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Chapter 7 **Statutes and Programs Relating To** **Marine Waste Disposal**

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Statutes and Programs Relating To Marine Waste Disposal

INTRODUCTION

Federal efforts to control and manage marine waste disposal are relatively recent in origin, with most programs being less than two decades old. In 1970, three major government reports recommended that a national policy for controlling ocean waste disposal be developed (11 5,382,623). In response to these and to the general environmental concerns of the 1960s and early 1970s, Congress passed a suite of major statutes that provide the general legal structure currently used to regulate all waste disposal activities. One of the reports, the Council on Environmental Quality's "Ocean Dumping—A National Policy" (1 15), became the primary basis for the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 and for much of the policy developed throughout the decade for regulating marine disposal (377,420).

MPRSA and the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act, or CWA) are the two major statutes controlling waste disposal in marine environments. In general, the open ocean is reasonably well-protected

as a result of MPRSA, but other areas of the marine environment remain more vulnerable. In particular, estuaries and other coastal waters, primarily regulated under CWA, have received less protection. In fact, a 1981 study by the National Advisory Committee on Oceans and Atmosphere (NACOA) concluded that the Council on Environmental Quality (CEQ) report was responsible for the near total restriction of open ocean waste disposal (377). The NACOA report disagreed with this approach, and proposed that some wastes could be disposed of in marine waters under certain conditions. It recommended that a more comprehensive waste management strategy include greater use of the open ocean. This recommendation influenced an important 1981 court decision, *City of New York v. United States Environmental Protection Agency* (543 F. Supp. 1084) (155). The NACOA report and the court decision signaled a changing attitude toward the ocean, from relatively strict protection to carefully managed use (12,291 ,531).

OVERVIEW OF THE EXISTING LEGISLATIVE AND REGULATORY FRAMEWORK

The major provisions of the two major statutes, MPRSA and CWA, are summarized in table 11. (A number of other statutes that also have some affect on marine waters are described briefly in box O.) MPRSA regulates the *dumping* of any material in the territorial sea (0 to 3 nautical miles), the contiguous zone (3 to 12 nautical miles), and beyond in the open ocean. It applies to dumping of U.S. -origin materials from all U.S. vessels, but it only applies to foreign vessels dumping foreign-origin materials within 12 miles of the U.S. coast. CWA regulates *discharges* from all point sources into all U.S. waters, including the territorial sea,

the contiguous zone, and beyond.¹ Although both laws establish procedures to administer regulatory permit programs, there are basic differences in their regulatory approaches to marine waste disposal. MPRSA requires the balancing of all relevant factors (e. g., socioeconomic factors, land-based alternatives, etc.), while CWA primarily relies on technological considerations, giving some attention to economic feasibility.

¹Except discharges from vessels beyond the 3-mile boundary.

Table 11.-Major Legislative Provisions Affecting Waste Disposal in Marine Waters

Statute and section	Purpose
Marine Protection Research, and Sanctuaries Act:	
Sec. 101	Prohibits, unless authorized by permit, the transportation of wastes for dumping and/or the dumping of wastes into the territorial seas or the contiguous zones.
Sec. 102	Authorizes EPA ^a to issue permits for dumping of nondredged materials into the contiguous zone and beyond as long as the materials will not "unreasonably degrade" public health or the marine environment, following criteria specified in statute or established by the Administrator.
Sec. 103	Authorizes Corps of Engineers to issue permits for dumping dredged material, applying EPA's environmental impact criteria to ensure action will not unreasonably degrade human health or the marine environment.
Sec. 104	Specifies permit conditions for waste transported for dumping or to be dumped, issued by EPA or the Coast Guard.
Sec. 107	Authorizes EPA and Corps of Engineers to use the resources of other agencies, and instructs the Coast Guard to conduct surveillance and other appropriate enforcement activities as necessary to prevent unlawful transportation of material for dumping or unlawful dumping.
C/can Water Act:^b	
Sec. 104(n)	Directs EPA to establish national estuaries programs to prevent and control pollution; to conduct and promote studies of health effects of estuarine pollution.
Sec. 104(q)	Establishes a national clearinghouse for the collection and dissemination of information developed on small sewage flows and alternative treatment technologies.
Sec. 201, 202, 204	Specifies sewage treatment construction grants program eligibility and Federal share of cost.
Sec. 208	Authorizes a process for States and regional agencies to establish comprehensive planning for point and nonpoint source pollution.
Sec. 301	Directs States to establish and periodically revise water quality standards for all navigable waters; effluent limitations for point sources requiring BPT should be achieved by July 1, 1977; timetable for achievement of BAT and other standards set. Compliance deadlines for publicly owned treatment works (POTWs) to achieve secondary treatment also set.
Sec. 301(h)	Authorizes waivers for POTWs in coastal municipalities from secondary treatment for effluent discharged into marine waters if criteria to protect the marine ecosystem can be met.
Sec. 301(k)	Allows industrial dischargers to receive a compliance extension from BAT requirements until July 1, 1987, for installation of an innovative technology, if it will achieve the same or greater effluent reduction than BAT at a significantly lower cost.
Sec. 302	Allows EPA to establish additional water quality-based limitations once BAT is established, if necessary to attain or maintain fishable/swimmable water quality (for toxics, the NRDC v. EPA consent decree sets terms).
Sec. 303	Requires States to adopt and periodically revise water quality standards; if they determine that technology-based standards are not sufficient to meet water quality standards, they must establish total maximum daily loads and waste load allocations, and incorporate more stringent effluent limitations into Sec. 402 permits.
Sec. 303(e)	Requires States to establish water quality management plans for watershed basins, to provide for adequate implementation of water quality standards by basin to control nonpoint pollution; Section 208 areawide plans must be consistent with these plans.
Sec. 304	Requires EPA to establish and periodically revise water quality criteria to reflect the most recent scientific knowledge about the effects and fate of pollutants, and to maintain the chemical, physical, and biological integrity of navigable waters, groundwater, and ocean waters and establish guidelines for effluent limitations.
Sec. 304(b)	Outlines factors to be considered when assessing BPT and BAT to set effluent limitation guidelines, including accounting for "non-water quality impact," age of equipment, etc.
Sec. 305(b)	Sets State water quality reporting requirements.
	Sets new source performance standards for a list of categories of sources.
Sec. 307	Requires EPA to issue categorical pretreatment standards for new and existing indirect sources; POTWs required to adopt and implement local pretreatment programs; toxic effluent limitation standards must be set according to the best available technology economically achievable.
Sec. 308	Requires owners or operators of point sources to maintain records and monitoring equipment, do sampling, and provide such information or any additional information.
Sec. 309	Gives enforcement powers primarily to State authorities. Civil penalties, however, and misdemeanor sanctions can be issued by EPA in U.S. district courts for violation of the act, including permit conditions or limitations; EPA also is authorized to issue criminal penalties for violations of Sections 301, 302, 306, 307, and 308. EPA may take enforcement action for violations of Section 307(d) which introduce toxic pollutants into POTWs.
Sec. 402	Establishes National Pollutant Discharge Elimination System (NPDES), authorizing EPA Administrator to issue a permit for the discharge of any pollutant(s) to navigable waters that will meet requirements of Sections 301, 302, 306, 307 and other relevant sections; States can assume administrative responsibility of the permit program.

Table 11.—Major Legislative Provisions Affecting Waste Disposal in Marine Waters—Continued

Statute and section	Purpose
Sec. 403	Directs EPA to establish Ocean Discharge Criteria as guidelines for permit issuance for discharge into territorial seas, the contiguous zone, and open ocean.
Sec. 404	Directs Secretary of the Army to issue permits for dredged or fill material; EPA must establish criteria comparable to Section 403(c) criteria for dredged and fill material discharges into navigable waters at specified disposal sites.
Sec. 405	Requires EPA to issue sludge use and disposal regulations for POTWs.
Sec. 504	Grants emergency powers to Administrator to assist in abating pollutant releases; establishes a contingency fund, and requires Administrator to prepare and publish a contingency plan to respond to such emergencies.
Sec. 505	Citizen suit provision allows citizens to bring civil action in district court against any person in violation of an effluent standard or limitation of an order by the Administrator for failing to perform a nondiscretionary act.

^aUnless otherwise noted, the Environmental Protection Agency (EPA) is responsible for implementing Provision(s)

^bRelevant Provisions of the recently-enacted Water Quality Act of 1987, which reauthorized and amended the Clean Water Act, are discussed in box C and corresponding text.

^cWater quality standards are ambient standards designed to achieve certain uses of water; these now play a secondary role. Technology-based effluent standards are given the primary role and are designed to reduce pollutants so that ultimately all water is "fishable, swimmable." Effluent standards are performance standards and specify the maximum permissible discharge of a pollutant from a type of source and usually specify the degree of technology to be used ("best available," "best practicable," "reasonably available," etc.), but not the particular method needed to comply. Effluent limitation guidelines, on the other hand, apply to individual sources and specify their particular performance levels. Water quality standards (Sec. 303) are now the benchmarks by which to measure the success of the effluent standards in meeting clean water goals.

SOURCE: Office of Technology Assessment, 1987

BOX O.—Additional Laws Affecting ne Waste Disposal

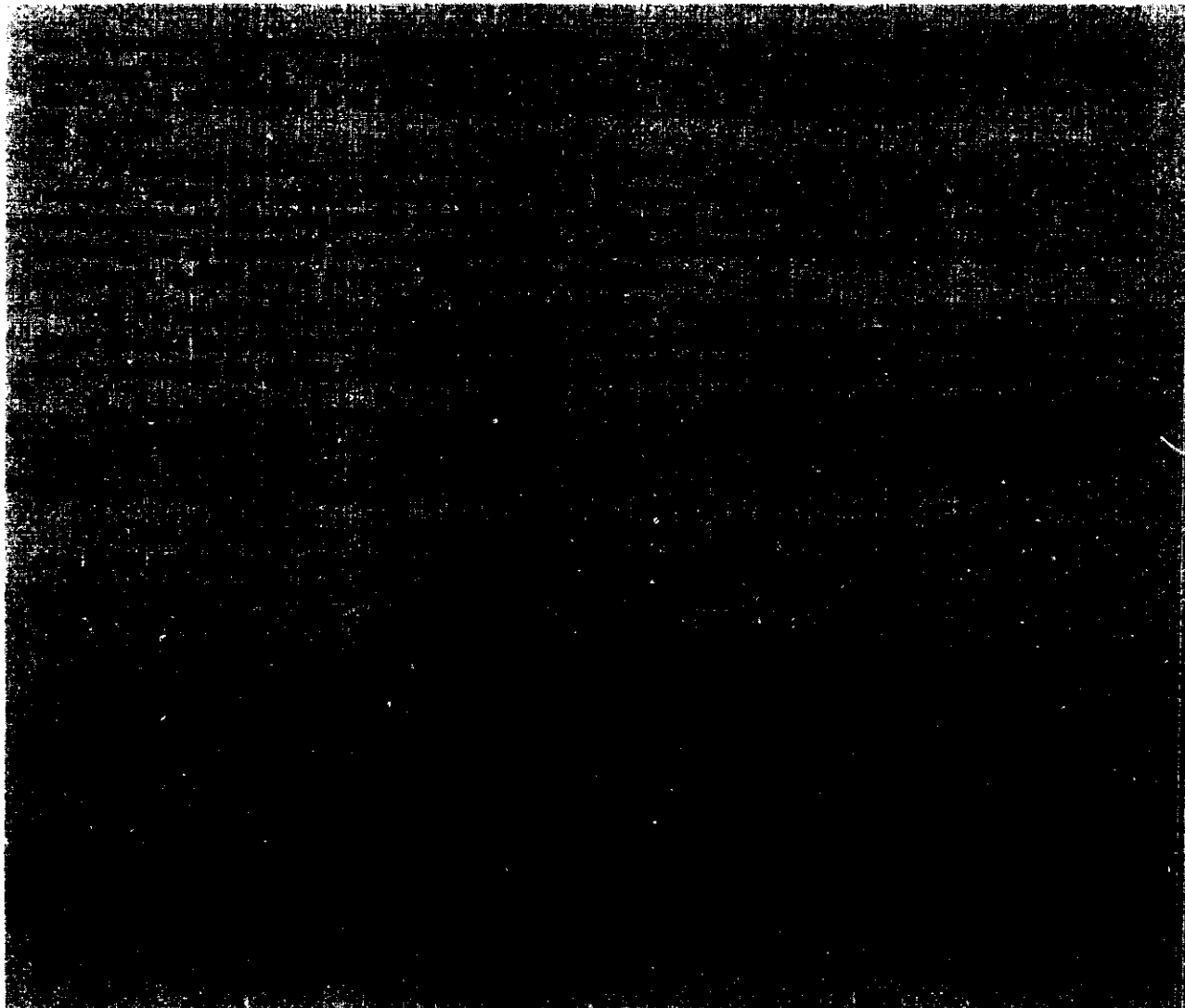
Although MPRSA and CWA are the statutes profound effects on marine waste disposal, a number of other laws are also relevant; the amount of waste needing disposal or by regulating certain uses. The Resource Act and Recovery, discussed in box P, while other statutes are briefly described here.

The Clean Air Act Amendments (CAA) of 1977 (401 et seq.) have indirectly resulted in the generation of large amounts of air pollution control ash, flue-gas desulfurization sludges, and other air pollution control sludges) which have been marine disposal at various times. These wastes are generated by the air pollution equipment to comply with national emission and air quality standards for stationary sources of air.

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451 et seq.) provides Federal grants to States to develop Coastal Zone management plans for economic development and the need for environmental protection. EPA cannot permit for an activity affecting land or water use in a coastal zone until it has certified that the activity does not violate a State's management plan. Through the National Estuarine Sanctuary Program, the act authorizes 50 percent matching grants to States to acquire and manage estuaries for research and educational purposes. Amendments to CZMA in 1980 state that management policies should protect coastal natural resources estuaries, beaches, and fish and wildlife and their habitat) and encourage area management plan for estuaries, bays, and harbors.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (42 U.S.C. 9601 et seq.), better known as Superfund, was enacted to provide emergency response and cleanup capabilities for chemical spills and releases from hazardous waste treatment, storage, and disposal facilities. Its primary impact on marine waste disposal involves: 1) the identification of large numbers of hazardous waste sites in the coastal zone, with potential for movement of waste pollutants into marine waters; 2) the suggestion that some waste be remedial action at Superfund sites in the coastal ocean; and 3) provisions regarding the liability of ocean incineration vessels (586).

The Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.) requires all Federal agencies and their permittees and licensees to ensure that their actions are not likely to jeopardize the existence of an endangered or threatened species or result in the destruction or adverse modification of critical habitats of such spe-



The Marine Protection, Research, and Sanctuaries Act

Introduction

When passed in 1972, MPRSA became the first comprehensive legislation to regulate ocean dumping of all types of material that may adversely affect human health, the marine environment, or the economic potential of the ocean. MPRSA (33 U.S.C. 1401 et seq.) is the only pollution law exclusively devoted to the ocean and is the only law that explicitly requires consideration of alternative

land-based disposal methods (Sec. 102(a)).² In contrast, other statutes such as the Resource Conservation and Recovery Act (RCRA) typically regulate disposal in one environment without explicitly considering the consequences in other environments.³

²One major finding in the *City of New York v. United States Environmental Protection Agency* decision (543 F. Supp. 1084) was the court's interpretation that the Act requires EPA to balance the **need** for ocean dumping with potential environmental, social, and economic impacts of land-based disposal options.

³Under certain conditions, RCRA precludes land disposal without requiring that alternative disposal methods first be evaluated (box P).

Box P.—The Importance of the 1984 RCRA Amendment

The Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C. 6901 et seq.) defines and lists "hazardous" wastes and controls their generation, transport, storage, and disposal. Some hazardous wastes currently enter marine waters from disposal sites located on land but near estuaries or coastal waters, or as part of "indirect" industrial discharges into municipal treatment plants that subsequently discharge into these waters. Exemption of domestic sewage allows legal "indirect" discharges of some hazardous wastes into municipal treatment plants.

The 1984 Hazardous and Solid Waste Amendment to RCRA dramatically increased the scope and complexity of the RCRA program and represented an attempt by Congress to control most land-based disposal methods for managing hazardous wastes. Section 201 is the most important amendment affecting marine waste disposal. It prohibits land-based disposal of dioxin-containing and spent-solvent wastes by November 1986. Eight months later, all "California list" wastes must be banned from land-based disposal unless EPA determines that land-based disposal is safe for a particular waste. The California wastes include liquid hazardous wastes and sludges containing specified levels of metals, arsenic, halogenated chemicals, PCBs, or highly acidic liquids. Underground injection of dioxins, solvents, and California wastes would stop by 1988, unless EPA finds that they can be safely disposed of in this way. For all other hazardous wastes, EPA is given deadlines of 44, 55, and 66 months to review and set standards for the most hazardous and highest volume wastes. If the first two deadlines are missed, the wastes are automatically banned from land-based disposal if adequate alternative disposal facilities exist.

These "hammer provisions" are intended to force the phasing out of land-based disposal for hazardous wastes. In many cases, EPA probably will find it difficult to meet the deadlines or to determine that land-based disposal is safe, so the provisions may effectively encourage alternatives such as physical and chemical treatment methods (487,684). These provisions also could lead to the consideration of marine disposal of hazardous wastes. One preliminary study estimated that these restrictions might cause annual shortfalls in land-based treatment and disposal capacity of over 50 million gallons of certain solvents, dioxins, and California list wastes; based on the ocean dumping regulations, however, none of these would be legally acceptable for ocean dumping (241). Finding sites on land for the disposal of sludge and dredged material also could become more difficult. In addition, regulations now require that hazardous waste generated by small quantity generators (those businesses generating between 100 and 1,000 kilograms of hazardous waste per month) be disposed of in permitted or interim status facilities. Enforcing this requirement is difficult; illegal discharges to municipal sewers could increase and such discharges could further contaminate municipal effluent and sludge.

"Material" is defined in MPRSA as all wastes except effluent discharged through an outfall, oil, or sewage from vessels, all of which are regulated under CWA. Thus MPRSA governs solid wastes, incinerator residues, sewage sludge, industrial wastes, dredged materials, low- and high-level radioactive waste, and chemical and biological warfare agents. High-level radioactive waste and chemical and biological warfare agents are specifically prohibited from ocean disposal, while other materials are allowed under some circumstances. Fish cleaning wastes are generally not regulated except if disposed of in harbors or other protected or enclosed coastal waters, although seafood processing

is regulated under CWA through National Pollution Discharge Elimination System permits.

Under the first two titles of MPRSA, commonly referred to as the Ocean Dumping Act, four Federal agencies have responsibilities: the Environmental Protection Agency (EPA), the Corps of Engineers (COE), the National Oceanic and Atmospheric Administration (NOAA), and the Coast Guard. Title I of the Act authorizes EPA to designate specific ocean disposal sites, establishes a permit system for the use of such sites, and directs EPA to establish ocean dumping criteria based on specified factors. The permit system is administered

by EPA for all materials except for dredged material, which is under the jurisdiction of the Corps of Engineers, although EPA does retain review authority.

Title II requires EPA and NOAA to conduct research and monitoring on ocean dumping and to study alternative disposal methods. The Coast Guard is charged with maintaining surveillance of ocean dumping. Section 203 was amended in 1986 (as part of the Title 11 reauthorization of MPRSA included in the Consolidated Omnibus Budget Reconciliation Act of 1985, Public Law 99-272, Apr. 7, 1986) to direct EPA to cooperate with other appropriate government agencies to assess the feasibility of regional management plans for waste disposal in coastal areas. The plans would integrate all the waste disposal activities in an area into a comprehensive regional disposal strategy.

Title III of MPRSA gives the Secretary of Commerce authority to establish marine sanctuaries. Through the National Marine Sanctuary Program, marine areas as far seaward as the outer edge of the continental shelf, including inland waters, can be designated if this is determined necessary to preserve or restore an area for conservation, recreational, ecological, or esthetic purposes (Sec. 302). The designation of certain sanctuary sites has created controversy when it entailed prohibiting oil and gas development activities or conflicted with other economic interests (e. g., the creation of the Channel Islands National Marine Sanctuary in California). Although this is an important program, it is not directly concerned with the control of disposal activities and thus is not discussed further in this report.

In 1974, MPRSA was amended so that all U.S. criteria covering the dumping of wastes in marine waters would be consistent with and contain all the basic constraints set forth in the London Dumping Convention (LDC) (box Q). In practice, however, a number of administrative and court actions have not always taken full account of the Convention's requirements (12,214,712).

Permitting—Sections 102 and 103

Section 102 of MPRSA authorizes the EPA Administrator to issue permits, following notice and opportunity for public hearings, for the transpor-

tation and dumping of nondredged material in ocean waters provided that it:

will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities.

The Administrator is further directed to establish Ocean Dumping Criteria, based on nine factors specified in the statute (box R), and use these to review permit applications for both dredged and nondredged material. The factors include the need for the proposed dumping; its effect on human health, the environment, and economic and recreational values; and alternative disposal options and their potential impacts.

In 1973, EPA issued final regulations that established these Ocean Dumping Criteria (40 CFR 227). The criteria reflected EPA's policy at that time of terminating all ocean dumping, even if the dumping could be shown not to "unreasonably degrade" the marine environment. EPA also established, however, "interim" and "special" permit procedures to allow the dumping of some materials prohibited by MPRSA. Emergency and research permits were also allowed. The criteria were not entirely consistent with LDC constraints when the United States became a signatory in 1974, which led to later revisions of the regulations and the Act. In 1977, EPA again revised the Ocean Dumping Criteria (42 FR 2462, Jan. 11, 1977), in part as a response to a case brought by an environmental group challenging the dumping regulations and permit criteria already promulgated by EPA (*National Wildlife Federation v. Costle*, often referred to as *Costle I*; 14 E. R.C. 1680 (D. C. Cir. 1980)) (420).

Section 103 of MPRSA authorizes the Secretary of the U.S. Army, acting through the Chief of Engineers of COE, to issue permits for the dumping of dredged material. Federal responsibilities under this section are bifurcated. COE applies criteria developed by EPA pursuant to the Section 102 environmental impact criteria. EPA has the authority to review the application before COE issues a permit and also has the authority to approve site designation. EPA initially exempted COE from several of the more stringent criteria and site designation and evaluation procedures generally applied to nondredged material permits. However,

Box Q.—Relevant International Conventions

Several international conventions affect marine waste disposal activities (165). The two most significant are the London **Dumping** Convention and the **Oslo Convention**. Some conventions (e.g., the Barcelona and **Kuwait** Conventions) were developed under the **United Nations Regional Seas Programme**,* while other conventions and **agreements** (e.g., the Helsinki Convention, the **Bonn Agreement**, and **MARPOL**) were developed under other auspices.

The London Dumping Convention (LDC) of 1972, often called “The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter,” is the primary international agreement dealing with marine waste disposal and is the only convention to which the United States is a signatory. As a signatory nation, all U.S. criteria covering marine disposal must, at a minimum, be equivalent to and contain the basic constraints in the LDC. The LDC has been ratified by 61 countries, and the International Maritime Organization serves as the administrative mechanism for cooperation among the contracting States. The LDC’s jurisdiction includes all waters seaward of the inner boundary of the territorial sea.

The LDC prohibits dumping of “**substances defined in its Annex I** (e.g., **organohalogens**, **mercury and mercury compounds**, **cadmium compounds**, **plastic oils and oily mixtures**, **radioactive materials**, and **agents of biological and chemical warfare**) and allows dumping of “**grey-list**” substances defined in its **Annex II** only by special permits. Substances that are not on either list require a general permit for dumping, from either the flag State or the loading State.

The Oslo Convention of 1974, titled “The Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft,” was the first international agreement to regulate the dumping and incineration of wastes at sea by most European countries. Discharges from rivers, estuaries, pipelines, and outfalls are not included. The jurisdiction of the Oslo Convention includes a portion of the Arctic Ocean, the northeastern Atlantic Ocean, and the North Sea. The Oslo Convention has black and grey lists for different pollutants, although the lists vary slightly from those of the LDC. The major difference between the two conventions is that the Oslo Convention has stricter limits for incineration at sea.

The Paris Convention was developed in 1978 by the signatory nations of the Oslo Convention to prevent marine pollution from land-based sources. Also, the contracting parties can adopt discharge standards and environmental quality standards regulating the composition and use of waste substances and products.

The Barcelona Convention for the Protection of the Mediterranean Sea Against Pollution (1978) was developed as part of the **Regional Seas Programme** of the **United Nations Environment Programme**. It addresses only dumping from aircraft, ships, and platforms, and pollution from land-based sources.

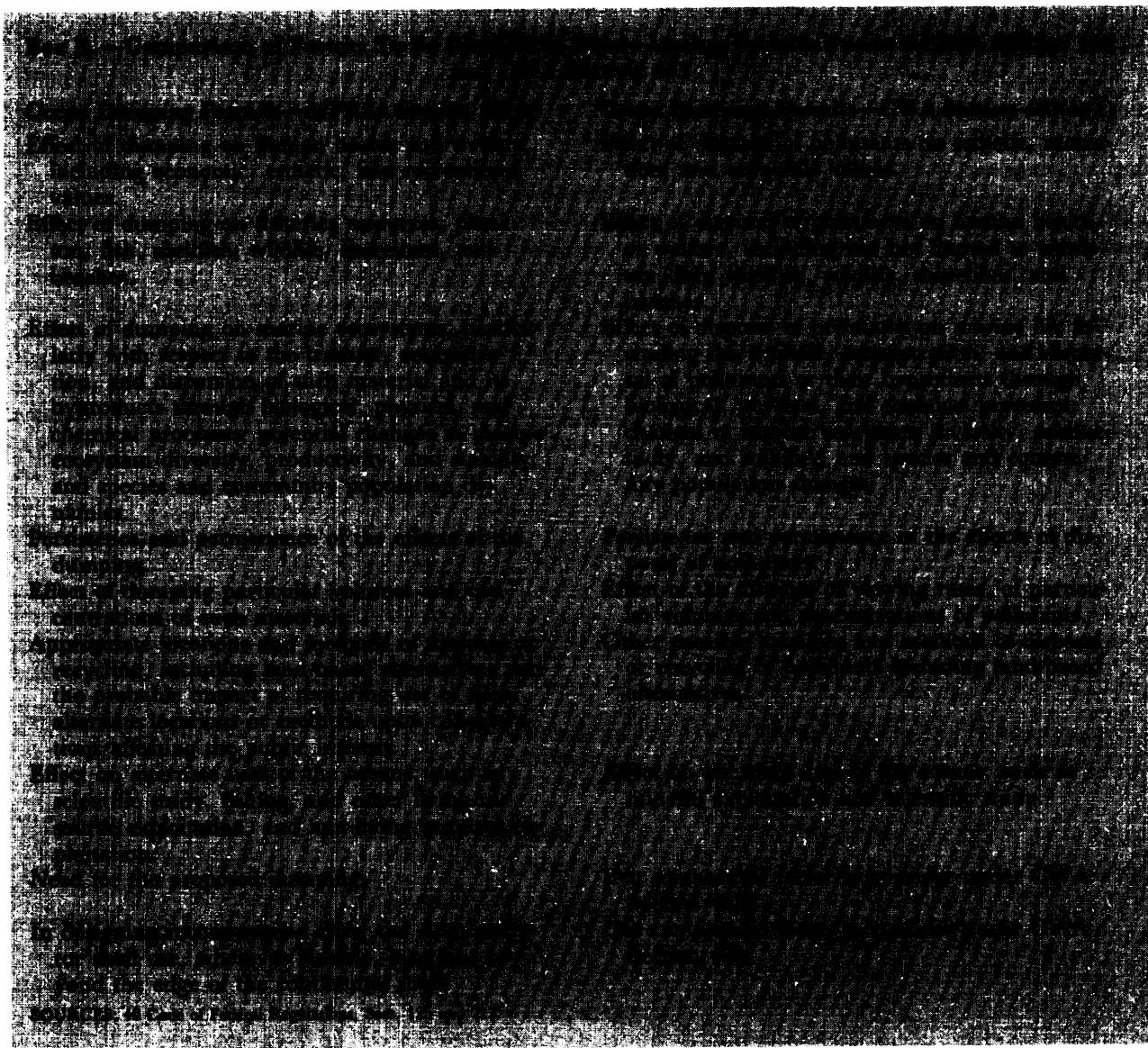
The Kuwait Convention entered into force in 1979 under the title “Kuwait Regional conference of Plenipotentiaries on the Protection and Development of the Marine Environment in the Coastal Areas.” It is part of UNEP’s **Regional Seas Programme** and focuses on oil pollution from tankers, refineries, and petrochemical industries.

The Helsinki Convention, titled “The Convention on the Protection of the Marine Environment of the Baltic Sea Area,” was adopted in 1974 by the seven Baltic Sea States and came into force in 1980. It is the first international marine protection convention that encompasses all pollution sources, including nonpoint agricultural runoff, and it has resulted in some reduction in ocean dumping.

The Bonn Agreement, the 1969 “Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil,” is the first regional agreement to promote the development of contingency plans for responding to oil spills and other similar types of accidents.

The International Convention for the Prevention of Pollution from Ships (1973 and Protocols of 1978), often referred to as **MARPOL 73/78**, attempts to reduce pollution by prohibiting discharges from ships; currently, additional annexes to control substances such as nondegradable plastics, noxious liquids in bulk, and sewage are being considered for adoption.

* The **Regional Seas Programme** of the **United Nations Environment Programme** encourages international cooperation to abate marine pollution and protect living marine resources. More than 120 coastal nations are part of the Programme, grouped into 10 regions. Each region develops “action plans” that delineate areas of cooperation and adopts conventions which provide legal frameworks for activities in the region. Note that the United Nations Law of the Sea Convention, of which the United States is not a signatory, is potentially relevant to ocean dumping practices but is not yet in force.



the different treatment of dredged and nondredged material was successfully challenged in court in *National Wildlife Federation v. Cosde* (often referred to as Costle 11; 629 F.2d 118 (D.C. Cir. 1980)). The court held that EPA must consider all Section 102(a) criteria in developing regulations, but that it is not bound to apply all criteria to every permit decision or to every type of waste material.⁴

⁴Prior to 1974, under Sec. 103(d), COE could apply to EPA for a waiver of the environmental impact criteria. Only one waiver was ever applied for and it was not granted; the 1974 amendments to MPRSA prohibited EPA from issuing such waivers.

The Continuance of Ocean Dumping and the City of New York Decision

Throughout most of the 1970s, EPA invoked a policy of phasing out all ocean dumping and encouraging municipal and private dumpers to seek land-based alternatives. In 1977, Congress statutorily mandated phasing out all "harmful" sewage dumping by December 1981 and later imposed a similar deadline for terminating the dumping of industrial wastes. These stringent deadlines were set primarily because several severe marine pollution incidents in the mid- 1970s had heightened pub-

lic awareness of actual and potential adverse health and environmental impacts from marine disposal.

The 1981 deadlines for phasing out dumping of harmful sewage sludge and industrial waste initially seemed a way to bring an end to ocean dumping. In fact, since 1973 about 319 permits or permit applications have been withdrawn, phased out, or denied. Some large municipalities (e. g., Philadelphia) ceased dumping sewage sludge in the ocean.

In 1981, New York City brought suit against the EPA to stop implementation of the regulations. In *City of New York v. United States Environmental Protection Agency*, the Federal District Court in New York ruled that dumping of municipal sewage sludge in the New York Bight could not be banned without full consideration of the costs and environmental consequences of alternative disposal methods. According to the court, EPA's conclusive presumption that many materials which fail ocean environmental impact criteria will unreasonably degrade the environment was arbitrary and capricious. Many factors, including the environmental and socioeconomic impacts of alternative disposal options, also needed to be considered when analyzing the acceptability of a given disposal alternative. The decision granted New York City and several other sewerage authorities in New York and New Jersey permission to continue dumping sludge on an interim basis, even though MPRSA did not allow interim permits to be granted after December 31, 1981. Thus, the court decision effectively postponed the December 1981 deadline.

The interim permit procedure under Section 102 has been considered by some observers to be a 'substantial loophole' which allows the dumping of materials that do not meet ocean disposal criteria (12,2 14), even though the justification for interim permits was to provide time for research and the development of alternative, land-based options.⁵ Twenty-two interim permits had been granted by 1980. After 1981, fewer than 10 such permits remained in effect, but the terms of these permits were extended (291). The amount of sewage sludge dumped in marine waters steadily increased during this time, while the disposal of industrial wastes

declined dramatically (531). A number of cities, including Philadelphia, Boston, Washington, D. C., Seattle, and San Francisco have indicated that they would consider ocean dumping as a potential disposal option in the future if it was permitted.

EPA did not appeal the 1981 court decision. In light of the decision and various arguments that a total ban on marine waste disposal was unnecessary and perhaps counterproductive (377), EPA began to focus on developing a more comprehensive management strategy. EPA is still in the process of promulgating new regulations based on the decision. Major questions remain, however, about how much analysis will be required when the economic and technical feasibility and environmental soundness of alternative options are considered. It is also unclear how decisions will be made when alternatives to marine disposal of sludge are not environmentally superior or readily implemented (291,502). The philosophical shift from ocean protection to management is not yet incorporated into MPRSA, but amendments passed by the House of Representatives in 1985 showed some movement in that direction (H. R. 1957).

The Federal Water Pollution Control Act

The Federal Government has played a role in the abatement of water pollution since the turn of the century. Initially, the Federal role was limited to offering assistance to the States in cases that involved interstate waters. This role has gradually increased over the last several decades: today's Federal Water Pollution Control Act, the Clean Water Act (CWA) (33 U.S. C. 1251 et seq.), has jurisdiction over all U.S. waters, establishes standards for industries and municipalities, and contributes billions of dollars to the construction of municipal waste treatment plants.

When enacted in 1972, CWA was the most comprehensive and expensive environmental legislation to date. It set the ambitious goal of eliminating all discharges of water pollutants by 1985, and had an interim objective, where possible, of making the Nation's waters "fishable and swimmable" by 1983. Major revisions were made in 1977 and 1981, which among other things modified these deadlines. The Water Quality Act of 1987 further amended the act (see box C in ch. 1).

⁵For example, an interim permit was used to phase out the disposal of sewage sludge by Philadelphia, which was able to develop land-based options (578).

The primary purpose of CWA is to restore and maintain the chemical, physical, and biological integrity of U.S. water resources. To accomplish this, Congress established a combined Federal and State system of controls to implement water programs. CWA consists of two major parts: the Federal grant program to help municipalities build sewage treatment plants (Title II); and the pollution control programs, which consist of regulatory requirements that apply to industrial and municipal dischargers. Responsibility for implementing and administering CWA programs is delegated to States that can demonstrate that they have the legal authority and resources to do so.

NPDES and the National Pretreatment Program—Sections 402 and 307

Under Section 402, all facilities—industrial and municipal—discharging directly into the navigable waters of the United States are required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. ‘ ‘Direct’ discharges regulated under NPDES must:

1. comply with applicable effluent limitations;
2. not result in violation of applicable water quality standards; and
3. for marine discharges, comply with the Ocean Discharge Criteria (Sec. 403).

Industrial effluent limitations are based on national guidelines developed by EPA for major industrial categories.⁶ Municipal effluent limitations are based primarily on requirements to provide ‘ ‘secondary’ levels of treatment (ch. 9).

Section 307 established the National Pretreatment Program (40 CFR 403.5), which authorizes and mandates municipalities operating publicly owned treatment works (POTWs) to develop a pretreatment program capable of regulating industrial

discharges into municipal sewers (‘ ‘indirect’ discharges). General pretreatment standards prohibit the discharge of pollutants that can create a fire or explosion, or damage or interfere with POTW operations. Categorical pretreatment standards have also been developed for major industrial categories; these are intended to remove pollutants that might otherwise pass through POTWs into U.S. waters.

Implementing the NPDES and pretreatment programs has affected marine waste disposal in at least two major ways.⁷ First, it has resulted in the generation of large quantities of treatment sludges, some of which have been considered for marine disposal—particularly municipal sludges. Second, it provides direct control over the discharge of pollutants from point sources to marine environments, or to other bodies of water that eventually reach marine waters.

Types of Pollutants Regulated.—When first adopted, CWA focused primarily on the control of highly visible *conventional* pollutants such as suspended solids and, as added later, oil and grease. There was, however, increasing recognition of the serious impacts associated with the discharge of *non-conventional* and *toxic* pollutants. ‘ ‘The development of a list of so-called toxic ‘ ‘priority pollutants, resulting from settlement of a suit (commonly known as the ‘ ‘Flannery Decree’ brought against EPA by the Natural Resources Defense Council (NRDC), reflected this growing concern.⁸ This list was incorporated into CWA in the 1977 amendments. Pollutants listed were to be the first toxic pollutants for which EPA would develop pollution control standards.

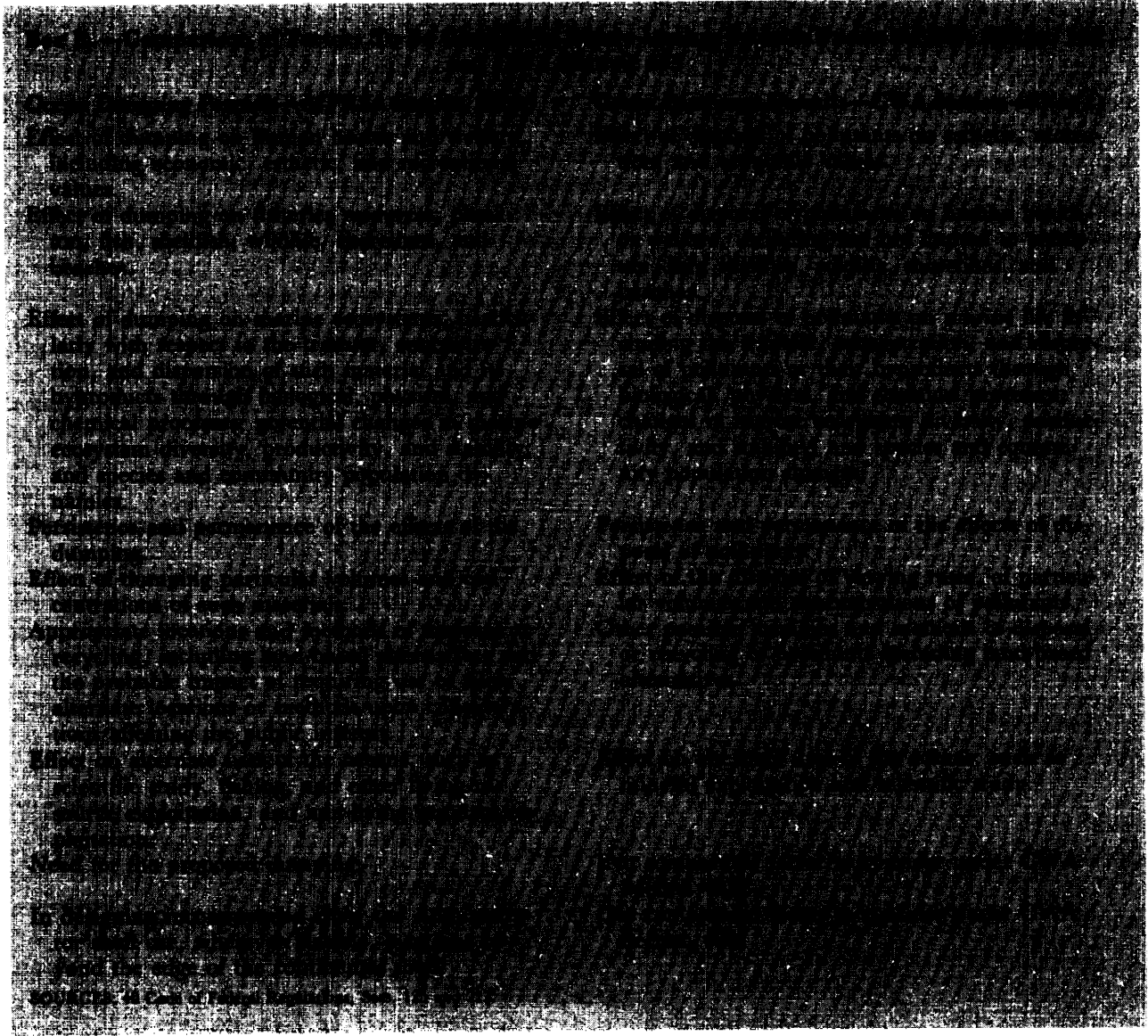
Types of Standards Governing Pollutant Discharges.—Each NPDES permit contains effluent limitations on specific pollutants that are present

⁶The ‘ ‘fundamentally different factors’ (FDF) variance procedure (40 CFR 125.30-32) allows a discharger to apply to EPA for modification of an effluent limitation when additional information demonstrates that the characteristics of the discharge are ‘ ‘fundamentally different’ from those considered when the effluent limitation was set. If a variance is granted, EPA or a delegated State tailors an effluent limitation to the discharge. Some observers have expressed concern that the use of such variances, as encouraged by the courts (e. g., *Chemical Manufacturers Association v. NRDC*; 105 S. Ct. 1102, 1985), could lead to less stringent controls on toxic water pollution (176). The Water Quality Act of 1987 authorized EPA to grant FDF variances under strictly limited conditions.

⁷NPDES and the National Pretreatment Program, including problems associated with their implementation, are discussed in detail in ch. 8.

⁸See box A in ch. 1 for definitions of these classes of pollutants.

The current list of 126 regulated toxic pollutants is largely the result of two court settlements, *Natural Resources Defense Council v. Train* (Civ. A No. 2153-73 (D. 1st, (3, 1976)) and *Natural Resources Defense Council v. Costle* (636 F.2d 1229 (D. C. Cir. 1980)), which require EPA to develop technology-based effluent limitations based on Sees. 301 and 304 for these priority pollutants. The Flannery Decree also included a list of primary industrial categories for which EPA was to develop specific effluent limitations. See ch. 8 for further discussion.



the different treatment of dredged and nondredged material was successfully challenged in court in *National Wildlife Federation v. Cosde* (often referred to as *Costle 11*; 629 F.2d 118 (D.C. Cir. 1980)). The court held that EPA must consider all Section 102(a) criteria in developing regulations, but that it is not bound to apply all criteria to every permit decision or to every type of waste material.⁴

⁴Prior to 1974, under Sec. 103(d), COE could apply to EPA for a waiver of the environmental impact criteria. Only one waiver was ever applied for and it was not granted; the 1974 amendments to MPRSA prohibited EPA from issuing such waivers.

The Continuance of Ocean Dumping and the City of New York Decision

Throughout most of the 1970s, EPA invoked a policy of phasing out all ocean dumping and encouraging municipal and private dumpers to seek land-based alternatives. In 1977, Congress statutorily mandated phasing out all “harmful” sewage dumping by December 1981 and later imposed a similar deadline for terminating the dumping of industrial wastes. These stringent deadlines were set primarily because several severe marine pollution incidents in the mid- 1970s had heightened pub-

in the discharge. These effluent limitation standards are either technology-based, as set forth in Sections 301 and 304, or water quality-based, as set forth in Section 302. Technology-based standards are derived from estimates of the removal of pollutants that could be achieved through application of best practicable technology (BPT), best available technology (BAT), or best conventional technology (BCT). EPA or a State with an approved NPDES program is responsible for translating the applicable standards into specific effluent limitations on a permit-by-permit basis.

The 1972 CWA (Sec. 307(a)(2)) mandated that EPA establish toxic effluent standards based on health and environmental considerations such as water quality (567). For a variety of reasons, including lack of needed scientific information, only six toxic effluent standards of this type were ever developed (177).¹⁰ The 1977 amendments, largely through the incorporation of the Flannery Decree, further directed EPA's efforts toward the development of technology-based standards. These standards are derived by estimating the extent of pollutant removal accomplished through use of a particular level of control technology.

The legislation required the use of increasingly stringent control technology. For existing sources discharging directly to U.S. waters, BPT primarily designed to control conventional pollutants was to be employed initially; later, BAT was to be introduced for toxic and non-conventional pollutants and BCT for further reduction of conventional pollutants (Sees. 301 and 304). For new sources, compliance with new source performance standards (NSPS) equivalent to BAT/BCT was mandated (Sec. 306). Finally, indirect dischargers using municipal sewers were required to comply with pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS), which were analogous to BAT and NSPS, respectively.

Since the 1977 CWA Amendments, EPA has promulgated BPT, BAT, BCT, NSPS, and pretreatment standards for most of the primary industries. Industrial sources were originally to have

achieved BPT by July 1, 1977 and BAT/BCT by July 1, 1984. However, final compliance dates for many of these standards have yet to be reached (ch. 8).

CWA retained provisions to allow the development of water quality-based standards. Section 303 requires States to set water quality-based standards for their waters. If a permitted discharge is likely to violate these standards, Section 302 requires that water quality-based effluent limitations be incorporated into the discharge permit to ensure achievement of the standards. Several States with approved NPDES programs have instituted a number of innovative approaches to water quality-based permitting (130).

Dredged Material Disposal—Section 404

The disposal of dredged material in U.S. waters is regulated by several statutes (582). Under the Rivers and Harbors Act of 1899, COE has authority to regulate any activity in rivers and coastal waters which could directly interfere with their navigability. Although much of the law has been superseded by CWA and other laws, COE still uses this authority, for example, to regulate dredge and fill activities beyond the 3-mile limit. As noted above, Section 103 of MPRSA controls the *dumping* of dredged material in coastal waters and the open ocean. The *discharge* of dredged or fill material is regulated under Section 404 of CWA.

The 404 program is complicated and somewhat controversial (572,582). COE evaluates permit applications using guidelines developed jointly with EPA, and in light of review comments by EPA, the Fish and Wildlife Service, the National Marine Fisheries Service, and the States. EPA can veto any proposed sites for dredged or fill material disposal. Where COE's jurisdictions under Section 103 of MPRSA and Section 404 of CWA overlap in the territorial sea, COE typically issues an ocean dumping permit.

Provisions Specific to Marine Waters

The Ocean Discharge Criteria.—Section 403 of CWA requires that all NPDES-permitted discharges from point sources into certain marine environments—the territorial seas, the contiguous zone, or the open oceans—must not “unreasona-

¹⁰This slow rate of progress was one of the primary factors that motivated NRDC to bring suit against EPA in the first place.

bly degrade the marine environment” (225).¹¹ Under this delineation, marine waters shoreward of the baseline are excluded, and thus the criteria do not apply to discharges into estuaries and coastal waters such as Chesapeake Bay, New York Harbor, and Puget Sound (45 FR 65944, Oct. 3, 1980). Section 403 only began receiving dedicated funding in fiscal year 1987. EPA, however, is considering applying the criteria to estuaries and other waters *inside* the baseline of the territorial sea. Given that the criteria are considered relatively stringent, this could provide an additional level of protection for these waters.

The ocean dumping and ocean discharge regulations (40 CFR 227 and 40 CFR 125, respectively) rely on similar data and require similar decisions, but for different activities.¹² This has led some observers to argue that the criteria should at least be consistent (377). The main differences between the two sets of criteria is that MPRSA has additional requirements to consider the *need* for the proposed dumping and to use locations, when possible, beyond the edge of the continental shelf (see box R).

Waivers from Secondary Treatment.—Section 301(h) of CWA exempts qualified POTWS that discharge into marine waters from the requirement to achieve secondary treatment; yet, it still requires monitoring, implementation of existing pretreatment requirements, and compliance with existing water quality standards. EPA adopted final amended rules in 1982 (47 FR 53666, Nov. 26, 1982), and a total of 208 applications were received by the administering EPA regional offices. By January 1987, EPA had approved 46 applications; another 125 applications were withdrawn or denied, and no final action had been taken on the remain-

ing 37 (see ch. 9, figure 34). The 301(h) program was initially envisioned as appropriate primarily for west coast municipalities discharging effluent into deep, cold waters, and for the most part EPA's decisions reflect this intent.

Provisions Addressing Comprehensive Waste Management in Estuaries and Coastal Waters

A number of statutory provisions potentially bear on estuaries and coastal waters. Currently, 21 programs—under 8 different statutes administered by 11 different Federal agencies—affect these waters in some way (670). Clearly, efficient management of estuaries and coastal waters requires careful integration and coordination of these various programs. Several provisions of CWA address or could address long-term planning and management efforts in estuaries and coastal waters:

- estuarine programs (Sec. 104),
- estuarine management conferences, and
- area-wide planning (Sees. 208 and 303).

National Estuary Program—Section 104.—CWA is the primary statute governing pollution in estuarine and coastal marine environments. Section 104(n) directs EPA—through appropriate coordination of interagency, intergovernmental, and public and private sectors—to conduct comprehensive studies on the effects of pollution on estuaries and estuarine zones. EPA was directed to coordinate interstate pollution abatement and management in the waterbodies and to transfer funds to NOAA to develop a comprehensive water quality sampling program. To carry out these responsibilities, EPA created the Office of Marine and Estuarine Protection (OMEP) and NOAA created the National Estuarine Program.

Appropriations were first made in fiscal year 1985, when \$4 million was designated as part of Public Law 99-160 for water quality research, monitoring, and assessments in four waterbodies: Long Island Sound, Narragansett Bay, Buzzards Bay, and Puget Sound. This initiative has since been known as the National Estuary Program (NEP). Additional waterbodies—San Francisco Bay and the Albemarle and Pamlico Sounds in North Carolina—were added to NEP in April 1986. The 1986 budget was \$5.6 million. The Water Quality Act of 1987 authorized additional funding and provided more direction for NEP (ch. 1).

¹¹The definition (40 C.F.R. 125.121) of “unreasonable degradation of the marine environment” is:

- significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within and surrounding the discharge area,
- threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or
- loss of aesthetic, recreational, scientific, or economic values that is unreasonable in relation to the benefit derived from the discharge.

¹²In a 1977 case, *Pacific Legal Foundation v. Quarles* (440 F. Supp. 316), the court found that these criteria could be applied concurrently to ocean discharges or dumping. This combination of discharge and dumping criteria was subsequently challenged and in 1979 the court ordered EPA to issue new guidelines for Sec. 403 ocean discharge permits (*Pacific Legal Foundation v. Costle*, Civ. No. 5-79-429-PCW).

A Comprehensive Master Environmental Plan is being developed for each waterbody. Ideally, each plan will address the control of point and nonpoint sources of pollution, implementation of environmentally sound land-use practices, the control of freshwater input and removal, and the protection of living resources and pristine areas. In addition, the plans are supposed to delineate public participation and monitoring programs, and identify personnel and funding needs. The focus of the Federal effort is on planning and management; given statutory limits, implementation of the plans will generally be left to local or State authorities. In most cases, this means that EPA supports the efforts of a particular local or State planning or management agency, rather than serving as the lead agency for an area.

In some areas, however, the coordination between Federal and State efforts has not been entirely smooth. In the Puget Sound region, for example, programs of the State of Washington and of EPA Region 10 currently are separate, but loosely coordinated. One source of contention is that EPA has kept control of the \$1.4 million received by the area from the Federal Government and restricted the participation of all other agencies to "review and comment. The Puget Sound Water Quality Authority contends that greater Federal-State coordination in deciding on the priorities for spending these moneys will be needed to avoid having the two programs operate in different directions (K. Skinnerland, Puget Sound Water Quality Authority, pers. comm., 1986).

Drawing on experience with the Chesapeake Bay and Great Lakes Programs, EPA has developed a draft manual that will provide guidance on the development of comprehensive management plans for current and future sites. In a related effort, EPA's Near-Coastal Waters Strategic Planning Initiative is identifying implementation options that EPA could pursue to better control point and nonpoint sources, protect living resources, and manage land use in and around estuaries and coastal waters (670).

Estuarine Management Conferences.—The Water Quality Act of 1987 authorized EPA to convene management conferences to solve pollution

problems in estuaries. The conferences would be authorized to:

1. collect data on toxics and other pollutants within an estuary,
2. develop comprehensive conservation and management plans that recommend priority corrective actions and compliance schedules to control point and nonpoint sources of pollution,
3. monitor for program effectiveness, and
4. develop plans for intergovernmental coordination for implementation.

Areawide Planning—Section 208 and 303.—Two existing sections of CWA address regional or areawide planning and can be applied to estuary management. The intent of Section 208 is to link various water pollution control requirements on the basis of watersheds, primarily to control nonpoint source pollution. Section 303(e) provides for a Continuing Planning Process by States and is another regional approach to water quality management. This provides for coordination with Section 208 and emphasizes better implementation of water quality standards.¹³

Under Section 208, an agency of local governments is selected by the governor(s) of the State(s) to coordinate regional planning. The emphasis has frequently been on controlling nonpoint sources and linking their control with controls on wastewater and storm discharges. This involves coordinating State and local efforts, with at least partial guidance and funding by the Federal Government. However, the program encountered numerous problems resulting from disagreements among State and local officials over authority for implementation, discontinuity in funding levels, inadequate technical information on nonpoint pollution, and delays by EPA in issuing rules and guidelines (88, 557,570,699). Section 208 funding was terminated in 1981, although some funds for areawide planning continue to be distributed under Section 203(j) of CWA.

¹³The Water Quality Act of 1987 included a provision that would require the inclusion of proposed treatment works in areawide Sec. 208 and Sec. 303(e) plans. The act also included a provision that would establish a program for management of nonpoint sources of pollution. The program would provide \$400 million for 4 years to States to develop nonpoint source management programs.

Section 208 plans have been developed for some coastal areas. In San Francisco Bay, for example, a regional body (the Association of Bay Area Governments) received Section 208 funding and produced a comprehensive Environmental Management Plan in the late 1970s. The plan covered air, water, and solid waste management for the Bay, and called for, among other things, establishing a research program to improve monitoring and understanding of pollutant impacts in the Bay. As a result, in 1982 the San Francisco Bay Regional Water Quality Control Board adopted the Aquatic

Habitats Program Plan to assess pollutant effects in the San Francisco Bay/Delta estuary (R. H. Whitsel, California Regional Water Quality Control Board, pers. comm., November 1986; also see app. 1). In the Puget Sound area, the Washington Department of Ecology used Section 208 funding to develop a dairy waste management plan. In the Chesapeake Bay watershed, both Sections 208 and 303(e) were used to prepare and adopt a number of river basin plans to help alleviate water quality problems; these programs, however, have achieved only limited success (168).

KEY ISSUES AFFECTING MARINE WASTE DISPOSAL PROGRAMS

The most important findings and policy options discussed in this report relate to the need to improve current water pollution control programs, the need for and desirability of more comprehensive management in estuaries and coastal waters, and the great need for information in these areas (ch. 1). Three sets of issues are critical to understanding these findings and options and to the development of sound marine waste disposal management:

1. issues associated with the management of industrial effluents under current water pollution control programs,
2. issues related to the effectiveness of existing comprehensive waterbody management programs, and
3. issues related to the status and needs of relevant information programs.

Industrial Effluents and Current Water Pollution Control Programs

OTA's analysis of current water pollution control programs discovered several key problems related to the adequacy of the regulatory framework for controlling point source pollution. These issues are briefly summarized here and discussed in detail in chapter 8.

Delays in Program Implementation.—Federal regulations for some significant industrial categories have yet to be promulgated or have compliance dates that have not yet been reached, and enforcement actions cannot be taken until compliance

dates have been reached. Incomplete and inconsistent identification and permitting of dischargers is also a widespread problem. Finally, some POTWs have been slow to develop pretreatment programs and have them approved by States or EPA, and thus many indirect industrial dischargers remain essentially unregulated.

Gaps and Deficiencies in Program Coverage.—For a variety of reasons, several significant industrial categories and many toxic pollutants—both priority and nonpriority—remain unregulated under the current framework. Moreover, the incorporation of new or upgraded effluent limits even for regulated pollutants and regulated industries has been sporadic and slow. Finally, only marginal development and use of water quality-based standards for toxic pollutants has occurred.

Inadequacy of Regulatory Compliance and Enforcement.—Problems in three major areas exist:

1. the quality and completeness of data submitted by dischargers;
2. the extent of noncompliance with effluent standards or other permit requirements; and
3. the extent, timeliness, and effectiveness of enforcement actions taken in response to violations.

Additional Issues Facing the Pretreatment Program.—Other issues that must be addressed include the potential for conflict between the need for local control and national consistency; the lack of incentives for full implementation and enforce-

ment of pretreatment programs; and the adequacy of controls over the legal discharge of hazardous waste into sewers.

Waterbody Management Programs

One key finding of this report is that estuaries and coastal waters are in need of further protection if even the current level of water quality is to be maintained. Several recently established programs are attempting to provide more comprehensive and coordinated management of estuaries and coastal waterbodies. This section briefly illustrates the general approaches, capabilities, and deficiencies of several of these "waterbody management" programs, including some non-Federal programs.¹⁴

A variety of local, State, and national programs exist to manage estuaries and coastal waterbodies (table 12 and app. 1). Some programs address only one waterbody, while others address multiple areas. The Chesapeake Bay Program, for example, focuses on a single estuary, while the National Estuary Program currently is conducting activities in six areas. Programs are also initiated at various levels of government. For example, some programs are initiated primarily by the Federal Government (e. g., the Chesapeake Bay Program), while others are initiated by the States (e. g., Puget Sound Water Quality Authority), or by local authorities (e.g., the Southern California Coastal Waters Research Project).

Regardless of the level at which a program is initiated, a number of agencies from different levels of government are likely to be involved in implementation. The Federal EPA and State environmental protection departments generally are involved in various aspects of a program. In addition, other Federal agencies (e. g., COE, NOAA, Fish and Wildlife Service), their counterparts at the State level, and various municipal and county authorities (e. g., port districts, sewerage authorities) can have specific responsibilities or interests in managing the water quality of estuarine or coastal waters. The Puget Sound Water Quality Authority (PSWQA), for example, involves the coordina-

tion of many State, regional, and local government agencies (464,5 13).

Waterbody management programs are designed to serve a variety of functions and their structures vary accordingly (table 12). The wide variety of programs is understandable. Some programs are designed primarily to share information about research needs or findings; some are given decision-making authority only for distributing research funds; others have clear goals for improving water quality and have authority for planning and/or coordination.

For example, the Southern California Coastal Waters Research Project (SCCWRP) focuses its research on the environmental effects of marine disposal of municipal wastes; in contrast, the Aquatic Habitat Institute (for San Francisco Bay) directs its research to facilitate coordination of the efforts of other regional, State, and Federal agencies in the area. For the Chesapeake Bay, all these functions—research, planning, and program coordination—are the responsibility of one management body, the Chesapeake Bay Program.

At least two broad needs must be met by any program designed for the management of waterbodies: 1) it must possess sufficient statutory and regulatory authority to carry out its assigned functions, and 2) it must have the ability to coordinate other agencies and programs already involved in some aspect of managing the waterbody. Since numerous Federal, State, and local programs and agencies are typically involved in the management of individual waste types and/or sources for a given waterbody, it is essential that the various programs be informed of each other's actions and that lines of authority and jurisdiction be clearly defined.

Within these two general areas of need, a number of specific functions can be performed by a program, including:

- **Planning:** Includes setting priorities among pollution sources, waste types, or pollutants; setting goals and target dates for their achievement; scheduling research and other programmatic activities; and planning the allocation of resources.
- **Initiating research and establishing data requirements:** Includes identification of research needs, and initiation and coordination of re-

¹⁴ It does not attempt to evaluate the successes and failures of the selected programs, to identify all existing programs, or to identify geographic areas in great need of such programs. Box S describes some selected international perspectives on waterbody management.

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establishing an Interministerial Committee for Marine Resources in 1979 and issuing a “National Policy for Marine Resources” in 1980.

Brazil also has attempted to tackle some specific marine pollution problems, for example in the Santos Estuary, one of the most polluted estuaries in the world. Santos is a major port and tourism area, located downstream from Sao Paulo (a city of 15 million people) and Cubatao, major industrial area. The Santos Estuary receives raw sewage from Sao Paulo and industrial and hydroelectric powerplant discharges from Cubatao. High levels of oxygen-demanding substances, phenols, metals (e. g., copper and zinc), and pesticides have been detected in the water, and metals and pesticides have been found in sediments. Some observers suggest that the chronic pollution of the estuary could cause a total collapse of its ecosystem.

In 1983, the Brazilian environmental agency (CETESB) established the Program for Environmental Pollution Control to survey pollution sources, inventory emissions to the estuary, and develop environmental control plans for each industrial source in Cubatao. Public participation has been encouraged throughout the process; for example, CETESB held quarterly public meetings to discuss progress of the plans. Thus far, measurable emission reductions of different pollutants (as well as improved air quality) have been recorded. The program is particularly noteworthy for its development and use of epidemiological studies, biological methods and criteria for assessing toxicity, and models for evaluating environmental risks (196).

search to support the management program; conducting ambient monitoring and establishing databases.

- Obtaining and allocating funding: Includes obtaining and allocating financial resources for research, planning, and other program activities.
- Implementation: Includes integrating and coordinating basinwide cleanup efforts, for both water quality and resource management (e. g., through the use of management committees).
- Establishing public participation: Includes developing and implementing effective mechanisms for public education and participation in decisionmaking.

Critical Function: Planning

One of the central features of most waterbody programs is planning. It can involve research planning or management planning, both of which may include establishing goals for improving water quality and setting priorities for action. Almost all programs are involved in research planning. For example, programs such as SCCWRP and the Aquatic Habitat Institute are oriented primarily towards research. Some programs are involved in both kinds of planning. For example, the Chesapeake Bay Program (CBP) emphasizes comprehensive management for the Bay estuarine system. The Great Lakes Program, which was the first compre-

hensive waterbody management program, and CBP, which is the oldest estuarine management program, are serving as models for the development of the National Estuary Program (NEP). NEP is attempting to identify conditions and trends in the systems and develop comprehensive plans for selected estuaries and coastal waters. Management committees are established in each selected NEP area to carry out the planning function.

The Gulf Coast Waste Disposal Authority (GCWDA) is a program that falls somewhere between a research-oriented regional program and a comprehensive management plan. Its focus is on planning and developing regional facilities for treatment of industrial and municipal wastewater, hazardous wastes, municipal solid wastes, and sludge. It also provides technical assistance to area industries (ref. 2 15; L. Goin, GCWDA, pers. comm., 1986).

Despite variation among existing programs, certain planning elements are generally necessary. For example, four factors are associated with the Chesapeake Bay Program's success thus far:

1. Preliminary research: The effort began by conducting research which was then synthesized and used along with other Bay studies to understand the conditions and trends of the Bay and the sources of pollutants; this scientific information on the Bay's ecological con-

Table 12.—Selected Waterbody Management Programs

Program features	Chesapeake Bay Program	Puget Sound Water Quality Authority	Great Lakes National Program	Gulf Coast Waste Disposal Authority	Southern California Coastal Water Research Project	San Francisco Bay Regional Water Quality Control Board	Aquatic Habitat Institute	National Estuary Program
January purpose	Overall Federal-State efforts to control point and nonpoint source pollution to the Bay	State agency to study and report on impacts of pollution on marine and human life; and to devise plan for management whose recommendations are binding on other State and local agencies	Federal-State effort to control point and nonpoint pollution of Great Lakes and basin area, emphasis on toxic pollution; primary activity is research and monitoring	Multi-county unit to control point sources by constructing regional treatment plants to abate pollution of Houston Ship Channel and Galveston Bay	Primarily local research program to study and monitor impacts of municipal discharges on marine life in coastal waters of southern California	State's regional board for water resources control in SF. Bay area, oversees programs (e.g., Aquatic Habitat Program) to monitor municipal and other point source discharges	Quasi-public organization, conducts independent research on S.F. Bay resources. Also coordinates other research efforts, conducts public education	Federal program to study water quality and pollution effects in selected estuarine waters; ^b coordinates efforts with other Federal, State, and local agencies
Date of Initiation	1976	1983	1977	1969	1969	1970	1983	1985
Participating authorities	<ul style="list-style-type: none"> Chesapeake Bay Executive Council: <ul style="list-style-type: none"> EPA* (Federal) State agencies of MD, VA, PA District of Columbia other Federal agencies: SCS, NOAA, FWS, Corps of Engineers, USGS, DOD 	<ul style="list-style-type: none"> Composed of appointees of diverse interests and geographical areas in the Sound region; ex-officio members are the Director of Ecology and the Commission of Public Lands 	<ul style="list-style-type: none"> EPA (Federal) Great Lakes Nat'l Program 	<ul style="list-style-type: none"> Composed of 9 members, 3 each from counties of Chambers, Galveston, and Harris 	<ul style="list-style-type: none"> Commission Members: <ul style="list-style-type: none"> Sanitation Districts of Orange, L. A., and Ventura Counties Cities of San Diego and L.A. 	<ul style="list-style-type: none"> San Francisco Bay Regional Water Quality Control Board 	<ul style="list-style-type: none"> Board of Directors:^a <ul style="list-style-type: none"> U.C. Berkeley 3 dischargers (municipal, industrial, nonpoint) 3 environmental group members 3 regulators (Cal. F&G, Cal. Reg. Bd., EPA) 	<ul style="list-style-type: none"> EPA (Federal) NOAA appropriate State and/or local authorities (lead authority varies in different areas)
Funding	<ul style="list-style-type: none"> EPA Maryland Virginia Pennsylvania Other Federal agencies 	<ul style="list-style-type: none"> State of Washington 	<ul style="list-style-type: none"> EPA (Federal) 	<ul style="list-style-type: none"> Counties Pollution Control Board Fees and service charges from dischargers 	<ul style="list-style-type: none"> Joint Points Agreement (Commission Members) NOAA EPA other local authorities 	<ul style="list-style-type: none"> California Water Resources Control Board 	<ul style="list-style-type: none"> EPA (Federal-NEP) S.F. Bay Regional Water Quality Control Board California Water Resources Control Board Donations from dischargers 	<ul style="list-style-type: none"> EPA (Federal) State and/or local authorities

^aThis program evaluates present and future effects of pollutants on Bay resources and encourages integration of all Bay-Delta Water-related studies

^bIndividual programs have been established in Puget Sound, San Francisco Bay, Narragansett Bay, Buzzards Bay, Long Island Sound, and Albemarle-Pamlico Sounds, as well as Chesapeake Bay and the Great Lakes

*Indicates lead authority if more than one authority involved

SOURCE Office of Technology Assessment, 1987



Photo credit: S. Dollar, University of Hawaii

Monitoring waste disposal impacts is a critical component of **any** waterbody management strategy. Here a diver is surveying a coral reef community near a **sewage** outfall from Oahu, Hawaii.

dition provided a relatively objective base from which to generate cooperation and develop control programs.

2. Adequate funding: The Federal Government and States provided sufficient funds (e. g., nearly \$30 million was spent on research over a 7-year period).
3. Long-term effort: The pace of the program was deliberate, allowing adequate time to develop a database, clearly define the major problems, and lay the foundation for the institutional relationships necessary for sustaining later efforts.
4. Strong public participation: Strong public support existed and an active public participation program was encouraged (21).

The Ability To Set, Review, and Achieve Specific Goals

Comprehensive planning for an estuarine or coastal waterbody involves many elements. First, conditions in the waterbody must be understood and specific goals set to improve trends. An effective

management structure and an effective public participation program must be established; these can involve, for example, the scientific community, periodic review of progress toward achieving those goals, and a master plan endorsed by the public, scientific community, and managers. The implementation of any plan depends to a large extent on the planning agency's ability to involve other entities in the process. 15

One of the oldest programs is CBP. After 7 years of study, CBP produced the Chesapeake Bay Restoration and Protection Plan. It identifies the Bay's most important problems, assesses current pollutant control efforts, and sets general goals for achieving pollution abatement. The plan addresses both point and nonpoint sources of pollution and sets a goal of restoring the Chesapeake Bay to its condition of the 1950s, recognizing the need for long-term strategies to achieve this goal.

¹⁵In addition, achieving goals would of course depend on the enforcement of existing regulations under various pollutant control programs.

Currently, the Chesapeake Bay Program is implementing a \$100 million cleanup effort directed at nutrient control to improve the dissolved oxygen problem in the central Bay. Additional control efforts underway include: 1) a phosphate ban in Maryland and the District of Columbia; 2) new nonpoint source programs in Maryland, Pennsylvania, and Virginia; 3) major point source reductions from municipal sewage treatment plants basinwide; 4) land use controls in Maryland; 5) a moratorium on harvesting rockfish; and 6) submerged aquatic vegetation restoration efforts (96). These efforts have only recently been initiated, so it is too soon to judge the success of CBP's transition from planning to implementation.

Two important issues regarding the Chesapeake Bay Executive Council are its ability to: 1) define specific goals for program managers in the various State and local governments, and 2) influence actual practices in these jurisdictions. Some observers have suggested that the Council should recommend water quality standards, establish baywide goals for inputs of CWA priority pollutants and nutrients, and identify point and nonpoint control strategies to achieve them. These observers further suggest that the Council adopt some features of the Great Lakes Water Quality Agreement of 1978 (168,590), which focuses on toxic pollutants and establishes specific goals and standards.

A program is likely to be more effective if it has adequate review procedures so it can adjust to changing conditions and priorities. Yet, neither the CBP nor the Great Lakes Water Quality Board, for example, have specified review periods to update their management plans or agreements.¹⁶ On the other hand, determining the appropriate time periods for reviews can be difficult. In fact, CBP officials have expressed resistance to updating the 1985 plan anytime soon, maintaining that in sufficient time the existing plan will lead to more stringent control efforts (590).

One example of a program that has relatively broad authority is the Puget Sound Water Quality Authority (PSWQA). One of its greatest

strengths is its clear statutory authority to be the lead agency for managing and protecting water quality in Puget Sound (K. Skinnerland, PSWQA, pers. comm., September 1986). PSWQA has developed a comprehensive management plan for the Sound and is authorized to produce biennial reports on the state of the Sound. Its recommendations are binding on all other State and local government agencies involved in Puget Sound water quality management. The lines of authority and coordination among the various jurisdictions are specified by PSWQA in the management plan. The authority also can revise its management plan, which should allow for quicker assessments of its success in meeting goals and for changing priorities.

In addition, the Puget Sound Water Quality Management Plan is more comprehensive and detailed than those for other areas. The emphasis is on preventing pollution by effectively implementing programs, having adequate staff and funding, and developing a nonpoint source pollution program to address problems that cross jurisdictional lines. It proposes specific programs for several critical areas: water quality, fish and shellfish, wetlands, and wildlife habitat. While based on up-to-date scientific information, the plan also recognizes the need (given the uncertainty surrounding many issues) for continued support of research and monitoring in the Sound (464). Clear goals are defined, guidelines for priority-setting are established, standards for development and implementation of the program are specified, and a schedule for completing the planning of programs is set (subject to revision). Although the plan appears to be a promising approach to water quality management, it was adopted in late 1986 and it is too soon to judge its effectiveness.

The Importance of Coordination

Adequate cooperation among multiple jurisdictions and among various agencies is likely to be crucial to successful waterbody management. Difficulties arise because of jurisdictional disputes and because land-use management issues are involved. Such problems can be overcome, however. For instance, CBP has achieved a remarkable degree of cooperation between the multiple jurisdictions of the Bay. Maryland and Virginia each are developing some land-use management programs, but

¹⁶Despite the 1978 agreement, high levels of toxic pollutants continue to flow into the Great Lakes (200,389). This may in part be the result of the Great Lakes Commission's lack of enforcement authority and insufficient authority to encourage participating governments to follow its recommendations (389,538).

the amount of resources available varies with a State's level of interest in the Bay; in particular, Pennsylvania's efforts are relatively small. Yet Pennsylvania, which borders the Bay in only one small region, is the Bay's main nonpoint contributor of nutrients (543).

PSWQA has an advantage in achieving coordination because the sound is located within one State. Moreover, most of its funding is from the Washington State legislature. Even so, there has been some difficulty in coordinating the State and Federal efforts (see above). Other areas such as San Francisco Bay are located within one State, but efforts to develop comprehensive water quality management have been frustrated by the lack of a lead agency with clear authority for coordination of various program efforts.¹⁷

Two additional factors appear crucial to effective interagency or multiple jurisdiction cooperation: 1) the number of agencies already attempting to manage the waterbody, and 2) the degree of environmental degradation in the waterbody. For example, at the time PSWQA was established there were no well-developed, independent government programs working on comprehensive management plans for the Sound.⁸ In San Francisco, on the other hand, several agencies—none with any greater lead authority than the others, and each focused only on particular aspects of management of the Bay's resources—exist and compete for funding and greater authority. The San Francisco Bay Regional Water Quality Control Board could conceivably be the lead agency for San Francisco Bay, but it lacks authority as well as necessary resources (R. H. Whitsel, San Francisco Bay Regional Water Quality Control Board, pers. comm., September 1986). In addition, the Sound is generally consid-

ered to have less severe environmental problems than other areas such as San Francisco Bay or Chesapeake Bay (464).

One purpose of the management committees established by EPA's NEP is to encourage cooperation by bringing together the managers of the various organizations involved. Recently, mediation has been used to help resolve conflicts among various jurisdictions involved in development planning for an estuary (i. e., the Columbia River estuary in Oregon and Washington; (2 16)). This technique could be applied to developing waste management plans for an estuary or coastal area where there are disagreements among the controlling jurisdictions.

Additional Functions—Research, Funding, and Public Participation

Research.—One major objective in most waterbody programs is the study of the existing conditions in a particular waterbody and, in some cases, the coordination of research efforts in the area. For example, EPA's Great Lakes National Program monitors water, sediments, fish tissue, and air deposition to identify critical areas in the lakes that need remedial action. It also prepares plans for phosphorous control and for nonpoint source control of conventional and toxic pollutants (1 ,663). CBP and PSWQA also play lead roles in coordinating and conducting research for Chesapeake Bay and Puget Sound, respectively, and research is the sole purpose of SCCWRP.

A unique approach is being tested for San Francisco Bay, where numerous agencies are involved in research and management and no one program has the lead authority to coordinate these efforts. Disagreements over the interpretation of research findings led the State and Regional Water Quality Boards to create the Aquatic Habitat Institute. Its purpose is to conduct independent research on the Bay and serve as an unbiased authority on scientific and technical matters related to the Bay (D. Segar, Aquatic Habitat Institute, pers. comm., September 1986).

Funding.—Adequate funding is obviously essential for any waterbody management program. Existing programs obtain funding in several ways, for example, from government agencies and from user fees or other revenue-generating mechanisms.

¹⁷For point sources, the San Francisco Bay Regional Water Quality Control Board has authority to formulate and adopt water quality control plans and in the process must consider recommendations of affected State and local agencies. The basin plan documents for this must be approved by the State Water Resources Control Board. In this way, for *point sources* the Regional Board acts to encourage regional planning and takes any action required within its authority to achieve water quality control; however, no authority in the Bay area coordinates *comprehensive* management activities (i.e., both nonpoint and point source controls) (R. H. Whitsel, California Regional Water Quality Control Board, pers. comm., November 1986).

¹⁸One exception is EPA's Puget Sound Estuary Program which focuses on problems of contaminated sediments in the urbanized bays of Puget Sound.

Strong governmental funding, for example, has been key to CBP's accomplishments. CBP has obtained more research money from the Federal and State governments than any other program, in part because Chesapeake Bay is the Nation's largest estuary and has high commercial and recreational value. Initial funding for CBP came from the Federal Government, but recently the States have assumed more responsibility. Currently, States (with Maryland as the main contributor) contribute \$47 million and EPA contributes approximately \$10 million each year for research and monitoring (334, 543).

Other programs have been funded quite differently. For example, PSWQA is funded by the State of Washington. One of the innovative features of the Aquatic Habitat Institute is its funding; the institute was created by the California legislature and receives about one-third of its funding from the State, one-third from EPA's National Estuary Program, and the remaining third from sources such as donations from municipal and industrial dischargers. The institute is required, however, to develop its own funding strategies to eventually support itself as an independently funded, nonprofit organization. It is likely to use discharger taxes or user surcharges, rather than line-item appropriations as most waterbody programs do. The Gulf Coast Waste Disposal Authority (GCWDA) funds its operations with non-public sources of revenue by issuing bonds to build waste treatment facilities that are then repaid by the industries or municipalities involved. GCWDA, although a unit of government, is designed to operate much like a business; any excess funds generated by its pollution control programs are used for other experimental or innovative programs (L. Goin, GCWDA, pers. comm., 1986).

Public Participation. —Public participation is also critical to the success of waterbody management programs. It provides people an opportunity to have a say in decisions that affect them, and it can help ensure that economic and technical issues are not considered in isolation from relevant social and political aspects of environmental problems. In addition, waterbody management is likely to be given higher priority if the public is greatly concerned and well-informed about protecting a particular waterbody. For this reason, public educa-

tion programs, as well as public participation in citizen advisory panels or through other means, are important aspects of any management program.

Most waterbody management programs make some provision for public participation (e. g., PSWQA, Great Lakes Water Quality Board). CBP has encouraged particularly strong citizen involvement through the Citizen's Program for the Chesapeake Bay, Inc., an alliance of nonprofit organizations formed in 1971. The public is also involved through the Chesapeake Bay Foundation, a nonprofit organization with an endowment of \$3 million and an annual budget of \$400,000. The foundation has initiated educational and land acquisition projects, as well as activities in legislative, administrative, and judicial proceedings (21 ,543).

Summary of Waterbody Program Functions

Estuaries and other waterbodies do not recognize political boundaries, so programs for their comprehensive management often require the coordination of many political jurisdictions and agencies. This can greatly complicate the functioning of any such programs. Frequently, the implementation of several statutes is also involved.

It is critical that there be a lead agency to coordinate the efforts of everyone involved and establish clear lines of responsibility and authority in any effort to better manage estuaries and coastal waters. The success of establishing such authority often depends on how well-established existing institutions are, because agencies are generally reluctant to surrender authority to other agencies.

Other factors are also critical to the successful functioning of waterbody programs. These include:

1. adequate study and assessment of the waterbody, including peer review of the findings as part of the development of an adequate scientific basis for decisionmaking;
2. setting specific goals and priorities;
3. the ability to evaluate the program on a continuous basis and shift priorities for action accordingly;
4. sufficient funding and staff to support these efforts; and
5. strong public participation programs.

The role of the Federal Government in waterbody management programs varies greatly. The

Federal Government has been very active in initiating and participating in CBP, and has been referred to as “the glue which binds the Bay Program together” (168). Its role in other programs has been more peripheral. Even in the National Estuary Program, which is administered by EPA, the Federal role is primarily one of guidance. In some areas, for example, the Federal Government uses NEP to channel Federal funding to the lead agency of a waterbody management effort. In other cases, Federal money is sprinkled among regional, State, and local agencies, which can reinforce the tendency toward fragmented efforts or lead to duplication of or competition between efforts. Enforcement may be an area where a strong Federal presence is appropriate; it can also be argued, however, that the States should have greater control of enforcement programs because they are in closer proximity to the problems, and that EPA’s role should be one of strong oversight.

Information Programs

An assortment of public and private entities generate and disseminate the information that is needed to develop and implement sound waste disposal policies. Much has been done in recent years to improve the Nation’s ability to obtain and use such information, but serious gaps still persist in understanding waste disposal and its impacts. These gaps exist partly because some important types of information are not gathered or analyzed, and partly because existing information often is difficult to access and use.

Cutbacks in the funding of information-related activities can further limit our ability to detect and understand trends. Yet, such cutbacks are particularly likely during periods of economic constraints. If current and future efforts (e. g., monitoring, research, analysis) are not maintained at a sufficient level, then the utility of information collected in the past may be seriously compromised and accurate determinations of past trends and future changes may not be possible.

Types of Information Activities

To develop and implement sound waste disposal policies, information is needed about ecosystem

characteristics, the status and value of marine resources such as commercial fisheries, the types and quantities of pollutants entering marine waters, and the ecological and human impacts of these pollutants. Several major Federal programs are designed to generate, analyze, and disseminate such information (app. 2).

Ecosystem Characteristics.—The effects of waste disposal activities on marine waters and resources cannot be evaluated unless the basic characteristics of different marine ecosystems are understood. Among the important characteristics are those of the water (e. g., flow patterns, temperature, turbidity, and chemical parameters); sediment (e. g., composition); and biological relationships (e.g., diversity of organisms, food chains). Many of these characteristics are affected by natural and anthropogenic activities that occur over different periods of time and over varying areas.

Many public and private agencies are engaged in efforts to increase our understanding of ecosystems and their basic characteristics. Numerous studies are supported by Federal agencies, such as EPA, the Fish and Wildlife Service (FWS), and NOAA’s National Marine Fisheries Service (NMFS) and National Ocean Service. The National Ocean Service, for example, is developing a National Estuarine Inventory that describes the physical, hydrological, and biological characteristics of many estuaries. When completed, this should provide a sound basis for comparing and assessing conditions in these estuaries. The agency also is generating atlases that include detailed information on the physical and biological characteristics of U.S. coastal regions.

Despite these and other efforts, information about these characteristics often is not sufficient to identify or understand the impacts of waste disposal (226,341). Of necessity, most studies are restricted to small areas, short periods of time, or limited groups of variables. Objectives, methods, and the quality and quantity of results vary considerably among waterbodies or watersheds. More research needs to be conducted on changes over relatively large scales—for long periods of time and for entire ecological communities.

While some marine waters have received adequate attention, other waterbodies have not, includ-

ing some that—while relatively free from waste disposal activities or impacts in the past—are now threatened with imminent and rapid increases in waste inputs. These areas include many waterbodies that receive wastes from the rapidly growing regions of the Southeastern United States, such as parts of North Carolina, Florida, and Louisiana.

Status and Value of Marine Resources.—Many resources (e. g., commercial fisheries and uncontaminated swimming beaches) are of obvious and substantial value. Because commercial fisheries and shellfisheries are of considerable economic value, important data about them have been collected and analyzed for many years. Information tends to be more sparse and widely scattered, however, about trends in quality, quantity, and value of other resources.

At the national level, several regular analyses provide data on the quantity and quality of commercially important fish and shellfish populations. The National Shellfish Register, for example, provides information on the degree to which shellfish waters are contaminated, although its usefulness in fully characterizing stocks is restricted (app. 2). Data on the quantities of fish and shellfish landed commercially are frequently and regularly collected, analyzed, and disseminated by Federal and State agencies. However, these data often are inadequate to evaluate population conditions because, for example, they may not reflect fishing effort or natural population fluctuations. Information on the economic value of fish and shellfish can be used, but it has limitations because a sizable amount of commercial activity is not reported (38,443,514, 705). For example, small commercial fishermen or sport fishermen may not report their catch but still sell it in roadside stands. The Federal budget for analyzing commercial fishery statistics was stable during the 1980s, and no immediate changes are expected (ref. 618;; S.W. McKeen, NOAA, pers. comm., August 1986).

Federal, State, and local governments and other public and private groups also provide supplemental information on commercial fish resources, varying from studies of particular fishing industries to analyses of pollutants in marketed fish and shellfish. The Food and Drug Administration (FDA), for example, routinely samples a wide assortment

of fish and analyzes edible tissues for the presence of specified pollutants. While these sources of information are useful in specific situations, they offer only a fragmented and incomplete picture of the nationwide status and value of commercial stocks.

Considerably less information is available on the value of recreational fishing, although in many areas it may far exceed the importance of commercial fishing. Two major Federal sources provide information: surveys conducted every 5 years by the FWS and Bureau of the Census (628), and annual surveys conducted by NMFS (605,606). Other public and private entities also generate information on recreational fisheries. For example, some States require licenses for marine recreational fishing and thereby generate information on the number of fishermen in those States. In addition, several government studies address the health risks suffered by recreational fishermen who consume contaminated catches.

Little information is available, on a national scale, about the value of recreational resources such as beaches and coastal parks. The primary data come from a few Federal surveys that summarize visits to coastal wildlife refuges and National Parks. The National Ocean Service's *Economic Survey of Outdoor Marine Recreation in the USA* will include a comprehensive inventory of publicly provided outdoor recreation when completed (348, 611). Additional information on these resources (as well as on commercial and recreational fisheries) in more geographically limited areas—at the State level, for example—comes from studies supported by the Federal Sea Grant College Program (604, 61 7,706). The Sea Grant program received about \$40 million in fiscal year 1986, but was slated for elimination in the proposed fiscal year 1987 budget.

Pollutant Inputs and Transport.—Information on the levels of pollutants in discharges, dumped material, or runoff is gathered by multiple sources—from Federal, State, and local governments; from dischargers themselves; or from private research efforts. The levels are measured both directly and indirectly; for example, permits can indirectly indicate the expected level and composition of discharges, and discharges or runoff can sometimes be described on the basis of pollutants found in nearby sediments, water, and organisms.

Information from these sources varies widely in accuracy, completeness, and accessibility.

Related activities can affect the quality and quantity of information on permitted discharges. For example, Federal laws and regulations prescribe what information dischargers must report. Enforcement generally reduces the deviation of discharges from legal levels, which enhances the value of permits as indicators of discharge quality and quantity.

Federal agencies—the primary ones being EPA, the Corps of Engineers (COE), and NOAA—are involved in efforts to generate, analyze, and disseminate information on pollutant inputs. EPA and COE generate a great deal of information on discharges from particular industries or waste disposal activities. Other Federal agencies, such as the U.S. Geological Survey (USGS) and Department of Agriculture, generate information on nonpoint runoff. The National Stream-Quality Accounting Network of USGS provides information on pollutants discharged into fresh waters and ultimately transported into estuaries. Compiling this information accurately and comprehensive on a national scale is difficult.

One notable Federal effort is NOAA's National Coastal Pollutant Discharge Inventory, which pools information from numerous sources on pollutant inputs into U. S. estuaries and coastal waters. When complete, and if updated periodically, it could provide useful overviews of trends in pollutant inputs into these waters. It also could be useful as a tool for evaluating the effects of different pollution control policies (6 10).

It is not possible to accurately estimate the total Federal expenditures being directed toward information gathering and dissemination because of the number and variety of agencies and programs involved, and the large overlap between program objectives. Given current economic restrictions and past trends in analytical program funding, it is likely that accurate and comprehensive information on discharges will remain difficult to obtain.

Many States also conduct programs to monitor pollutant inputs into marine waters. Since 1977, for example, California's Mussel Watch has used strategically located 'sentinel' organisms—in this case, mussels—to detect pollutants in coastal

waters. The Mussel Watch has generated data on the geographic and temporal variations in the concentrations of many pollutants. By 1985, this effort had identified at least eight areas where metals or organic chemicals had contaminated mussels to alarming levels (71).

Impacts on Resources and Human Well-being.—Large amounts of information about actual impacts on marine ecosystems and humans are generated each year by local, State, and Federal agencies, numerous private organizations, and academic groups. At the Federal level, many of the efforts are concentrated within the National Marine Pollution Program (NMPP). Despite these efforts, most experts agree that much more remains unknown and that the assessment of impacts should be more coordinated and integrated than it has been in the past (161, 170,505,508).

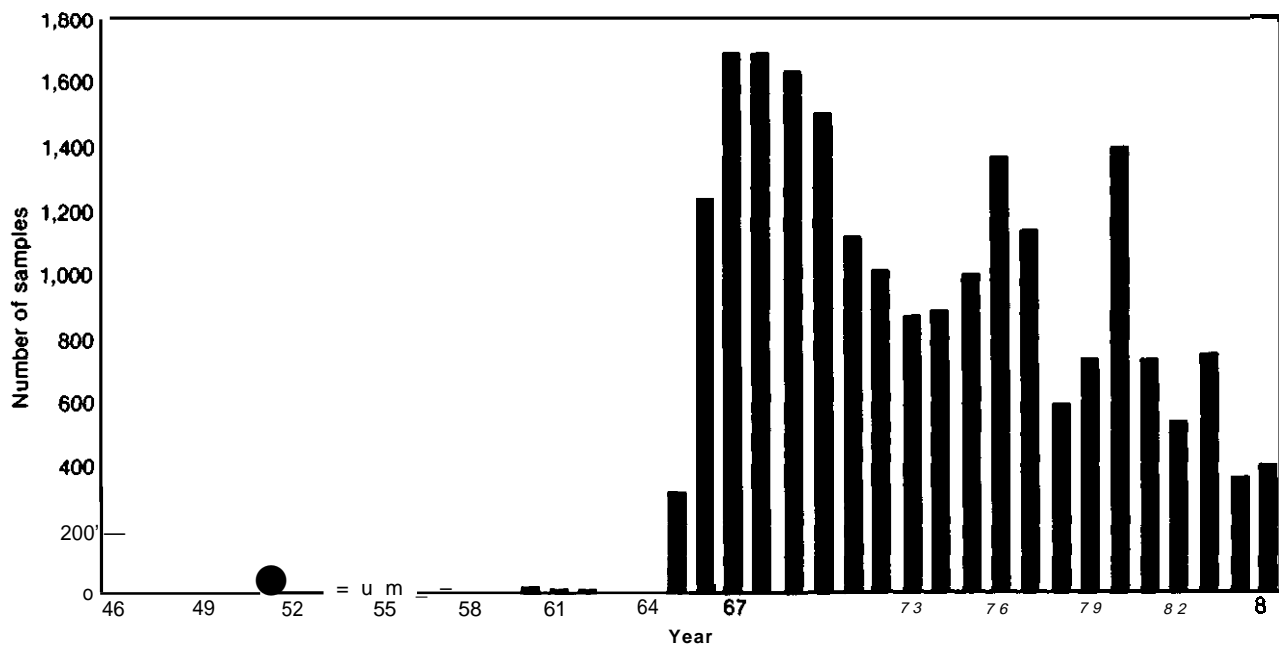
The level of effort expended to generate information on marine impacts has varied around the country and from year to year. While general trends are difficult to ascertain because of the diversity of individuals and organizations involved and the variety of efforts, some specific trends are apparent. For example, the number of samples of certain toxic pollutants in marine organisms that were archived each year increased dramatically and peaked in the late 1960s and then declined, with large fluctua-



Photo credit Woods Hole Laboratory, National Marine Fisheries Service

Laboratory work should be closely linked with field work, and both are time-consuming and expensive. Here a technician is sectioning fish liver tissues to analyze pollutant impacts.

Figure 26.—Number of Archived Samples Per Year of Chlorinated Pesticides and Polychlorinated Biphenyls in Fish and Invertebrates From U.S. Marine Waters, 1945-85



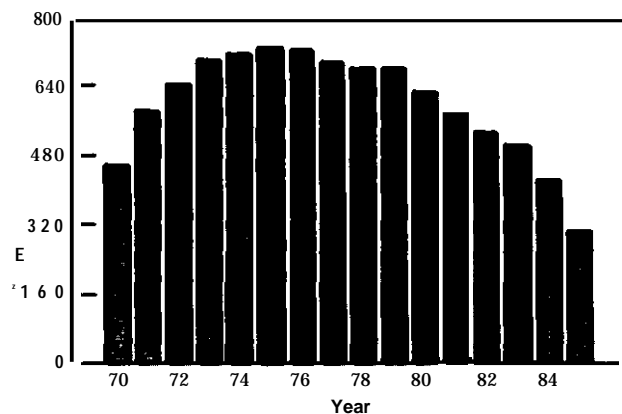
NOTE: Years lacking bars, no data are available.

SOURCE: A.J. Mearns, et al., *The Historical Trend Assessment Program, PCBs and Chlorinated Pesticide Contamination in U.S. Fish and Shellfish: An Assessment Report* (Seattle, WA: National Oceanic and Atmospheric Administration, Ocean Assessments Division, Coastal and Estuarine Assessment Branch, November 1966)

tions during the late 1970s (figure 26). A similar decline has occurred in the number of water quality samples collected in individual States such as Florida (figure 27), reflecting monitoring cutbacks by various Federal and State agencies (658).

Understanding and predicting how humans will be affected by marine waste disposal activities involves additional layers of complexity. Determining the full impact to humans of waste-induced changes in marine environments, for example, presupposes that adequate information is available about pollutant inputs and the ecological processes that affect the fate of pollutants. ¹⁹This is rarely possible.

Figure 27.—Number of Waterbody Segments in Florida for Which Water Quality Monitoring Data Are Available, 1970-85



The decline in the number of segments for which data are available reflects cutbacks in monitoring by Federal and State agencies. Only data entered into STORET (the U.S. Environmental Protection Agency's system for storing and retrieving data on water quality) are included. Twenty percent of the 926 segments of water bodies in Florida are estuaries.

SOURCE: J. Hand, et al., *Water Quality Inventory For the State of Florida: Technical Appendix* (Tallahassee, FL: State of Florida Department of Environmental Regulation, June 1966).

¹⁹The complexity and difficulty of establishing impacts on marine resources and humans, specifically economic injury, is reflected in regulations proposed by the Department of the Interior for "43 CFR Part 11. Natural Resource Damage" (51 FR 27674-27753, Aug. 1, 1986).

The Need for Integration and Coordination

Information must be accessible and integrated so it can be used by a wide variety of people, including policy makers. Greater integration and coordination of information-related activities, as well as increased financial resources for their implementation, is considered essential by most observers (266,412 ,413,415,505,506,692,693).

Many suggestions to improve the planning, execution, and usefulness of these activities have been incorporated into the recommendations of NMPP (app. 2). Federal agencies have heeded NMPP recommendations to a degree; for example, NOAA's Ocean Assessments Division has undertaken several projects to develop more comprehensive databases and disseminate increasingly sophisticated analyses.

In addition, programs that are directed toward specific waterbodies and that are capable of cutting across social, institutional, and scientific boundaries may be of special value. Some cross-cutting programs have been established for individual estuaries and coastal waters. Notable examples include the Puget Sound Water Quality Authority, the Aquatic Habitat Institute for San Francisco Bay, the Chesapeake Bay Program and the Chesapeake Research Consortium, and the individual programs established under EPA's National Estuary Program. These efforts are promising approaches to the many problems inherent in generating and applying useful information to an issue as large and complex as marine resource management. Similar efforts, however, do not exist for most other waterbodies.

APPENDIX 1: EXISTING WATERBODY MANAGEMENT PROGRAMS

Numerous programs have been initiated at the Federal, State, and local levels to address water quality problems in a particular estuary or coastal waterbody, including:

The Chesapeake Bay Program

The primary purpose of CBP is to develop a comprehensive understanding of the Bay's ecosystem. It is a combined State-Federal effort initiated by EPA in response to legislation passed by Congress in 1976. The intensive study of the Chesapeake Bay's water quality and resources was the result of heightened concern in the early 1970s about the health of the Nation's largest estuary. Specifically, EPA was directed to assess and make recommendations on how to improve water quality management in the Bay, to coordinate all research in the Bay, and to establish a system of data collection and analysis. The study of Chesapeake Bay was authorized for 5 years, but was twice extended by a year and was completed in 1983 at a cost of nearly \$30 million.

The study focused on the Bay's 10 most critical water quality problems, three of which were studied intensively: 1) nutrient enrichment, 2) toxic substances, and 3) the decline of submerged aquatic vegetation. The findings documented a historical decline in living resources in the Bay and indicated the need for better management (95). As a result, several State and Federal entities signed the Chesapeake Bay Agreement. The Agreement established the Chesapeake Executive Council to facilitate the implementation of coordinated plans

for the improvement and protection of the Chesapeake Bay estuarine system.

The Chesapeake Bay Restoration and Protection Plan, issued in September 1985, was the first planning effort to result from the Agreement. The Plan describes Federal and State strategies and programs designed to coordinate, evaluate, and oversee the Bay's restoration and protection (95). The first annual progress report, published in December 1985, discusses the plan; the coordinated monitoring program which has been developed; and modeling, research, and data management efforts (96). In 1986, the Council began reporting on the Bay's water quality conditions and working with the agricultural community on nonpoint source pollution control programs.

The Puget Sound Water Quality Authority

PSWQA, established by the Washington State legislature in 1983, was authorized by the legislature in 1985 to develop a comprehensive management plan for Puget Sound and its related waterways. The plan will be revised every 2 years and a 'State of the Sound' report completed. The first Puget Sound Water Quality Management Plan was adopted in late 1986, with implementation beginning in early 1987 (464). The plan focuses on protecting Puget Sound from toxic pollutants and pathogens, both of which have contaminated sediment and harmed resources such as fish and shellfish, and on the control of nonpoint pollution. It emphasizes a lead

role for local governments in identifying and controlling important nonpoint sources.

The Authority will oversee the implementation of the plan, propose funding mechanisms and, if necessary, propose new legislation. Although many Federal, State, and local agencies are involved in the study and regulation of the Sound, the Authority is the only agency specifically responsible for planning, oversight, and coordination of programs related to Puget Sound. It has considerable authority because State agencies and local governments are required to evaluate, incorporate, and implement applicable provisions of the plan.

The Great Lakes Water Quality Board

The Great Lakes together represent an extremely large surface expanse of freshwater, yet the Great Lakes system also functions somewhat like a large-scale estuary. The experience of the Great Lakes National Program thus serves as a model for the development of other waterbody management programs, such as those of the National Estuary Program. The Great Lakes Water Quality Board was established by the United States to implement agreements with Canada, reached under the auspices of the International Joint Commission, regarding the water quality of the Great Lakes. The Great Lakes National Program Office of EPA staffs the Board and ensures that U.S. commitments are met.

Two major agreements have been reached by the Commission: the *Great Lakes Water Quality Agreements* of 1972 and 1978. The 1972 agreement established water quality objectives and focused on pesticide control. The 1978 agreement added an ecosystem management approach and the goal of essentially zero discharge of pollutants; it also calls for the control of all toxic substances.

The agreements thus encourage the protection of the Great Lakes and call for remedial actions against pollution, as well as research and monitoring programs. EPA's Great Lakes National Program Office and Region 5 are most involved in coordinating activities relating to the Agreements. In May 1986, the Great Lakes States issued *The Great Lakes Toxic Substance Control Agreement*. Intended to be consistent with both the Federal Clean Water Act and the Great Lakes Water Quality Agreement, the agreement establishes a framework for coordinating regional action to control toxic pollutants entering the Great Lakes system (200, 389,663).

The Gulf Coast Waste Disposal Authority

GCWDA is a unique example of a within-State waste coordination effort. The authority is a three-county unit

of local government, established by Texas statute in 1969 to abate point source pollution in the heavily industrialized Houston Ship Channel and Galveston Bay area. It has established numerous waste management facilities, primarily sewage treatment plants, but also some industrial treatment facilities and a land-based incineration facility. The system is funded by issuing bonds for construction and these are repaid through user charges (ref 215; L. Goin, GCWDA, pers. comm. , 1986).

The authority is active in pollution control financing and itself owns and operates four industrial wastewater treatment facilities. These facilities treat and dispose of liquid wastes from over 40 industrial plants. In addition, its 22 municipal wastewater treatment plants and 7 drinking water treatment plants serve over 40 water districts or cities. The objective is for at least one-third of these facilities to become large, regional waste treatment facilities. The authority is also pursuing regional approaches to municipal sludge disposal and resource recovery for municipal solid wastes.

The Southern California Coastal Water Research Project

SCCWRP is dedicated to researching and monitoring the effects of municipal wastewater discharges on marine life. The project publishes a report on recent research efforts every 2 years. It is sponsored by the sanitation districts of Orange County and Los Angeles County and the cities of Oxnard, San Diego, and Los Angeles. These wastewater dischargers created SCCWRP through a joint powers agreement. Each has representatives on a commission that oversees the operation of the project.

The project is not intended to study specific pollution sources or needed controls. Instead, its focus is a variety of specific environmental problems, such as predicting sediment quality around outfalls, fish reproduction near outfalls, and the influence of chlorinated hydrocarbons on fish. The goal of the research is to develop predictive models that would help determine what levels of wastewater treatment are needed to protect marine life (527,528).

The San Francisco Bay Regional Water Quality Control Board

The San Francisco Bay Regional Water Quality Control Board is one of the major agencies involved in managing the Bay's waters. It operates independently of, but is responsible to, the State of California Water Resources Control Board. The Regional Board, comprised

of nine appointed members who are involved in activities to control water quality in the Bay, is primarily an enforcement agency and is limited to activities such as controlling and monitoring sewage outfalls and other point source discharges. It has no authority to control impacts caused by pollutants carried by the Sacramento and San Joaquin Rivers or from other areas; these are under the exclusive jurisdiction of the State Board. It also has no authority to coordinate activities of the other agencies involved in Bay water quality management.

The Regional Board is active in planning, reviewing, and amending the Basin Plan for the Bay area and in reviewing water quality standards. The plan, last amended in 1982, is the basis for distributing both State and Federal grants for water quality programs such as building and upgrading wastewater treatment facilities. The Board is also active in the study of shellfish through the San Francisco Bay Shellfish Program and in the State's Mussel Watch Program. Its Aquatic Habitat Program studies the effects of toxic pollutants on aquatic life in the Bay (67,70).

The Aquatic Habitat Institute

The Aquatic Habitat Institute is a nonprofit, quasi-public corporation independent from, but highly supportive of, the Regional Board's Aquatic Habitat Program. Although established in 1983, funding only began in 1986. Its purpose is to produce independent research acceptable to all agencies and interests concerned with the management of the Bay area. The Institute is planning a number of scientific assessments and education programs, and will attempt to better coordinate research and monitoring in the San Francisco Bay/Delta area.

The Institute's 10-member Board of Directors consists of representatives from a wide range of government

and nongovernment interests (see table 12). Currently, the program's largest single source of funding is EPA's National Estuary Program. This funding will continue for 5 years. The California State and Regional Water Quality Control Boards also contribute funds, and donations are accepted from municipal and industrial dischargers. Eventually, however, the Institute is required to rely on its own funding strategy. This is another unique requirement of the program and will most likely involve the use of discharger taxes or sewer user surcharges, rather than direct appropriations (ref. 66; also D. Segar, Aquatic Habitat Institute, pers. comm., 1986).

The National Estuary Program

NEP was created within EPA in 1985 to oversee the implementation efforts in the Great Lakes and Chesapeake Bay, and to initiate comprehensive programs in other estuaries in the United States. Programs are underway in Puget Sound, Long Island Sound, Buzzards Bay, Narragansett Bay, San Francisco Bay, and Albemarle-Pamlico Sounds. NEP uses existing authorities under the Clean Water Act (Sec. 104), other Federal statutes, and State legislative authorities to control sources of pollution. The program emphasizes the need to focus and integrate existing programs at the Federal, State, and local levels to maximize benefits of pollution abatement. The objective of each program in NEP is to characterize the conditions and trends in the system and develop an integrated management program to maintain or restore the estuary.

The Water Quality Act of 1987 expanded the scope of NEP and authorized additional funding for the development, under its auspices, of individual waterbody management programs.

APPENDIX 2: FEDERAL INFORMATION AND MONITORING PROGRAMS

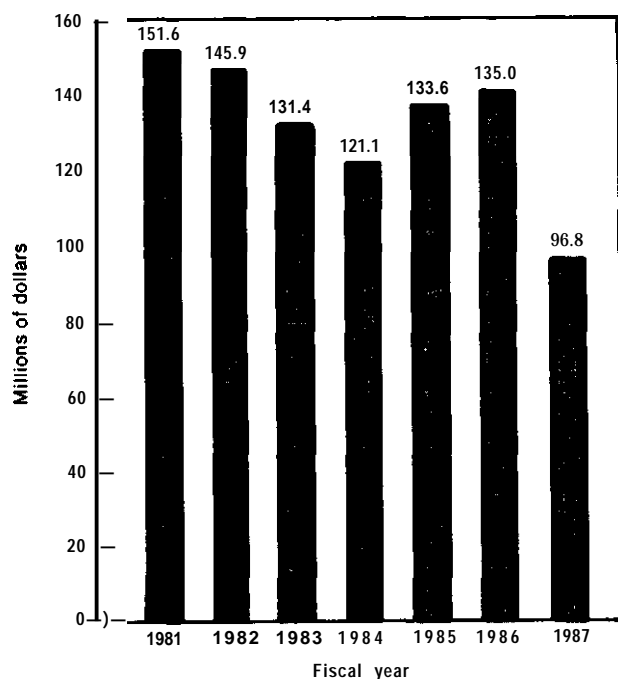
National Marine Pollution Program

The National Marine Pollution Program (NMPP) was established to coordinate the 11 departments and agencies that are engaged in research or monitoring related to marine pollution (including the Great Lakes) (598,599). The program was mandated under the National Ocean Pollution Planning Act of 1978. Figure 28 indicates the overall Federal marine pollution research budget for fiscal year 1984; figure 29 indicates funding of selected activities.

In late 1985, the program issued a Federal plan for fiscal years 1985 to 1989 (601). The plan recommended, among other things, a greater Federal emphasis on:

1. resource-oriented monitoring to provide national assessments of the status and trends in environmental quality,
2. better coordination of monitoring efforts,
3. research and monitoring programs related to municipal and industrial effluents,
4. research and monitoring on nutrients and pathogens (with less emphasis on metals and petroleum),

Figure 28.—Total Federal Funding for the National Marine Pollution Program, Fiscal Years 1981-87



NOTE: 1987 amount is from the proposed budget.

SOURCES: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Pollution Program, *Federal Plan for Ocean Pollution Research, Development, and Monitoring, Fiscal Years 1985-1989* (Washington, DC: September 1985); U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Pollution Program, *Summary of Federal Programs and Projects, FY 1985 Update* (Washington, DC: 1986).

5. data synthesis, interpretation, and information dissemination; and

6. studies conducted in estuaries and coastal waters.

The level of funding of marine pollution research conducted by the Federal agencies has declined during the 1980s, from approximately \$152 million in fiscal year 1981 to about \$135 million in fiscal year 1986. The presidential budget for 1987 was approximately \$97 million (see figure 28). The effects of the decline on the above recommendations are uncertain.

The Northeast Monitoring Program

The Northeast Monitoring Program (NEMP) monitors waters from the Gulf of Maine to North Carolina's Cape Hatteras. Established in 1979 by NOAA, NEMP monitors physical, chemical, and biological variables over long periods. It establishes benchmarks for both the concentration and distribution of pollutants and for their effects. Since 1980, NEMP has issued several reports summarizing the health of these estuaries and coastal waters (592,597). The reports condense a large

body of monitoring information, present it to a wide audience, and provide extensive references for those seeking further information. The information facilitates efforts to assess the effects of pollutants on ecosystems and resources, and to detect and respond to important environmental changes.

NOAA Ocean Assessments Division

NOAA's activities involving marine pollution assessment, monitoring, and research are conducted primarily by the Ocean Assessments Division (OAD), housed within the National Ocean Service (610). Two branches of the division are especially active in matters pertaining to waste disposal and its effects: the Strategic Assessment Branch and the Coastal and Estuarine Assessment Branch.

Strategic Assessment Branch

The Strategic Assessment Branch evaluates and inventories coastal resources and their exploitation, and also assesses national policies and strategies with regard to these resources and uses (611). Its activities, which accounted for 19 percent of OAD's fiscal year 1985 budget, include:

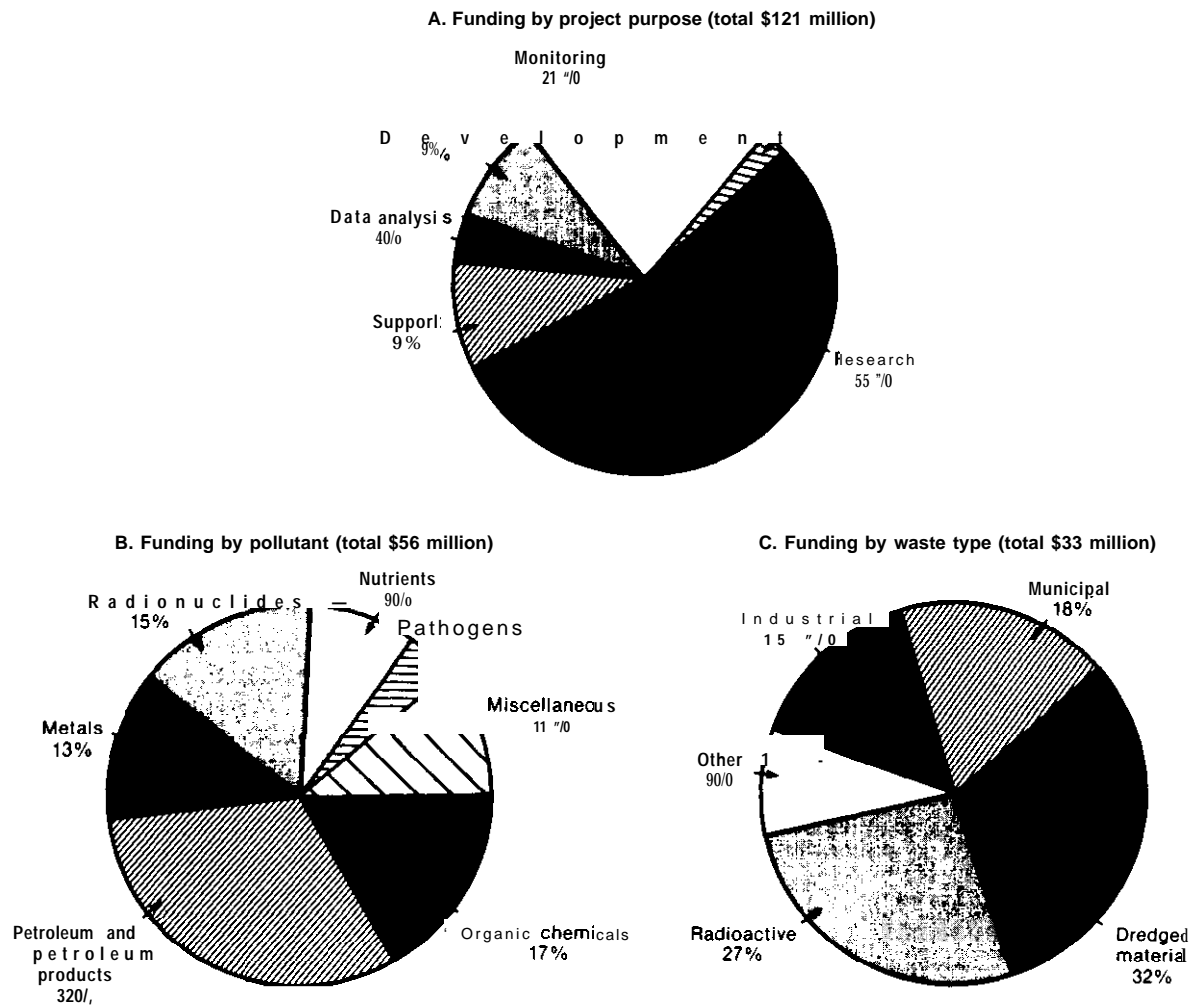
- assembling Strategic Assessment Data Atlases that summarize key ecological, economic, and political characteristics of each major marine region of the United States (607);
- producing a series of maps on the health and use of U.S. coastal waters;
- surveying Federal, State, and local government expenditures on outdoor marine recreation (348);
- assessing levels of pollutants entering marine waters (the National Coastal Pollutant Discharge Inventory (600));
- inventorying estuaries around the Nation (National Estuarine Inventory), which will allow comparisons of their use and health (362,602,619); and
- periodically inventorying the status of shellfish areas (National Shellfish Register of Classified Estuarine Waters).

Coastal and Estuarine Assessment Branch

The primary function of this branch is to assess the consequences of human activities on marine environments; its activities accounted for 35 percent of OAD's fiscal year 1985 budget. The branch has two relevant programs: National Status and Trends, and Consequences of Contaminants. The bulk of the branch's budget goes into the Status and Trends Program.²⁰

²⁰Up-to-date information on the Status and Trends Program and on another program, the Quality Assurance Program, is available in the *biannual* Newsletter issued by these programs.

Figure 29.—Federal Funding of Selected Activities Within the National Marine Pollution Program in Fiscal Year 1984



Diagrams for B and C only include funding that can be specifically categorized by pollutant or waste type; hence totals are less than the total for A.

SOURCE: Office of Technology Assessment, 1987; after U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Pollution Program, *Federal Plan for Ocean Pollution Research, Development, and Monitoring, Fiscal Years 1985-1989* (Washington, DC September 1985).

The Status and Trends Program.—The objective of the National Status and Trends Program is to document the current status and long-term trends in the quality of estuaries and coastal waters (61 5,616). The program consists of four components which perform three major tasks:

1. providing data on concentrations of pollutants in finfish, shellfish, and sediments;
2. measuring biological parameters that reflect stress associated with human-induced perturbations; and

3. assessing marine environmental quality and recommending Federal responses.

The fiscal year 1985 budget for the program was \$3.3 million, the fiscal year 1986 budget was \$2.7 million (a decline of 18 percent), and the proposed budget for fiscal year 1987 was \$4.3 million (J. Calder, pers. comm., August 1986). A major component of the program is the Benthic Surveillance Program, which collects samples of sediment, bottom-dwelling mollusks, and bottom-feeding fish from numerous sites throughout the

country. The samples are analyzed for substances such as toxic metals, polynuclear aromatic hydrocarbons, and chlorinated organic chemicals (610,62 1).

Consequences of Contaminants Program.—This program develops techniques to determine how pollutants in marine waters have affected or can affect marine fish and shellfish and human health (620). The techniques then can augment the capabilities of the Status and Trends Program. Recent activities have emphasized:

- evaluating indicators that signal the risk of shellfish contamination,
- documenting exposure to pollutants that results when fishermen eat their catches, and
- quantifying the relationship in fish between exposure to pollutants and reproductive impairment.

National Shellfish Register

The Shellfish Register, issued periodically since 1966, contains information on shellfish contamination incidents and provides important indicators of the extent to which shellfish in U.S. waters are contaminated; the

latest register was published in 1985 (603). It uses a classification system based on concentrations of coliform bacteria and natural marine biotoxins, although it also includes information on substances that might be considered hazardous in the shellfish. Productive shellfish waters can be classified as approved, prohibited, conditionally approved, or restricted. Most States implement the system voluntarily, although they may differ in how they meet the general requirements,

The register provides only limited information on the current status of shellfishing areas and still less information regarding past trends, in part because the classification scheme is not used consistently by the States. For example, the classification of a shellfish area could be changed from approved to restricted simply because an area was not surveyed in a particular year, not because of actual contamination. Thus, the register is currently not well-suited for establishing trends in the contamination of shellfish and shellfish waters, although efforts are being made to improve it. These efforts are, however, constrained by severely limited budgets at both the State and Federal levels.