PROPERTIES OF OCEAN SLUDGE

Floyd K Mitchell

Wastewater particulate matter discharged into the ocean may cause changes in the local marine environment in a number of ways. In general, most wastewater particulates are more dense than seawater and tend to settle to the bottom of the ocean. While the particulates are settling to the bottom, they may cause decreased transparency in the water column, serve as food for free swimming detritus feeders, (becoming incorporated into these organisms and their fecal pellets), and release material such as soluble organics or heavy metals to the water through which they pass. Once on the bottom, the particulates become part of the ocean sediments, serving both as food and as home for a multitude of benthic organisms.

The Project has previously demonstrated that trace constituents of treated wastewaters such as heavy metals and chlorinated hydrocarbons are predominantly associated with wastewater particulate matter. Since these trace materials, as well as the particulate matter itself, are potential pollutants of concern, an understanding of the ultimate fate and environmental impact of wastewater particulates discharged to the ocean is an essential part of a thorough assessment of man's overall effects on the ecology of the Southern California Bight.

A logical starting point is a program to determine the quantities and the physical, chemical, and biological characteristics of the particulate matter currently being discharged to the Bight from discrete sources. Discharger records of effluent quality supply some of the necessary information for this task. We have planned sampling and analysis programs to supply additional data not available from such records. We are also reviewing data in the literature on the characteristics of wastewater effluent particulate matter to determine the extent to which the particulates discharged in the southern California region are comparable to those of other areas. Our initial findings indicate that, while such particulate characteristics as heavy metals content are variable from location to location, the reported values for particulates discharged to southern California ocean waters are about average.

Interactions between ocean water and the discharged wastewater particulates prior to their deposition on the ocean bottom are likely to alter the particulate characteristics and to affect the expected patterns and quantities of mass deposition on the sea floor. Examples of such interactions are agglomeration of the effluent particulates with each other or with naturally occurring particulate matter in the ocean, mobilization of particulate associated heavy metals, and dissolution or decay of particulate organic material. We have conducted laboratory experiments to investigate one aspect of these interactions the effects of mixing with seawater on the distribution of settling velocities of effluent particulates from the Hyperion 7 mile (sludge) pipeline. Three different dilutions, 19:1, 49:1, and 99:1, have been tested at a mixture temperature of 14°C. The results of these experiments to date show that dilution is an important factor in

determining the settling velocity distributions, at least in the laboratory, and that increasing dilution results in suspensions with lower mean settling velocities. If a similar relationship between dilution and settling velocities pertains in the sea, the initial dilution achieved by an outfall system may be an important factor in determining the field of dispersion of effluent particulates on the ocean bottom. Research in this area is continuing.

Ocean sediments made up of significant proportions of wastewater particulates might be called "ocean sludge" for want of a better verbal description. Because wastewater particulates are characterized by high organic content (more than 30 percent organic carbon), ocean sludge will show high concentrations of organic material. But to identify ocean sludge, we must be able to distinguish between bottom deposits of naturally high organic content and those of high organic content due to the incorporation of wastewater particulates. Our analyses of the limited data available on the heavy metal and organic carbon content of Palos Verdes shelf sediment samples have shown that the individual heavy metal concentrations are highly correlated with organic carbon concentrations. In addition, the ratios of metal to organic carbon were found to be higher in the sediments than they are in the effluent particulates for most of the metals analyzed. Figure 1 presents two examples of these metal to organic carbon relationships. For reference, natural background organic carbon, chromium, and zinc concentrations in Palos Verdes shelf sediments are estimated to be 5 to 10 gm/dry kg, 53 mg/dry kg, and 75 mg/dry kg, respectively. We feel that such relationships may be the key to distinguishing the ocean sludge now found in southern California from natural organic deposits and to quantifying the extent to which the sediments are composed of wastewater particulates.

The question of how much of the particulate matter that has been discharged can be accounted for in the sediments in the vicinity of the outfall is important in determining the ultimate fate of the discharged material. We have made a quantitative estimate of the amount for the Hyperion sludge discharge, using reported values of zinc concentrations in surface sediment samples taken from Santa Monica canyon. Several rough but seemingly reasonable assumptions are involved in the estimation, future work will be oriented to some extent to providing data for a more firm estimate. The estimated mass accumulation of zinc in excess of natural background in Santa Monica Canyon sediments as of 1971 is 788 metric tons, with about 50 percent of this within 2 km of the discharge point and about 75 percent within 4 km. The estimated total mass of zinc discharged up to the time these samples were taken is 1,330 metric tons. Recent work on the probable mobilization of zinc prior to particulate deposition indicates that about 15 percent of the zinc could mobilize from the particulates during their passage through the water to the ocean bottom. If that is true, then 70 percent of the particulates discharged are accounted for in the sediments. This is a significant finding in light of the much lower estimates that have been reported for the effluent particulates of the Los Angeles County Joint Water Pollution Control Plant.

FIGURES

Figure 1.

Figure 1. Metals versus organic carbon concentrations in sediment samples from the Palos Verdes shelf