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COUNCIL ON ENVIRONMENTAL QUALITY
ON OCEAN DUMPING

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REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY ON OCEAN DUMPING

MESSAGE

FROM

THE PRESIDENT OF THE UNITED STATES

TRANSMITTING

A REPORT OF THE COUNCIL ON ENVIRONMENTAL QUALITY ON OCEAN DUMPING

OCTOBER 7, 1970.—Message and accompanying papers referred to the Committee of the Whole House on the State of the Union and ordered to be printed

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U.S. GOVERNMENT PRINTING OFFICE
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To the Congress of the United States:

The oceans, covering nearly three-quarters of the world's surface, are critical to maintaining our environment, for they contribute to the basic oxygen-carbon dioxide balance upon which human and animal life depends. Yet man does not treat the oceans well. He has assumed that their capacity to absorb wastes is infinite, and evidence is now accumulating on the damage that he has caused. Pollution is now visible even on the high seas—long believed beyond the reach of man's harmful influence. In recent months, worldwide concern has been expressed about the dangers of dumping toxic wastes in the oceans.

In view of the serious threat of ocean pollution, I am today transmitting to the Congress a study I requested from the Council on Environmental Quality. This study concludes that:

—the current level of ocean dumping is creating serious environmental damage in some areas.

—the volume of wastes dumped in the ocean is increasing rapidly.

—a vast new influx of wastes is likely to occur as municipalities and industries turn to the oceans as a convenient sink for their wastes.

—trends indicate that ocean disposal could become a major, nationwide environmental problem.

—unless we begin now to develop alternative methods of disposing of these wastes, institutional and economic obstacles will make it extremely difficult to control ocean dumping in the future.

—the nation must act now to prevent the problem from reaching unmanageable proportions.

The study recommends legislation to ban the unregulated dumping of all materials in the oceans and to prevent or rigorously limit the dumping of harmful materials. The recommended legislation would call for permits by the Administrator of the Environmental Protection Agency for the transportation and dumping of all materials in the oceans and in the Great Lakes.

I endorse the Council's recommendations and will submit specific legislative proposals to implement them to the next Congress. These recommendations will supplement legislation my Administration submitted to the Congress in November, 1969 to provide comprehensive management by the States of the land and waters of the coastal zone and in April, 1970 to control dumping of dredge spoil in the Great Lakes.

The program proposed by the Council is based on the premise that we should take action before the problem of ocean dumping becomes acute. To date, most of our energies have been spent cleaning up mistakes of the past. We have failed to recognize problems and to take corrective action before they became serious. The resulting signs of environmental decay are all around us, and remedial actions heavily tax our resources and energies.

The legislation recommended would be one of the first new authorities for the Environmental Protection Agency. I believe it is fitting that in this recommended legislation, we will be acting—rather than reacting—to prevent pollution before it begins to destroy the waters that are so critical to all living things.

RICHARD NIXON.

The WHITE HOUSE, *October 7, 1970.*

OCEAN DUMPING
A National Policy

A Report to the President
prepared by the
Council on Environmental Quality

October 1970

Foreword

Oceans—140 million square miles of water surface—cover over 70 percent of the earth. They are critical to maintaining the world's environment, contributing to the oxygen-carbon dioxide balance in the atmosphere, affecting global climate, and providing the base for the world's hydrologic system. Oceans are economically valuable to man, providing, among other necessities, food and minerals.

The coastlines of the United States are long and diverse, ranging from the tropical waters of Florida to the Arctic coast of Alaska. These areas, as biologically productive as any in the world, are the habitat for much of our fish and wildlife. They also provide transportation, recreation, and a pleasant setting for more than 60 percent of the Nation's population.

These waters are also the final receptacle for many of our wastes. Sewage, chemicals, garbage, and other wastes are carried to sea through the watercourses of the Nation from municipal, industrial, and agricultural sources or directly by barges, ships, and pipelines.

Industrial liquid wastes are the largest source of pollution in coastal and estuarine regions, followed by municipal liquid wastes. Agricultural pollutants from land runoff, animal wastes, pesticides, and fertilizers add to the load of wastes ultimately reaching the ocean. Sewage from vessels and spilled oil are two highly visible sources of marine pollution. And a large part of air pollutants eventually end up in the ocean, directly or through runoff from the land.

The amount of wastes transported and dumped in the ocean is small in terms of the total volume of pollutants reaching the oceans. But in the future the impact of ocean dumping will increase significantly relative to other sources. Although Federal laws on oil and vessel pollution and Federal-State water quality standards for land-based discharges will reduce the contribution of wastes from these sources, uncontrolled dumping in the ocean could increase greatly.

Recognizing the importance of this problem, the President directed the Council on Environmental Quality to study ocean dumping. In his April 15, 1970, message to the Congress,[1] he asked the Council to work with other Federal agencies and with State and local governments on a comprehensive study that would result in research, legislative, and administrative recommendations.

The Council is grateful to members of a Federal Task Force and individuals from their agencies[2] for preparing material for consideration at meetings of the Task Force, for their review of report drafts, and most important of all, for providing guidance in formulating the recommended policy. Helpful assistance was also received from agencies and individuals in State and local government and from scientists and academicians, including the National Academy of Sciences and the National Academy of Engineering.

The Council is also indebted to a number of excellent studies. These include the studies on the New York Bight, one initiated by the Corps of Engineers and another prepared by an Ad Hoc Committee for the Secretary of the Interior; the 20-city survey of barged wastes, prepared by the Dillingham Corporation under contract to the Bureau of Solid Waste Management; the study of Waste Management Research Needs, by the National Academy of Sciences Committee on Oceanography-National Academy of Engineering Committee on Ocean Engineering; the National Estuarine Pollution Study, by the Federal Water Quality Administration; and an economic study of marine solid wastes disposal, by the Massachusetts Institute of

[1] See Appendix A.
[2] See Appendix B.

Technology under contract to the National Council on Marine Resources and Engineering Development.

Sources of ocean dumping discussed in this report deserve definition:

- *Dredge spoils*—the solid materials removed from the bottom of water bodies generally for the purpose of improving navigation: sand, silt, clay, rock, and pollutants that have been deposited from municipal and industrial discharges.
- *Sewage sludge*—the solid material remaining after municipal waste water treatment: residual human wastes and other organic and inorganic wastes.
- *Solid waste*—more commonly called refuse, garbage, or trash—the material generated by residences; commercial, agricultural, and industrial establishments; hospitals and other institutions; and municipal operations: chiefly paper, food wastes, garden wastes, steel and glass containers, and other miscellaneous materials.
- *Industrial wastes*—acids; refinery, pesticide, and paper mill wastes; and assorted liquid wastes.
- *Construction and demolition debris*—masonry, tile, stone, plastic, wiring, piping, shingles, glass, cinderblock, tar, tarpaper, plaster, vegetation, and excavation dirt.
- *Radioactive wastes*—the liquid and solid wastes that result from processing of irradiated fuel elements, nuclear reactor operations, medical use of radioactive isotopes, and research activities and from equipment and containment vessels which become radioactive by induction.

In this report, the Council first summarizes its findings and recommendations for action to control ocean dumping. Chapter I inventories the sites, amounts, and composition of wastes dumped in the ocean and analyzes trends. The effects of these waste materials on the marine environment and man are outlined in Chapter II. Chapter III discusses alternatives to ocean dumping in terms of costs, availability, and effectiveness. The State and Federal agencies and authorities that deal with specific aspects of dumping are discussed in Chapter IV. Chapter V considers the international implications of ocean dumping.

Findings and Recommendations

The Council on Environmental Quality concludes that there is a critical need for a national policy on ocean dumping. It is not a serious, nationwide problem now, but the decisions made by municipalities and industries in the next few years could lead to dramatic increases in the level of dumping. Once these decisions are made and ocean dumping proceeds, it will be costly and difficult to shift to land-based disposal at some future date.

Ocean-dumped wastes are heavily concentrated and contain materials that have a number of adverse effects. Many are toxic to human and marine life, deplete oxygen necessary to maintain the marine ecosystem, reduce populations of fish and other economic resources, and damage esthetic values. In some areas, the environmental conditions created by ocean disposal of wastes are serious.

The Council study indicates that the volume of waste materials dumped in the ocean is growing rapidly. Because the capacity of land-based waste disposal sites is becoming exhausted in some coastal cities, communities are looking to the ocean as a dumping ground for their wastes. Faced with higher water quality standards, industries may also look to the ocean for disposal. The result could be a massive increase in the already growing level of ocean dumping. If this occurs, environmental deterioration will become widespread.

In most cases, feasible and economic land-based disposal methods are available for wastes currently being dumped in the ocean. In many cases, alternatives to ocean dumping can be applied positively for purposes such as land reclamation and recycling to recover valuable waste components.

Current regulatory activities and authorities are not adequate to handle the problem of ocean dumping. States do not exercise control over ocean dumping, and generally their authority extends only within the 3-mile territorial sea. The Army Corps of Engineers authority to regulate ocean dumping is also largely confined to the territorial sea. The Corps has responsibility to facilitate navigation, chiefly by dredging navigation channels. As such, it is in the position of regulating activities over which it also has operational responsibility. The Coast Guard enforces several Federal laws regarding pollution but has no direct authority to regulate ocean dumping. The authority of the Federal Water Quality Administration does not provide for issuance of permits to control ocean dumping. And the Atomic Energy Commission has authority only for disposal of radioactive materials. The Council believes that new legislative authority is necessary.

Finally, this report recognizes the international character of ocean dumping. Unilateral action by the United States can deal with only a part—although an important part—of the problem. Effective international action will be necessary if damage to the marine environment from ocean dumping is to be averted.

POLICY AND REGULATORY RECOMMENDATIONS

The Council on Environmental Quality recommends a comprehensive national policy on ocean dumping of wastes to ban unregulated ocean dumping of all materials and strictly limit ocean disposal of any materials harmful to the marine environment. In order to implement the policy, new regulatory authority is necessary. The Council on Environmental Quality recommends legislation that would:

- Require a permit from the Administrator of the Environmental Protection Agency for the transportation or dumping of all materials in the oceans, estuaries, and the Great Lakes.

- Authorize the Administrator to ban ocean dumping of specific materials and to designate safe sites.
- Establish penalties for violation of regulations.
- Provide for enforcement by the Coast Guard.

The Administrator of the Environmental Protection Agency would be guided by the following principles in exerting his authority:

- Ocean dumping of materials clearly identified as harmful to the marine environment or man should be stopped.
- When existing information on the effects of ocean dumping are inconclusive, yet the best indicators are that the materials could create adverse conditions if dumped, such dumping should be phased out. When further information conclusively proves that such dumping does not damage the environment, including cumulative and long-term damage, ocean dumping could be conducted under regulation.
- The criteria for setting standards for disposing of materials in the ocean and for determining the urgency of terminating disposal operations should include:
  1. Present and future impact on the marine environment, human health, welfare, and amenities.
  2. Irreversibility of the impact of dumping.
  3. Volume and concentration of materials involved.
  4. Location of disposal, i.e., depth and potential impact of one location relative to others.
- High priority should be given to protecting those portions of the marine environment which are biologically most active, namely the estuaries and the shallow, nearshore areas in which many marine organisms breed or spawn. These biologically critical areas should be delimited and protected.

The Council on Environmental Quality recommends the following policies relating to specific types of wastes currently being dumped in the ocean, in estuaries, and in the Great Lakes:

- Ocean dumping of undigested sewage sludge should be stopped as soon as possible and no new sources allowed.
- Ocean dumping of digested or other stabilized sludge should be phased out and no new sources allowed. In cases in which substantial facilities and/or significant commitments exist, continued ocean dumping may be necessary until alternatives can be developed and implemented. But continued dumping should be considered an interim measure.
- Ocean dumping of existing sources of solid waste should be stopped as soon as possible. No new sources should be allowed, i.e., no dumping by any municipality that currently does not do so, nor any increase in the volume by existing municipalities.
- Ocean dumping of polluted dredge spoils should be phased out as soon as alternatives can be employed. In the interim, dumping should minimize ecological damage. The current policy of the Corps of Engineers on dredging highly polluted areas only when absolutely necessary should be continued, and even then, navigational benefits should be weighed carefully against damages.
- The current policy of prohibiting ocean dumping of high-level radioactive wastes should be continued. Low-level liquid discharges to the ocean from vessels and land-based nuclear facilities are, and should continue to be, controlled by Federal regulations and international standards. The adequacy of such standards should be continually reviewed. Ocean dumping of other

radioactive wastes should be prohibited. In a very few cases, there may be no alternative offering less harm to man or the environment. In these cases ocean disposal should be allowed only when the lack of alternatives has been demonstrated. Planning of activities which will result in production of radioactive wastes should include provisions to avoid ocean disposal.

- No ocean dumping of chemical warfare materials should be permitted. Biological warfare materials have not been disposed of at sea and should not be in the future. Ocean disposal of explosive munitions should be terminated as soon as possible.
- Ocean dumping of industrial wastes should be stopped as soon as possible. Ocean dumping of toxic industrial wastes should be terminated immediately, except in those cases in which no alternative offers less harm to man or the environment.
- Ocean dumping of unpolluted dredge spoils, construction and demolition debris, and similar wastes which are inert and nontoxic should be regulated to prevent damage to estuarine and coastal areas.
- Use of waste materials to rehabilitate or enhance the marine environment, as opposed to activities primarily aimed at waste disposal, should be conducted under controlled conditions. Such operations should be regulated, requiring proof by the applicant of no adverse effects on the marine environment, human health, safety, welfare, and amenities.

RESEARCH NEEDS

In the long term, additional information is required in the implementation of this policy. Serious information deficiencies exist, and research is required in the following major areas:

- Broad-based ecological research is needed to understand the pathways of waste materials in marine ecosystems. Such studies should be directed to a better understanding of the food chain from microscopic plants and animals to high predators; how pollutants concentrate in the food chain; the origin and ultimate fate of pollutants in the oceans; and the effects of concentration on the marine environment and eventually man.
- Marine research preserves should be established to protect representative marine ecosystems for research and to serve as ecological reference points—baselines by which man-induced changes may be evaluated.
- Oceanographic studies of basic physical and chemical processes should be directed toward gaining a thorough understanding of the marine environment, with special emphasis on estuaries and coastal areas.
- Toxic materials should be identified and their lethal, sublethal and chronic long-term effects on marine life investigated. Information is needed on the persistence of toxic substances; how pollutants are degraded chemically and biologically; the effects of radioactivity on the marine environment and man; and the capacity of waters to assimilate waste materials.
- More information is needed about public health risks from ocean pollution. Studies should determine what pathogens are transported in marine ecosystems and how. Better methods of measuring public health dangers are also needed.
- Research is needed on the recycling of wastes and the development of alternatives to ocean dumping. Technical problems must be solved, but there is also a great need to study the social, institutional, and economic aspects of waste management.
- Effective national and international monitoring systems need to be developed. Research is necessary to develop improved

methods and technology so that alterations in the marine environment may be detected. But there is also a need for data coordination so that data gathering and analysis efforts are not duplicated.

SUMMARY

The Nation has an opportunity unique in history—the opportunity to act to prevent an environmental problem which otherwise will grow to a great magnitude. In the past, we have failed to recognize problems and to take corrective action before they became serious. The resulting signs of environmental degradation are all around us, and remedial actions heavily tax our resources. This is clearly the time for a conscious national decision to control ocean dumping.

RUSSELL E. TRAIN, *Chairman*
Robert Cahn
Gordon J. MacDonald

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CHAPTER I

Ocean Dumping: Location, Quantities, Composition, and Trends

About 48 million tons of wastes were dumped at sea in 1968. These wastes included dredge spoils, industrial wastes, sewage sludge, construction and demolition debris, solid waste, explosives, chemical munitions, radioactive wastes, and miscellaneous materials. This chapter indicates rapid increases in ocean dumping activity over the last two decades and the potential for great increases in the future. At the same time, ocean dumping of wastes from other sources should decrease through implementation of water quality standards and new Federal laws dealing with control of sewage from vessels and with oil pollution.

DISPOSAL SITE LOCATIONS

Data on disposal sites are still incomplete, with little definitive information on sites off Alaska and Hawaii and outside the U.S. contiguous zone (more than 12 miles offshore). There are almost 250 disposal sites off U.S. coasts. Fifty percent are located off the Atlantic Coast, 28 percent off the Pacific Coast, and 22 percent in the Gulf of Mexico. Table 1 summarizes the number of sites for each major area and the number of permits issued for their use. The locations of the disposal sites are indicated in Figure 1.

TABLE 1.—*Ocean Dumping: Site Location Summary (22, 66)*

Coastal area	Number of sites	Active Corps disposal permits
Atlantic Coast	122	136
Gulf Coast	56	50
Pacific Coast	68	71
Total	246	257

Not included in Table 1 are some 100 artificial reefs constructed by private concerns under permits issued by the U.S. Army Corps of Engineers. (66) These reefs, sometimes formed of old car hulks or tires, are intended to provide artificial shelters for fish.

QUANTITIES AND TYPES OF WASTES

The categories of wastes covered in this report are used because of the large quantities of materials currently dumped, their potential for increase, or their special characteristics, such as toxicity. The quantities for each category are summarized by coastal region in Table 2. Radioactive wastes and chemical munitions are not included in the table because weight is not a meaningful descriptor. Each, however, will be discussed later.

The Bureau of Solid Waste Management estimates that the data in Table 2 represent about 90 percent of ocean dumping. However, the data undoubtedly underestimate the size and scope of the problem because of the time lapse and the possibility of many small community operations or illicit operations by private firms. Also not included in the table are those wastes that are piped to sea.

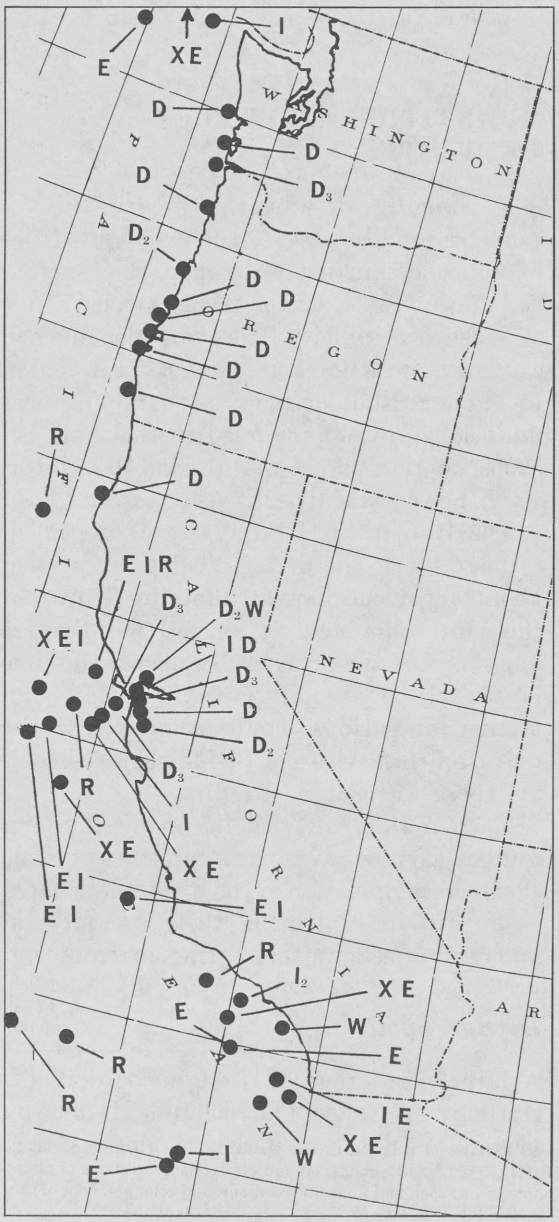
Each major category of ocean dumping sources is now discussed and the possible chemical composition of the wastes delineated as an aid in evaluating their present and potential effects on the marine environment.

Dredge Spoils

A large percentage of dredging is done directly by the Corps. The remainder is done by private contractor under Corps permit. Spoils are generally disposed of in open coastal waters less than 100 feet deep.

LEGEND

D DREDGE SPOILS
I INDUSTRIAL WASTES
S SEWAGE SLUDGE
E EXPLOSIVES
R RADIOACTIVE WASTES
W SOLID WASTE
X INACTIVE SITE



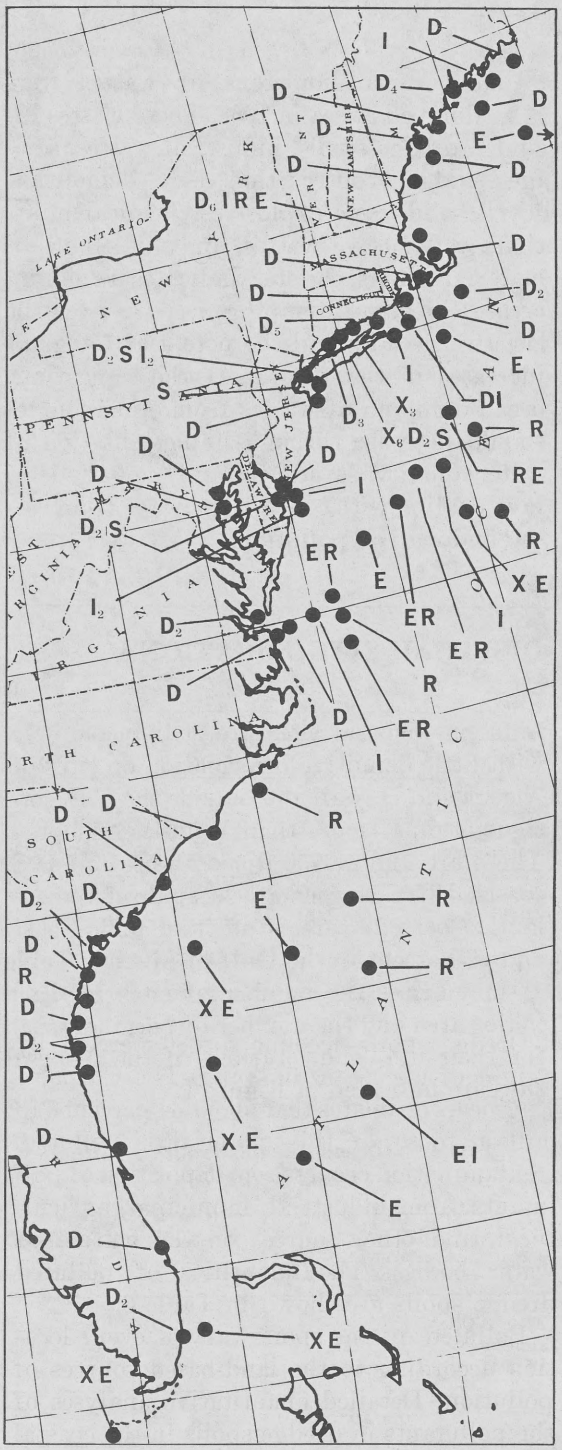


Figure 1.—Known Dumping Sites Off U.S. Coasts (22, 66)

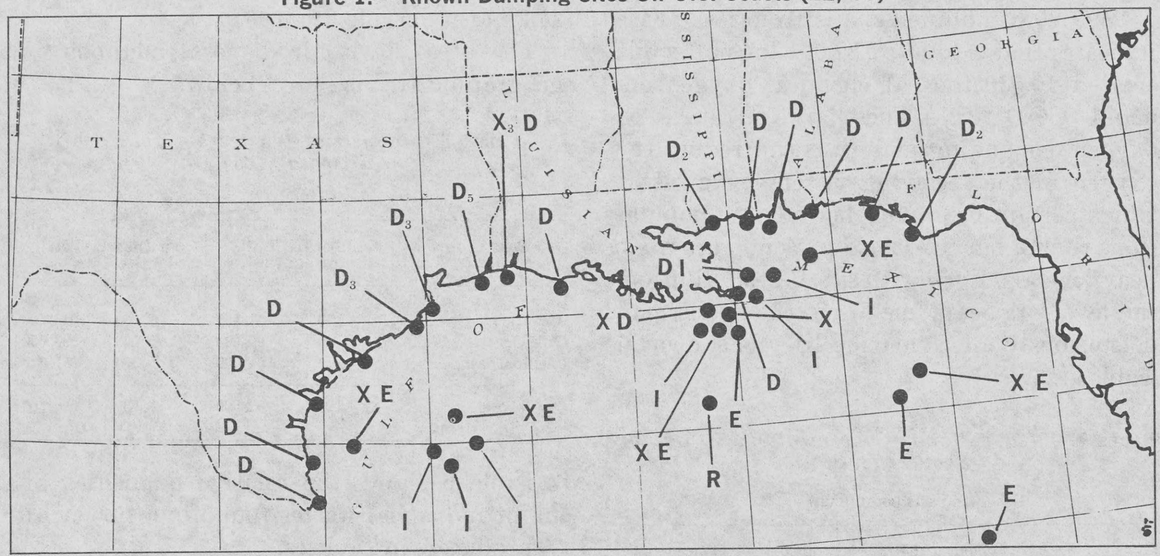


TABLE 2.—*Ocean Dumping: Types and Amounts, 1968* (66)

(In tons)

Waste type	Atlantic	Gulf	Pacific	Total	Percent of total
Dredge spoils	15, 808, 000	15, 300, 000	7, 320, 000	38, 428, 000	80
Industrial wastes	3, 013, 200	696, 000	981, 300	4, 690, 500	10
Sewage sludge	4, 477, 000	0	0	4, 477, 000	9
Construction and demolition debris	574, 000	0	0	574, 000	<1
Solid waste	0	0	26, 000	26, 000	<1
Explosives	15, 200	0	0	15, 200	<1
Total	23, 887, 400	15, 966, 000	8, 327, 300	48, 210, 700	100

Dredge spoils account for 80 percent by weight of all ocean dumping. The Corps of Engineers estimates that about 34 percent (13 million tons) of this material is polluted. Contamination occurs from deposition of pollutants from industrial, municipal, agricultural, and other sources on the bottom of water bodies. The quantities of polluted dredge spoils are shown in Table 3.

Polluted dredge spoils vary at every location according to the land-based sources of pollution. Detailed quantitative analyses of the pollutants in dredge spoils in the coastal

TABLE 3.—*Estimated Polluted Dredge Spoils* (22)

Coastal area	Total spoils (in tons)	Estimated percent of total polluted spoils [1]	Total polluted spoils (in tons)
Atlantic Coast	15, 808, 000	45	7, 120, 000
Gulf Coast	15, 300, 000	31	4, 740, 000
Pacific Coast	7, 320, 000	19	1, 390, 000
Total	38, 428, 000	34	13, 250, 000

[1] Estimates of polluted dredge spoils consider chlorine demand; BOD; COD; volatile solids; oil and grease; concentrations of phosphorous, nitrogen, and iron; silica content; and color and odor of the spoils.

areas are not available. An analysis by the Federal Water Quality Administration (FWQA) of polluted spoils from Lake Erie indicates that a total of 82,091 tons of spoils created 10,500 tons of chemical oxygen demand (COD). (23) These large quantities of oxygen-demanding materials can reduce the oxygen in the receiving waters to levels at which certain fish and other aquatic populations cannot survive. Also present were toxic heavy metals. Even with substantial dilution, the levels of heavy metals in the spoils may deleteriously affect marine life, as shown in Table 4.

TABLE 4.—*Heavy Metals Concentrations in Dredge Spoils (23, 36)*

(In parts per million)

Metal	Concentrations in dredge spoils	Natural concentrations in sea water	Concentrations toxic to marine life
Cadmium	130	.08	.01–10.0
Chromium	150	.00005	1.0
Lead	310	.00003	.1
Nickel	610	.0054	.1

Industrial Wastes

Industrial wastes were the second largest category of pollutants dumped at sea in 1968 (4.7 million tons, or 10 percent of the total). (66)

Most industrial wastes are commonly transported to sea in 1,000- to 5,000-ton-capacity barges. Sites are 4 to 125 miles off the Atlantic Coast, from 25 to 125 miles off the coast of the Gulf of Mexico, and from 5 to 75 miles off the Pacific Coast. Most of the sites are at the nearshore end of the range.

Highly toxic industrial wastes are sometimes contained in 55-gallon drums and are jettisoned from either merchant ships or disposal vessels at least 300 miles from shore. The containers are sometimes weighted and sunk. More frequently, they are ruptured at the surface, either manually with axes or by small arms or rifle fire. (66)

The breakdown for disposal methods by geographic area is shown below.

TABLE 5.—*Industrial Wastes by Method of Disposal (66)*

(In tons)

Coastal area	Number of sites	Bulk wastes	Containerized wastes	Total
Atlantic Coast	10	3,011,000	2,200	3,013,200
Gulf Coast	6	690,000	6,000	696,000
Pacific Coast	7	981,000	300	981,300
Total	23	4,682,000	8,500	4,690,500

Table 6 shows the relative quantities of major industrial wastes found in a survey of 50 producers in 20 cities.

TABLE 6.—*Industrial Wastes by Manufacturing Process (66)*

Type of waste	Estimated tonnage	Percent
Waste acids	2,720,500	58
Refinery wastes	562,900	12
Pesticide wastes	328,300	7
Paper mill wastes	140,700	3
Other wastes	938,100	20

The types of contaminants in industrial wastes dumped at sea vary greatly because of the diversity of industries and production processes involved. Many of the wastes are toxic—some highly toxic. For example, refinery wastes, which are 12 percent of the total ocean-disposed industrial wastes, can include cyanides, heavy metals, mercaptides, and chlorinated hydrocarbons. Pulp and paper mill wastes may contain "black liquor" and various organic constituents which are toxic to the marine environment. Chemical manufacturing and laboratory wastes that are dumped include arsenical and mercuric compounds and other toxic chemicals. (66)

Sewage Sludge

Sewage sludge is the waste solid byproduct of municipal waste water treatment processes. These solids can be further treated by digestion, a process which allows accelerated decomposition of the sludge to control odors and pathogens. Most sewage sludge is disposed of on land or is incinerated. Relatively small amounts (4.5 million tons on a wet basis) are currently dumped at sea, of which almost 4.0 million tons are dumped off New York harbor. (66) As of 1968, there were no similar operations on either the Gulf or Pacific Coasts, although sludge is being discharged from Los Angeles by pipeline.

Sewage sludge in digested or undigested form contains significant quantities of heavy metals. A study by the FWQA indicated that copper, zinc, barium, manganese, and molybdenum are present in sewage sludge. (9) The concentrations and types of toxic materials vary because sludge is the residual of waste water treatment and contains whatever domestic and industrial contaminants have entered the system. Table 7 shows the minimum, average, and maximum values for three heavy metals found in one analysis of sewage sludge.

TABLE 7.—*Heavy Metals Concentrations in Sewage Sludge (8, 9, 36)*

(In parts per million)

Metal	Concentrations in sewage sludge			Natural concentrations in sea water	Concentrations toxic to marine life
	Min.	Avg.	Max.		
Copper	315	643	1,980	.003	.1
Zinc	1,350	2,459	3,700	.01	10.0
Manganese	30	262	790	.002	----------

Sewage sludge also contains significant amounts of oxygen demanding materials. In 1969, sludge dumped in the New York Bight, encompassing the New York harbor and some adjacent coastal areas, had an oxygen demand of about 70,000 tons. (15) These wastes also include some bacteria that cause diseases in man.

Construction and Demolition Debris

Only New York City disposes of debris at sea in significant quantities because of the lack of nearby available landfill. Sea disposal is conducted with 3,000- to 5,000-ton capacity barges that are towed some 9 miles offshore. These materials are generally inert and nontoxic.

Solid Waste

Solid waste, the byproducts and discards of our society, amounts to approximately 5.5 pounds per capita per day collected by municipal and private agencies. (28) Although these wastes total approximately 190 million tons per year, ocean disposal accounted for only about 26,000 tons. (66) Ocean dumping of solid waste occurred exclusively on the Pacific Coast, where they were generated by cannery operations and commercial and naval shipping operations. Other sources no doubt exist, but the overall magnitude of the current problem is minor.

The composition of solid waste, ascertained by sampling, is shown in Table 8. It is presented here to indicate the materials that would be introduced into the marine environment if ocean dumping of solid waste becomes a common practice.)

Solid waste disposed of in the ocean interacts with the water, but the resultant chemical products are difficult to determine. Studies have been done on the interaction between solid waste and fresh water in sanitary landfills as the water percolates through the waste materials. (The resultant mixture of water and chemicals is called leachate.)

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TABLE 8.—*Composition of Solid Waste* (28)

Type of waste	Average (percent)
Paper products	43.8
Food wastes	18.2
Metals	9.1
Glass and ceramics	9.0
Garden wastes	7.9
Rock, dirt, and ash	3.7
Plastics, rubber, and leather	3.1
Textiles	2.7
Wood	2.5
Total	100.0

The percentage of pollutants in solid waste is not nearly as high as in sewage sludge or dredge spoils, but it does contain nutrients, oxygen-demanding materials, and heavy metals. Laboratory studies of water contaminated by solid waste have shown significant quantities of heavy metals, with zinc, nickel, and magnesium present in concentrations of 13, .27, and 378 parts per million respectively. (29) These concentrations are well above toxic levels for marine life.

Up to 50 percent of solid waste is usually paper, wood, plastics, and rubber, all of which can float to the surface. Particularly significant are the plastics which will not become water soaked and will not degrade for many, perhaps even hundreds, of years. Even if baled before ocean disposal, it is almost certain that over time the bales will disintegrate and the floatables will rise to the surface. The potential esthetic problems of large quantities of solid wastes floating to the surface and then being carried to shore are staggering.

Explosives and Chemical Munitions

Unserviceable or obsolete shells, mines, solid rocket fuels, and chemical warfare agents have been disposed of in deep water for many years. In 1963, the Navy initiated Operation "CHASE," in which munitions were disposed of by sinking them in obsolete hulks. Since then, 19 gutted World War II Liberty ships containing munitions have been scuttled. In the last six operations, the weapons were to detonate, but the S.S. ROBERT LOUIS STEVENSON failed to do so as planned and is located on the continental shelf near Alaska in 2,200 feet of water.

Since 1964 at least 18,342 tons of ammunition and explosives have been dumped in this manner. Additional cargoes of approximately 35,000 tons containing an unknown proportion of net explosives were also scuttled. A detailed listing of the ships scuttled, their cargoes, and disposition are shown in Table 9.

Detonation of explosives can result in trace amounts of lead, nickel, bronze, and other metals in the water, depending on corrosion processes and the materials used in the munitions.

Radioactive Wastes

Most nuclear waste products are liquid and of low radioactivity. They consist mostly of decontaminated process and cooling waters from reactors, fuel processing, and other operations. Small amounts of liquid wastes are highly radioactive; they result from the reprocessing of reactor fuel elements.

Solid radioactive wastes are produced by contamination of equipment and other materials during nuclear power plant operations, from medical use, and by research and development activities.

Solid radioactive wastes have been buried in carefully controlled landfill sites. Low-level liquid nuclear wastes are treated and/or stored to reduce radioactivity before disposal. High-level liquid wastes are stored exclusively in tanks at land-based sites.

TABLE 9.—*Explosives and Chemical Munitions, 1964–1970 (30)*

Year	Name	Total cargo (in tons)	Nature of cargo	Net explosives (in tons)	Disposition
1964	S.S. John F. Shafroth	9,799	A&E	Unknown	SDW
	S.S. Village	7,535	A&E	Unknown	SDW
1965	M.V. Coastal Mariner	4,040	A&E	512	D at 1,000′
	S.S. Santiago Iglesia	8,715	A&E	408	D at 1,000′
1966	S.S. Issac Van Zandt	7,500	A&E	1,625	D at 4,000′
	S.S. Horace Greely	6,033	A&E	442	D at 4,000′
1967	S.S. Robt. L. Stevenson	6,600	A&E	2,327	S
	S.S. Corporal Eric G. Gibson	9,005	Chem.	None	SDW
	S.S. Monahan	833	A&E	Unknown	SDW
1968	S.S. Mormactern	7,763	Chem.	N.A.	SDW
	S.S. Richardson	7,437	A&C	138	SDW
1969	S.S. Cape Tryon	7,626	A&E	1,145	DU
	S.S. Cape Catoche	6,348	A&E	1,359	DU
	S.S. Cardinal O'Connell	6,431	A&E	2,144	DU
1970	S.S. Frederick E. Williamson	5,245	A&E	478	DU
	S.S. Cape Comfort	6,200	A&E	N.A.	DU
	S.S. Walker D. Hines	6,500	A&E	N.A.	DU
	S.S. David Hughes	5,000	A&E	N.A.	DU
	S.S. LeBaron Russell Briggs	2,664	Chem.	N.A.	SDW

Definitions: A&E=ammunition and explosives; N.A.=not available; DU=Detonated unintentionally; SDW=sunk in deep water; D=detonated; S=sunk at less than 4,000 feet and did not detonate as planned; A&C=ammunition and cylinders contaminated with residues of GB nerve gas.

Liquid and solid radioactive wastes which have been dumped in the ocean are usually in concrete-filled metal drums or containers. Table 10 summarizes the amounts of these wastes disposed of at sea.

The quantities of radioactive materials disposed of at sea have decreased dramatically for several reasons. First, in 1960 the Atomic Energy Commission placed a moratorium on new licenses for disposal of radioactive wastes in the ocean. Only one commercial organization (which has never conducted any sea disposal), two Government agencies, and one university are still authorized to dispose of radioactive wastes in the ocean. Second, the major contractors of the AEC have not disposed of any wastes at sea since 1962. And for economic reasons, those firms with licenses are phasing out sea disposal of radioactive wastes in favor of land disposal.

TABLE 10.—*Radioactive Wastes: Historical Trends, 1946–1970 (70)*

Year	Number of containers	Estimated activity at time of disposal (in curies)
1946-1960	76,201	93,690
1961	4,087	275
1962	6,120	478
1963	129	9
1964	114	20
1965	24	5
1966	43	105
1967	12	62
1968	0	0
1969	26	26
1970	2	3
Total	86,758	94,673

Two sites have been used for disposal of most of the wastes in the Pacific Ocean. These sites are approximately 48 nautical miles west of the Golden Gate Bridge. One commercial firm has disposed of wastes in the Pacific Ocean farther than 150 miles from the U.S. coast; these disposals, 11 in number, were at depths greater than 6,000 feet. In the Atlantic Ocean, the major sites for disposal were in the area of Massachusetts Bay, approximately 12 to 15 miles from the coast; approximately 150 miles southeast of Sandy Hook, N.J.; and approximately 105 miles from Cape Henry, Va. With the exception of the Massachusetts Bay site, disposal was at depths greater than 6,000 feet. The Massachusetts Bay site was in 300 feet of water.

PAST TRENDS

Figure 2 shows significant increases in ocean dumping activities during the years 1951–1968. These data do not include dredge spoils or explosives because historical data could not be readily reconstructed. Radioactive wastes are also excluded because of their negligible weight contribution.

Table 11, on which Figure 2 is based, shows a fourfold increase in tonnage dumped at sea from 1949 to 1968. The 28 percent increase between the 1959–1963 period and the 1964–1968 period is largely attributable to dramatic increases in industrial wastes and sewage sludge disposal. In 1959, industrial wastes disposed of at sea approximated 2.2 million tons. By 1968, the amount had increased to over 4.7 million tons, a 114 percent increase in 9 years. The amount of sewage sludge disposed of at sea increased by 61 percent in the same period, from 2.8 million tons to 4.5 million tons. (66)

FUTURE TRENDS

Assessing future trends in ocean dumping requires analysis of basic population trends. Population growth is accompanied not only by increased amounts of wastes but also by decreased space available for their disposal.

Between 1930 and 1960 the coastal population increased by 78 percent, compared with a 48 percent increase nationwide. (36) The figures below (25) indicate the population growth in the coastal region projected through the year 2000:

1960	57, 946, 000
1970	68, 397, 000
1980	76, 607, 000
1990	92, 940, 000
2000	106, 900, 000

TABLE 11.—*Ocean Dumping: Historical Trends, 1949–1968* [1] (66)

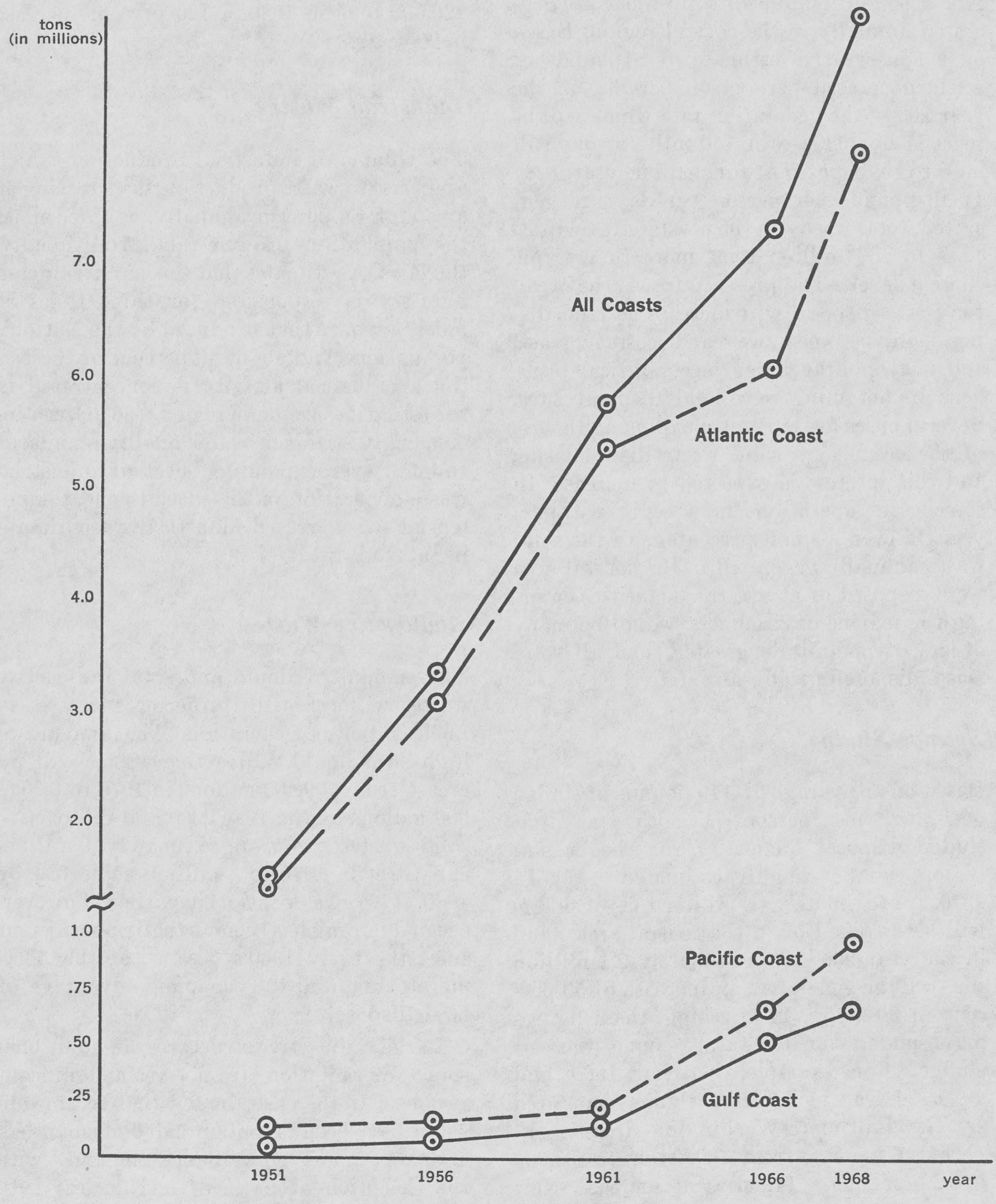
Coastal area	1949–1953		1954–1958		1959–1963		1964–1968	
	Total	Avg./Yr.	Total	Avg./Yr.	Total	Avg./Yr.	Total	Avg./Yr.
Atlantic Coast	8, 000, 000	1, 600, 000	[2] 16, 000, 000	3, 200, 000	27, 270, 000	5, 454, 000	31, 100, 000	6, 200, 000
Gulf Coast	[3] 40, 000	8, 000	283, 000	56, 000	860, 000	172, 000	2, 600, 000	520, 000
Pacific Coast	487, 000	97, 000	850, 000	170, 000	940, 000	188, 000	3, 410, 000	682, 000
Total	8, 527, 000	1, 705, 000	17, 133, 000	3, 426, 000	29, 070, 000	5, 814, 000	37, 110, 000	7, 422, 000

[1] Figures do not include dredge spoils, radioactive wastes, and military explosives.

[2] Estimated by fitting a linear trend line between data for preceding period and data for succeeding period.

[3] Disposal operations in the Gulf of Mexico began in 1952.

Figure 2.—Average Annual Tonnage Dumped at Sea—
by Coastal Area (66)



Solid Waste

About 65 million tons of solid waste are generated annually in the coastal region. Based on a conservative estimate of 8 pounds of waste generated per person per day in the year 2000—the generation rate which will be reached by 1980—over 150 million tons will need to be disposed of for that one year. (28) If 10 pounds per person per day are generated, total wastes in the coastal area will be close to 200 million tons, more than triple current levels. The pressure to use the ocean for waste disposal will increase as land disposal sites become more scarce, costs increase, and metropolitan areas face political problems in obtaining new land disposal sites. Several cities are currently exploring the use of the ocean as a solid waste disposal site, and this interest is expected to increase. In some cases operations may begin within a year. If even a small percentage of the solid waste annually generated in the coastal area were disposed of at sea, the quantities entering the marine environment would be many orders of magnitude greater than all solid waste disposed of at sea to date.

Sewage Sludge

Based on an average of .119 pounds of sludge generated per person per day, potential sludge disposal quantities for the coastal region can be roughly estimated. (37) In 1970, approximately 1.4 million tons of sludge will be disposed of in the coastal areas, and in the year 2000, approximately 2.1 million tons will be generated, an increase of 50 percent in 30 years. If anything, these figures may underestimate future quantities of sludge. For example, between 1960 and 1980, 20-year period, the sludge generated by the Baltimore-Washington area is expected to increase from 70,000 tons to 166,000 tons, or about a 140 percent increase. New York City's sludge barged to sea is expected to increase from 99,000 tons in 1960 to about 220,000 tons in 1980, a 120 percent increase in 20 years. (66)

Industrial Wastes

The volume of industrial production, which gives rise to waste production, is increasing at a rate of 4.5 percent annually, or three times the population growth rate. Additionally, the FWQA estimates that the manufacturing industry is responsible for three times as much waste as that produced by the Nation's population. And about 40 percent of the Nation's industrial activity is concentrated in the estuarine economic region. (36) Given increasingly stringent water quality standards and the ever expanding level of industrial waste generation in the coastal zone, the potential for increased industrial waste dumping at sea is great.

Radioactive Wastes

The amount of liquid and solid radioactive wastes will rise with projected increases in nuclear power generation. The amount of high-level liquid radioactive wastes will increase from 100,000 gallons in 1970 to 6,000,000 gallons by the year 2000 and radioactive solid wastes, from approximately 1 million cubic feet in 1970 to 3 million cubic feet by 1980. (70) As mentioned earlier, however, ocean dumping has been virtually nonexistent since the early 1960's because of the AEC moratorium and the economic advantage of land disposal.

Large radioactive structures, an additional source of radiation, are not yet a significant problem. In the past, the few that became obsolete have been decontaminated, dismantled, and kept under surveillance on land—with the exception of parts of one nuclear submarine, which were disposed of in the ocean. Currently, however, there are 16 nuclear power plants in operation, 55 under construction, and 25 for which construction permit applications are pending with the Atomic Energy Commission. (70) If current forecasts are realized, by the year 2000, the equivalent of up to 1,000 nuclear power units, each with a capacity of some 1,000 megawatts, may be operating. In addition, the Navy has about 90 nuclear-powered submarines and surface ships, and many more may be built in the next 30 years as a large portion of the current naval fleet is replaced. Commercial nuclear ships—currently the N.S. SAVANNAH is the only one—may become economically feasible in the future.

A lifetime of 10 to 30 years for the power plants' and ships' reactor vessels is reasonable in terms of physical or technological obsolescense. Their radiation levels vary considerably, up to 50,000 curies of induced radiation in each structure. (70)

Individually none of these sources adds significant amounts of radioactivity to the ocean. Taken together, however, the increases could be of significant concern.

Dredge Spoils

In the long run, the reduction of polluted discharge from municipal and industrial sources, brought about by water quality standards, will lessen the problem from dredge spoils. However, they will remain a problem for at least the next 5 to 10 years. During this period, there will be pressures for more dredging to deal with increasing marine commerce, to meet the desire of cities for new deep-water harbors, and to provide draft for larger vessels (including the supertankers used to transport oil). These needs will all increase total dredging and hence dredge spoils.

Explosives and Chemical Munitions

The following are Department of Defense estimates of conventional munitions planned for disposal: in 1970, 103,777 tons; in 1971, 88,835 tons; and in 1972, 80,000 tons. (26) These quantities are several times larger than the total volume of these wastes disposed of at sea in the last two decades. They indicate the quantities which would enter the marine environment if no other disposal technique were employed.

Chemical munitions have also been disposed of at sea in three deep-water disposal operations, but actual quantities involved are not known. No future ocean disposal operations are planned. Biological agents have not previously been disposed of at sea, and no future disposal is projected.

SUMMARY

The data indicate that the volume of wastes dumped in the ocean is increasing rapidly. Many are harmful or toxic to marine life, hazardous to human health, and esthetically unattractive. In all likelihood, the volume of ocean-dumped wastes will increase greatly due to decreasing capacity of existing disposal facilities, lack of nearby land sites, higher costs, and political problems in acquiring new sites.

CHAPTER II Ocean Pollution

Chapter II deals with the effects of ocean dumping in terms of the broader problem of ocean pollution. This view is necessary because wastes affect marine ecosystems no matter where or how the pollutants originate and because pollutants tend to interact, sometimes synergistically, in the environment.

Marine pollution has seriously damaged the environment and endangered humans in some areas. Shellfish have been found to contain hepatitis, polio virus, and other pathogens; pollution has closed at least one-fifth of the Nation's commercial shellfish beds; beaches and bays have been closed to swimming and other recreational use; lifeless zones have been created in the marine environment; there have been heavy kills of fish and other organisms; and identifiable portions of the marine ecosystem have been profoundly changed.

THE PATHWAYS OF POLLUTION

In order to understand the effects of pollutants on marine ecosystems, one needs to understand how pollutants are dispersed and concentrated. The dispersal of wastes depends on the material involved. Most wastes, but far from all, sink to the bottom. Others, such as solid waste, oil, and garbage, contain many floatable materials. Floating wastes can be transported great distances by current and wind. Early in 1970, the Heyerdahl expedition encountered wastes over large areas of water in mid-ocean, reporting that the ocean was "visibly polluted by human activity." (55)

Suspended materials, such as fine particles, are also transported by currents over great distances. For example, horizontal currents flush the 500 square miles of the New York Bight, completely exchanging the water in less than 1 week. (42) Vertical movement is considerably slower, and pollutants may remain in layers of water for quite some time.

Pollutants enter living systems through biological concentration. Billions of tiny phytoplankton organisms act as a great biological blotter, picking up nutrients, trace metals, and other materials. Organisms feed on the phytoplankton and successively pass the pollutants on to higher organisms. As this process moves through the food chain, concentrations reach their highest levels in predators such as marine mammals, birds, and man. An example of the food chain may be seen in the North Atlantic—1,000 pounds of phytoplankton produces:

100 pounds of zooplankton or shellfish

50 pounds of anchovies and other small fish

10 pounds of the smaller carnivores

1 pound of the carnivores harvested by man. (41)

The concentration of chemicals by phytoplankton and subsequent further concentration within the food chain have lethal and sublethal effects on organisms.

Heavy metals have been found in toxic concentrations in plankton, seaweed, and shellfish, although levels of concentration in the surrounding water were not high. The ability of biota to concentrate materials varies from a few hundred to several hundred thousand times the concentrations in the surrounding environment. (8, 42, 48) Table 1 shows phytoplankton concentration factors for selected metals.

EFFECTS ON MARINE LIFE

Pollution affects marine life directly through toxicity, oxygen depletion, biostimulation, and habitat changes.

TABLE 1.—*Phytoplankton Concentration of Some Heavy Metals.* (45)

Metal	Concentration factor
Aluminum	100,000
Cobalt	1,500
Copper	30,000
Iron	45,000
Lead	40,000
Radium	12,000
Zinc	26,000

Toxicity

Although plants and animals are sometimes killed by toxic wastes, organisms may be affected by concentrations far below the lethal level. Sublethal effects include reduced vitality or growth, reproductive failure, and interference with sensory functions.

Copper was found in the waters of the New York Bight in concentrations greater than 0.120 milligrams per liter. (8) These concentrations, found throughout the water column, indicate widespread copper contamination.

With even lower concentrations of copper, laboratory experiments have shown that:

- Concentrations of 0.1 milligrams per liter killed soft clams in 10–12 days. (62)
- Concentrations of 0.05 milligrams per liter killed polychaete worms in 4 days. (63)
- Concentrations of 0.1 milligrams per liter inhibited photosynthesis in kelp 70 percent in 9 days. (16, 17)

Pesticides and other toxic materials are a major cause of fish kills in fresh water. Although there are few recorded fish kills in the ocean resulting from pesticides, pesticide concentrations are rising every year. They reduce the size and strength of mollusk shells. Reduced growth rate and reproductive activity in fishes exposed to sublethal doses of pesticides and copper have also been shown. (54)

Pesticides endanger higher predators because of biological concentration. For example, pesticides amplified through the food chain damage birds' reproductive capability and in some cases seriously reduce their populations. The peregrine falcon is the most dramatic example; pesticide accumulation through the food chain has led to drastic reduction and projected extinction in the coterminous United States.

Oil introduced into the marine environment produces several adverse effects: Reproduction and other behavior is altered. Direct contact with respiratory organs weakens or kills animals. And oil clogs their filtering mechanisms. (67) Experiments with oysters have shown that when water-soluble fractions of oil were introduced into water, the amount of water filtered by the oysters decreased from between 207 and 310 liters per day to between 2.9 and 1.0 liters after 8 to 14 days. (13)

Cancer in fishes is very likely a result of contact with certain waste products. Cancerous growths on the lips of croakers have been found in areas of the Pacific Ocean polluted by oil refinery wastes. (65) Growths on several species including White Seabass and Dover Sole caught in oil polluted areas have been reported. (72) Oysters and barnacles are also known to concentrate cancer-producing agents.

Laboratory tests with "black liquor" from a paper mill showed that 0.05 grams per liter affected photosynthesis and 1 gram per liter killed the four species of phytoplankton tested. (66)

In laboratory experiments with polluted sediments from the New York Bight disposal area, the following sublethal effects were shown:

- Serious infections were found in native species.

- Bottom waters inhibited phytoplankton cell growth and division. (34)

Lethal and sublethal effects from toxic wastes are complex and not well understood. But evidence is mounting that these effects may be widespread and very harmful to the marine environment. Their potential for deferred and long-range ecological damage must be taken into account in any program to control ocean dumping.

Oxygen Depletion

Oxygen supports marine and aquatic life and is necessary to the biological degradation of organic materials. Organic wastes dumped or discharged into water bodies demand oxygen to decompose. If waste loads are too heavy, the oxygen levels become depleted and the diversity of marine organisms is altered.

Many of the Nation's rivers, estuaries, and harbors are in this condition. In the Potomac estuary, severely polluted by municipal wastes, dissolved oxygen levels approach zero in some reaches during low flow periods of warm summer months. (33)

When all the oxygen is depleted, organisms die, and anaerobic bacteria produce hydrogen sulfide and methane gas, which are malodorous. Large amounts of oxygen are required to decompose some materials. The dissolved oxygen in 320,000 gallons of air-saturated sea water is required to oxidize 1 gallon of crude oil completely. (64) If the oxygen level is already low, damage from oil spills may increase.

Dumping undigested sewage sludge in the ocean can create a significant demand on the dissolved oxygen. And oxygen depletion can develop rapidly. In the New York Bight waste disposal area, where sludge has been dumped for 40 years, the oxygen concentration as a percent of saturation declined from 61 percent in 1949 to 59 percent in 1964. It then dropped to 29 percent in 1969 and was as low as 10 percent in the center of the dump. (42) This may indicate that a threshold was reached and that the water quality then deteriorated rapidly.

Oxygen levels fell below those necessary to sustain life in species of lobster and crab normally found in the area. Researchers have noted that:

> the most striking effect observed was the *extreme depletion of dissolved oxygen* in the bottom waters over the disposal areas during the summer months. Levels frequently fell below 2 parts per million during the period from July to mid-September . . . This condition is undoubtedly caused by the heavy oxygen demand of the organic-rich waste materials coupled with the reduced mixing rates normally found during the summer. (43)

Oxygen deficit in a waste disposal area may be self-perpetuating. The accumulation of organic matter, sulfides, and some metals can act as a reservoir of future oxygen demand. Even after the disposal of the organic matter is stopped, it may be a long time before the area recovers.

Biostimulation

Some wastes, such as sewage sludge, are particularly rich in nutrients, such as phosphates and nitrates. These nutrients can cause biostimulation—the accelerated fertilization of plant life. When the plants die, oxygen necessary to support marine life is used in their decomposition. And when dead algae are carried to beaches, they rot and produce unpleasant odors.

By creating excessive blooms of algae, biostimulation indirectly changes the nature of bottom sediments and thus whole communities of bottom organisms. For example, areas which formerly supported surf clams in sand may become covered with an algal mud to which the surf clams cannot adapt. Sediments adjacent to disposal areas show greatly increased concentrations of organic matter. Some come directly from the wastes, but other material filters down from algal blooms. (2)

In the past, biostimulation has been recognized as a major problem of fresh waters, but not of the oceans. Increasingly, however, biostimulation is affecting estuaries and bays and even some portions of the continental shelf.

Shock

Explosions from dumping of munitions cause death in marine organisms surrounding the explosion point. The Department of Defense calculates that detonation of 1,000 tons of explosives—the approximate amount contained in the September 4, 1970, "Deep Water Dump" off Washington State—generates a shock wave that will kill most marine animals within 1 mile of the explosion and will probably kill those fish with swim bladders [1] out to 4 miles from the explosion.

Habitat Changes

Evidence indicates that waste disposal practices drastically alter certain marine communities. Habitat changes are the most common change that can affect entire ecosystems.

The most pronounced ecological changes, caused by dumping sewage sludge and polluted dredge spoils, have been found in the New York Bight. The consistency of bottom sediments changed from sand or hard mud to muddy ooze. Nematode worms, normally tolerant of pollution, were completely absent from the center of the dredge spoil dump and were found in very low numbers in the center of the sewage sludge dump. (2)

Changes in the kinds and quantities of sediments deposited may alter ecosystems. The plague of starfish in the Pacific may be an example of this effect. In recent years, the numbers of Crown of Thorns starfish have multiplied. This coral-eating starfish has devastated large areas of the coral reefs off many Pacific islands and the Great Barrier Reef of Australia. The population explosion may be linked to sediment protecting the larval starfish from their predators, which normally keep the population in balance. The sediment results from blasting, dredging, and dumping.

Significant changes in the benthic ecology of the Southern California coast have been caused by wastes from several municipalities. (11) These wastes brought about a shift in the marine population. Large numbers of sea urchins replaced other organisms and grazed off most of the giant kelp beds near the sewer outfalls. Because of the commercial value of giant kelp and the habitat it provides for many marine animals, the changes were an economic and an ecologic loss.

Habitat changes may be quite subtle. Near a sewer outfall off San Diego, species variety declined an average of 30 percent. Populations of remaining species sometimes overran their food supply. The loss of species diversity made the ecosystem less stable. (71)

HUMAN IMPACTS

Public health problems are created by toxic agents and pathogens that find their way into the human food chain through seafood. Floating refuse and surface films reduce recreation opportunities and damage esthetic values. Economic losses are incurred when seafood

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[1] A large group of fish with respiratory organs that adjust to different depths.

species are killed or are rendered inedible by pollution.

Public Health

The standard method for determining the potential public health hazard of fish is the coliform bacteria count. (These harmless bacteria are rough indicators of pathogens.) If the count exceeds Food and Drug Administration (FDA) standards, shellfish beds are closed to harvesting.

Effluents from land-based sewage outfalls are the major source of coliform bacteria, but ocean dumping of sewage sludge is also significant. The FDA found that ocean bottom sediments up to 6 miles from the New York Bight sludge dump contained coliform counts that exceeded permissible levels. On May 1, 1970, this area, 12 miles in diameter, and a similar area off Delaware Bay were closed to shellfishing. Clams harvested for sale in the New York Bight contained coliform bacteria 50 to 80 times higher than the standards set by FDA. (2)

Hepatitis virus are carried by shellfish. A 1961 outbreak of infectious hepatitis was traced to raw shellfish taken from Raritan Bay, N.J. (36) Shellfish have been collected with polio virus concentrated to at least 60 times that of surrounding waters. (52)

White perch have become actively infected with human pathogens by exposure to human wastes, and they may transmit these pathogens over considerable distances. Exposure is sufficient for them to develop antibodies to such human diseases as pseudo-tuberculosis, paratyphoid fever, bacillary dysentery, and a variety of chronic infections. (40)

Aquatic and marine organisms are capable of concentrating radioactivity to high levels (45). In a study near Oak Ridge National Laboratory, dead embryos and abnormalities appeared in irradiated broods of killifish. This is the only example of a natural marine or aquatic population subjected to high-level irradiation over many generations. (68)

Hydrocarbons of the type known to cause cancer in man and animals are concentrated by oysters and mussels in polluted areas. These substances remain invisible and odorless in seafood tissues, even after frying. (28) Cancer in humans has not yet been traced to consumption of carcinogens from seafood, but public health officials do not discount the possibility.

Between 1953 and 1960, 111 persons were reported to have been killed or to have suffered serious neurological damage near Minamata, Japan, as a result of eating fish and shellfish caught in areas contaminated by mercury. Among these were 19 congenitally defective babies whose mothers had eaten the fish and shellfish. Subsequently, at Niigata 26 more cases of mercury poisoning were noted. (1) The fish eaten by the affected Japanese contained from 5 to 20 parts per million of methyl mercury.

Mercury pollution recently discovered in 33 States and in Canada caused many fishing areas to be closed. Concentrations of as high as 5 parts per million have been found in fish in the Great Lakes. (1)

Loss of Amenities

The coastal zones provide recreation and beauty for the 60 percent of the Nation's people dwelling there. Oceans afford swimming, boating, water skiing, sport fishing, and wildlife viewing opportunities,[2] and they are some of the most scenic areas of the United States.

Many beaches have been closed to swimming because of the high coliform content of the water. Most closed beaches are near large

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[2] The Bureau of Sport Fisheries and Wildlife estimates that as many as 100 million people observe the wildlife of the U.S. estuarine zones.

metropolitan areas, such as San Francisco and New York. Floating materials, such as solid waste and oil, pose a major threat to amenity values. Rotting algae and anaerobic waters cause unpleasant odors and visual pollution. And debris are often a hazard to small boats.

Economic Loss

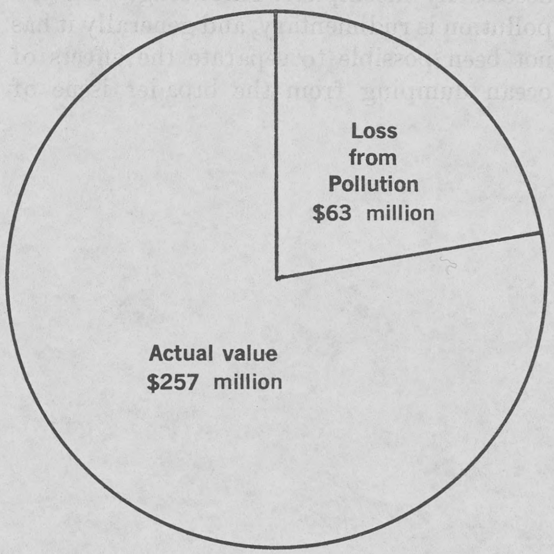
Significant economic losses result from ocean pollution. A major loss is the commercially valuable fish or other seafood species killed directly or indirectly or rendered inedible. They represent serious social and financial losses because of the near subsistence level of many fishermen.

In 1969, the total catch of crabs, lobsters, shrimp, oysters, clams, and scallops was 729 million pounds. Because one-fifth of the Nation's 10 million acres of shellfish beds are closed due to contamination, it can be estimated that the total catch would have been 181 million pounds higher. This estimate is probably low, since the closed areas are particularly productive—in lush estuarine systems in close proximity to large cities where they would have been harvested intensively. Figure 1 indicates the financial impact assuming a loss of one-fifth the potential catch.

The loss is well documented in San Francisco Bay. (36) Prior to 1935, the annual commercial harvest of soft shell clams was between 100,000 and 300,000 pounds. Today clam-digging is virtually nonexistent because of pollution. The annual commercial landings of the shrimp fishery prior to 1936 were as high as 6.5 million pounds; landings in 1965 were only 10,000 pounds.

Contamination by pesticides or mercury has rendered nine species of fish unfit for consumption by humans. Many States have

Figure 1.
Potential Value of U.S. Shellfish Catch, 1969
$320 million



banned fishing and impounded fish because of mercury poisoning, and the FDA impounded coho salmon due to high levels of DDT.

Even where contaminant levels do not prevent safe consumption, the food may be discolored or tainted. Sludge decay can result in the production of hydrogen sulfide, which blackens the shells of clams and oysters and affects their taste and odor. (36) In even very small amounts, oil can taint the flesh of fish. The discharge residue from burning 2.6 gallons of a gasoline-oil mixture in an outboard motor was sufficient to taint fish in 1 acre-foot of water. (67)

A further ocean dumping cost is that of cleaning up or rehabilitating polluted beaches and other shores. If projected increases in solid waste are dumped at sea, continuous and expensive clean-up operations will be required.

SUMMARY

The information presented in this chapter is necessarily incomplete. Knowledge of ocean pollution is rudimentary, and generally it has not been possible to separate the effects of ocean dumping from the broader issue of ocean pollution. Yet one general conclusion is apparent: There is reason for significant concern. Dealing with ocean pollution requires that all sources be greatly reduced. If no action is taken and ocean dumping continues to increase, the long-term damage to the marine environment will be great.

CHAPTER III

Alternatives to Ocean Dumping

The critical or potentially critical sources of ocean pollution and their effects on the marine environment are described in Chapters I and II. Based on these findings, a strong national policy has been recommended to stop or limit ocean dumping substantially. The extent to which the recommended policy can now be implemented depends on existing alternatives for handling wastes.

This chapter sets forth alternatives, both interim and longer term. The interim alternatives discussed are practical, available disposal techniques which can be used now to reduce or prevent damage to the marine environment without shifting the problem to another part of the environment. Long-term alternatives look toward recycling, resource conservation, and more economic and environmentally safe techniques of waste management. Costs and capacity are estimated to indicate the impact of the alternatives.

The types of wastes for which alternatives are presented include: solid waste, sewage sludge, dredge spoils, industrial wastes, construction and demolition debris, radioactive wastes, and explosive and chemical munitions.

Although dredge spoils and industrial wastes are the two largest sources of ocean dumping, solid waste is discussed first because the alternatives are largely applicable to the other wastes dumped in the ocean.

SOLID WASTE [1]

The amount of solid waste dumped in the ocean is not yet significant, less than 1 percent of all wastes disposed of in the ocean. Only about 26,000 tons were dumped in the ocean in 1968, (66) compared to the 190 million tons of municipal solid waste collected and disposed of on land. (28) However, many communities are beginning to look to the ocean as a place to dispose of solid waste in light of increasing population; increasing per capita rates of solid waste generation; and the declining capacity, increasing costs, and lack of nearby land disposal sites. If many coastal cities were to dump solid waste in the ocean, many millions of tons would be introduced annually into the marine environment. Although little research has been done on how solid waste affects marine ecology, it is known that improper disposal of solid waste on land seriously contaminates ground water. Further, floating materials from the solid waste dumped in the ocean would be unattractive, especially when carried to shore. Accordingly, the policy recommended would prohibit new sources of solid waste in the ocean and call for phasing out existing sources.

Interim Alternatives

Nationwide, landfill capacity is generally adequate. The average time remaining for currently used landfills in all metropolitan areas is 16 years, although some large metropolitan areas will soon exhaust their current sites. (28) Only 10 percent of land disposal operations are sanitary landfills, in which the wastes are covered daily by soil. The other 90 percent are open dumps, which create many health and esthetic problems. Rodents and insects breed and carry infectious diseases, and ground water often becomes polluted. Esthetically, open dumps are unattractive and malodrous. Converting open dumps to sanitary landfills can be accomplished relatively quickly and inexpensively.

There are two alternatives to ocean dumping of solid waste. New sites can be developed, but often at a considerably increased distance. Or incinerators can be constructed. By reducing the volume, possibly up to 90

[1] Includes residential, commercial, industrial, institutional, and agricultural solid wastes.

percent, they can prolong the use of existing sites by many years.

The barriers to acquiring new sites are political and financial. Communities are reluctant to be the dumping ground for the wastes of large metropolitan areas, and transport to distant sites increases costs. Transfer stations and rail or transfer truck operations make these longer hauls more costly than collection vehicles' traveling only a few miles to the disposal area. But they provide more flexibility in site selection. The barriers to the construction of new incinerators are largely financial. They are expensive to build and to operate. More stringent air pollution standards will add to both capital and operating costs.

Comparative costs for various alternative methods of disposal are shown in Table 1. As it indicates, the additional costs for use of rail haul and land disposal instead of ocean dumping are not so high when the distances are comparable. For example, when the wastes are transported 50 or 100 miles by either method, the costs of land disposal are less than 10 percent higher.

If conducted correctly, rail haul and land disposal offer an economically attractive method of disposing of solid waste. However, the political problems are a significant barrier to a good economic and environmental solution. A stronger regional approach to waste management, better disposal operations, and adequate payment for the use of land could well overcome these barriers.

One possible alternative deals with the problems of both solid waste disposal and abandoned strip mines. Because of the small incremental costs involved in rail haul, large coastal cities could haul their wastes to these mines economically.

Available acreage within range of the three coastal areas has been estimated. In the mid-Atlantic States of Ohio, Pennsylvania, West Virginia, Virginia, New York, and New Jersey, over 660,000 acres of unreclaimed surface-mined land are available. Over 300,000 additional unreclaimed acres are available in the Gulf Coast States, Texas, Alabama, Mississippi, Louisiana, and Florida. On the West Coast, California and Nevada have approximately 150,000 acres of available, unreclaimed surface-mined land.

Nationwide, surface mining has disturbed over 3.2 million acres of land. The Department of the Interior estimates that over two-thirds of this acreage is completely unreclaimed. This 2 million acres represents 3,300 square miles of potential solid waste disposal sites. (31)

TABLE 1.—*Comparison of Estimated Solid Waste Disposal Costs (28, 47)*

[On a cost-per-ton basis]

Unit process	Sanitary landfill at nearby site	Incineration at central city site	Rail haul and landfill			Baling and ocean dumping			Incineration ship-based
			50 mi.	100 mi.	150 mi.	20 mi.	50 mi.	100 mi.	
Collection [1]	$15.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00
Transfer operation [2]	0	0	4.05	4.05	4.05	4.20	4.20	4.20	0
Haul	0	0	2.65	3.00	3.45	.60	1.30	2.25	0
Disposal [3]	1.25	10.50	.65	.65	.65	0	0	0	10.89
Total	16.25	24.50	21.35	21.70	22.15	18.80	19.50	20.45	24.89

[1] Higher cost of collection for nearby landfill due to lack of central city site.

[2] Higher cost of ocean baling due to higher density requirements.

[3] Lower cost of landfill operation due to baling.

These figures do not consider suitability of terrain, amount of cover material, volume in need of fill, or other limiting factors. Nevertheless, there are access roads and rail lines to almost all this land, and if legal and social barriers can be removed, the problems both of providing large disposal areas and of reclaiming the land would be solved.

Containerizing wastes—that is, enclosing them in plastic or other material to prevent interaction with the sea—raises a number of potential problems. First, any containment system will still allow leaching of the wastes, some of which are toxic. Second, containment systems will probably not isolate the wastes from the ocean environment indefinitely. Plastics and other floatables are likely to be released eventually. As indicated in Table 1, the economics of containerizing wastes are not significantly better than for land disposal, assuming that solid waste would have to be dumped some distance from shore.

Ship-based incineration has also been suggested as an alternative disposal technique. It appears, however, to have little economic or environmental advantage. As Table 1 indicates, the costs are higher than for rail haul or land-based incineration. And difficulties of systematically locating and using sea dump sites may be a problem compounded by the difficulties of operating during bad weather. Further, many of the materials are noncombustible, and the effects of large amounts of ash residue on the ocean environment are not clearly known.

Longer-Term Alternatives

Although ship-based incineration may not be practical, other advances in incineration may have long-term benefits for solid waste management. A new type of incinerator, the CPU–400, is being developed under a Bureau of Solid Waste Management contract. Shredded and dried refuse is burned in a fluidized bed reactor to produce gas for turboelectric power generation. A 400-ton-per-day modular unit will produce up to 15,000 kilowatts of electric power. Total annual cost is projected at between $4.27 per ton for a municipal utility and $5.99 per ton for private ownership; the difference is a function of the interest rate. (18) (Current incineration costs are $10.50 per ton.) Depending on revenues from the sale of electricity and residue byproducts, the net cost could be reduced. Soon in the pilot plant stage, this incinerator may provide a low-cost, environmentally sound method of dealing with solid waste.

Recycling may also become general practice. Technology exists to recycle many types of paper, glass, aluminum, and ferrous metals, among others. Currently, 19 percent of the materials used to manufacture paper products in the United States are recycled rather than virgin materials. (28) Eighty-five percent of all automobiles taken out of service are recycled and used in steelmaking, and tires and aluminium cans are beginning to be recycled. (28) The problems and associated costs of separation; transportation; poor secondary markets; and other legal, economic, and social barriers have limited recycling. However, with new approaches to these barriers, new technology, and the need to conserve resources, recycling may become practical on a broad scale in the future. And as more materials are reused, disposal needs will lessen. It is important to note that inexpensive but environmentally unsound practices such as ocean dumping discourage waste reuse and recycling, which are desirable in the long term.

SEWAGE SLUDGE

In 1968, about 200,000 tons of sewage sludge on a dry basis were disposed of at sea, compared to about 3 million tons disposed of by other means. Increasing population and the higher levels of treatment required to meet water quality standards will generate even more sludge. Given the difficulties of sludge disposal and the high costs involved, pressures to use the oceans will necessarily increase. The environmental problems from sludge disposal in the ocean are significant, in terms both of volume and of the toxic and sometimes pathogenic materials involved. Accordingly, the policy recommended would phase out ocean disposal of sewage sludge and prevent new sources.

Alternatives (Interim and Longer Term)

Sewage sludge is primarily disposed of by using it as a soil conditioner or landfill and, to a much lesser degree, by incineration. The costs of present ocean disposal operations are generally far below costs for land-based disposal. Ocean disposal a few miles from shore costs an average $1 per ton. (66) Table 2 contains more detailed data on the per-ton-mile costs for longer hauls.

TABLE 2.—*Barge Haul Costs for Sewage Sludge Disposal* (37)

City	Distance (miles)	Cost per-ton-mile	Cost per ton
New York City	25	$0.30	$7.50
Elizabeth, Md	30	.23	6.90
Baltimore, Md	230	.08	18.40
Philadelphia, Pa	300	.04	12.00

Depending on distance, actual barge haul costs range from $1 to $12 per ton. Thickening, a process preparatory to barging, can add $2 to $6. Digestion can raise total ocean disposal costs by $5 to $18 per ton. Total ocean dumping costs can range from $3 for undigested sludge deposited nearshore to perhaps $40 per ton for digested sludge dumped several hundred miles offshore. The current average is low because most communities that use the ocean for disposal dump undigested sludge nearshore. Table 3 summarizes costs for land and ocean disposal of sewage sludge.

TABLE 3.—*Estimated Costs of Land-Based Sewage Sludge Disposal* (37, 50)

Location	Method	Cost per ton
Land	Digestion and lagoon storage (Chicago)	$45
	Digestion and land disposal [1]	22
	Composting	35–45
	Processing into granular fertilizer (net cost)	35–50
	High temperature incineration	35–60
Ocean	Barging undigested sludge	3–18
	Barging digested sludge	8–36
	Piping disposal	12–30

[1] At Chicago, with a 7-mile pipeline to the land disposal site.

These data indicate that land-based sewage sludge disposal is more expensive than nearshore ocean disposal. But when sewage is digested and barged a distance from shore, the costs become comparable, and land-based disposal may even be cheaper. As indicated in the discussion on solid waste disposal alternatives, the capacity does exist to handle more sewage sludge. But current land-based operations are often not adequate to protect the environment.

Pipeline disposal of treated sewage sludge, used by Los Angeles, has been proposed for other areas. Because piped and barged sludge materials are the same, the same policy is recommended. Further, the potential savings for piping are not significant in light of the potential environmental impact.

Piping digested sewage sludge 7 miles from Los Angeles costs an estimated $1.55

per ton. (37) FWQA estimates that current costs on the East Coast would double the net cost—a function of both increasing costs since the Los Angeles pipeline was constructed and the higher construction costs on the East Coast. Costs for longer pipelines to limit environmental damage would increase at a linear rate, and perhaps even faster, as the distance increased because of construction and pumping difficulties. A 30-mile pipeline might raise the cost to $12 per ton and a 50-mile pipeline to perhaps $20 to $30 per ton.

More promising is the use of digested sludge for land and strip mine reclamation and for a supplemental crop fertilizer. As discussed earlier, many strip mines are in need of reclamation. Sewage sludge is high in nutrient value and can be used to improve lands low in organic matter.

The Metropolitan Sanitation District of Chicago has intensively researched the environmental impact and potential of using digested sewage sludge as a crop fertilizer and in land reclamation. Their studies document the nutrient value, lack of odor, and safety when used on all types of land, including clay, sand, and acid strip mine tailings. Depending on crops and soil condition, other nutrients may be needed, but the sludge can supply much of the needed nutrients and moisture. Chicago now spends over $20 million annually to dispose of 900 tons (on a dry weight basis) of sewage sludge per day, using incineration, lagoon storage, and other methods. (50) The District is prepared to initiate a program of rail or barge haul for sludge disposal and land reclamation within a year. The program should cost approximately the same amount as current operations and has potential for large savings if pipe transport becomes feasible. Use of sludge for land reclamation looks promising, but it must be carefully controlled and monitored to assure no environmental harm.

In this discussion of land-based sewage sludge disposal, the alternatives to ocean dumping do not involve significantly greater costs. However, a phase-out period is required because of substantial commitments by some communities and the lead time necessary to develop the alternatives.

DREDGE SPOILS

Disposal of dredge spoils—38 million tons—represents 80 percent of all ocean dumping in 1968. (66) Removed primarily to improve navigation, spoils are usually redeposited only a few miles away. About one-third is highly polluted from industrial and municipal wastes deposited on the bottom. (22) Their disposal at sea can be a serious source of ocean pollution. The recommended policy to phase out ocean disposal of polluted dredge spoils recognizes that the speed of implementation depends almost entirely on available alternatives.

Interim Alternatives

Disposing of all dredge spoils on land is not possible simply because of the vast tonnage. The Corps of Engineers estimates that of the total dredge spoils removed from each coastal region, 45 percent, or approximately 7,120,000 tons, on the Atlantic Coast are polluted; 31 percent, or 4,740,000 tons, on the Gulf Coast, are polluted; and 19 percent, or 1,390,000 tons, on the Pacific Coast are polluted.

Until land-based disposal facilities can handle these quantities, the following interim operational techniques are recommended: First, the pollutant level of dredge spoils should be determined by sampling and analysis for such key factors as BOD and concentration of heavy metals. If the spoils are not polluted, they can be disposed of in the ocean.

However, care must be taken in the location of disposal sites and in the method of disposal in order to minimize turbidity and to protect marine life.

For polluted dredge spoils, current disposal practices are not adequate, but mitigation of damage to the environment is possible without recourse to sophisticated and/or expensive processing techniques. The estimated cost increases for hauling polluted spoils farther from the dredging site are presented in Table 4.

TABLE 4.—*Estimated Dredging Costs Per Cubic Yard (24)*

Method	1 mile	3 miles	10 miles	20 miles	50 miles
Hydraulic pipeline dredging	$0.95	$1.30	(1)	(1)	(1)
Dipper dredging and dump scows	1.10	1.25	$1.50	$1.80	$3.60
Hopper dredging	0.28	0.34	0.54	0.81	1.66

[1] Pipeline dredging operations beyond 3 miles are usually not practical because of problems in handling long floating pipelines and the extra pumping equipment involved.

Most spoils are now deposited within a few miles from shore in less than 100 feet of water. Table 5 summarizes the additional costs for disposing of polluted dredge spoils farther out to sea using a hopper dredge.

As the table indicates, the additional cost for dumping polluted dredge spoils 10 miles rather than 3 miles out is $2.7 million annually. For 20 miles, the additional cost is $6.2 million; for 50 miles, it is $17.5 million.

Diking is another interim alternative for disposing of polluted dredge spoils. Briefly, a dike is constructed to hold the dredge spoils nearshore or at the shoreline. Its effectiveness depends on the prevention of contaminated spoils' interaction with surrounding waters. At Cleveland, diking was successful in containing over 99 percent of the contaminants in dredge spoils removed from Lake Erie. (23)

Estimates for 35 dike projects on the Great Lakes indicated that the costs of diking and depositing dredge spoils vary greatly—from $0.35 to over $6 per cubic yard. (23) The increased cost for disposal by diking over open-lake disposal ranged from $0.03 to almost $5.50 per cubic yard, with an average increase of $1.50 per cubic yard.

Diking is not without environmental problems. Dredge spoils would not provide fill of sufficient strength to allow use of the diked area for many years. Hence, areas of the coastal zone, already in high demand, would be unusable. Further, diking is unattractive and may cause greater environmental problems than controlled dispersal of pollutants.

Longer-Term Alternatives

Reduction in the volume of sediments requiring dredging and higher levels of treatment of wastes will both lessen the problem of polluted dredge spoils. Erosion control through improved construction, highway, forest, and farm planning and management will reduce future dredging needs. One example is the recently completed stream bank stabilization project on the Buffalo River,

TABLE 5.—*Estimated Costs for Disposal of Polluted Spoils Using Hopper Dredge*

Coastal area	Tons	3 miles	10 miles	20 miles	50 miles
Atlantic Coast	7,120,000	$2,421,000	$3,845,000	$5,767,000	$11,819,000
Gulf Coast	4,740,000	1,612,000	2,560,000	3,839,000	7,868,000
Pacific Coast	1,390,000	473,000	751,000	1,126,000	2,307,000
Total	13,250,000	4,506,000	7,156,000	10,732,000	21,994,000

which reduced maintenance dredging requirements 40 percent. (23) The level of pollution in dredge spoils will be reduced by the higher levels of treatment of municipal and industrial wastes required by Federal-State water quality standards within a few years.

High-temperature incineration of contaminated dredge spoils is a longer-term alternative requiring further development and testing. Such incineration can render spoils an inert ash, safe for land disposal. Processing costs are a function of the size of the plant, the percent of total solids, and the percent of volatile solids. Figure 1 illustrates disposal costs per cubic yard for incinerating dredge spoils whose total solid content ranges between 30 percent and 45 percent (a normal range) and volatile solids between 10 percent and 20 percent (a normal range). Also shown are costs for aerobic stabilization, a process similar to that used for sewage treatment. These costs can range from $2 to $12 per cubic yard or roughly 4 to 24 times current ocean disposal costs. Compared to disposal 20 miles out to sea, however, incineration is 3 to 15 times as costly. But compared to disposal at 50 miles, incineration may cost the same or it may be as much as 8 times more costly.

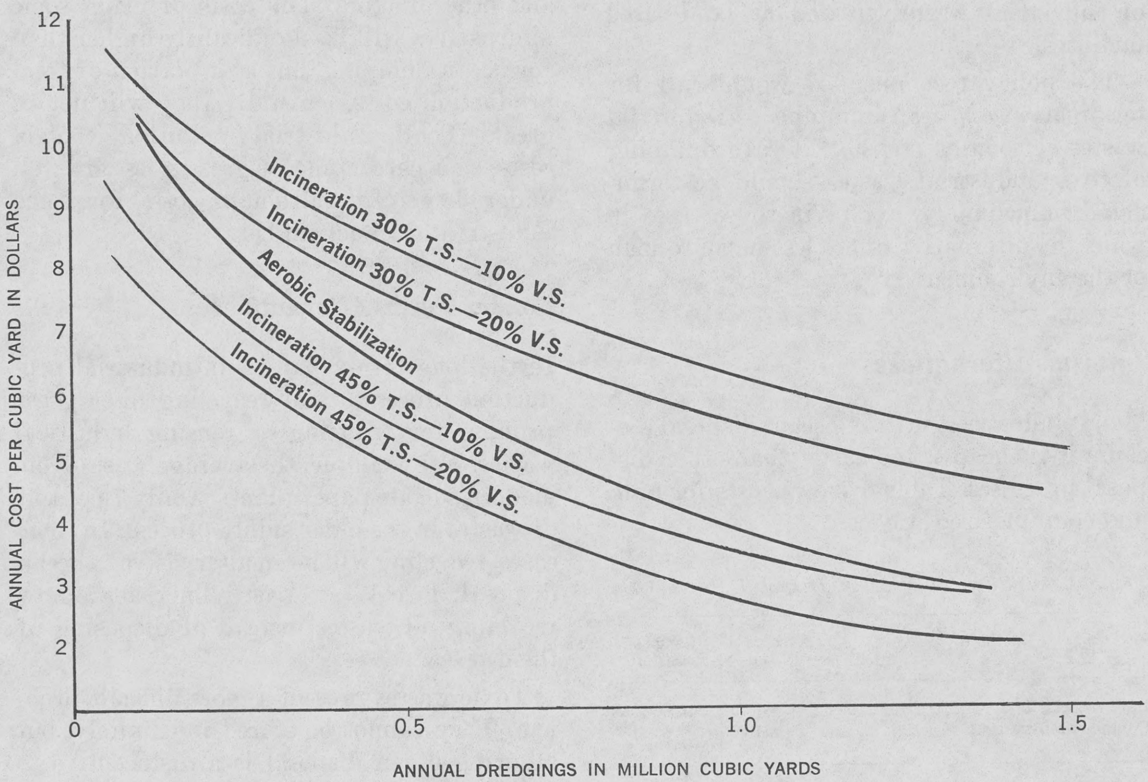


Figure 1.—Total Annual Cost Per Cubic Yard for Complete Treatment Using Incineration and Aerobic Stabilization (23)

T.S.=TOTAL SOLIDS

V.S.=VOLATILE SOLIDS

Special treatment to remove toxic materials so that the sludge may be used as a fertilizer either on arid lands or for ocean farming is possible. An approach similar to that discussed for use of digested sewage sludge as a fertilizer may be feasible.

INDUSTRIAL WASTES

Industrial wastes vary widely, but they usually contain nutrients, heavy metals, and/or other substances toxic to marine biota. Although the volume of industrial wastes is 10 percent of all wastes disposed of in the ocean, it is minor compared to the quantities of industrial wastes treated at land-based facilities.

The policy recommended would call for termination of ocean dumping of industrial wastes as soon as posssible. Ocean dumping of toxic industrial wastes should be terminated immediately, except in those cases in which no alternative offers less harm to man or the environment.

Interim Alternatives

Many industries utilize ocean disposal because it is cheaper and easier than other disposal processes. Table 6 shows costs for bulk and containerized wastes.

TABLE 6.—*Industrial Wastes Disposal Costs* (66)

Method	Average cost/ton	Range of cost/ton
Bulk wastes	$1.70	$0.60-$9.50
Containerized wastes	24.00	$5-$130

The costs of discharging bulk wastes directly into the sea are significantly lower than for other disposal techniques. Containerization, used mainly for toxic materials, is much more costly than dumping bulk wastes.

Industrial wastes can be treated and disposed of on land, or they can be incinerated. Whichever technique is used, it is necessary to assure that the environment is protected. Treatment of wastes should not add to stream pollution, and incineration should not add to air pollution. Deep-well disposal of toxic wastes is generally undesirable because of the danger of ground water pollution.

Unlike the other categories discussed, industrial wastes are not homogeneous. Hence, interim disposal methods will vary not only among the different types of wastes but also according to process, location, local practices, and other factors. The costs of using some alternatives will be significantly higher than for ocean dumping, but as a portion of total production costs, generally they will not be great. Total industrial pollution control costs, as a percentage of gross sales, are well under 1 percent, although costs for some industries are much higher.

Longer-Term Alternatives

In the long term, changes in industrial production processes and recycling offer great promise for reducing or reusing industrial wastes. For example, the average waste from modern sulfate paper plants is only 7 percent of wastes in the older sulfite process. In some cases, recycling will be an alternative to ocean disposal. Two West Coast refineries are now recycling oil wastes instead of disposing of them at sea.

Toxic wastes present a more difficult problem. They cannot be stored indefinitely, but allowing ocean disposal is a disincentive to development of adequate detoxification and recycling techniques and of production processes with fewer toxic byproducts. But highly toxic wastes will continue to be produced, and many will not be amenable to land disposal.

One alternative worthy of further study is the establishment of regional disposal, treatment, and control facilities. Federally or privately operated, the facilities could conduct research on and provide for waste detoxification and storage. Complicated disposal processes that are too expensive or complex for a single company could be used jointly to dispose of wastes. Fees would need to be sufficiently high to encourage development of private solutions, except in the most troublesome cases or when significant economies would result from shared use of facilities.

CONSTRUCTION AND DEMOLITION DEBRIS

Construction and demolition debris, less than 1 percent of all wastes dumped in the ocean, (66) are composed mainly of dense and inert materials. Because of the small amounts dumped and their character, these wastes are not a threat to the marine environment. Moreover, amounts dumped in the ocean are not expected to increase significantly because of their high value as landfill. The recommended policy assumes continued ocean dumping, but with care to prevent damage to the marine ecosystem.

RADIOACTIVE WASTES

Since 1962, no significant quantities of radioactive wastes have been dumped at sea. Rather, they have been stored at several sites operated or regulated by the Atomic Energy Commission or at sites regulated by the States. Increasing demands for electricity and for use of nuclear power portend a dramatic increase in the amounts and kinds of nuclear wastes produced. Hence, it is important to develop policy to prevent contamination of the ocean.

The policy recommended would continue the practice of prohibiting high-level radioactive wastes in the ocean. Dumping other radioactive materials would be prohibited, except in a very few cases for which no practical alternative offers less risk to man and his environment.

Alternatives (Interim and Longer Term)

The quantity of nuclear wastes is not large, and the technology for storing and treating them is well developed. However, the AEC estimates that the amount of high-level liquid radioactive wastes will increase approximately sixtyfold between 1970 and the year 2000. High-level wastes, usually liquid, are now stored on an interim basis in large, well-shielded tanks. In the long run, the wastes will be solidified, reducing their volume by a factor of ten, for eventual storage in special geological formations, such as salt mines. As new nuclear facilities are constructed, provision is being made for parallel construction of storage tanks and treatment facilities to handle the wastes.

Solid radioactive wastes have been buried in carefully controlled landfill sites. In 1970, about 40,000 cubic yards of solid radioactive wastes will be buried in approximately 15 acres. (70) The increase in the amount of these wastes in the next decade will require about 300 acres. This figure could be reduced with compaction and incineration, which are currently being used or planned.

Low-level liquid wastes from nuclear power generation, medical facilities, etc. are treated and/or stored to reduce radioactivity. A small amount is eventually released to the environment under controlled conditions.

Large radioactive structures, chiefly reactor vessels and associated parts, have heretofore not presented a significant problem. With the exception of ocean disposal of the SEAWOLF submarine reactor vessel, obsolete reactor vessels and associated parts have been decontaminated, dismantled, and stored on land. Sixteen nuclear power plants are now operating, and 80 are either under construction or permit applications are pending. There may be as many as 1,000 plants by the year 2000. When reactor vessels are taken out of service, each used structure is a source of high-level induced radiation.

There are three alternative ways to dispose of these vessels and associated parts: ocean disposal; entombment in place, with final disposition after radioactive decay; and dismantling and burial. Ocean disposal is the cheapest method when the facility is on the coast or when waterborne transportation is available. Entombment provides an opportunity to monitor disposal operations carefully but occupies valuable land during the period of radioactive decay. Dismantling and burial is the most expensive of the alternatives.

Because of the need to keep all sources of radioactivity at the lowest possible level, ocean disposal of the wastes should be avoided except when no alternative offers less harm to man or the environment. These cases should be carefully examined to assure that no safe and practical alternatives do exist. If ocean disposal is necessary, it should be carefully controlled.

EXPLOSIVES AND CHEMICAL MUNITIONS

Large quantities of explosives and some chemical warfare agents have been disposed of at sea. No biological warfare agents have been disposed of at sea. The policy recommended would prohibit ocean disposal of chemical and biological warfare agents and phase out disposal of explosive munitions.

Alternatives (Interim and Longer Term)

Ocean disposal of munitions was developed as an alternative to burning them in the open. That practice is often hazardous, is noisy, and creates air pollution.

Other alternatives to ocean dumping are available and should be used. In some cases weapons can be dismantled and critical components, such as gunpowder, lead, etc., either disposed of safely or sold for reuse. Centralizing the disposal of obsolete munitions may be desirable to provide efficient dismantling. Alternatively, portable disposal facilities, under development by the Department of Defense, offer promise. When salvage value is significant, commercial contracting for disposal services may be possible. Mass underground burial or detonation is another alternative.

The alternatives used for disposal of munitions will depend on ability to train people for disposal operations, relative costs, available sites, and their environmental impact. Dismantling and recycling the materials is the preferable alternative from an environmental point of view, but facility and manpower constraints may dictate the use of other alternatives to ocean dumping.

For chemical warfare agents and munitions, the alternatives to ocean disposal are neutralization and incineration. Toxic chemical warfare agents can be separated from munitions or containers and then treated. Facilities are currently being modified at the Rocky Mountain Arsenal near Denver, Colo., for disposal of toxins. Similar facilities for treatment of chemical warfare agents are needed elsewhere. (26)

SUMMARY

Interim alternatives exist to mitigate the environmental damage of ocean dumping. Land capacity can be expanded by use of rail haul, and strip mines and other lands can be reclaimed. In the long run, technological advances and new methods of recycling should help reduce pressures for ocean disposal. The major conclusion is that a program of phasing out all harmful forms of ocean dumping and prohibiting new sources is feasible without greatly increased costs.

CHAPTER IV Legislative Control of Ocean Dumping

The previous chapters indicate the need for a national policy to control ocean dumping. This chapter examines the adequacy of State and Federal regulatory authorities to implement that policy.

STATE CONTROL ACTIVITIES

Although by tradition and Federal law the States have primary responsibility for water pollution control, the response of the coastal States to ocean dumping has not been extensive. Where the Federal Government has assumed authority over ocean dumping—in New York, Baltimore, Boston, and Hampton Roads, Va.—States have subordinated their activities to Federal control.

In some circumstances States exercise regulatory authority. California, for example, through State and regional agencies, has provided the leading role in control of ocean dumping of such materials as municipal garbage and industrial chemicals and solid waste. In the San Francisco Bay area and in the San Diego area, regional water quality control boards regulate ocean dumping operations and provide for monitoring and surveillance to enforce the regulations. Disposal operators are required to file detailed trip reports and a monthly summary of the volume and types of wastes dumped. In the San Diego area, prior notification of ocean dumping is required so that a board staff member can accompany the dumping vessel. In the Los Angeles area, the California Department of Fish and Game is the lead agency. In Oregon, the State Board of Health regulates ocean dumping, with special emphasis on chemicals. No other States regulate ocean dumping to a greater extent than California and Oregon.

State regulation has not established a basis for an extensive and comprehensive method of controlling ocean dumping. Besides general lack of authority and programs, State jurisdiction would generally be limited to the 3-mile territorial sea.

FEDERAL CONTROL ACTIVITIES

Four Federal agencies have some responsibilities for ocean dumping: the Corps of Engineers, the Federal Water Quality Administration, the Atomic Energy Commission, and the Coast Guard.

Corps of Engineers

The Corps of Engineers is the only agency with regulatory authority to control dumping of a broad class of materials. This authority stems from Corps responsibility for maintaining navigation in U.S. territorial waters. In general, the Corps has no power other than in internal navigable waters and in the territorial sea.

Special authority for the port areas of New York, Baltimore, and Hampton Roads, Va., was given to the Corps of Engineers under the Supervisory Harbors Act of 1888 (33 U.S.C. 441–451b). Under that Act, the Corps exerts jurisdiction over ocean dumping beyond the territorial sea by controlling transit through the territorial sea. The Act provides for the appointment of a harbor supervisor to control ocean dumping, authorizing him to issue permits for the transportation and dumping of materials into the ocean. For ocean dumping in territorial seas, the Corps relies on both section 4 of the Rivers and Harbors Act of 1905 (33 U.S.C. 419) and section 13 of the Rivers and Harbors Act of 1899 (33 U.S.C. 407). Through the regulatory and permit authority conferred by the Supervisory Act, logs and fathometer charts are required of tugboat operators transporting material for dumping to provide surveillance of their operations. Infrequent ship and aircraft patrols are made for the same purpose. The permit operation has three steps: application by the prospective dumper according to the type of waste, issuance or rejection of a permit by the Corps after review, and monitoring of operations by the Corps as waste materials are transported to the designated dumping grounds.

The Corps has cautiously exercised its power under the 1899 and 1905 Acts. Its policy on enforcing these authorities can be attributed largely to emphasis on navigation in the enabling statutes. Until recently there was considerable doubt whether the Corps could deny a permit to a prospective waste disposal applicant for any reason other than obstruction to navigation. These doubts were dispelled only on July 16, 1970, when, in *Zabel* v. *Tabb*, —— F. 2d —— (5th Cir.), a Federal circuit court reversed a district court ruling. The district court disputed Corps authority to consider environmental as well as navigational factors in denying a permit and directed that the permit be granted. The circuit court, relying on the Fish and Wildlife Coordination Act (16 U.S.C. 661–666c) and the National Environmental Policy Act of 1969 (42 U.S.C. 4331–4347), held that the Corps does have this authority and could deny the permit.

Despite jurisdictional limitations, the Corps has occasionally concurred in ocean dumping outside the territorial seas when its direction was requested. For example, dumping areas have been established off Boston Harbor by the Corps, but with full recognition that authority was lacking. In such instances the action is taken at the request of the user. Often when the Corps receives a request to dump in areas beyond the territorial sea, it simply issues a letter of no objection. Prior to issuing such a letter, the Corps consults other governmental agencies such as the Fish and Wildlife Service of the Department of the Interior and the fish and game department of the affected State.

In the New York Bight area, the Corps has designated areas for the deposit of rock, dredged material other than rock, cellar dirt, sewage sludge, chemicals, and other substances. Specific regulations define the areas in which dumping can take place. Special permits, usually of 3 months' duration, are issued for the transit of material to the dumping areas.

Criminal penalties are authorized to punish violations of the various Corps authorities. Fines of up to $2,500 may be levied, or imprisonment up to 1 year may be imposed. Under the Supervisory Harbors Act, when dredged matter is illegally dumped, a fine of $5 per cubic yard of material can be prescribed.

Corps authority over ocean dumping has several limitations: First, with the exception of three harbors, it is restricted to the 3-mile territorial sea; yet most waste disposal sites lie outside the territorial sea. Second, its authority originates from responsibility for the navigability of waterways, not for their ecology. Third, while operational authority is lodged in an agency with responsibility to promote navigation, the water quality agency has no direct control over actions of the operating agency. In fact, the Corps could conceivably issue permits for activities that FWQA believes damage the quality of marine waters. Fourth, to a large extent the Corps regulates itself because it is a major producer of dredge spoils, the material most commonly dumped at sea. This is the type of conflict of interest that the creation of the Environmental Protection Agency was designed to prevent. Nonethless, the Corps has capabilities which could be effectively used to implement the recommended policy on ocean dumping. It possesses a large field organization strategically located in areas where ocean dumping regulatory action is important.

Federal Water Quality Administration

The Federal Water Quality Administration (FWQA), in the Department of the Interior, administers section 10 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 466g). Under this section, States develop water quality standards for interstate and coastal waters within their jurisdiction. The standards require Federal approval, thus becoming joint Federal-State standards.

These standards consist of water quality criteria (e.g., 5 parts per million of dissolved oxygen) to meet designated water uses (e.g., water supply, recreation, etc.). The standards must also include an enforcement and implementation plan in which remedial measures are to be taken in accordance with a schedule for achieving the water quality levels established. The Federal Water Pollution Control Act provides procedures for abating pollution which violates water quality standards, endangers health or welfare, or interferes with the marketing of shellfish in interstate commerce.

The Administration has proposed amendments to the Federal Water Pollution Control Act (S. 3471) that would authorize the Secretary of the Interior to establish water quality standards for the contiguous zone when pollution in these waters is likely to cause pollution in the territorial sea and to set standards for discharge beyond the contiguous zone of substances transported from territory under U.S. jurisdiction. The legislation would also call for specific effluent discharge requirements for all discharges into waters covered under the Act.

The authority of FWQA under the Federal Water Pollution Control Act, even with the proposed new amendments, would not be adequate to control ocean dumping. First, there is no authority for requiring permits to dump wastes in the oceans—authority essential to enforcement of any effective control program. Second, the Act's general thrust is control of continuous discharges that clearly violate the water quality standards, rather than control of intermittent dumping.

Other sections of the Federal Water Pollution Control Act deal with ocean disposal of specific materials or classes of materials. Section 11 of the Act prohibits discharge of harmful quantities of oil into the navigable waters of the United States and the contiguous zone, but it deals only with oil and is aimed chiefly at spills, rather than at purposeful dumping.

Section 12 of the Act provides authority for Federal agencies to clean up and to prevent discharge of hazardous substances into the navigable waters of the United States and the contiguous zone. Hazardous substances are those that present an imminent and substantial danger to the public health and welfare. Many materials now dumped in the oceans could be classified as hazardous: solid waste containing heavy metals, DDT, or other persistent pesticides and sewage sludge from limited-treatment facilities. But regulating intentional ocean disposal of materials is beyond the scope of section 12.

Section 13 of the Act provides for control of sewage from vessels, chiefly by requiring the installation of marine sanitation devices.

Although FWQA lacks authority for issuing permits to control ocean dumping, it has several related responsibilities. These include approval, and in some circumstances establishment, of water quality standards in interstate and coastal waters; enforcement; research; technical assistance; monitoring; and other water quality functions.

Atomic Energy Commission

The Atomic Energy Act of 1954 authorizes the AEC to regulate the receipt, transfer, and possession of nuclear source, byproduct, and special materials (42 U.S.C. 2077, 2092, 2111); these include most radioactive substances. In addition, the AEC has authority to regulate and control contractually the use of radioactive materials for its own activities, such as AEC-supported research and development programs. These authorities cover ocean disposal of radioactive materials but not other wastes.

Coast Guard

The Coast Guard is the principal maritime law enforcement agency. It enforces or assists in the enforcement of all Federal laws on the high seas and waters subject to the jurisdiction of the United States and has authority to make inspections, searches, seizures, and arrests. In addition, the Coast Guard can assist other Federal agencies and State and local governments in carrying out their responsibilities. The Coast Guard's law enforcement capability can be an effective means of enforcing controls and standards set by other agencies, but it has no independent authority to control ocean dumping.

RECOMMENDATIONS

Authority to control ocean dumping is currently dispersed among several agencies. Jurisdiction is generally confined to the territorial sea, where most material is currently not dumped. Authority that is now used for control is not lodged in agencies responsible for environmental control. Conflicts of interest exist in that some regulatory powers are exercised by agencies with operational responsibilities in the same area.

These problems must be resolved before a national policy on ocean dumping can be implemented. Full regulatory responsibility—involving both setting standards and issuing permits—should be placed in one organization. The Council recommends that this agency be the Environmental Protection Agency.

The organization charged with implementation of the national policy should have as its chief purpose the protection of the environment. It should also command sufficient research and monitoring resources for evaluating the environmental effects of the broad spectrum of materials currently dumped in the oceans.

Authority to control ocean dumping must be tied closely to efforts to abate other sources of pollution in the marine environment. Municipal and industrial discharge in rivers and harbors, urban and rural runoff, and other sources are important components of marine pollution. A regulatory program for ocean dumping should be defined to complement the efforts in these other areas.

Most of the wastes now dumped in the oceans originate in the United States and are transported to sea for dumping. Accordingly, primary jurisdictional emphasis should shift from a territorial basis to regulation of the transportation of materials from the United States for dumping.

The Environmental Protection Agency will have the broad responsibility as well as the necessary supporting programs to protect the marine environment. To give it the power to regulate ocean dumping, legislation is required.

CHAPTER V *International Aspects of Ocean Disposal*

The oceans of the world are a truly international resource, forming a vast environmental system through which its components circulate or are dispersed by currents and the migrations of organisms. They are critical to maintaining the world's environment, contributing to the oxygen-carbon dioxide balance in the atmosphere, affecting global climate, and providing the base for the world's hydrologic system.

Within the oceans, fish may travel great distances during their lifetimes. Although the oceans are important to all nations, they are particularly significant for many developing countries, which increasingly depend on fisheries for essential protein. A disturbance in the chemistry of the oceans which could be multiplied in the food chains would have a major impact on food-deficient nations. Hence, pollutants from one country may ultimately affect the interests of many other nations.

WORLDWIDE CHEMISTRY OF THE OCEANS

Of the materials entering the oceans through natural processes, the amounts of two, mercury and lead, have probably been doubled by man's activities. In addition, man has introduced new chemical compounds, such as chlorinated hydrocarbons (including DDT), gasoline, dry cleaning solvents, and other organic materials, whose biological significance is unknown.

The rate of transfer of mercury from land to oceans by natural weathering is estimated at 5,000 tons per day. (38) This amount, about one-half the total world production of mercury, is used by agriculture and industry in such a way that it eventually enters the oceans. As yet, this approximate doubling has not been chemically measured, but it is thought responsible for the 10 to 20 times increase in mercury found in sea birds off Sweden between prewar years and the 1950's (5) and for additions to the high mercury content of fish off Japan.

Natural weathering introduces into the oceans about 150,000 tons of lead each year. Man introduces about 250,000 tons in the Northern Hemisphere alone (69). Most of this lead is derived from the washout into the oceans of atmospheric lead produced by burning gasoline enriched with tetraethyl lead. Industrial waste products further contribute lead. Over the last 45 years these additions have raised the average lead content of ocean surface waters from 0.01–0.02 to 0.07 micrograms per kilogram of sea weater. (19) Slow mixing within the oceans keeps the lead within the upper layers, the region where biological productivity is greatest and the chances of biological enrichment highest. However, the biological effects of this changing lead concentration remain unknown.

Industrial wastes and sewage sludge also introduce large quantities of such metals as vanadium, cadmium, zinc, and arsenic. Man's contribution relative to nature's is not known, but civilization may well be close to matching nature's contribution of these materials to the oceans.

The fact that man is changing the chemical composition of the oceans focuses attention on the need for international action to control the introduction of wastes into the ocean.

INTERNATIONAL LAW ON WASTE DISPOSAL

In an environmental sense there are no subdivisions within the oceans. The highly productive coastal waters are continuous with and contribute to the biologic activity of the deepest trenches. Legally, the oceans are divided into the seabed and the superjacent waters, and further subdivided into distinct zones with particular legal characteristics. International law governing ocean waste disposal must take into account these legal characteristics and the material to be dumped.

Four conventions, referred to as The Law of the Sea Conventions, were adopted at Geneva in 1958 codifying existing international law and establishing new rules governing the law of the sea. The Convention on the Territorial Sea and the Contiguous Zone sets out three zones—the territorial sea, the high seas, and the contiguous zone between them.

Narrow bays, estuaries, and other semienclosed areas are classed as internal waters. Seaward of the internal waters and of the low-water line along uninterrupted coasts is the territorial sea, extending for 3 miles. Between 3 and 12 miles from the shore is the contiguous zone. The contiguous zone, together with the waters lying seaward of it, comprise the high seas. Each has distinct legal characteristics affecting rights to dispose of materials in it and to control such disposal.

A coastal state (nation) has exclusive control over its internal waters and its territorial sea. In these areas, the coastal state has exclusive power to determine dumping sites and to enact necessary sanitary and pollution laws to protect its citizens and their property. These laws can be enforced against ships of both the coastal state and of foreign registry. In addition, a coastal state may control the transport of waste products from its ports. However, in its territorial sea, the coastal state must permit the innocent passage of foreign vessels that do not prejudice its peace, good order, or security. As discussed in Chapter IV, Congress has enacted legislation that covers ocean disposal of oil and sewage wastes from vessels.

Within the contiguous zone, 3 to 12 miles out to sea, the coastal state may exercise some control necessary to prevent pollution. The right to exercise these controls in the contiguous zone, however, does not change the high seas status of those waters. Under the terms of the Convention on the Territorial Sea and the Contiguous Zone, a coastal state cannot act to prevent dumping in the contiguous zone unless such action is necessary to prevent infringement of sanitary regulations within its territorial sea.

The international law governing the high seas, the largest jurisdictional zone, is codified in the 1958 Geneva Convention on the High Seas. This Convention provides for freedom of navigation and of fishing, freedom to lay submarine cables and pipelines, freedom to fly over the high seas, and other freedoms recognized by international law, such as dumping.

The Convention sets forth two fundamental concepts: It declares the high seas as an area not subject to sovereignty, and it states that the freedoms of the seas which are recognized in international law must be exercised by states with reasonable regard to the interests of all other states in their exercise of freedom of the high seas. Inasmuch as one use may interfere with another current or potential use of the high seas, the reasonable regard standard holds that there must be an accommodation of the various and possibly conflicting uses of the high seas.

The right to dispose of waste materials in the high seas is a traditional freedom of the seas. However, under the standards set out in the Geneva Convention on the High Seas, this freedom—like all other freedoms of the seas—must be exercised with reasonable regard to other states' use of the oceans. It is not possible to say that any particular waste disposal or dumping project will meet the requirements of international law. Only after careful consideration can it be determined that a particular ocean dumping proposal meets the reasonable regard standard set out in the Convention. For example, a project for disposal of unpolluted dredge spoil may be suitable for an area of the high seas in which disposal of chemical waste would neither be suitable nor legal.

Unfortunately, the law of the sea conventions do not establish a hierarchy of ocean uses. However, international law places paramount importance on the protection of human life. It allows destruction of property to save human life or to prevent greater property damage. Clearly, any dumping activity that threatens life or directly damages property violates international law.

It is important to recognize that the law of the sea is based primarily on conventions or other agreements which were concluded prior to current understanding of the actual and potential impacts of dumping on the marine environment. Consequently, present international law appears inadequate to deal with possible long-term environmental effects of various actions.

INTERNATIONAL ACTIVITIES

Many international organizations engage in activities related in some way to marine pollution. Most of these activities are designed to exchange ideas and/or to coordinate national efforts. It is important to recognize, however, that in most cases, their concern with ocean pollution and particularly with ocean dumping is only incidental or peripheral. Although efforts such as the International Decade of Ocean Exploration will provide useful data, the IDOE does not give the highest priority to ocean pollution. Combined annual expenditures on activities designed to improve environmental quality, of which ocean waste disposal problems constitute but a small part, probably do not exceed $5 million, a small sum compared with the $100 million of the FWQA in fiscal year 1970 for water pollution control and research alone.

Research concerned with ocean pollution and establishment of controls on waste disposal is undertaken mainly through national efforts, rather than by the intergovernmental agencies. Even national efforts are limited. Basic studies of the character of the oceans and the seabeds have dominated U.S. oceanographic research. There has been little or no emphasis on such questions as the capacity of the oceans to absorb wastes.

Several countries have begun to search for solutions. Canada is developing regulations governing the disposal of garbage and sewage from vessels. As now drafted, the regulations would apply to non-pleasure craft within the territorial sea and inland waters of Canada and would require new vessels in Canadian inland waters to carry sewage treatment equipment. The regulation would also prohibit discharge of garbage in all Canadian waters. Israeli scientists have been studying pollution of the Mediterranean coast off Tel Aviv since 1963. All new vessels constructed for the Argentine Merchant Marine are required to meet international standards on waste disposal, including holding tanks and oil-water separation tanks. Argentinian law also requires all foreign ships to be similarly equipped or access to Argentina ports will be denied. Similar legislation is contemplated for pleasure craft.

NEED FOR INTERNATIONAL ACTION

International cooperation is essential to preservation of the oceans. The quantities of wastes dumped in the oceans are increasing rapidly in this country and will increase internationally as other countries experience similar waste disposal pressures. Consequently, control of ocean dumping necessitates action.

Recognition of the need for international cooperation is an initial step toward reaching worldwide agreements to control ocean pollution. There will be obstacles. Nations' interests in the oceans vary, as do their ideas on the controls that may be required.

RECOMMENDATIONS

The United States should assist in finding a solution to the international problem of ocean dumping through a twofold approach. First, it must systematically attack its own problems. As a significant polluter of the ocean and at the same time a technologically advanced nation, the United States must show its serious intention to meet its responsibility as a matter of urgent national priority. In demonstrating determination to preserve the marine environment, the Nation will develop valuable information on costs, effects, and technology associated with ocean dumping and its alternatives.

Second, the U.S. should take the initiative to achieve international cooperation on ocean dumping. The Council on Environmental Quality recommends that at the outset the Federal Government develop proposals to control ocean dumping for consideration at international forums such as the 1972 U.N. Conference on the Human Environment at Stockholm. U.S. initiative should suggest a basis for international control over ocean dumping similar to the policy recommended in this report. Provision should be made for:

- Cooperative research on the marine environment and on the impacts of ocean dumping of materials;
- Development of a worldwide monitoring capability to provide continuing information on the state of the world's marine environment;
- Development of technological and economic data on alternatives to ocean disposal.

Domestic and international action is necessary if ocean dumping is to be controlled. The United States must show its concern by strong domestic action through implementation of recommended policy. But unilateral action alone will not solve a global problem. International controls, supported by global monitoring and coordinated research, will be necessary to deal effectively and comprehensively with pollution caused by ocean dumping.

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APPENDIX A

The President's Message on Waste Disposal

To the Congress of the United States:

The first of the Great Lakes to be discovered by the seventeenth century French explorers was Lake Huron. So amazed were these brave men by the extent and beauty of that lake, they named it "The Sweet Sea".

Today there are enormous sections of the Great Lakes (including almost all of Lake Erie) that make such a title ironic. The by-products of modern technology and large population increases have polluted the lakes to a degree inconceivable to the world of the seventeenth century explorers.

In order to contribute to the restoration of these magnificent waters, this Administration will transmit legislation to the Congress which would stop the dumping of polluted dredged spoil into the Great Lakes. This bill would:

—Discontinue disposal of polluted dredged materials into the Great Lakes by the Corps of Engineers and private interests as soon as land disposal sites are available.

—Require the disposal of polluted dredged spoil in containment areas located at sites established by the Corps of Engineers and approved by the Secretary of the Interior.

—Require States and other non-Federal interests to provide one-half the cost of constructing containment areas and also provide needed lands and other rights.

—Require the Secretary of the Army, after one year, to suspend dredging if local interests were not making reasonable progress in attaining disposal sites.

I am directing the Secretary of the Army to make periodic reports of progress under this program to the Chairman of the Council on Environmental Quality.

This bill represents a major step forward in cleaning up the Great Lakes. On the other hand, it underlines the need to begin the task of dealing with the broader problem of dumping in the oceans.

About 48 million tons of dredging, sludge and other materials are annually dumped off the coastlands of the United States. In the New York area alone, the amount of annual dumping would cover all of Manhattan Island to a depth of one foot in two years. Disposal problems of municipalities are becoming worse with increased population, higher per capita wastes, and limited disposal sites.

We are only beginning to find out the ecological effects of ocean dumping and current disposal technology is not adequate to handle wastes of the volume now being produced. Comprehensive new approaches are necessary if we are to manage this problem expeditiously and wisely.

I have therefore directed the Chairman of the Council on Environmental Quality to work with the Departments of the Interior, the Army, other Federal agencies, and State and local governments on a comprehensive study of ocean dumping to be submitted to me by September 1, 1970. That study will recommend further research needs and appropriate legislation and administrative actions.

Specifically, it will study the following areas:

—Effects of ocean dumping on the environment, including rates of spread and decomposition of the waste materials, effects on animal and plant life, and long-term ecological impacts.

—Adequacy of all existing legislative authorities to control ocean dumping, with recommendations for changes where needed.

—Amounts and areas of dumping of toxic wastes and their effects on the marine environment.

—Availability of suitable sites for disposal on land.

—Alternative methods of disposal such as incineration and re-use.

—Ideas such as creation of artificial islands, incineration at sea, transporting material to fill in strip mines or to create artificial mountains, and baling wastes for possible safe disposal in the oceans.

—The institutional problems in controlling ocean dumping.

Once this study is completed, we will be able to take action on the problem of ocean dumping.

The legislation being transmitted today would control dumping in the Great Lakes. We must now direct our attention to ocean dumping or we may court the same ecological damages that we have inflicted on our lands and inland waters.

RICHARD NIXON

The White House,
April 15, 1970

APPENDIX B

Task Force Membership

Council on Environmental Quality

Atomic Energy Commission
Division of Waste and Scrap Management

Department of the Army
Office of Chief of Engineers

Department of Commerce
Environmental Science Services Administration
Coast and Geodetic Survey

Department of Defense
Office of the Assistant Secretary for Health and Environment

Department of Health, Education, and Welfare
Public Health Service
Environmental Control Administration
Bureau of Solid Waste Management

Department of the Interior
Bureau of Commercial Fisheries

Department of the Interior
Federal Water Quality Administration

Department of State
Bureau of International Scientific and Technological Affairs
Office of Environmental Affairs

Department of Transportation
U.S. Coast Guard

Executive Office of the President
Office of Management and Budget

Executive Office of the President
Office of Science and Technology

National Council on Marine Resources and Engineering Development

National Science Foundation
Office of the Director

Smithsonian Institution
Oceanography and Limnology Program