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The Oceans and U.S. Sewage Sludge Disposal Strategy

by

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Abstract

Various aspects of the dumping of barged sludge at designated disposal sites along the northeast coast of the United States are described. By law, this practice is due to terminate by the end of 1981 when only non marine solutions to sludge disposal will be acceptable. The above decision is now being questioned because of doubts concerning the adequacy of the costly alternative disposal strategies being advanced by the regulatory agencies. Also, support for a more balanced approach to sludge disposal utilizing the combined potentials of land, sea and atmosphere is becoming increasingly popular. An important deterrent to a multimedia approach to the U.S. sludge dilemma is identified as the lack of information on the effectiveness of offshore as opposed to nearshore receiving areas for sludge disposal.

Introduction

Sewage sludge is the generic term applied to the principle end product of domestic wastewater treatment and its effective processing and disposal remains a major concern of wastewater management. In the United States about 40 percent of the generated sewage sludge is deposited in landfills, 20 percent is used in agriculture, 25 percent is incinerated and the remaining 15 percent discharged to the oceans.

The impressive background of information which exists on the use of sewage sludge in agriculture has no counterpart in the oceanographic literature. Rather, oceanic solutions as applied to sludge disposal have developed rather spontaneously and too often reflect expedient rather

than sound solutions. Typical of the above are the past practices in behalf of the metropolitan coastal areas of New York, Pennsylvania and New Jersey which tax the regenerative capacities of nearby relatively shallow waters. Failure to provide more effective marine disposal options may relate to uncertainties concerning the ultimate costs and consequences of sludge dumping in more remote and deeper waters of the continental shelf. Figure 1 locates the sludge dumping areas designated by the United States Environmental Protection Agency which service New York, New Jersey and Pennsylvania coastal regions.

Negative impacts from indiscriminate sludge release in the ocean include excessive accumulations of inorganic and organic nutrients which can adversely affect the quality of biochemical cycles and lead to oxygen depletion and unfavorable population changes. In extreme situations, anoxic conditions, hydrogen sulfide evolution and marked reductions in the benthic biota can occur. Of added concern are public health hazzards including the threat of long-term heavy metal toxicity, accumulations of persistent chlorinated hydrocarbons and creation of insidious reservoirs of pathogenic viruses, bacteria and parasites.

Legal Considerations

By law, the licensed disposal of sewage sludge in U.S. controlled coastal waters will terminate at the end of 1981. Enabling legislation for this decision is provided by Public Laws 92-532 and 95-153 known as the Marine Protection Research and Sanctuaries Act of 1972. The broad intention of this legislation is to prohibit the dumping of all substances having an adverse effect on human health and welfare as well as those disruptive to the marine environment and its economic potential. Besides sewage sludge, the Act also applies to industrial and high level radioactive wastes and to noxious entities associated with chemical, biological or radiological weaponry.

Enforcement of Public Law 92-532 is placed with the Administrator of the U.S. Environmental Protection Agency (U.S.E.P.A.) who only in extraordinary or emergency situations will be allowed to issue ocean dumping permits on a temporary basis. Strict interpretation of PL 92-532 poses a severe problem for densely populated U.S. coastal municipalities accustomed to a marine solution with regard to their sludge disposal problems.

The need to regulate sludge dumping in the ocean at an international level was addressed during the 1972 London Dumping Convention* on the prohibition and/ or control of hazardous ocean dumping. Representatives from some 80 attending nations acknowledged the limited capacity of the oceans to detoxify and assimilate man's wastes and agreed to weigh future national policies in terms of their potential environmental impact. The

*Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

recommendations of the London Convention were ratified by the U.S. Senate in 1973 and shortly after U.S. Public Law 92-532 was ammended for purposes of conformity. Presently, more than 22 nations are signatory to the provisions of this convention.

Present and future concerns regarding sludge dumping

An inability to agree on effective non-marine, disposal alternatives for densely populated northeastern U.S. coastal areas has already caused a delay of one year in implementing the sludge moritorium. Meanwhile, pressure is being maintained by the regulatory agencies for new and more advanced wastewater treatment facilities which inevitably will increase the amount of sludge generated. In 1968 the total amount of sewage sludge dumped off New York and New Jersey was about 4.5 million metric tons. Projected to the year 2000 a conservative estimate of the amount of sludge to be produced by the same generating area is 16 million tons, an increase of 3.5 fold.

Increasing skepticism concerning the nation's ability to fullfill the U.S.E.P.A.'s sludge directive by the end of 1981 has evoked a variety of responses from official sources. The Office of the Comptroller General, 1977; the National Academy of Sciences, 1978; and the Environmental Protection Agency, 1978 and 1980 have all voiced strong and sometimes varied opinions on sludge disposal policy. Expectations are that the existing uncertainties would lessen given a better assessment of the true assimilative capacity of the oceans for sewage sludge. Particularly useful would be a clear differentiation between sludge attenuation in deep offshore as opposed to shallow nearshore waters. Many among the oceanographic community believe that the above distinction is essential to a balanced solution of the nation's sludge dilemma.

Significant conclusions and recommendations from the Comptroller General's Report of 1977 are enumerated below.

1. The major municipalities now practicing ocean dumping will be unable to convert to the proposed alternative disposal methods until several years beyond the projected deadline.

2. Presently, insufficient information exists to determine whether greater use of the atmosphere, groundwater, and/or land as media for sludge disposal would be more or less disruptive than coastal dumping.

3. Efforts should be made to locate oceanic sites that permit dumping at rates that would provide greater safety.

4. Before phasing out sludge dumping at sea, the effects of alternatives to ocean dumping on the total environment should be more thoroughly assessed.

Relevant statements which appear in the comprehensive report by the National Academy of Science's Committee on a Multimedium Approach to Municipal Sludge Management are paraphrased below.

1. A multidiciplinary effort involving ecologists, engineers, economists and social scientists will be necessary for a full solution of the nation's sludge problem.

2. Exclusion of the ocean from the sludge disposal equation precludes a balanced multimedia approach and places an unequal burden on the land and its attendent water resources.

3. The U.S.E.P.A. should reexamine current interpretations of those laws which preclude the disposal of domestic sewage sludge in the oceans.

4. Recognition that an essential prerequisite for safe environmental sludge recycling is the point source removal of industrial heavy metals and other toxic sludge components.

5. Systematic mariculture research should be undertaken to assess the possibility of improving the fertility of coastal waters via the managed release of wastewater residuals to the sea.

Both the Comptroller General and the National Academy of Sciences reports favor the development of a broadly based, multienvironmental approach to sewage sludge disposal. Conversely the U.S.E.P.A. has insisted that the only acceptable long-term solution of harmful sewage sludge is by land-based or atmospheric dissemination. The specific alternatives suggested as replacements for marine disposal are:

1. Direct land application.

2. Incineration and atmospheric disposal.

3. Pyrolysis - combustion under reduced oxygen and above atmospheric pressures.

4. Use in agriculture as a soil conditioner.

Site characteristics affecting sludge disposal

In the shallow waters of the New York Bight (average depth 29 meters) 13 permittees annually release about 3.5×10^6 metric tons of sludge in a designated area of about 100 km^2. Off Philadelphia, about 2.5×10^4 metric tons annually enter a 50 km^2 area having an average depth of 40 meters. These shallow and relatively undifferentiated waters ensure that even small sludge particles (2 - 50μm diameter) descend rapidly and dominate the sediment regime.

Conversely, at other locations having depths in excess of 150 meters, strong seasonally oriented density gradients can exert a pronounced influence on sludge dispersal patterns. In such situations particle descent can be delayed in accordance with the strength and depth of the density gradients and horizontal transport as opposed to vertical descent can become an overriding factor.

Recent observations of the Woods Hole Oceanographic Institution in deep waters (> 2000 meters) of the Atlantic continental slope are supportive of the horizontal dispersal pattern described above (Orr et al., 1980). The instrumentation used was a 200 KHz acoustic backscattering system aboard the Research Vessel, ALBATROSS IV. Soon after dumping commenced, high concentrations of sludge aggregates were observed to accumulate within the upper portions of the density gradient (15-30 meters). Thermocline layering persisted for at least eight hours during which time sludge particles became associated with internal waves and were dispersed in a horizontal direction.

Many marine zooplankton depend on particle feeding to provide the carbohydrates, fats and protein essential for their vital activities. They may also have special requirements for essential amino acids, trace metals and vitamins. The release of substantial amounts of nutrients in the form of small particles of sewage sludge could therefore have an appreciable effect on the normal herbivorous or carnivorous feeding habits of these organisms.

Previous studies on zooplankton have established that their utilization of detritus is largely a function of particle size, shape, sinking rate and nutritive composition (Roman, 1977; Paffenhoffer and Strickland, 1979; Paffenhoffer and Knowles, 1979). Although detritus per se is considered an incomplete diet for zooplankton, it could provide a potentially important supplementary food source (Heinle et al., 1977).

The rich organic and nutritional value of sewage sludge is not unlike that offered by marine detritus. Studies with poultry, cattle, rabbits and rats offered rations of sludge have clearly demonstrated its value as a diet supplement (Day and Harmon, 1974). In these studies adverse effects from heavy metals were not observed for mixed diets containing 10 percent or less of sewage sludge. Therefore, it is conceivable that sludge particals under ideal circumstances could make a substantial contribution to marine food chains. If so, the use of sludge to help promote fertility in the oceans could help provide a broader and more effective solution to one of the nation's most recalcitrant disposal problems. Relevent research in this area should be solicited and supported by the appropriate granting agencies.

Conclusions

Past practice in congested maritime areas of the United States has centered on the dumping of barged sewage sludge in relatively shallow coastal waters of the continental shelf. Comparable interest in deep water locations has not developed to any large extent nor have their been any serious scientific efforts to explore their potential. The resulting information gap is in marked contrast to the knowledgeable use of sludge in agriculture, which even in the United States is becoming increasingly popular.

Predicted overloading of the northeastern sludge receiving areas now in use has resulted in Public Law 92-532 which calls for the termination of all barged sludge dumping by the end of 1981. In particular, the above legislation is working a severe hardship on the densely populated northeastern seaboard. Of additional concern is the questionable utility of recommended alternative sludge disposal options. In view of these uncertainties there is a growing belief that solution of the nation's sludge disposal problem will require a more balanced use of the full assimilative potential of the land, ocean and atmosphere. Some recent observations on deep water sludge disposal would appear to encourage a reappraisal toward a broader oceanic role in future sludge management.

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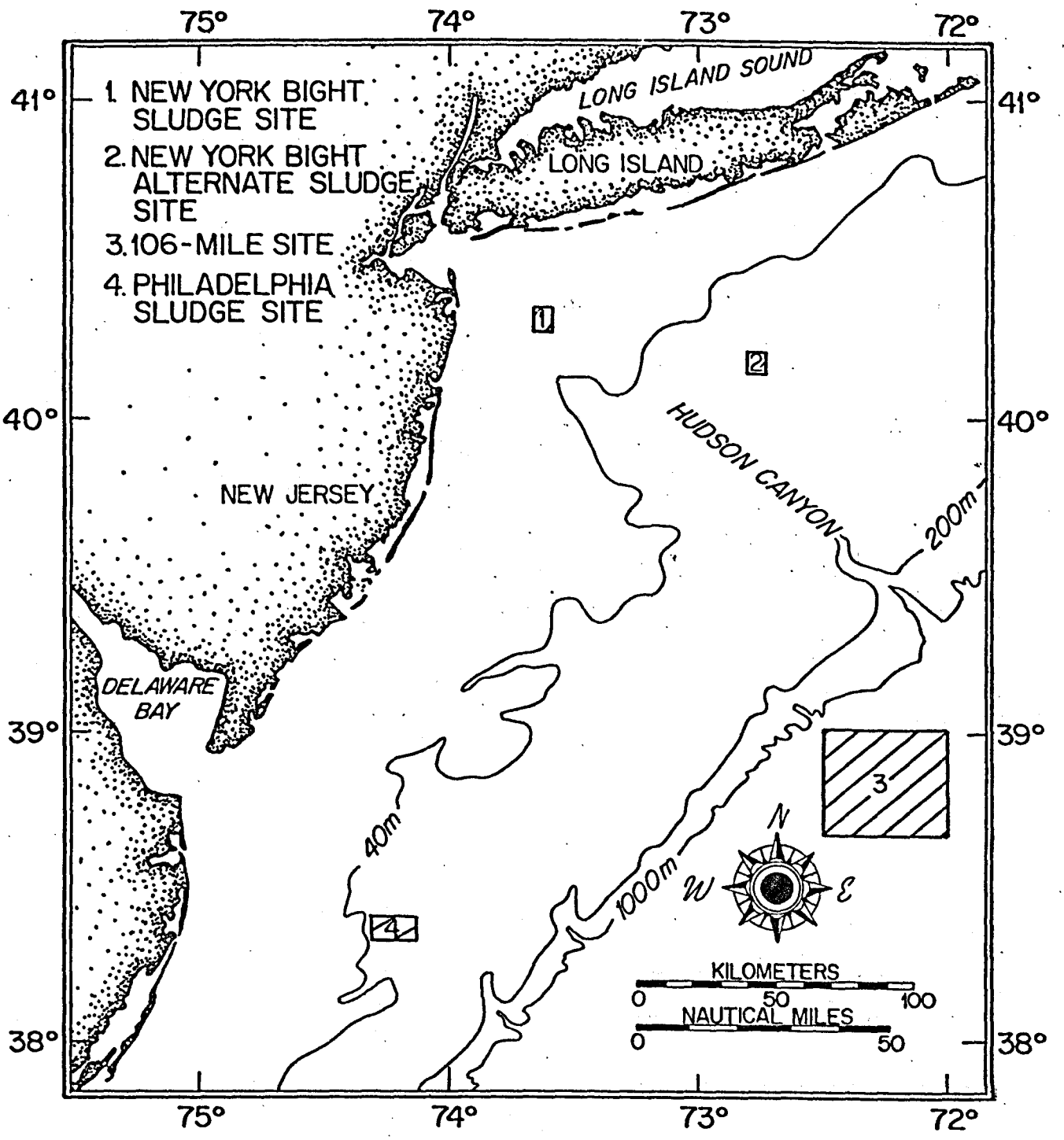

FIG. 1. OPERATIVE AND ALTERNATIVE ATLANTIC SEWAGE SLUDGE DISPOSAL SITES.