dumping include the use of Raman spectroscopy for quantifying organic pollutants and the use of acoustical tracking for following particulate dispersion.

NOAA also has a number of ongoing studies which will help determine the possible effects of ocean dumping on human health. These include a study on the effects of shellfish consumption, studies of the survival of sewage associated pathogens, and the measurement of tissue residues of PCBs and PAHs in fish and shellfish.

NOAA has several specific studies which relate to heavy metals in the marine evironment. Many of these directly study the laboratory and field effects of heavy metals on organisms, including the plankton. Another examines trace metals in sewage sludge and the effects on phytoplankton and bacterioplankton. Other NOAA studies on the effects of heavy metals are focused towards the use of metallothionein as a biochemical indicator os stress in marine organisms.

NOAA has a number of ongoing studies which relate to the fate and effects of synthetic or petrochemical organics in the marine environment and which, therefore, are of importance to ocean dumping research. Two ongoing studies are examining the fate and effects of PAHs in the marine environment. NOAA currently has studies examining the biogeochemistry of PCBs in the heavily contaminated New Bedford Harbor, Massachusetts area. NOAA is also examing the long-term fate and persistence of synthetic organics including aspects of transformation, assimilation, cycling, degradation, and transport. Other studies examine the effects of PCBs, TCDD, and TCDF on fish and shellfish, including effects on disease resistance and reproductive capacity. A separate study is focused towards the effects of petrochemicals on juvenile striped bass. Other related research includes studies on fish energetics and reproduction near waste sources, the susceptibility of fish to viral disease following exposure to PCBs and dioxin, early mortality in striped bass due to polltuion, and the effects of ocean dumping on the settlement of bivalve larvae.

Other NOAA studies which relate to ocean dumping are the study of immune response and lysosomal enzyme release as measures of stress in fish. NOAA is also conducting field studies of fish populations, attempting to link trends in field populations with pollution events or contaminant inputs. Finally, NOAA is conducting a study to estimate the assimilative capacity of a specific marine area for several pollutants.

EPA: EPA has several ongoing projects which relate directly to their responsibilities in the area of ocean dumping and disposal of municipal and industrial wastes. Several current research studies address the development of predictive hazard assessment strategies for coastal and deep ocean dumping. The exposure components of this research include developing

and validating quantitative models for describing the transport, transformation and fate of wastes and their constituent pollutants. Complementary effects assessment research examines acute and chronic toxic effects of ocean-disposed contaminants at the species, population and community levels. These efforts are a part of a larger Agency multimedia risk assessment for the disposal of municipal and industrial wastes.

EPA is examining the bioavailability and the bioaccumulation potential of contaminants from sediments and particulate waste. A thermodynamic partitioning model is being evaluated with laboratory and field data to predict the maximum bioaccumulation of PCBs and PAHs from sediments. Studies include examining the kinetics of uptake, depuration and metabolism of contaminants. A bioenergetic model is being developed to predict bioaccumulation of contaminants in fish transiting a disposal site. EPA also has ongoing studies to link tissue levels in organisms to biological effects. One study for the National Cancer Institute examines the carcinogenic effects of ocean-disposed wastes on mollusks and fish.

EPA has a number of research studies to develop and validate biomonitoring methods for coastal and deep water applications. Effects measures include biochemical, physiological, genetic, growth, survival, and reproduction and apply to transplanted (caged) organisms as well as indigenous populations. A complementary study is examining existing chemical data bases and archived samples to identify new groups of chemical pollutants for use in monitoring strategies.

Other EPA studies which relate to ocean dumping include a survey of available ocean areas regarding their suitability as future ocean dumping sites. Finally, EPA is developing laboratory systems (microcosms, mesocosms) ecosystem responses to specific contaminants and complex wastes.

Recommendations for Research Studies by Appropriate Agencies

Table 5-1 lists the agencies currently conducting some research in the various recommended research areas and gives the agencies whose programs and mandates are appropriate to the type of research. Even in an area where an agency is identified as currently conducting research, the existing research may not be adequate to fufill the goals of the recommended research area. However, of greatest concern are the 12 areas with no ongoing research efforts either by EPA or NOAA. Five of these areas ranked in the lower 25% by overall priority, but 3 were among the top 10 research areas.

EPA and NOAA are the only two agencies with active research responsibilities on ocean dumping of non-dredged material. In general, EPA's ongoing programs have emphasis in studies designed to support the ocean dump site designation and permit process and are, therefore, more focused towards specific research goals in support of regulatory requirements. NOAA's programs and mandates are more directed toward environmental research, monitoring and general oceanographic information which bears on the in situ environmental effects of ocean dumping. Several of the recommended study

areas have significant elements which relate to the priorities and mandates of both EPA and NOAA. Therefore, there is need to coordinate research efforts in these specific areas to ensure efficient use of resources and non-duplication of effort.

There are 5 recommended research areas with no ongoing research where EPA is identified as the proposed lead agency. Two of these are among the top 10 research areas.

Recommended Research Areas	Overall Priority
Develop methods to determine dumpsite capacity in terms of maximum daily load.	5
Determine the difference in sensitivity between near-shore and offshore species used in sewage-sludge bioassays.	10
Evaluate uncertainty levels in hazard assessment protocols that use exposure and effects data.	13
Develop methods to optimize dispersion of wastes using engineering technologies, disperions protocols, or control of sedimentation rates.	29
Determine the dispersive characteristics of potential new ocean-dumped wastes (e.g., dewatered sewage sludge, coal ash, scrubber sludge).	32

Research efforts and results from the first four research areas listed above would be of immediate use in the management of ocean dumping, but the last area would be of use only if modified or new wastes are expected to be ocean dumped. EPA should initiate studies which support these research areas in order of their importance to the management of ocean dumping.

There are 3 recommended research areas with no ongoing research and where NOAA is identified as the proposed lead agency. All of these research areas are in the lower 25% according to overall priority. However, many of thse lower overall priority scores reflect the difficulty of obtaining information and definitive results from research conducted in the environment. NOAA should examine the possibility of initiating studies which support these research areas.

Recommended Research Areas	Overall Priority
Study the effects of environmental/oceanic variability on the exposure of organisms to ocean-dumped contaminants.	34
Develop methods to identify large-scale water mass characteristics for use in real-time dumpsite management.	35
Evaluate beneficial effects of alternative dumpsite management options designed to increase productivity and enhance fisheries.	39

Both NOAA and EPA were seen to have joint interest and responsibility for 4 of the recommended research areas for which there is no ongoing research activity. One of these research areas is among the top 10 according to overall priority.

Recommended Research Areas	Overall Priority
Develop methodology to accurately predict environmental and ecological responses in the field based on laboratory data.	9
Conduct regional demonstration study to evaluate the ability to compare environment effects across media.	15
Evaluate the sensitivity of offshore species to ocean-dumped pollutants.	21
Conduct regional demonstration study to evaluate the ability to compare environmental effects among different ocean disposal options.	28

Knowledge in most of these research areas would immediately contribute to the management of ocean dumping. It is recommended that EPA and NOAA coordinate efforts in these areas to ensure that the research needs are addressed in a coordinated and efficient manner.

NOAA and EPA are proposed as joint lead agencies for four other recommended research areas but for which only one of the agencies have any ongoing research effort.

Recommended Research Area	Overall Priority	Ongoing Agency Studies
Conduct case-studies at new and closed dumpsites to determine requirements (parameters, frequency, duration) for the detection of long-term ecological trends.	1	
Develop methodology to predict population and community responses from single species tests.	17,23	EPA
Develop measures of sublethal effects to detect environmental change at ocean dumpsites.	22	NOAA
Develop methods for analyzing uncertainties in measuring effects.	24	NOAA

Increased knowledge in each of these areas would greatly improve our ability to manage ocean dumping activities and it is recommended that EPA and NOAA coordinate efforts in these areas.

Summary and Final Recommendations

This Action Plan has identified research areas requiring further study in support of management information needs for ocean dumping. Both EPA and NOAA already have extensive research efforts which, directly or indirectly, suport some of the identified management information needs. Of the 39 recommended research areas, only 12 research areas have no ongoing studies by either EPA of NOAA. Several additional steps need to be taken prior to the initiation of research in any of these areas.

- The 27 research areas for which there is some ongoing and related research efforts need to be examined closely to ensure that the recommended research areas are being adequately addressed.

- The 12 identified research areas with no ongoing studies need to be prioritized within and between EPA and NOAA in order of the most pressing regulatory and managment needs. The priorities developed in the present study may not be adequate for this purpose, although they indicate the usefulness of the research to management needs and the probability of achieving useful results.

- Specific studies need to be outlined for each research area to be pursued. For each proposed research area, it is necessary to define the specific research endpoints necessary to meet regulatory and management needs. Specific information of this type must be developed by discussion between research scientists and managers for both EPA and NOAA.

- Coordination of research efforts between EPA and NOAA need to be continued to ensure that research efforts do not overlap and that, where appropriate, the research results are achieved in a form which is useful to managers of ocean dumping activities in both agencies.

Table 5-1
Overall Ranking for Ocean Dumping Research
and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Objective 2.A: Develop hazard assessment protocols to evaluate ocean disposal impacts (exposure and effects assessment)						
Develop methods to conduct hazard assessments for far-field impacts	9.0	2	4a	0.5	EPA	EPA
Apply existing exposure and effects estimating procedures to hazard assessments and revise procedures based upon results	8.2	6	1a	1.0	EPA	EPA
Develop methodology to accurately predict environmental and ecological responses in the field based on laboratory data	8.2	9		0.3		EPA, NOAA
Evaluate uncertainty levels in hazard assessment protocols that use exposure and effects data	7.8	13		1.0		EPA
Develop methodology to predict population and community responses from single species tests	7.5	17	2c	0.7	EPA	EPA, NOAA
Develop methods for analyzing uncertainties in measuring effects	6.8	24		1.4	NOAA	EPA, NOAA
Evaluate the toxicity of particle-bound contaminants in the water-column	6.0	33	4a	1.4	NOAA,EPA	NOAA,EPA

Table 5-1
Overall Ranking for Ocean Dumping Research
and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Study the effects of environmental/oceanic variability on the exposure of organisms to ocean-dumped contaminants	6.0	34		0.8		NOAA
Develop measures of ecosystem-level response to environmental contamination	5.8	37	3b	0.3	NOAA, EPA	NOAA, EPA
Objective 2.B: Develop methods for comparing ocean disposal alternatives						
Conduct regional demonstration study to evaluate the ability to compare environmental effects across media	7.8	15		0.0		EPA, NOAA
Conduct regional demonstration study to evaluate the ability to compare environmental effects among different ocean-disposal options	6.5	28		0.1		EPA, NOAA
Objective 2.C: Develop new procedures or improve existing procedures for evaluating or screening wastes proposed for ocean dumping						
Demonstrate rapid, cost-effective screening tools for ranking relative toxicity of ocean-dumped pollutants	8.5	4		1.3	EPA	EPA
Develop rapid test measures to identify chronic effects (e.g., growth, reproduction) due to ocean dumping	8.2	7		1.1	EPA	EPA

Table 5-1
Overall Ranking for Ocean Dumping Research and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Determine the difference in sensitivity between near-shore and offshore species used in sewage-sludge bioassays	8.0	10	3b 4b	1.0		EPA
Determine settling rates of sewage sludge as function of initial sludge conditions and discharge techniques	7.2	18	1a	1.2	NOAA	EPA
Develop methodology to predict population and community responses from single species tests	7.0	23	2a	0.5	EPA	EPA, NOAA
Investigate suborganism responses (e.g., histopathology, "stress proteins," enzymatic responses) of organisms to ocean-dumped pollutants	6.8	25		0.8	NOAA, EPA	NOAA, EPA
Determine the dispersive characteristics of potential new ocean-dumped wastes (e.g., dewatered sewage sludge, coal ash, scrubber sludge)	6.0	32	1a	1.5		EPA
Objective 3.B: Develop procedures for monitoring ecological trends in and near dumpsites						
Conduct case-studies at new and closed dumpsites to determine requirements (parameters, frequency, duration) for the detection of long-term ecological trends	9.0	1	4b	0.1	NOAA	EPA, NOAA

Table 5-1
Overall Ranking for Ocean Dumping Research and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Develop measures of environmental degradation and interpret what they mean at the ecosystem level	7.2	20	2a	0.4	EPA, NOAA	NOAA
Develop measures of sublethal effects to detect environmental change at ocean dumpsites	7.0	22	2c 4b	1.1	NOAA	NOAA, EPA
Improve and employ transplant techniques (e.g., caged mussels), as a substitute for baseline data, using control sites to determine environmental effects	6.2	30		0.9	NOAA, EPA	NOAA, EPA
Objective 3.C Develop and evaluate site management options						
Develop methods to determine dumpsite capacity in terms of maximum daily load	8.5	5		0.5		EPA
Develop methods to optimize dispersion of wastes using engineering technologies, dispersion protocols, or control of sedimentation rates	6.2	29		1.0		EPA
Develop methods to identify large-scale water mass characteristics for use in real-time dumpsite management	5.8	35		1.5		NOAA

Table 5-1
Overall Ranking for Ocean Dumping Research
and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Evaluate beneficial effects of alternative dumpsite management options designed to increase productivity and enhance fisheries	4.2	39	1a 2b	0.4		NOAA
Objective 4.A: Determine fate of contaminants (water column, sediments, biota) in near- and far-field						
Investigate the long-term biological fate of ocean-dumped pollutants and the movement and transformation of contaminants through the food web (i.e., bioavailability, bioconcentration and biomagnification)	8.0	12		0.3	EPA, NOAA	NOAA
Develop and validate models to predict far-field transport, transformation and fate of pollutants	7.8	14	2a	0.2	EPA, NOAA	EPA, NOAA
Investigate the effects on particle settling rates by physical and chemical processes associated with ocean dumping (e.g., flocculation, salinity, density gradients)	7.5	16		1.2	NOAA	NOAA
Investigate the effects on particle settling rates by biological processes (e.g., zooplankton grazing and formation of fecal pellets)	6.8	26		1.2	NOAA	NOAA

Table 5-1
Overall Ranking for Ocean Dumping Research and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Lead Agency	Proposed Lead Agency
Investigate the phase-partitioning of contaminants as a function of particle type and size	6.5	27	2a	1.2	NOAA	NOAA
Investigate the effects of resuspension and bioturbation on the long-term fate of contaminated sediments	5.8	36		0.9	EPA, NOAA	EPA, NOAA
Objective 4.B: Determine effects of dumping activities and evaluate significance to human health, living marine resources, and integrity of marine ecosystems						
Determine linkage between tissue residues and effects (growth, reproduction) in selected biota	9.0	3	2c 3b	0.5	EPA, NOAA	EPA, NOAA
Determine the linkage between sediment concentrations and effects of pollutants on biota, and develop appropriate sediment quality criteria	8.2	8		0.3	EPA	EPA
Conduct laboratory and field studies of pollutant effects on contamination, survival and reproductive success of selected living marine resources within the dumpsite area	8.0	11		0.2	NOAA, EPA	NOAA, EPA
Monitor post-dumping ecological recovery at the 12-Mile Site and other areas of opportunity	7.2	19	3b	0.5	EPA, NOAA	EPA, NOAA

Table 5-1
Overall Ranking for Ocean Dumping Research
and Monitoring Recommendations

Research Recommendation	Rank Score (1-10)	Overall Rank (1-39)	Related Objectives	Relative Cost (0-2)	Ongoing Agency Studies	Proposed Lead Agency
Evaluate the sensitivity of offshore species to ocean dumped pollutants	7.2	21	2c 3b	1.1		NOAA, EPA
Investigate the kinetics of tissue/sediment/water-column pollutant transfer	6.2	31	2a	0.8	EPA, NOAA	NOAA, EPA
Develop multispecies techniques (e.g., microcosms/mesocosms) to study the effects of ocean dumping of specific wastes	5.5	38		0.8	EPA	EPA

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APPENDICES

APPENDIX I

LIST OF INDIVIDUALS AIDING IN THE DEVELOPMENT OF ACTION PLAN

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APPENDIX II

Federal Research Related to Ocean Dumping: FY 1984

NATIONAL MARINE POLLUTION INFORMATION SYSTEM

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Ocean Service
Coastal and Estuarine Assessment Program

| 1| Record Number 0194

BENTHIC TOXICANT EFFECTS, VARIABILITY, AND MONITORING IMPLICATIONS FOR THE NEW YORK BIGHT

The purpose of this project is to assess the measurable pollutant effects upon the benthic community structure. The information gained from this assessment would be the basis for improved monitoring strategies and for the development and testing of indices of pollutant degradation. The two major objectives are to reassess the real extent of toxicant induced benthic community structural changes in the New York Bight based on existing data and to define the monitoring implications of findings by developing one or more improved monitoring strategies for the New York Bight.

Principal Investigator: RAYMOND W. ALDEN
Old Dominion University
P.O. Box 6369
Norfolk, VA 23508

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	4.230	0.000
Performing:		0.000
Other:		0.000
Total Project Funding:	4.230	0.000

| 2| Record Number 0748

PHYTOPLANKTON IN MIDDLE ATLANTIC BIGHT SEDIMENTS: SIGNIFICANCE TO RECURRENT HYPOXIA

To evaluate the contribution of natural phytoplankton loading from blooms sinking into or near bottom waters and sediments to enhanced oxygen demands in the Middle Atlantic Bight. The role of accumulations of phytoplankton within sediments and controlling factors as well as possible resuspension events is to be clarified.

Principal Investigator: ELIZABETH M. COSPER
State University of New York
P.O. Box 9
Marine Sciences and Research Center
Albany, N.Y. 12201

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	19.996	
Performing:		
Other:		
Total Project Funding:	19.996	0.000

| 3| Record Number 0201

DEVELOP AND TEST INDICES OF COASTAL POLLUTANT DEGRADATION

The purpose of this project is to define and test indices of coastal degradation with data from areas of known environmental and ecosystem impact. The indices will be subjected to rigorous scientific and management testing to gain scientific and user consensus on the utility of the indices.

Principal Investigator: TERRY E. WHITLEDGE
Brookhaven National Laboratory
Oceanographic Sciences Division
Upton, NY 11973

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	9.940	0.000
Performing:		0.000
Other:		0.000
Total Project Funding:	9.940	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Ocean Service
Coastal and Estuarine Assessment Program

| 4| Record Number 0749

ANALYSIS OF PHYTOPLANKTON SAMPLES TAKEN DURING TWO NOAA WATER QUALITY CRUISES IN 1985 FOR PHYTOPLANKTON COMPOSITION AND ABUNDANCE

The purpose of this project is to provide the analysis of phytoplankton from water samples taken during two NOAA water quality cruises in 1985. Approximately 200 to 250 water samples will be provided to the principal investigator, who will determine the compostion and concentrations of the phytoplankton in the samples.

Principal Investigator: HAROLD G. MARSHALL
Old Dominion University
Dept. of Biological Sciences
Hampton Blvd. and Bolling Ave.
Norfolk, VA 23508

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	9.997	
Performing:		
Other:		
Total Project Funding:	9.997	0.000

| 5| Record Number 0232

MID-ATLANTIC BIGHT WATER COLUMN MONITORING-CHEMISTRY

Purposes are to monitor levels of dissolved oxygen, nutrients, and chlorophyll in the context of eutrophication/hypoxia in the Middle Atlantic Bight and to enter the data (and that from cruises conducted during the period 1980-1984) into a Water Quality Data Base on the VAX 11/780 computer at the Woods Hole Oceanographic Institute.

Principal Investigator: TERRY E. WHITLEDGE
Brookhaven National Laboratory, Bldg. 318
Oceanographic Sciences Division
Upton, NY 11973

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	88.256	50.000
Performing:		0.000
Other:		0.000
Total Project Funding:	88.256	50.000

| 6| Record Number 0753

REPRODUCTION IMPAIRMENT IN FISHES INHABITING SOUTHERN CALIFORNIA WASTE OUTFALL AREAS

This project addresses the need for an in-depth understanding of the effects of contaminants on reproduction of sport and commercially important fishes. A recent survey performed by Southern California Coastal Water Research Project (SCCWRP) disclosed that reproduction of fishes around sewage outfals was impaired and that tissue and sediment burdens of chlorinated hydrocarbons were surprisingly high. However, because tissue contaminant levels are intimately tied to the reproductive cycle, a more extensive study is being proposed here to refine our knowledge of contaminant-induced reproductive impairment.

Principal Investigator: WILLARD N. BASCOM
Southern California Coastal Water Research Project
646 West Pacific Coast Highway
Long Beach, CA 90806

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	194.000	
Performing:		
Other:		
Total Project Funding:	194.000	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Ocean Service
Coastal and Estuarine Assessment Program

| 7| Record Number 0757

SETTLING VELOCITY MEASUREMENT ON SEWAGE SLUDGE

Determine the effect of the initial mixing process on the settling velocity distribution of sewage sludge and on methods which sludge generators can employ to measure settling velocity. The results of this work will define the settling velocity spectra for sewage sludge at several dilutions in salt-water, and for four separate treatment plants, compare the results from field dilutions and lab dilutions using Hyperion (Los Angeles) discharge, and provide a procedure manual for use by municipalities.

Principal Investigator: WILLIAM N. LAVELLE
Marine Assessment Research Division
7600 Sand Point Way NE B32
Seattle, WA 98115

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	57.127	
Performing:		
Other:		
Total Project Funding:	57.127	0.000

| 8| Record Number 0761

TRANSFORMATION AND ASSIMILATION OF POLLUTANTS THROUGH NATURAL CHEMICAL PROCESSES

Will make correlations between anodic stripping voltametric method of trace metal characterization and planktonic response to trace metal additions. Copper concentration increases which could be sustained without loss of productivity in the area of the Mississippi River outflow will be estimated. Ability of fish oil additions to northern waters to ameliorate trace metal activities will be assayed. Methods for measuring instantaneous growth rate of zooplankton will be developed. Trace metal activities and plankton productivity will be measured in the northeast Atlantic.

Principal Investigator: DONALD K. ATWOOD
NOAA/OAR/AOML/Ocean Chemistry Lab
4301 Rickenbacker Causeway
Miami, FL 33149

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	100.000	100.000
Performing:		
Other:		
Total Project Funding:	100.000	100.000

| 9| Record Number 0239

HEALTH EFFECTS ASSOCIATED WITH CONSUMPTION OF SHELLFISH

The purpose of this project is to identify accurate indicators of disease risk to consumers of raw shellfish. Coliform indicators have been in use for decades, but are known to be inaccurate for predicting disease risk to the consumer. The present study will survey a number of potential indicators both in the shellfish meats and in the harvesting waters; simultaneously, shellfish will be harvested and fed to human subjects, whose epidemiology will be followed subsequently. The most accurate indicator will be identified, and its accuracy quantified.

Principal Investigator: ALFRED DUFOUR
U.S. Environmental Protection Agency
Health Effects Research Laboratory
26 W. St. Clair St.
Cincinnati, OH 45268

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	142.600	150.000
Performing:		
Other:		0.000
Total Project Funding:	142.600	150.000

U.S. Department of Commerce
National Ocean Service
National Marine Pollution Coordination Program
National Oceanic and Atmospheric Administration

| 10| Record Number 0068

ACTION PLAN FOR OCEAN DUMPING RESEARCH AND MONITORING

This is an in-house activity of the National Marine Pollution Program Office (NMPPO) performed in conjunction with members of the Interagency Committee on Ocean Pollution Research, Development, and Monitoring (COPRDM). The purpose of this activity is to develop a coordinated Interagency Action Plan for research and monitoring related to ocean dumping of municipal and industrial wastes. The plan is scheduled for publication in December 1986.

Principal Investigator: DR. WILLIAM G. CONNER
NOAA/N/MPP
National Marine Pollution Program Office
Rockwall Building, Room 610
11400 Rockville Pike
Rockville, MD 20852

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	25.000	0.000
Performing:		0.000
Other:		0.000
Total Project Funding:	25.000	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Ocean Service
Measurement Systems Development and Engineering Services Program

| 11 | - Record Number 0034

DETERMINATION OF ORGANIC POLLUTANTS IN SEA WATER BY RESONANCE ENHANCED RAMAN SPECTROSCOPY

The objective is to develop a real-time qualitative and quantitative measurement system for determining dissolved organic substances, i.e., key organic pollutants in natural waters and other environmental media. This objective is to be accomplished through a NOAA/EPA inter-agency agreement in accordance with the following approach: 1) complete final development stage of laboratory laser Raman system at Florida State University, 2) conduct laboratory intercalibration experiments, 3) design and construct a shipboard prototype system and 4) conduct at-sea trials.

Principal
Investigator: CHARLES K. MANN
Florida State University Chemistry Department
Florida State University
600 W. College Avenue
Tallahassee, FL 32306

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	25.300	0.000
Performing:		0.000
Other:	50.000	0.000
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Total Project Funding:	75.300	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
Oceanic and Atmospheric Research
Environmental Research Laboratories Ocean Pollution Studies

| 12| - Record Number 0708

ACOUSTICAL RESEARCH

Physical oceanographic research aimed at identifying processes and oceanic structures that influence the transport, mixing, and source/sink characteristics of oceanic contaminants. This project develops and tests acoustical remote sensing instrumentation for measuring water motions and structure, and properties of suspended matter.

Principal Investigator: JOHN R. PRONI
NOAA/AOML
4301 Rickenbacker Cswy
Miami, FL 33149

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	100.000	100.000
Performing:		
Other:		
Total Project Funding:	100.000	100.000

| 13| - Record Number 0709

POLLUTANT TRANSPORT AND FATE IN ESTUARIES

Field, laboratory and modelling studies are being conducted to determine the transport and fate of pollutants in marine estuaries and coastal systems. Field studies emphasize circulation patterns, and exchange processes, pollutant sources, concentrations, distributions transport and loss. Laboratory studies focus on chemical and physical transformation and uptake by particulates. Modelling studies emphasize transport in the water column, the bottom boundary layer and mass balance and budgets in estuaries. The field studies are conducted in Puget Sound, a convenient, natural laboratory and address Sec. 2 of Public Law 92-532.

Principal Investigator: HERBERT C. CURL, JR.
Pacific Marine Environmental Laboratory
7600 Sand Point Way NE
Seattle WA 98115

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	492.000	492.000
Performing:	330.000	366.000
Other:	327.000	200.000
Total Project Funding:	1,149.000	1,058.000

U.S. Department of Commerce
Oceanic and Atmospheric Research
Environmental Research Laboratories Great Lakes Pollution Studies

National Oceanic and Atmospheric Administration

| 14| - Record Number 0044

TOXIC ORGANIC CYCLING

To develop a model hierarchy to simulate the fate and transport of selected toxic organic substances in the Great Lakes and to perform laboratory and field experiments designed to provide information on various pathways and rates of removal of toxic organics from the ecosystem.

Principal
Investigator: BRIAN J. EADIE
NOAA/R/E/Great Lakes Environmental Research Lab
2300 Washtenaw Avenue
Ann Arbor, MI 48104

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	410.000	447.000
Performing:		0.000
Other:	7.000	25.000
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Total Project Funding:	417.000	472.000

| 15| - Record Number 0136

INTERACTION OF POLYCHLORINATED BIPHENYLS AND 2,3,7,8 TETRACHLORODIBENZO-P DIOXIN WITH THE RESISTANCE OF RAINBOW TROUT TO VIRAL DISEASE

The objectives of this project are: 1) to determine whether prolonged, sublethal dietary exposure of rainbow trout to PCB mixtures alters the resistance of the fish to infectious pancreatic necrosis virus and infectious hematopoietic necrosis virus; 2) determine whether such exposure affects specific and/or non-specific defense mechanism of the fish against disease; 3) assess the effect of TCDD on rainbow trout in a similar series of tests.

Principal Investigator: K. A. Schat
Cornell University
Ithica, NY 14853

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	23.500	0.000
Performing:	16.500	0.000
Other:		0.000
Total Project Funding:	40.000	0.000

| 16| - Record Number 0806

DETERMINATION OF THE ORIGIN OF FECAL COLIFORMS ISOLATED FROM THE MISSISSIPPI SOUND

To isolate representative indicator organisms from the Mississippi Sound, coastal city storm drains, and coastal city sanitary sewer lines. To isolate and characterize the DNA profiles of the plasmids found in the above indicator bacteria. To compare the plasmid DNA profiles of the indicator organisms isolated from the various water sources described above. To determine from these plasmid profiles the source of the indicator bacteria isolated from the Mississippi Sound.

Principal Investigator: JEFFREY A. EVANS
Chemistry Department
University of Southern Mississippi

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	31.863	
Performing:	28.128	
Other:		
Total Project Funding:	59.991	0.000

| 17| - Record Number 0115

FATE ASSESSMENT OF HYDROPHOBIC ORGANIC CHEMICALS IN AQUEOUS ENVIRONMENTS

The purpose of this project is to improve and evaluate present assessment procedures that can be used to predict the fate of selected chemicals in aqueous systems such as the lower Fox River/Green Bay area. We will measure, predict via structure-activity relations, and couple basic physical-chemical parameters such as solubility vapor pressures, absorption coefficients, degradation rates, photolysis rates, and volatilization rates. These parameters will be incorporated into multicompartimental models that are designed to yield pollutant behavior profiles for a variety of aqueous systems.

Principal Investigator: ANDERS W. ANDREN
University of Wisconsin @ Madison
Water Chemistry
Madison, WI 53706

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	24.100	0.000
Performing:	25.000	0.000
Other:		0.000
Total Project Funding:	49.100	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
Oceanic and Atmospheric Research
Sea Grant Ocean Pollution Program

| 18| Record Number 0111

TRANSPORT AND FATE OF TOXIC SUBSTANCES IN A NORTHERN TEMPERATE ESTUARY

The objectives of this project are: 1) to determine the rates and characteristics of adsorption of a variety of polynuclear aromatic hydrocarbons (PAH) on to a variety of particulates. Initial work will involve clays, hydrous oxides and humic acids, followed by more complex natural particulates found in New Hampshire estuaries. 2) To determine the rates of microbial degradation of the PAHs investigated in the presence and absence of the same particulates. 3) To determine the rates of formation of organometalic compounds (alkyl derivatives of the heavy metals) in the presence and absence of the same range of particultes investigated in 1 and 2. 4) Preliminary development of a sediment transport model incorporating information generated in objectives 1-3 above.

Principal Investigator: CLARENCE L. GRANT
University of New Hampshire
Department of Chemistry
Durham, NH 03824

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	77.500	0.000
Performing:	42.900	0.000
Other:		0.000
Total Project Funding:	120.400	0.000

| 19| Record Number 0108

BIOGEOCHEMISTRY OF PCB TRANSPORT IN NEW BEDFORD HARBOR

The objectives of this project are: 1)to investigate and define physical-chemical aspects of PCB biogeochemistry in coastal waters with particular emphasis on the role of partitioning of the hydrophobic PCB molecules onto high molecular weight dissolved colloidal organic matter in both the water column and sediment pore waters. 2) to characterize the monthly and seasonal fluctuations of PCBs in Mytilus edulis and Mercenaria mercenaria in PCB polluted waters in conjunction with biological effects studies of PCBs on populations of these organisms; 3) to provide high resolution glass capillary gas chromatography analyses of PCBs in fish for colleagues studying sublethal effects of PCBs on fish.

Principal Investigator: JOHN W. FARRINGTON
Woods Hole Oceanographic Institute
Chemistry Department
Woods Hole, MA 02543

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	63.600	0.000
Performing:	18.600	0.000
Other:		0.000
Total Project Funding:	82.200	0.000

| 20| Record Number 0105

PCB's IN BUZZARDS BAY: EFFECTS ON ENERGETICS AND REPRODUCTIVE CYCLES OF BIVALVE MOLLUSCS

The objectives of this project are to characterize the biological consequences of PCB uptake and accumulation in marine bivalve molluscs. During the first project year we will characterize the effects of PCB accumulation on energetics and reproductive potential of Mytilus edulis transplanted in cages to New Bedford Harbor, MA, an area heavily contaminated with PCB's. During the second project year, we will extend our studies to identifying the responses of natural populations of bivalve molluscs, specifically two important commercial resources of Buzzards Bay -- the soft shell clam Mya arenaria and the hard shell clam Mercenaria mercenaria.

Principal Investigator: JUDITH M. CAPUZZO
Woods Hole Oceanographic Institute
Biology Department
Woods Hole, MA 02543

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	45.600	0.000
Performing:	27.300	0.000
Other:		0.000
Total Project Funding:	72.900	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
Oceanic and Atmospheric Research
Sea Grant Ocean Pollution Program

| 21| Record Number 0801

THE EFFECTS OF SIZE CLASS AND BIOTURBATION ON FINE GRAINED TRANSPORT IN COASTAL SYSTEMS: SPECIES-SPECIFIC APPLICATION TO BIOGEOCHEMISTRY OF PCB TRANSPORT IN NEW BEDFOR HARBOR

To determine the relative role of size class distribution and biological effects on the transport of fine sediment.

Principal Investigator: WILLIAM D. GRANT
Woods Hole Oceanographic Institution
Ocean Engineering Dept.
Sea Grant Program
Woods Hole, MA

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	49.600	
Performing:	75.053	
Other:		
Total Project Funding:	124.653	0.000

| 22| Record Number 0798

TRACING AND MODELLING MDC SEWAGE EFFLUENTS RELEASED TO BOSTON HARBOR

The objectives are to quantify halocarbons in MDC sewage effluents; determine spatial mixing of halocarbons into Boston Harbor; estimate Boston Harbor reaeration rates; apply hydrodynamic and transport numerical models to Boston Harbor; validate models with current, dye, and halocarbon distribution data; develop modelling/measurement framework to assess Harbor-wide pollution problems.

Principal Investigator: P.M. GSCHWEND
Civil Engineering
Massachusetts Institute of Technology
Cambridge, MA 0213

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	55.000	
Performing:		
Other:		
Total Project Funding:	55.000	0.000

| 23| Record Number 0100

METALLOTHIONEIN AS AN INDICATOR OF FISH EXPOSURE TO TOXIC ORGANIC CHEMICALS

The objectives of this project are: to determine whether the host response of rainbow trout to metals and toxic organic chemicals involves metallothionein; measure the dose-dependent distribution of CC14, 3-methylcholanthrene and selected P.C.B.s in liver to see if binding of their metabolites to metallothionein is significant; use model systems to study reactions of electrophilic species with metallothionein; determine if liver synthesizes metallothionein in response to host exposure to infectious agents.

Principal Investigator: FRANK SHAW III
University of Wisconsin @ Milwaukee
Department of Chemistry
Milwaukee, WI 53420

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	21.600	0.000
Performing:	22.400	0.000
Other:		0.000
Total Project Funding:	44.000	0.000

| 24| - Record Number 0098

PUBLIC HEALTH ASSESSMENT OF HEPATITIS AND ROTAVIRUS POLLUTION

The objectives of this project are: 1) to perfect and evaluate the merits of a new A-ELISA test for detection of hepatitis A virus in estuarine environments; 2) to determine the extent of hepatitis and rotavirus occurence in polluted waters; distribution among water, suspended solids and fluffy sediments; and correlation with bacterial indicated sanitary quality; 3) to assess the potential for solids-associated hepatitis A virus and rotavirus to pass from polluted to nonpolluted recreational and shellfish waters.

Principal
Investigator: JOSEPH L. MELNICK
Baylor College of Medicine
Houston, TX 77030

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	55.600	0.000
Performing:	27.600	0.000
Other:		0.000
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Total Project Funding:	83.200	0.000

| 25| - Record Number 0082

STUDIES OF THE BIOGEOCHEMISTRY OF SELECTED PERSISTANT ORGANIC CONTAMINANTS

The objectives of this project are: a) to identify the role of a variety of substrates including sediments, particulates and colloids, in the transport of selected organic pollutants in the estuarine environment; b) to determine the possible effects of temperature, salinity, pH and redox potential on the sorption/desorption of organic pollutants to the substrates listed in the first objective; c) to determine the relative bioavailability of selected organic pollutants to two estuarine species Macoma sp. (a benthic clam) and sheepshead minnow (fish) in soluble, colloid-sorbed and sediment-sorbed form.

Principal
Investigator: JAY C. MEANS
University of Maryland
Chesapeake Biological Laboratory
Solomons, MD 20688

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	30.000	0.000
Performing:	22.000	0.000
Other:		0.000
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Total Project Funding:	52.000	0.000

| 26| - Record Number 0131

MICROBIAL AND PHOTOCHEMICAL DEGRADATION OF CHLOROPHENOLS AND CHLOROANILINES IN ESTUARINE WATER

The objectives of this project are to determine the relationship between rates of combined photochemical and microbial degradation of selected organochlorine compounds in seawater, the concentration of the compounds in the water and the microbial biomass. We will develop methods for analysis of toxic metabolites produced by combined photochemical and microbial breakdown of the organochlorine compounds and develop the ability to predict persistence of the organochlorine compounds in various marine environments.

Principal
Investigator: RICHARD F. LEE
Skidaway Institute of Oceanography
Sea Grant Program
Savannah, GA 31406

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		0.000
Performing:		0.000
Other:		0.000
	-------	-------
Total Project Funding:	0.000	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
Oceanic and Atmospheric Research
Sea Grant Ocean Pollution Program

| 27| Record Number 0823

COPROSTANOL AND CLOSTRIDIUM PERFRINGENS SPORES AS INDICATORS OF SEWAGE CONTAMINATION IN NARRAGANSETT BAY

1) To compare two long-lived fecal indicators, C. perfringens spores and coprostanol, in surface sediments, sediment cores and Mercenaria mercenaria (hard shell clams) from Narragansett Bay; 2) To generate a geographical chart of potential fecal contamination in Narragansett Bay sediments and clams and compare the distribution with current shellfishing closure lines; and 3) To assess the feasibility of using these fecal indicators as shellfishing enforcement tools.

Principal Investigator: JAMES QUINN
GSO/University of Rhode Island
Narragansett, RI

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	50.900	
Performing:	26.900	
Other:		
Total Project Funding:	77.800	0.000

| 28| Record Number 0123

TRACING OF POLLUTANTS USING TRACE METALS ASSOCIATED WITH SEDIMENT IN THE LAGOONS OF SOUTHERN NEW JERSEY

The objectives of this program are: 1) determine the gross distribution of grain sizes present in bottom samples and cores areally and vertically; 2) determine the levels of metallic constituents in sediment samples collected and the areal and vertical distributions of such metals; 3) determine the organic content of the samples collected; and 4) initiate, coordinate and integrate investigations with researchers into the report.

Principal Investigator: M. J. HALL
Ryder College
Trenton, NJ 08648

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	11.000	0.000
Performing:	31.800	0.000
Other:		0.000
Total Project Funding:	42.800	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Marine Fisheries Service
National Fishery Ecology Program

| 29| Record Number 0001

STRIPED BASS: SOURCES OF EARLY MORTALITY (POLLUTION EFFECTS-LIAISON/MANAGEMENT)

Study of biochemical effects of selected pollutants on striped bass at several life history stages. Effects of petrochemicals on hormones, energy utilization and metabolism. Also the provision of information to management and the public, as needed, on effects of pollutants on fishes, fisheries populations and habitats of fishes. Final data analyses and preparation of manuscripts from previous research on the physiological effects of pollutants on striped bass. Emphasis on petroleum hydrocarbons and pesticides. Also, manuscripts prepared on otolith development in larval striped bass and lipoprotein characterization in adult striped bass. Provision of information to management and public on results of research program and pollutant effects in fish, in general.

Principal Investigator: JEANNETTE A. WHIPPLE
NOAA/NMFS/SWFC, Tiburon Laboratory
3150 Paradise Drive
Tiburon, CA 94920

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	115.500	0.000
Performing:	0.000	0.000
Other:	0.000	0.000
Total Project Funding:	115.500	0.000

| 30| Record Number 0853

ENVIRONMENTAL CHEMISTRY INVESTIGATION

Monitoring the abundance, distribution, sources, fates and biological effects of key contaminants, biostimulants, and phytoplankton. The purpose is to construct comprehensive baselines in order to help ensure sustained optimal yields of the fishery. Monitoring and research studies of hypoxia in the New York Bight area are also conducted. Participation in NOAA Benthic Surveillance Status and Trends Program (responsible for heavy metal monitoring in sediment and fish tissue at 14 estuarine sites in the Northeast).

Principal Investigator: ANDREW F. DRAXLER
NOAA/NMFS/NEFC
Sandy Hook Laboratory
Highlands, NJ 07732

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		
Performing:		
Other:		
Total Project Funding:	0.000	0.000

| 31| Record Number 0848

SATELLITE MONITORING OF WATER MASSES AT THE 106-MILE DUMPSITE

Surveillance of the surface water masses present and receiving industrial wastes periodically discharged into the 106-mile Dumpsite is accomplished by monitoring data and derived charts from infra-red sensors (VHRR) on NOAA satellites.

Principal Investigator: REED S. ARMSTRONG
Marine Climatology Investigation NMFS/NOAA
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		
Performing:		
Other:		
Total Project Funding:	0.000	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Marine Fisheries Service
National Fishery Ecology Program

| 32| Record Number 0851

COASTAL DYNAMICS

Monitoring temporal and spatial changes of selected indicators of ecosystem energy flow, algae bioassay, and phytoplankton community structure. Remote sensing is being used to map and monitor coastal wetlands and define water management units and change over time. The project is giving particular attention to documenting and assessing the extent and severity of eutrophication in coastal waters and the impacts of ocean disposal on the marine ecosystems. Monitoring of 12-mile dumpsite recovery using seabed metabolism as an indicator of the dumpsites health.

Principal Investigator: WILLIAM C. PHOEL
NOAA/NMFS/NEFC
Sandy Hook Laboratory
Highlands, NJ 07716

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		
Performing:		
Other:		
Total Project Funding:	0.000	0.000

| 33| Record Number 0847

NATIONAL ANALYTICAL FACILITY

The National Analytical Facility's three main functions are to 1) perform chemical analyses for trace chemical contaminants and transformation products thereof, 2) develop and/or improve state-of-the-art analytical methods for trace con-taminanats in the marine samples, and 3) serve as the focal point within NOAA for checking the validity of analyticalmethodology employed by NOAA grantees and contracts by managing quality assurance efforts and conducting interlaboratorycomparison exercises.

Principal Investigator: WILLIAM D. MACLEOD
NMFS/Northwest and Alaska Fisheries Center
2725 Montlake Blvd. East
Seattle, WA 98112

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	52.800	52.800
Performing:		
Other:	520.400	579.400
Total Project Funding:	573.200	632.200

| 34| Record Number 0845

NORTHEAST MONITORING PROGRAM

The areal scope of NEMP consists of the waters of the northeastern United States continental shelf from the Gulf of Maine to Cape Hatteras. The program encompasses systematic physical, chemical, biological, and geological measurements at approximately 80 monitoring/sampling sites located throughout the NEMP region. The products of NEMP include a series of reports on the trends and levels of various pollutants and biological effects in this region, and site-specific studies pin-pointing localities in which pollution problems are either an on-going concern or can be shown to represent an increasing threat to the habitat and associated living marine resources. Program funding is reported as part of other NMFS and NOS projects.

Principal Investigator: ROBERT A. MURCHELANO
DOC/NOAA/NMFS/Northeast Fisheries Center
Woods Hole Laboratory
Water Street
Woods Hole, MA 02543

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		
Performing:		
Other:		
Total Project Funding:	0.000	0.000

U.S. Department of Commerce
National Marine Fisheries Service
National Fishery Ecology Program

National Oceanic and Atmospheric Administration

| 35| - Record Number 0849

BENTHOS TASK

This project consists of three subprojects. One is a semiannual monitoring of up to 25 sediment/benthic macrofauna sites on the northeast shelf plus an annual survey of 44+ NY Bight sites. The second is a synthesis of data on benthic function, including life history, biomass, production, caloric contents and use as forage, for NE benthos. This includes studies of pollution effects on benthic macrofauna productivity in the NY Bight, combined with gut content analysis, to determine links between benthos/resource species. Thirdly, in situ studies of growth potential and limits of bivalves and their interactions with the invertebrate community are combined with field experiments to determine factors affecting settlement and early survival of larval macrobenthos.

Principal Investigator: ROBERT N. REID
NOAA/NMFS/NEC4 Northeast Fisheries Center
Sandy Hook Laboratory
Highlands, NJ 07732

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	233.000	
Performing:		
Other:		
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Total Project Funding:	233.000	0.000

U.S. Department of Commerce — National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Microconstituents Program

| 36| - Record Number 0018

PRODUCT SAFETY -- ANALYSIS OF POLYCHLORINATED BIPHENYLS (PCB) AND POLYNUCLEAR AROMATIC HYDROCARBONS (PAH)

The product safety program conducts baseline studies of polychlorinated biphenyls and petroleum hydrocarbon residues in selected tissues of targeted fish and shellfish species. Species of commercial, recreational, and ecological importance are collected from various impacted control stations of the northeastern Atlantic coast and Middle Atlantic states. These compounds are measured, quantified, and characterized by GC-MS. This project supports the NEFC Ocean Pulse effort relating to the health of the environment.

Principal
Investigator: DONALD F. GADBOIS
NOAA/NMFS/NEC6
Northeast Fisheries Center
Gloucester Fisheries Laboratory
Gloucester, MA 01930

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:		0.000
Performing:		0.000
Other:		0.000
Total Project Funding:	0.000	0.000

U.S. Department of Health and Human Services — Food and Drug Administration

Shellfish Sanitation Program

| 37| - Record Number 4018

VIBRIO CHOLERAE METHODOLOGY RESEARCH

Develop improved methods for isolation, enumeration and identification of Vibrio species found in shellfish and estuarine waters. Species include V. cholerae, V. vulnificus and V. purahaemolyticus.

Principal
Investigator: DR. ANTHONY GUARINO
U.S. FDA
Center for Food Safety and Applied Nutrition
Fishery Research Branch
PO Box 158
Dauphin Island, Alabama 36528

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	400.000	0.000
Performing:		0.000
Other:		0.000
Total Project Funding:	400.000	0.000

U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
Marine Waste Disposal Program

| 38| - Record Number 0243

EFFECTS ASSESSMENT PROTOCOLS TO EVALUATE OCEAN DISPOSAL IMPACTS

This project will: 1) provide effects assessments at the species, population and community levels of biological organization, 2) predict the effects of ocean disposed materials on ecologically and commercially important species and communities, and 3) develop and verify laboratory and field methods at different levels of biological organization to measure exposure effects. These will provide a hazard assessment protocol when combined with exposure assessment.

Principal
Investigator: JOHN H. GENTILE
U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	1,012.500	959.900
Performing:		0.000
Other:		0.000
Total Project Funding:	1,012.500	959.900

| 39| - Record Number 0245

SIGNIFICANCE OF TISSUE RESIDUES IN MARINE ORGANISMS

The purpose of this project is to develop and verify chemical and biological methods for 1) determining the bioaccumulative potential of contaminants in waste to be ocean disposed, and 2) determining the biological significance of contaminant tissue levels. A research strategy and supporting methodologies will be developed to predict the bioavailability and bioaccumulation potential of organic and inorganic contaminants controlling the phase partitioning of organic contaminants from complex wastes.

Principal
Investigator: JOHN H. GENTILE
U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	689.000	959.900
Performing:		0.000
Other:		0.000
Total Project Funding:	689.000	959.900

| 40| - Record Number 0249

EXPOSURE ASSESSMENT

The purpose of this project is to develop and apply quantitative modeling techniques for relating mass inputs of waste contaminants to concentration distributions in water column, sediment, and biotic compartments. Modeling techniques will include statistical and deterministic approaches. Data acquisition will include grab sampling, deployment of in-situ instrumentation, and remote sensing.

Principal
Investigator: JOHN PAUL
U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	997.100	916.400
Performing:		0.000
Other:		0.000
Total Project Funding:	997.100	916.400

U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
Marine Waste Disposal Program

| 41 | - Record Number 0250

DUMPSITE MONITORING

The purpose of this project is to produce guidance documents for dumpsite monitoring based on a minimum data set necessary to provide feedback within a hazard assessment framework to validate predicted exposures and effects for given loading levels. The effects (i.e., energetics, growth, reproduction, genetic and histological damage) on target species (i.e., mussels, amphipods, polycheates and fish) from chemical compounds (i.e., PCBs, PAHs and trace metals) used in laboratory systems for waste characterization. Effects determination will be applied in dumpsite monitoring research efforts.

Principal
Investigator: DONALD K. PHELPS
U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	542.900	673.400
Performing:		0.000
Other:		0.000
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Total Project Funding:	542.900	673.400

| 42 | - Record Number 0576

OCEAN DISPOSAL SITE SURVEY AND DESIGNATION

The Environmental Protection Agency is mandated to designate sites for ocean dumping. EPA is conducting a site specific assessment of approximately 143 ocean disposal sites. For each of the sites, the evaluation consists of a complete biological, water and sediment survey followed by an assessment of the environmental effects that result from use of the site.

Principal
Investigator: TUDOR DAVIES
U.S. Environmental Protecion Agency
Office of Marine and Estuarine Protection WH-556
400 M Street, S.W.
Washington, DC 20460

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	1,800.000	4,041.100
Performing:		0.000
Other:	200.000	0.000
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Total Project Funding:	2,000.000	4,041.100

U.S. Environmental Protection Agency
Office of Research and Development
Water Quality Research

| 43| - Record Number 0248

COMPLEX EFFLUENTS TOXICITY TESTING

The purpose of this project is to develop, field test, verify and transfer to the regions and states toxicity testing methodologies for effluents and their receiving waters. Tests will be evaluated in the laboratory and at field sites using effluent and receiving water. Results will be compared with biological monitoring data to see if test results are related to impairment of receiving water use.

Principal
Investigator: DAVID J. HANSEN
U.S. Environmental Protection Agency
Narragansett Environmental Research Laboratory
South Ferry Road
Narragansett, RI 02882

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	264.000	660.600
Performing:		0.000
Other:		0.000
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Total Project Funding:	264.000	660.600

U.S. Environmental Protection Agency

Exploratory Research

| 44| Record Number 0574

MARINE ECOSYSTEMS RESEARCH LABORATORY/MARINE SCIENCE RESEARCH CENTER OF EXCELLENCE

The primary objectives are: a) to design, develop and operate experimental marine ecosystems; b) to investigate the behavior of these systems and the organisms which live in them, and from these studies to examine the feasibility of using mesocosms to improve our understanding of the behavior of natural systems; c) to study the effects of various perturbations on individual species, species-to-species interactions, and properties of the whole system; d) to investigate the geochemical and biogeochemical behavior of various elements and organic compounds in these complex enclosed ecosystems.

Principal Investigator: M.E.Q. PILSON
University of Rhode Island
School of Oceanography
Kingston, RI 02881

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	420.000	539.085
Performing:	22.000	28.442
Other:	439.000	0.000
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Total Project Funding:	881.000	567.527

U.S. National Aeronautics and Space Administration — Office of Space Science and Applications
Earth Science and Applications Division
Ocean Productivity Program

| 45 | - Record Number 0663

SIMULATION ANALYSIS OF NON-STATIONARY CZCS TIME SERIES FROM CONTINENTAL SHELVES

Two years of Coastal Zone Color Scanner (CZCS) derived phytoplankton maps will be combined with extensive shipboard, air craft, and in situ mooring data to determine the magnitude and variability of primary productivity off the East Coast of the United States. These studies will center about utilizing the spatially rich satellite data in computer simulation models of phytoplanktonic ecosystems which incorporate realistic physical oceanographic processes.

Principal
Investigator: JOHN J. WALSH
Dept. of Marine Science
University of South Florida
140 Seventh Ave. So.
St. Petersberg, FL. 33701

Funding Source(s) in Thousands of Dollars

	FY85	FY86
Federal:	223.000	253.000
Performing:		
Other:		
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Total Project Funding:	223.000	253.000