SOME OBSERVATIONS ON OCEAN DUMPING

J. R. Schubel

June 1981

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The use of the oceans as a waste receptacle is a very old practice, one that dates back hundreds, probably thousands of years. Most marine waste disposal has occurred in estuaries that discharge into the oceans rather than directly into the oceans themselves. Ocean disposal is easy, convenient, and economical. We all know that the oceans are vast, and that their assimilative capacity, their capacity to receive wastes without unacceptable adverse biological impacts, is extremely large. We now realize, however, that this capacity is finite, that it varies geographically, and that it varies for different wastes. We also realize that our ability to predict the assimilative capacity of different segments of the world ocean for wastes, individually and collectively, is poor. Recently scientists have used the conceptual model of the ocean as a mixing basin into which we are continually titrating the additions of wastes. While conceptually appealing, the model is difficult to apply because usually we neither know the appropriate end points nor how to identify them. Usually we do not know where we are on the titration curve until we have gone too far...until we have overshot the end point...until we have added too much waste, and the use of the ocean, or a segment of it, as a waste receiver interferes with other uses society wishes to make of it.

The uses we make of the ocean include not only waste disposal, but also sand and gravel mining, oil exploitation, shipping and transportation, recreation, aesthetic enjoyment, and fisheries. On a global scale fisheries are probably the most important renewable use. U.S. fisheries alone amount to some 3 million metric tons per year with a value of $2 billion; more than 6% of the total world catch. All of these uses of the ocean are legitimate. But they make conflicting demands on the sea and above some threshold one use may adversely affect others. The conflict arises principally between fisheries and recreational uses on the one hand, uses which require the maintenance of certain levels of environmental quality, and those uses on the other which not only are not dependent upon environmental quality, but which may lead to a degradation of existing quality.

We can point to coastal areas of the world ocean where waste disposal already has adversely affected environmental quality and living marine resources; where it has resulted in the loss of recreational resources, in the closing of beaches, and shellfish beds. We have seen all of these losses in the New York Bight region. In coastal marine environments around the world we can even point to areas where there have been serious human health effects resulting directly from the input of wastes. We are all familiar with the Minamata incident.

The first year that people began to take serious note of the volumes of wastes we dumped into the ocean as a Nation was 1968. A total of nearly 63 million metric tons of solid wastes was dumped from barges into the ocean by the United States in 1968. This accounted for approximately two percent of the total mass of solid wastes generated by the United States during that year. Estimates of the direct inputs of different kinds of solid wastes by barges are summarized in Table 1.

Waste disposal in the ocean is clearly a large volume business and the metropolitan New York-New Jersey area is a leader. Our motto might be "When it comes to waste, New York and New Jersey are experts." The 500,000 km^2 area of the New York Bight that stretches from Cape May (NJ) to Montauk Point (NY) and is bounded on its seaward margin by the edge of the continental shelf is the site of the United States' largest ocean dumping program. According to Dewling and Anderson (1976), approximately 80 percent of the nation's ocean dumping is carried

TABLE 1 Solid wastes dumped by barges into the ocean by the U.S. in 1968.

Waste	Mass in Millions of Metric tons
Dredged material	53
Sewage sludge	4.6
Industrial wastes	4.7
Cellar dirt (Construction and demolition debris)	0.5
Total Mass	62.8

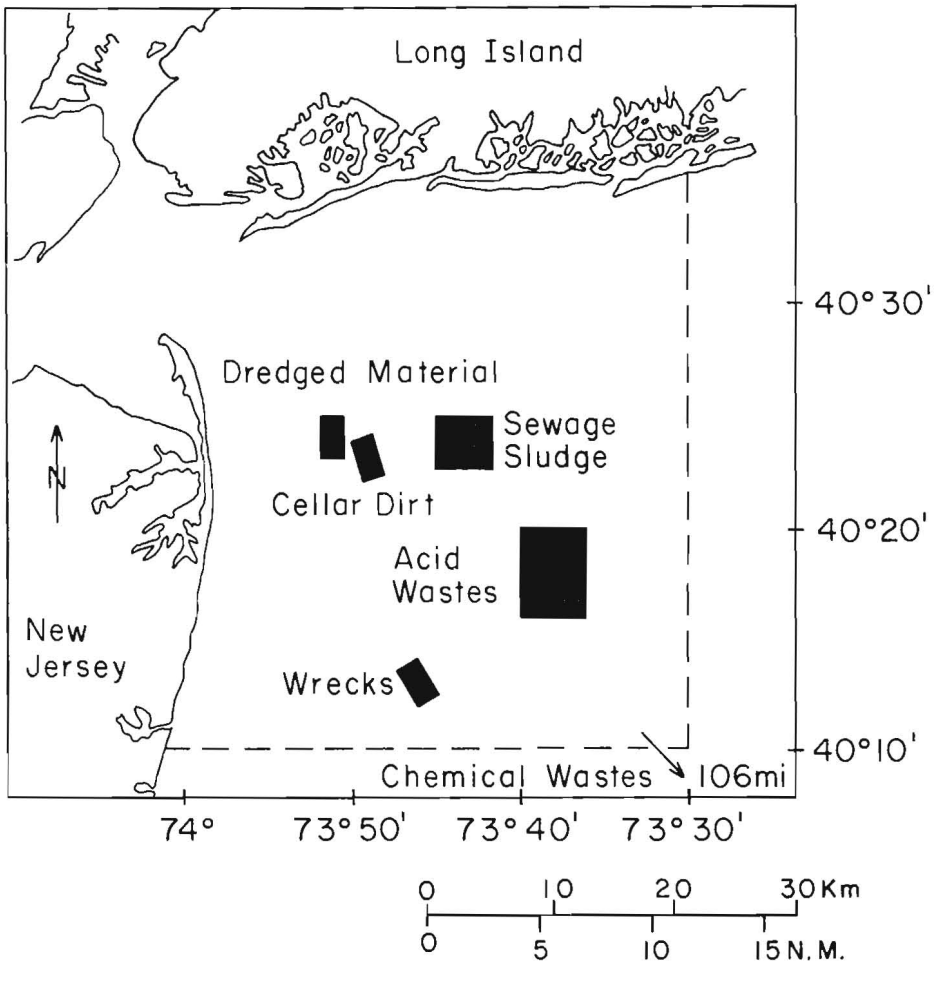

Fig. 1. New York Bight Waste Disposal Dumpsites.

out in the New York Bight.

Dewling and Anderson (1976) point out that of the total volume of waste materials dumped into United States coastal ocean waters, the New York Bight was the recipient of

- more than 85 percent of all municipal sludges dumped from barges (3,732,000 m^3)
- more than 65 percent of all industrial wastes (2,720,000 m^3)
- more than 90 percent of all acid wastes (2,272,000 m^3).

Gross (1976) estimated that between 1890 and 1971 a total of nearly 850 million m^3 of solid wastes were dumped in the New York Bight. This is approximately 25 times the amount of material removed for construction of the Panama Canal. Spread uniformly over Manhattan Island, these wastes would form a deposit more than 10m thick; a thickness roughly equivalent to the height of a three story building.

Several kinds of wastes are barged to the Bight and dumped there. These include: sewage sludge, dredged materials, industrial wastes, cellar dirt (excavation and construction materials), and wrecks. Wastes also are carried to the Bight by the estuarine discharge through the Sandy Hook-Rockaway Transect. Others are added directly to the Bight by rivers and streams, by the atmosphere, and by municipal outfalls. Still other wastes are added to and concentrated within the waters and sediments of the New York Bight Apex when meteorological and oceanographic conditions are "right" (or "wrong").

The quantities of wastes barged to the Bight are quite well known. The quantities of wastes added to the Bight by discharge through the Sandy Hook-Rockaway Transect are poorly documented, but are almost certainly at least an order of magnitude smaller in total mass and volume than the barged wastes. The qualities, the characteristic properties, of the wastes added to the Bight by barges and by other sources are relatively poorly known, although our knowledge in this area has improved dramatically within the past few years primarily because of the National Oceanic and Atmospheric Administration's Marine Ecosystems Analysis (MESA) New York Bight Project.

Locations of waste disposal sites in the New York Bight are shown in Fig. 1. Some have changed in the past few years. For example, some waste chemicals that had been dumped at the designated Apex acid waste site have been dumped at Deep Water Dump Site 106 since 1974. The dates when original New York Bight dumpsite locations were established are summarized in Table 2. It is clear that dumping in the New York Bight is not only of large proportions, but that it is a practice of long standing.

The relative contributions to the New York Bight Apex of different kinds of barged wastes are summarized in Table 3. In terms of total mass and volume of waste dumped, dredged materials dominate. The relative contributions of a number of the more important "contaminants" are summarized in Table 4. Once again dredged materials are the dominant source of most contaminants--in terms of mass. Sewage sludge dumping accounts for only some 5 to 15 percent of the total masses of most contaminants added to the Bight. It does *not* follow necessarily that of the various dumping activities, dredged material dumping has the most deleterious impacts on the environment and the biota. The effects of contaminants depend not only upon their total amounts and concentrations, but also upon the forms in which they occur since this determines their "availability" for uptake by organisms.

The composition of the various wastes obviously depends upon the kind of waste; sewage sludge is not the same as cellar dirt, or dredged material. But the composition of wastes of the same kind, or class, also varies widely, depending upon the sources of materials. Material

TABLE 2 Dates of Establishment of Original Dumpsites in the New York Bight.

Waste Material	Year
Dredged material	1888
Wrecks	1889
Cellar dirt	1908
Sewage sludge	1924
Acid waste	1948
Toxic chemicals	1965

TABLE 3 Annual Inputs of Barged Wastes to the New York Bight Apex.

Year	Sewage Sludge (Millions of Wet Metric Tons)	Acid Wastes (Millions of Wet Metric Tons)	Cellar Dirt Millions of m^3	Dredged Material (Millions of m^3
1973	4.25	2.50	0.35	6.35
1974	3.89	2.12	0.28	8.27
1975	3.87	1.89	0.14	4.89
1976	3.97	1.28	0.11	7.12
1977	4.07	0.64	0.03	4.04
Totals	20.05 (4.01)			

TABLE 4 Total Waste Mass Loads to New York Bight during 1973

	Percentage Contribution						
	Direct Bight		Coastal Zone				
			Wastewater		Runoff		
Parameter	Barge	Atmospheric	Municipal	Industrial	Gaged	Urban	Groundwater
FLOW	0.02	59	5	0.4	33	2	0.4
SS	63	5	4	0.2	16	12	Nil
ALK	1	Nil	35	0.3	59	5	0.03
BOD_5	21	9	48	2	11	9	0.01
COD	32	10	35	1	13	9	0.01
TOC	25	12	29	1	18	15	0.02
MBAS			86		5	9	0.05
O&G	38		22	0.7	16	23	
NH_3-N	24	4	55	3	10	4	0.04
ORG-N	19	9	45	2	21	5	0.02
TKN	21	6	51	2	15	5	0.02
NO_2+NO_3-N	0.07	33	6	0.3	60	0.6	0.7
TOTAL-N	16	13	40	2	25	4	0.2
ORTHO-P		1	72		18	9	Nil
TOTAL-P	50	0.7	35	1	9	4	Nil
Cd	82	2	5	0.6	5	5	0.001
Cr	50	1	22	0.8	10	16	Nil
Cu	51	3	11	9	10	16	0.006
Fe	79	3	5	0.5	6	6	0.01
Hg	9		71	2	13	5	
Pb	44	9	19	3	6	19	0.004
Zn	29	18	8	2	21	22	0.009
F. Coli - winter	0.01	Nil	87	0.2	0.01	13	Nil
summer	0.01	Nil	85	0.2	0.01	15	Nil
T. Coli - winter	0.01	Nil	91	0.1	0.05	9	Nil
summer	0.01	Nil	84	0.2	0.1	16	Nil

From Muller et al. (1976).

dredged from the Ambrose Channel in the Lower Bay is quite different from material dredged from the passenger slip terminal. And, sewage sludge composition reflects the makeup of the clientele in the area served by a particular treatment plant. The relative contributions from urban runoff and from industries are particularly important in determining contaminant levels. Sewage sludge from the Middlesex County Authority treatment plant which serves a highly industrialized area is not the same as sludge from the Oakwood Beach plant which does not. The characteristics of industrial wastes added to sewage systems and those dumped directly into the ocean are often dependent upon the cyclical and periodic nature of manufacturing runs. Not only do the total contaminant loads of wastes change, but the forms of the contaminants as well, and hence their "availability" to organisms.

Most of the more insidious contaminants are relatively insoluble in water and are attached to fine particles either before they enter the environment or soon after. They are rapidly scavenged from the water and once adsorbed to particles, their dispersal and accumulation are determined by the fine particle sediment system. Most of the contaminants added to the Bight are added to the Apex; most in particulate form; most are transported in barges. Not all stay there. It is a vigorous environment. The mean residence time of water in the Apex is only about one week and bottom currents are relatively strong.

The only documented accumulations of wastes on the bottom at the designated dumpsites are dredged materials, wrecks, and cellar dirt. Although some 20 million metric tons of sewage sludge have been dumped in the Bight since 1973, there is almost no accumulation of sewage sludge *at the dumpsite*.

In view of the intensity and diversity of the dumping activity in the New York Bight and the obvious degradation of environmental quality, it is not surprising that it was here where the ocean dumping act was born, or at least conceived. As stories of sludge monsters raising their ugly heads to cast covetous eyes on New York and New Jersey appeared, emotional outcries followed and policies were developed to assuage them. Let me sketch out very briefly some of the important history of those policies. You will hear more about these policies and their development later today.

Ocean dumping policies had their beginnings with NEPA, the National Environmental Policy Act of 1 January 1970. NEPA's declaration of purpose is succinct:

> "To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the nation..."

NEPA was an important piece of legislation. It forced Federal agencies to consider environmental impacts of their proposed activities, and gave public interest groups a voice in the decision making process. It would border on being un-American to criticize NEPA. Anyone concerned with the environment could hardly quarrel with the intent of NEPA. I shall not. But NEPA was procedural, not substantive. The voices had to be heard, but not heeded. The substantive laws followed.

The second important document was the report submitted by the Council on Environmental Quality (CEQ) to President Nixon in October 1970. The report contained the following recommendations:

- Ocean dumping of polluted dredged materials should be phased out as soon as alternatives can be employed.
- Ocean dumping of undigested sewage sludge should be stopped as soon as possible...and ocean dumping of digested or other stabilized sludge

should be phased out.

- 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 which no alternative offers less harm to man or the environment.
- The current policy of prohibiting ocean dumping of high level radioactive wastes should be continued.

The 92nd Congress passed six new statutes in response to NEPA. One of these was the Marine Protection Research and Sanctuaries Act, PL 92-532 (MPRSA), commonly called the Ocean Dumping Act. This act calls for the initiation of "...a comprehensive and continuing program of monitoring and research regarding the effects of the ocean dumping of material into our waters..."

The other five acts were:

(1) the Federal Water Pollution Control Act
(2) the Federal Insecticide Fungicide and Rodenticide Act
(3) the Coastal zone Management Act
(4) the Noise Control Act and
(5) the Marine Mammal Protection Act.

These were followed by other Acts in response to NEPA. In 1973, the 93rd Congress passed:

(1) the Endangered Species Act
(2) the Trans-Alaska Pipeline Authorization Act

and in 1974:

(1) the Forest and Rangeland Receivable Resources Planning Act
(2) the Safe Drinking Water Act
(3) the Deepwater Port Act.

in 1976 the 94th Congress passed:

(1) the Toxic Substance Control Act
(2) the Resource Conservation and Recovery Act (RCRA).

In 1977-78 the 95th Congress passed:

(1) major amendments to the Clean Air Act
(2) major amendments to the Federal Water Pollution Control Act
(3) Major amendments to the Safe Drinking Water Act
(4) major amendments to the Outer Continental Shelf Lands Act.

The Marine Protection and Sanctuaries Act (MPRSA) passed by the 92nd Congress was signed by President Nixon on 23 October 1972. In its final form the MPRSA states:

"The Congress declares that it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of any material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."

One response to the MPRSA was the establishment in 1973 of the MESA New York Bight Project which was designed to determine the condition of the New York Bight ecosystem, and to identify the practical significance of the environmental problems facing the Bight and its users. The consequences of ocean dumping in the New York Bight were to be examined in the context of its overall quality and other contaminant sources to the Bight. A secondary aim of the MESA Project was to provide a sound rationale for assessing ocean dumping in other areas. You will hear a summary of some of the findings of the MESA program later today by Dr. Swanson.

In 1977, during the MPRSA reauthorization process in the house, Congressman Hughes of New Jersey proposed a legislative finding that *all* sewage sludge would, by definition, "unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." The Hughes Amendment which grew out of the events of summer of 1976--the anoxia event and the floatable event--proposed an absolute ban on the disposal of any sewage sludge at sea after 31 December 1981. The

Hughes Amendment was adopted by the subcommittee on Oceanography and Fisheries and Wildlife, Conservation and the Environment. Congressman Breaux (LA) introduced an amendment during debate by the full Merchant Marine and Fisheries Committee to delete the Hughes Amendment in its entirety. Mr. Hughes then offered a substitute for his original amendment which would require a 31 December 1981 cutoff date for the dumping of "harmful" sewage sludge.

After vigorous debate the bill passed the house by a vote of 359 to 1 and six days later was unanimously passed by the Senate. The bill has important implications, economic and environmental, to the region, and indeed to the nation. On the surface, the ban on "harmful" sewage sludge dumping at sea would appear to be a good policy. But is it? The implication is that sewage sludge dumping has degraded the ocean; that if it is halted, there will be a recovery. As an oceanographer I find something satisfying about stopping the disposal of sewage sludge or any waste in the ocean. But as a member of the broader scientific community and as a citizen, I must ask what are the alternatives and what are their consequences?

It is clear that the discharge of wastes to the New York Bight has degraded that environment and its ecosystem. It is not clear to what extent this degradation has resulted from disposal of barged wastes, individually and collectively, and to what extent the degradation has been caused by the addition of wastes from other sources, particularly from the estuarine discharge through the Rockaway-Sandy Hook Transect. It is, in my opinion, unlikely that there will be measurable improvement in the quality of the waters, the sediments, or the ecosystem of the New York Bight with elimination of sewage sludge dumping in the absence of other remedial measures. It is unlikely that use patterns of these waters and contiguous shorelines will change with elimination of sewage sludge dumping in the absence of other remedial measures. It is unlikely that beach openings and closings will be affected by cessation of sewage sludge dumping in the absence of other remedial measures.

Does this mean that we should not eliminate sewage sludge dumping in the New York Bight in 1981...or in 1982...or in? Does this mean that we should write off the New York Bight as a recreational resource, as a segment of our coastal marine environment with a well-balanced indigenous population? Does it mean that we should designate the New York Bight as the Metropolitan New York-New Jersey waste disposal area? Not necessarily. But perhaps some level of waste disposal is an appropriate use of the Bight.

As a Nation, we generate large quantities of wastes which must be recycled or disposed of somewhere in the environment. The environment has only three different compartments: the land, the water, and the air. Those are our options. Disposal of wastes must take place within these three media. Disposal in each has environmental consequences; consequences that are unacceptable to some public interest groups and environmental management agencies. Wastes discharged into the air may be returned to the water and the land. Wastes disposed of on the land may find their way into the water and the air. Wastes disposed of in the ocean may be transferred to the atmosphere and back to the land. The compartments are not closed.

We can and should reduce the volume of wastes that require disposal. We can and should improve their quality by reducing their contaminant levels. Government should continue policies to develop incentives and regulations to reduce both the amount of toxic materials that require disposal and their persistence. But no matter how successful we are in these endeavors, there will continue to be contaminated wastes which will require disposal. Furthermore, recycling and pre-treatment of

wastes take energy and cannot violate the conservation of mass. There are trade-offs that must be considered among the degree of pretreatment that is desirable, the energy required to attain it, and the environmental effects for different levels of treatment. In the case of treatment of sewage we have an ironic situation. Upgrading sewage treatment will produce in the future larger amounts of sewage sludge than we have had in the past. This sludge will require disposal. When upgrading of New York and New Jersey metropolitan area treatment plants is complete, the volume of sludge requiring disposal will be two to three times greater than at present. Unless programs of source control are instituted to eliminate, or at least substantially reduce, the additions of contaminants to sewers and storm drains, the contaminant levels of this sewage sludge will not be reduced. The quantity of sludge goes up, the quality remains the same. The result: the disposal problem will be exacerbated.

Problems of the disposal of contaminated dredged materials also will continue. A number of us have argued for more than a decade that we need to develop for each major estuary or port a regional dredged material management plan to ensure that maintenance dredging projects can be carried out without prolonged and costly delays and with acceptable and predictable risks to the environment and to the living resources, including people. The plans also should provide mechanisms for making decisions on new dredging projects. These plans should be based on an assessment of the environmental, economic, public health and socio-economic impacts of *all* alternatives.

Most of our ports and harbors have been dredged since Colonial days. They will continue to require maintenance dredging if they are to be operated in their present mode without serious economic perturbations. Even if we were to adopt a policy here today to eliminate the addition of all new contaminants to our waters, and if somehow that goal could be miraculously achieved at this moment, we still would be dredging contaminated sediments already within the environment for decades--perhaps for as long as a century--to come. Those are the time scales for sediments to move through major river systems like the Hudson.

Can we deal with these waste disposal problems more effectively in the future than we have done in the past? I believe we can. But it will require different approaches.

What we do *not* need are any more people to create environmental "boogie men"... sludge monsters lurking in the Bight, ready to rise up from the deep in the dark of the night to take over our beaches. What we do *not* need are any more policies that attempt to provide quick fixes to environmental problems by prohibiting disposal of wastes in one segment of our environment--in one medium--without considering the effects associated with transferring these wastes to another segment of our environment.

What is needed is *not* an identification and assessment of the alternatives *to* ocean disposal of sewage sludge, of dredged materials, or of any other waste material. Rather, what *is* needed is a clear statement of the disposal problems for each class of wastes, an identification of *all* the disposal options--including ocean disposal--and a rigorous assessment of the environmental, public health, economic, and socio-political impacts of each disposal alternative in each of the three media. More attention should be paid to potential public health problems. The economic considerations must include not only the costs of disposal, but also any losses of resources and uses associated with adoption of each disposal option. The affected groups and their gains and losses should be identified explicitly. Only after such analyses have been made can we choose the best--the most acceptable--disposal alternative. Only after such analyses are made should policy governing disposal be set.

It is at this point that our environmental advocates and politicians should become environmental statesmen.

Our compartmentalization of the environment in dealing with waste disposal problems is unsound scientifically and has served neither the environment nor society well. We need to take a holistic view of the environment in developing and setting waste disposal policy. We swim in and harvest seafood from the ocean, but we live on the land and drink water from its surface and groundwater, and we breathe the air that surrounds us. No segment is inherently more, or less, important than the others. We need to make such assessments on a regional basis. The "best" disposal choices for New York may well not be the "best" choices for Norfolk, Baltimore, or Los Angeles.

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