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Environmental Effects of Dredging
Technical Notes

GENERAL GUIDELINES FOR MONITORING EFFLUENT QUALITY FROM CONFINED DREDGED MATERIAL DISPOSAL AREAS

PURPOSE: This note provides general guidance for developing plans for routine field monitoring of the quality of the effluent from confined dredged material disposal areas for determining compliance with effluent standards. It also provides guidance on additional monitoring which can provide other useful information for the project designers and sponsors.

BACKGROUND: The Corps of Engineers must dredge about 300 million cu yd of sediments from the nation's harbors and navigation channels each year to accomplish its mission of keeping the waterways open for navigation. Some of this material, especially in industrial harbors, is contaminated by pollutants, either residual materials in treated discharges from cities and industries or materials washed from farms, streets, parking lots, or industrial areas by runoff. In many cases, contaminated dredged material may not be disposed of in open water, but must be placed on land in a confined disposal area. The effluent from these large sedimentation basins/storage areas is considered a discharge under Section 404 of the Federal Water Pollution Control Act, which requires a permit. Certification must be obtained from or waived by the state under Section 401 such that the effluent discharge will not violate applicable water quality standards. Section 401 also requires the certification to set forth necessary effluent limitations and monitoring requirements. A National Pollution Discharge Elimination System (NPDES) permit is not required, so NPDES monitoring should not be imposed. This note provides guidance for developing appropriate effluent quality monitoring programs.

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General Considerations

The quality of effluent during filling operations is of concern for confined disposal projects when the sediments being dredged are contaminated.

Modified elutriate tests (Palermo 1985) and column settling tests (Headquarters, US Army Corps of Engineers 1987) provide information for prediction of the quality of effluent for a given set of operational conditions. The Section 401 water quality certification may contain requirements for effluent quality monitoring to ensure that standards are met.

Depending on the situation and the extent of data collection, the data gathered in routine field monitoring can be used to (1) demonstrate permit compliance, (2) aid in control of the dredging contractor to ensure compliance, (3) aid in demonstrating the adequacy of the disposal area design, (4) document the water quality impact (or lack thereof) if there are public concerns, and (5) document the presence of contaminants in the disposal area in case there are concerns about later land use.

In developing an effluent quality monitoring program, the following considerations should be addressed:

1. Parameters to be monitored.
2. Sampling and analysis techniques.
3. Sampling locations.
4. Monitoring frequency.

These and other aspects of effluent quality monitoring programs are discussed in detail in the following paragraphs.

Parameters to be Monitored

Parameters of potential interest may be grouped or classified in different ways, but the parameters (followed by examples) usually of most interest in dredging can be classified as follows:

1. Physical and physicochemical--temperature, suspended solids (SS), dissolved oxygen (DO), pH, and turbidity.

2. Nutrients--total organic carbon (TOC), NH_3, NO_3^-, and PO_4^-.

3. Metals--iron (Fe), manganese (Mn), nickel (Ni), zinc (Zn), cadmium (Cd), and chromium (Cr).

4. Organics--polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PAHs), and pesticides.

Parameters to be monitored are site specific and should be chosen only after an analysis of all conditions relating to a project, including the bulk sediment analysis, the effluent prediction if one is made, the water quality and hydrodynamics of the receiving water, and the requirements set forth by the state in the water quality certification. Contaminants should only be monitored if they are expected to be present. All parameters of concern need not be monitored at all locations at all times.

The first parameters to be selected are obviously the ones specified in the state certification and the discharge permit. They vary widely, depending on the site and the state, but usually SS, DO, some nutrients, and often some heavy metals are included. Specific toxic organics are normally not required to be monitored, unless there is evidence of their presence in the sediments in concentrations high enough to be of concern.

Suspended solids (or turbidity) should always be monitored, whether specified by the state or not, because it helps in management of the facility and evaluation of the design and is an indicator of other parameters. SS is the best indicator of overall performance of the disposal area, both for solids retention and for most other contaminants, which are strongly associated with SS by adsorption or ion exchange. Turbidity is a much more easily measured parameter than SS (it can usually be measured by the inspector in the field) and can often be used instead of SS routine monitoring after a correlation between the two has been established for the particular sediment and site. Earhart (1984) has described a method for correlating these parameters. Often, water quality standards are expressed in terms of turbidity, and thus it becomes the basic controlling parameter itself. Temperature, pH, and DO are easy to measure with a probe, but these parameters are rarely of concern, because dredging has little impact on them.

During the planning stages of all dredging projects in urban-industrial areas where contamination is likely, samples of the sediments to be dredged should be taken and analyzed for all contaminants which are reasonably expected to be present. Those which are potentially troublesome and which are found in the sediments in concentrations of concern should be monitored. These may include nutrients; toxic metals such as cadmium, chromium, nickel, or zinc; and toxic organics such as pesticides or PCBs.

Sampling and Analysis Technique

Standard procedures for sampling, preserving, and analyzing water samples should be followed for effluent quality monitoring programs. Detailed guidance is contained in Plumb (1981), American Public Health Association (1985), and US Environmental Protection Agency (USEPA) (1979, 1980, 1982, and 1986). These documents are updated periodically, so the latest version should always be used.

Sampling Locations

Several locations should be considered for monitoring, although not every monitoring location needs to be sampled each time for every parameter. Under Section 404, the effluent should meet applicable water quality standards within an acceptable mixing zone. Therefore, sampling should always be conducted at the edge of the mixing zone to determine permit compliance. Upstream or background receiving water should always be sampled to determine ambient conditions.

Several other locations may be sampled to provide information on the performance of the disposal area. Sampling at the overflow weir will provide data on the adequacy of the site design and the accuracy of laboratory tests used for effluent quality prediction. Sampling the influent to the disposal area (the dredge discharge) allows determination of the approximate removal efficiency of the disposal area and allows an estimation of the contaminant concentration of the stored dredged material.

In certain situations, there may be other desirable sampling locations. In multicell disposal areas with weirs between cells, the internal weir overflows should be sampled, at least for SS. This allows determination of the incremental removal efficiency of each cell as it changes during the project and is very useful information to the designer. In multipass disposal areas with internal baffles to reduce short circuiting, samples for SS at the openings may be useful. Where there is no direct discharge, but flow of supernatant water through porous dikes into a surrounding water body, the influent, the surface layer at a location away from the influent, and the water in the surrounding water body at the waterline adjacent to the dikes (in several locations) should be sampled.

Monitoring Frequency

The desirable frequency of sampling varies widely, depending on permit requirements, anticipated environmental impact, size and duration of project, progress of the dredge, the hydraulic retention time of the disposal area, and the funds available for analysis. Three samples should be the minimum number taken at any location, since three samples are required to determine a variance.

The maximum number of samples (or minimum sample spacing) is a function of the size or average retention time of the site. The sites act as mixing and equalization basins, damping out most sharp fluctuations in influent concentration, so the effluent concentrations are much less variable than are influent concentrations. As the average retention time increases, more mixing occurs and fewer samples are required to define the effluent characteristics. One sample per average hydraulic retention time is the maximum frequency that can be practically justified. The average retention time varies during the project, so the sampling frequency should vary also. Because most sites have an average retention time on the order of 24 hours, daily sampling for SS or turbidity is convenient and is recommended.

Sampling for nutrients, toxic metals, or organics, if required, can be less frequent, approximately once every two weeks. If frequent samples are analyzed for SS, which is easy and inexpensive to determine, less frequent samples for chemical contaminants are necessary, because variations in chemical concentrations are usually proportional to SS concentrations. Also, more frequent sampling does not necessarily provide more usable information, because analytical results for nutrients, metals, and organics frequently are not available for several weeks.

For a given average frequency of samples desired, sample spacing should be less (more frequent samples) when the dredge is moving rapidly, pumping consistently at a high rate, or is moving through highly contaminated areas. Sample spacing should be greater (less frequent samples) when the dredge is moving slowly, or is shut down often, or is moving through areas known not to be heavily contaminated.

Although water quality at the overflow weir is normally relatively stable, it can change very rapidly with changes in the weather. Therefore, samples should not be taken when the effluent from the disposal area is especially high in SS for short periods because of high winds, hydraulic surges from the dredge, weir problems, or other brief upsets, unless it is desired to document worst-case conditions. Such samples should be taken from the first overflow following an extended period of zero outflow, because these samples will be uncharacteristically low in SS and other contaminants.

Composite samples may be more accurate indicators of the true average conditions at a point than grab samples, especially for situations in which conditions fluctuate greatly. This is the case for many confined disposal areas. Therefore, if conditions and resources allow it, composites should be used. Composite samples may be taken in many ways. If sampling personnel will be on site for several hours, several grab samples may be taken during this time and composited. Automatic samplers may also be used to obtain periodic grab samples which can then be composited. It may be especially desirable to use composites for samples taken only infrequently, such as the ones for nutrients, heavy metals, TOC, and organics.

Typical Monitoring Program

As an illustration, a sampling schedule is presented below for a typical project. This hypothetical project is in an industrial harbor where a sediment inventory has indicated the presence of toxic metals and organics. The project dredging will take 8 weeks, and the disposal site will have an average retention time varying from two days at the beginning of the project to about one day at the end. The permit specifies a mixing zone 1,000 ft long. For these conditions, the recommended sampling schedule is as follows:

1. At the point of permit compliance (downstream end of mixing zone).
   a. SS--daily.
   b. Nutrients, metals, and organics--once every two weeks.
2. Influent.
   a. SS--twice per week.
   b. Nutrients, metals, and organics--once every two weeks.
3. Background in receiving water.
   a. SS--once per week.
   b. Nutrients, metals, and organics--three samples.
4. At the weir.
   a. SS--twice per week.
   b. Nutrients, metals, and organics--once every two weeks.

If cost considerations require that the total number of samples be reduced, the ratios of sampling frequencies should stay approximately the same.

Other Monitoring Requirements

In addition to taking water samples for analysis to determine concentrations of contaminants, other monitoring should be done to provide control over the quality of water discharged or to furnish background information to aid in the interpretation of the analytical results. This monitoring should be done by the resident engineer or inspector for the Corps.

On at least a daily basis, the inspector should observe and record the physical condition of the levees and discharge structure. He should note the condition of the weir boards, whether the weir is leaking, whether floating solids are caught on the weir, whether the weir is unlevel, and whether there are other unusual circumstances. Any change in weir elevation should be recorded.

The inspector should also note and record the visual quality of the effluent (whether clear, slightly turbid, or very turbid); any obvious flow patterns or changes, such as formation of deltas or obvious short-circuiting; and wind and weather conditions, especially the direction of the wind and relative wind velocity.

Cost

The cost of monitoring and analysis varies widely, depending on the length of the project, the number of locations sampled, and the parameters analyzed. Jacek (1986) reported that the cost of operational monitoring in the Detroit District varied from $2,100 to $15,500 per project and averaged $5,900. Individual laboratories may charge more or less, depending on local conditions, the number of samples analyzed simultaneously, and the number of parameters analyzed for in each sample.

The sampling schedule shown for the previous example would cost about $5,000 to $10,000 for analysis alone. To this, expenses for the sampling itself must be added, but these should be minimal, since samples can be taken by the regular inspectors. This estimate is in line with the costs reported by the Detroit District. Jacek and Schmitt (1986) reported that, in the

Detroit District, about 20 parameters are generally monitored at about five to nine locations, about three or four times during each project. This results in slightly more parameters and locations, but fewer sampling times, than the typical project and the example.

Costs can run as high as $100,000 per project if numerous organics which are present at very low concentrations are monitored or if the project is a lengthy one. However, this is unusual. The typical project monitoring cost is in the range $5,000 to $25,000.

Monitoring Responsibility

Responsibilities and duties vary from District to District and from project to project. However, usually the project sponsor (the Corps or other agency) is responsible for obtaining the state water quality certification and for meeting the Section 404 requirements (doing the Section 404(b)(1) analysis for a Corps project or actually getting a 404 permit if another agency is the sponsor), informing the dredging contractor of his responsibilities relative to water quality, taking the water samples, and transporting them (according to accepted standards of sample preservation) to the laboratory (in-house or commercial) selected to analyze them. The project sponsor is usually responsible for making those water quality measurements which can be done easily in the field with electronic probes or field instruments, such as DO, pH, temperature, and turbidity.

The laboratory is responsible for analyzing the samples for a preselected list of parameters (preselected by the project sponsor and listed in their contract or work order) and for reporting the results to the sponsor in a timely manner. The project sponsor is responsible for transmitting the results to appropriate state and local water pollution control agencies.

The Corps should be responsible for monitoring and recording the physical condition of the disposal area and the dredging operation and for documenting occurrences which might affect water quality or explain anomalies in the data.

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