Despite society's clear desire to protect the environment, many estuaries and coastal waters in the United States exhibit adverse effects from waste disposal and other sources of pollutants. This is distressing because of the great commercial, recreational, ecological, and aesthetic importance of these waters. If the Nation wishes to further protect and improve the health of estuaries and coastal waters, increased efforts to minimize disposal, reduce the levels of pollutants in municipal and industrial discharges, and reduce runoff will be needed.

The ability to minimize disposal depends on the feasibility of management options on land and in the open ocean. This paper explores the relationship between current waste management policies in these other environments and attempts to minimize disposal in estuaries and coastal waters.

1. INTRODUCTION

Estuaries and coastal waters are among the most important of all aquatic environments with respect to their commercial resources, recreational uses, and ecological roles. They also are repositories for large amounts of pollutants derived from the disposal of various wastes and from runoff.

As a result of these pollutant inputs, many estuaries and coastal waters around the country have suffered significant effects. The overall trend during the last ten to fifteen years, though, has been mixed. Some areas that once exhibited severe effects have improved in recent years, but noticeable deterioration continues to occur or is accelerating in others. Attention has focused on well-documented problems in the northeastern United States (including the Chesapeake Bay and the New York Bight), southern California, and Puget Sound. Serious impacts, however, also have occurred in the much less-studied Gulf of Mexico and the southeastern United States.

The extent of degradation varies greatly around the country -- in type, spatial scale, duration, and commercial importance -- and includes:

- changes in water quality (eutrophication, hypoxia, turbidity, elevated concentrations of pollutants);
- loss of submerged aquatic vegetation;
- impacts on fish and shellfish (bioaccumulation of toxic chemicals, disease and abnormalities, reproductive failure, mortality);
- impacts on entire marine communities (changes in diversity, abundance, and distribution as reflected, for example, in declines in commercial fisheries);
- closures of beaches and shellfish grounds because of microbial or chemical contamination;
- a rising incidence of reported human disease, from consumption of contaminated shellfish or swimming in contaminated marine waters; and
- accumulation of toxic pollutants in sediments (in some cases, to levels that warrant classification as Superfund sites).

OTA's analysis indicates that among disposal activities, industrial and municipal pipeline discharges are at least as important as dumping in causing damages. Urban and agricultural runoff, although not classed as disposal activities, also are very important. To regulate discharges and dumping, the Federal government enacted the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act (MPRSA), respectively. The pollutant control programs and permitting procedures developed under these acts have helped reduce the amounts of some pollutants (for example, suspended solids, nutrients, and oxygen-demanding substances) entering marine waters.

As implemented, however, these regulatory efforts have not protected some estuaries and coastal waters from degradation. Moreover, even with total compliance, which is unlikely, existing regulations will not be sufficient to maintain or improve the health of all estuaries and coastal waters. For example, current regulations do not adequately address toxic metals and organic chemicals or runoff. Without additional measures to protect these waters, new or continued
degradation will occur in many estuaries and some coastal waters around the country during the next few decades -- even in some areas that exhibited improvements in the past.

2. VIEWING MARINE WASTE DISPOSAL IN A BROADER CONTEXT

The pollutant control programs established by the environmental statutes of the past two decades each tend to focus on abating pollution in one particular environment (water, land, or air). While such programs represent a reasonable first step in approaching pollution problems, they sometimes result in the shifting of wastes from one environment to another, with long-term environmental and human health risks not always being substantially reduced. The expected trend of degradation in estuaries and coastal waters is in part the result of the current lack of comprehensive management (including disposal) of wastes.

For this reason, a consensus has developed recently about the need for a more comprehensive waste management strategy. Some problems might be alleviated if policy choices about the role of marine waters in waste disposal are made within the context of a hierarchy of preferred waste management strategies. Tiers in such a hierarchy are generally considered to include:

- reduced generation of waste, with respect to both volume and toxicity (using techniques such as product substitution and process modification);
- when possible, recovery of waste for recycling or reuse of materials for energy;
- when beneficial uses such as recycling are not possible, choosing treatment, destruction, or stabilization options to reduce toxicity (using techniques such as incineration, or neutralization and evaporation); and
- disposal, using either a containment/isolation strategy (e.g., in landfills) or a dispersion strategy (e.g., dumping or discharge), depending on the characteristics of the waste.

None of these options eliminates risks entirely, and in some cases new risks can be created. Moreover, not all waste generation can be eliminated. Once wastes are generated, some type of "multimedia assessment" that compares the risks and feasibility of different treatment and disposal options can help determine which options: 1) cause the least damage to the environment and human health, and 2) are acceptable to society at large. A critical component thus is public acceptability of the option itself and of the decision-making process.

To the extent that waste generation can be reduced or that wastes can be reused, then the need for disposal in different environments (including marine waters) can also be reduced. Even with extensive waste reduction and reuse efforts, however, large amounts of municipal wastes, industrial wastes, and dredged material will continue to require disposal for the foreseeable future. These wastes will probably continue to contain organic chemicals, metals, conventional pollutants, pathogens, and nutrients -- limiting possibilities for their beneficial re-use (e.g., sewage sludge must be relatively uncontaminated if it is to be used on cropland).

In addition, pressures to continue current disposal activities in estuaries and coastal waters will increase for several reasons:

- the proximity of marine waters to major urban areas generating large amounts of wastes requiring disposal;
- increased coastal population and development;
- the frequently lower costs of marine disposal;
- limits on the economic feasibility of land-based disposal for some highly voluminous wastes (such as municipal effluents); and
- limits on the availability of land-based disposal options for some wastes (such as sewage sludge, dredged material, and some industrial wastes) because of increased public opposition or regulatory restrictions.

3. IMPLICATIONS OF MINIMIZING DISPOSAL IN ESTUARIES AND COASTAL WATERS

If maintaining or improving the health of estuaries and coastal waters is desired, given their importance, then the only other policy choice is to minimize waste disposal and pollutant inputs in these waters. To achieve this goal, it will be essential to increase efforts to reduce the levels of pollutants in municipal and industrial discharges, to reduce runoff where necessary, and to minimize waste disposal in estuaries and coastal waters wherever possible.

The ability to minimize disposal in these waters, however, may be precluded by policy decisions made about disposal on land or in the ocean. For example, one option to minimize inputs is to shift some disposal activities to the open ocean. For technical, logistical, and economic reasons, however, most pipelines cannot be extended much further offshore and out of estuaries and coastal waters, especially on the east and Gulf coasts. Shifting marine dumping of dredged material further out to sea may be prohibitively costly in many situations; this is one reason why at least some dumping of dredged material in estuaries and coastal waters will continue to be necessary.

Furthermore, shifting pipeline discharges (where feasible) and dumping to the open ocean would run counter to current attitudes about open ocean disposal. For example, the MPRSA generally is interpreted as having a goal of eliminating or minimizing dumping. Thus, a policy of shifting disposal to the open ocean could require some easing of current restrictions on open ocean disposal activities. Yet, maintaining the current
restrictive policy, because of concerns about the long-term health of the open ocean, could interfere with attempts to protect estuaries and coastal waters by shifting disposal. If all marine waters are given a high degree of protection, then ensuring the availability of alternative, land-based management options (such as waste reduction, treatment, and disposal) will be critical.

On the other hand, the MPRSA is the only environmental statute exclusively devoted to the protection of coastal waters and the open ocean and the only statute which explicitly requires consideration of alternative land-based options. Under the MPRSA, the EPA is required to balance the need for ocean dumping with potential environmental, social, and economic impacts of land-based disposal options. In contrast, other environmental statutes typically regulate disposal in one environment without explicitly considering the consequences in other environments. For example, the Resource Conservation and Recovery Act precludes land disposal under some conditions without requiring that disposal in other environments be evaluated first.

Some marine disposal activities could be moved to land, where some forms of reuse are possible. For example, uncontaminated sewage sludge might be used beneficially on land to fertilize farms and forestland; uncontaminated dredged material could be used to replenish beaches. The availability of many land-based options, however, is becoming more restricted because of economic constraints, land availability, public opposition, and local and State regulations.

For these reasons, several other, more feasible options for minimizing waste disposal and pollutant inputs in estuaries and coastal waters deserve more attention. First, continued and enhanced implementation of the present pollutant control programs could be pursued to provide a consistent level of protection. This approach will likely be sufficient in many areas, but it will require some combination of continued Federal, State, and local investments in: the construction of municipal treatment plants; enforcement efforts; and monitoring and research, for purposes of enforcement and evaluating long-term trends. In addition, pollutant controls could be expanded to cover a broader range of toxic pollutants and industrial sources.

Even these improvements in current pollutant control programs will not be sufficient to protect all estuaries and coastal waters. For example, the current technology-based programs do not address runoff (or other sources of nonpoint pollution), as mentioned above, nor are they capable of addressing other activities that can lead to degradation, such as habitat destruction or freshwater diversion.

Second, then, is the need to supplement current programs by developing additional means of waterbody management in many areas. The Federal government and some States have recognized this need and have developed "waterbody management" programs for some estuaries and coastal waters -- the Chesapeake Bay Program and the Puget Sound Water Quality Authority being noteworthy examples.

In general, individual waterbody management programs attempt to bring together all appropriate parties, identify the most important problems and their causes, and devise a management plan to alleviate the problems. In essence, these programs use a broad interpretation of the water quality-based approach in establishing site-specific goals and selecting the most environmentally and economically effective means of achieving those goals. Among other things, these programs require coordination among numerous local, State, and Federal agencies.

These waterbody management efforts appear promising, but they exist for only a few estuaries and coastal waters. Mechanisms to spur the development and adequate design of such programs are in need of further attention. One fundamental and critical link is missing -- a systematic framework for deciding which estuaries and coastal waters need help, either to reverse current degradation or to prevent significant degradation from occurring.

Developing a framework to identify waterbodies and help initiate management plans now seems appropriate. Some components of such a framework already exist in various institutional guises. At the Federal level, for example, these include:

- The Water Quality Act of 1987, which authorizes:
  - a National Estuary Program, under which the Environmental Protection Agency (EPA) can convene management conferences for individual estuaries and provide funding to NOAA for estuarine research;
  - a toxic "hot spots" program, in which States identify waters not expected to meet water quality standards because of toxic pollutants in discharges, even after dischargers meet permit requirements;
  - a nonpoint source pollution program, in which States are to identify waters not expected to meet water quality standards and submit to EPA a management program for nonpoint pollution;
- The Coastal Zone Management Act, which encourages States to develop management plans for estuaries, bays, and harbors that balance the pressure for economic development and the need for environmental protection;
- EPA's internal initiative on Near-Coastal Waters, which would provide for long-term planning in coastal waters;
- Section 208 of the Clean Water Act, which has set up area-wide management plans for point and nonpoint pollution; and
- Section 303(e) of the Clean Water Act, which specified that States establish water quality management plans for watershed basins.
Implementing a systematic framework may require, more than anything else, consolidation of these sometimes disparate efforts and some explicit Federal direction to develop other components. Without this, many estuaries and coastal waters are likely to suffer more degradation.

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1 The Office of Technology Assessment (OTA) is an analytical arm of the U.S. Congress. This paper is based on an OTA report entitled "Wastes in Marine Environments" (and references therein) released in April 1987. Copies of the report are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325; the GPO stock number is 052-003-0152-3.