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Dredging Research Technical Notes

Site Selection Considerations for Capping

Purpose

This technical note describes site selection considerations for projects involving the capping of contaminated dredged material. General considerations in site selection and special consideration of bathymetry, currents, water depth, and operational characteristics are included.

Background

Some dredged material may be unsuitable for open-water disposal because of potential contaminant effects on benthic organisms. Capping contaminated dredged material with a layer of clean material is considered an appropriate contaminant control measure for benthic effects in the Corps' dredging regulations (33 CFR 335-338) and supporting technical guidelines (Francingues and others 1985) and is recognized by the London Dumping Convention as a management technique to rapidly render harmless otherwise unsuitable materials.

Guidelines are available on planning and design concepts (Truitt 1987a, 1987b), design requirements (Palermo 1991), and equipment and placement techniques (Palermo, in preparation) for capping projects. This technical note supplements and updates the available guidance by describing considerations for site selection for capping projects.

Additional Information

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Introduction

Capping is the controlled, accurate placement of contaminated dredged material at an open-water disposal site, followed by a covering or cap of clean isolating material. For purposes of this note, the term "contaminated" refers to material found to be unacceptable for unrestricted open-water disposal because of potential contaminant effects, while the term "clean" refers to material found to be acceptable for such disposal.

Level bottom capping (LBC) may be defined as the placement of a contaminated material on the bottom in a mounded configuration and the subsequent covering of the mound with clean sediment. Contained aquatic disposal (CAD) is similar to LBC but with the additional provision of some form of lateral confinement (for example, placement in bottom depressions or behind subaqueous berms) to minimize spread of the materials on the bottom.

Design Requirements for Capping

The selection of an appropriate site is a critical requirement for any capping operation. However, all components of design for a capping project are strongly interdependent. The major design requirements for a capping project and the sequence in which the design requirements should be considered are fully described in Dredging Research Technical Note (TN) DRP-5-03 (Palermo 1991). Site selection should be considered within the context of the overall design requirements for the project as described in TN DRP-5-03.

General Considerations for Site Selection

Capping projects require placement of contaminated dredged material at an open-water site, followed by placement of a clean capping material. Since the cap must provide long-term isolation of the contaminated material, capping sites should be characterized as nondispersive sites, where material is intended to remain in a stable deposit. Therefore, the considerations for site selection for a conventional nondispersive open-water disposal site also apply to capping sites.

Sites in ocean waters are regulated by the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, also called the Ocean Dumping Act. For MPRSA sites, a formal site designation procedure will usually include a detailed evaluation of site characteristics. Any capping project in ocean waters would occur at a designated ocean site.

Sites in waters of the United States (inland of the baseline of the territorial sea) are regulated by the Federal Water Pollution Control Act Amendments of 1972, also called the Clean Water Act (CWA). The specification of disposal sites under the CWA is addressed specifically in the Section 404 (b)(1)

Guidelines. Any capping project in waters of the United States would occur at specified Section 404 site.

A number of site characteristics must be considered in designating or specifying an open-water disposal site. These characteristics include the following:

- Currents and wave climate.
- Water depth and bathymetry.
- Potential changes in circulation patterns or erosion patterns related to refraction of waves around the disposal mound.
- Bottom sediment physical characteristics, including sediment grain-size differences.
- Sediment deposition versus erosion.
- Salinity and temperature distributions.
- Normal level and fluctuations in background turbidity.
- Chemical and biological characterization of the site and environs (for example, relative abundance of various habitat types in the vicinity, relative adaptability of the benthos to sediment deposition, presence of submerged aquatic vegetation, or presence of unique, rare, or isolated benthic populations).
- Potential for recolonization of the site.
- Previous disposal operations.
- Availability of suitable equipment for disposal at the site.
- Ability to monitor the disposal site adequately for management decisions.
- Technical capability to implement management options should they appear desirable.
- Ability to control placement of the material.
- Volumetric capacity of the site.

- Other site uses and potential conflicts with other activities (for example, sport or recreational fisheries).

- Established site management or monitoring requirements.

- Public and regulatory acceptability for use of the site.

The intent of the MPRSA criteria for site designation is to avoid unacceptable adverse impacts on biota and other amenities. The Section 404(b)(1) guidelines generally address the same concerns as the MPRSA criteria, but the primary emphasis is directed toward the potential effects of the disposal activity. The US Army Corps of Engineers has prepared an ocean site designation manual (Pequegnat, Gallaway, and Wright 1990) which provides useful guidance and procedures for conducting the appropriate investigations and studies. In addition, overview manuals for site designation are available (US Army Corps of Engineers/US Environmental Protection Agency 1984, US Environmental Protection Agency 1986).

The selection of a potential site for capping is subject to the same constraints and tradeoffs as any other nondispersive open-water disposal site. However, beyond normal considerations, the capping site should be in a relatively low-energy environment with little potential for erosion of the cap. This requires special consideration of bathymetry, currents, water depths, bottom sediment characteristics, and operational requirements such as distance and sea state (Truitt 1987a). These considerations are discussed in more detail in the following paragraphs.

Bathymetry

The bathymetry of the site will have an influence on the degree of spread during placement of both contaminated and capping material. For LBC projects, a relatively flat bottom is desirable, especially if material is to be placed by a hopper dredge. If the bottom in a disposal area is not horizontal, a component of the gravity force will influence the energy balance of the bottom surge following impact of the discharge with the bottom. It is difficult to estimate the effects of slope alone, since bottom roughness plays an important role in the mechanics of the spreading process. Placement of material on steep bottom slopes should generally be avoided for a capping project (Truitt 1987a).

Bathymetry forming a natural depression will tend to confine the material, resulting in a CAD project. This is the most desirable type of site bathymetry for a capping project.

Currents

Water column currents affect the degree of dispersion during placement and the location of the mound with respect to the point of discharge. Of more importance are the bottom currents which could potentially cause resuspension and erosion of the mound and cap. The effects of storm-induced waves on bottom current velocities should also be considered. Capping sites should have current and wave climate characteristics which result in long-term stability of the capped mound or deposit.

Basic current information should be collected at prospective disposal sites to identify site-specific conditions. The principal influence of currents in the receiving water during placement is to displace the point of impact of the descending jet of material on the bottom (by a calculable amount). Water column currents need not be a serious impediment to accurate placement, nor do they result in significantly greater dispersion during placement. Further currents do not appear to affect the surge phase of the disposal (Bokuniewicz and others 1978, Truitt 1986).

Long-term effects of currents at a prospective site may still need to be investigated from the standpoint of potential erosion of the mound and cap. Storm-induced currents are also of interest in the long-term stability of the site. However, disposal operations would be halted during storms, so the designer need consider only near-bottom currents, not water-column currents. Measured current data can be supplemented by estimates for external events using standard techniques; for example, see the Shore Protection Manual (Coastal Engineering Research Center 1984). Selection of a nondispersive site in a relatively low-energy environment would normally result in a site with low bottom current velocity and little potential for erosion. However, if the material is hydraulically placed, a thorough analysis of the potential for resuspension and erosion should be performed. Conventional methods for analysis of sediment transport should be used to evaluate erosion potential (Teeter 1988, Dortch and others 1990). These methods can range from simple analytical techniques to numerical modeling (Scheffner 1991). In the analysis of erosion, the effects of self-armoring due to the winnowing of finer particles should be considered. Sanderson and McKnight (1986) suggested that mound stability, when subjected to wave heights equal to those produced by the five-year storm, be used as a minimum criteria for screening potential sites.

Average Water Depths

Recent case studies have indicated that water depth is of particular interest in evaluating the potential suitability of a site for capping operations (Palermo 1989). The greater the water depth at the site, the greater the potential for water entrainment and dispersion during placement. However, greater water depths also generally provide more stable conditions on the bottom with less potential for erosion.

For deep-water projects, both the contaminated and clean material must descend through a greater water column depth. More material may be released to the water column during placement as compared to shallower water depth, all other factors being equal. Therefore, the fraction of the contaminated material that may not be finally capped is greater.

Entrainment of ambient water causes the descending material to become more buoyant; therefore, the effect of density stratification in the water column should be evaluated. Although density stratification in the water column may be encountered at some deep-water sites, stratification would not likely prevent descent of the dredged material mass during placement. The very cohesive fraction of mechanically dredged material (clods or clumps) attains terminal speed quickly after release from a barge and does not accelerate further with depth.

The increased water entrainment with deep-water placement may also result in a greater spread of the more fluid material on the bottom, but entrainment reduces the overall potential energy at bottom impact. Field studies indicate that the bottom surge does not spread at a faster rate, although because of additional entrainment, the initial thickness of the surge has been shown to be a function of water depth (Bokuniewicz and others 1978). Greater care in control of placement may therefore be required to develop a discrete mound of contaminated material and adequate coverage of the mound with capping material.

The use of a deep-water site for capping generally holds an advantage over a shallower site from the standpoint of cap stability with respect to erosive forces. Deep water acts as a buffer from wave action, and the resulting wave-induced currents from storm events are less than in shallow water. Therefore, deep-water sites are usually quiescent, low-energy environments which are better suited to capping from the standpoint of stability of the cap, but this must be balanced against material loss during placement. Generally, greater water depth at a site has a more favorable influence on long-term cap stability than an unfavorable influence on dispersion during the placement process (Truitt 1987b).

Operational Requirements

Among the operational criteria that should be considered in evaluating potential capping are: volumetric capacity of site, nearby obstructions or structures, haul distances, bottom shear due to ship traffic (in addition to natural currents), and ice influences. The effects of shipping are especially important since bottom stresses due to prop wash and direct hull contact at shallow sites are typically of a greater magnitude than the combined effects of waves and other currents (Truitt 1987a).

Summary

The selection of an appropriate site is a critical requirement for any capping operation. The general considerations for selection of any nondispersive, open-water site also apply to selection of a site for capping, but a capping site requires special consideration of bathymetry, currents, water depths, bottom sediment characteristics, and operational requirements. In general, the capping sites should be located in relatively low-energy environments with little potential for erosion of the cap.

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