AVAILABILITY AND BIOTREATMENT OF POLYCYCLIC AROMATIC HYDROCARBONS IN SEDIMENTS

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Key words: availability, biotreatment, contaminated sediments, CDF, PAH

This work applied new investigative techniques to assess the locations, distributions, and associations of polycyclic aromatic hydrocarbons (PAHs) in dredged harbor sediment. Dredged materials from the Milwaukee Confined Disposal Facility were collected and homogenized to provide sufficient sample for four month bioslurry treatment testing and for PAH analyses on various size and density fractions before and after biotreatment. Sediment PAH analyses included both whole-sample measurements and, most importantly, the determination of PAH distribution by sediment particle size and type. Physicochemical analyses included room temperature Tenax bead aqueous desorption experiments and thermal program desorption-MS studies to assess PAH binding energies on sediment particle types. Thermal programmed desorption-MS experimental protocols and data reduction techniques were developed to evaluate apparent PAH binding activation energies on sediment particles. Microbial ecology testing used polar lipid fatty acid (PLFA) and DNA procedures and radiolabel microcosm studies. Earthworm bioassays studied the acute toxicity effects and PAH bioaccumulation from untreated and biotreated PAH-impacted dredged materials. Overall, the results were used to synthesize and correlate data to assess the availability and treatability of PAHs in dredged sediments.

The significant findings of this work were: the release of PAHs is dependent both on PAH molecular weight and the character of the sediment sorbent material; two principle sediment particle classes dominated the distribution and release of PAHs - clay/silt and coal-derived; PAHs were found preferentially on coal-derived particles; clay/silt particles released PAHs more readily than coal-derived particles; bioslurry treatment reduced PAHs on the clay/silt fraction but not the coal-derived fraction; PAH reduction in clay/silt fractions by biotreatment resulted in significant reduction in earthworm PAH bioaccumulation; PAHs on coal-derived particles were associated with high binding activation energies; and changes in the phenotype and genetic potentials of the extant microbiota can be used to assess intrinsic biodegradative potential. The benefits of this work include: improved assessment of toxicity and risk for PAH contaminants in sediments by use of particle-scale techniques to assess PAH distribution and behavior; improved assessment for the potential success of biotreatment through understanding of factors contributing to available and unavailable PAH fractions; improved decision making regarding sediment quality criteria for PAHs and the biotreatment of PAH-impacted sediments; and reduced treatment costs and greater likelihood for reuse of dredged sediments through knowledge of the underlying processes affecting PAH locations, availability, treatability, and toxicity.

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USE OF SEAFLOOR VISUALIZATION TOOLS FOR DREDGED MATERIAL MONITORING AND MANAGEMENT

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Key words: seafloor visualization, dredged material management, monitoring, GIS, confined aquatic disposal

Efforts to evaluate the physical and environmental effects of dredged material placement on the seafloor traditionally have been hampered by the inability to visualize the affected environment. A variety of seafloor monitoring/remote sensing techniques, such as high-resolution bathymetry, sidescan sonar, subbottom profiling, and sediment-profile imaging, have been developed and refined in response to the need for more effective visualization tools. The emergence of Geographic Information Systems (GIS) software for the desktop PC represents a much-needed advancement in the state-of-the art by facilitating easy organization, manipulation, and widespread access to the results of remote sensing surveys.

The purpose of this presentation is to demonstrate how various seafloor remote sensing techniques, combined with GIS-based visualization tools, have proven effective for monitoring and managing dredged material placement in coastal environments. We will present results from recent studies in which clean sand has been used to cap contaminated dredged material at open-water disposal sites in both New England and New York, as well as results from monitoring the placement and capping of dredged material in in-channel confined aquatic disposal (CAD) cells in Boston Harbor.

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THE DIFFICULTIES OF DREDGING AND PLACEMENT FOR BENEFICIAL USE PROJECTS

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Key words: dredging, beneficial uses, contaminated sediments, disposal, ports.

The Port of New York and New Jersey's goal of being the Northeast Hub Port for the 21st century will be achieved only if it can provide 15-meter channels to service the new 6000 TEU, and larger, post-panamax vessels. However the Port is naturally shallow (6 meters deep) and must dredge its channels and berths to serve these deep-draft vessels. Annual maintenance dredging requirements are approximately 1.5 million cubic meters (0.9 million contaminated and 600,000 uncontaminated). New channel construction for 12.5, 13.7 and 15-meter projects will require the additional excavation of 7.6 million cubic meters of contaminated sediment, 31 million of clean sediment, and 6.5 million of rock during the next 12 years.

Clean dredged materials, including rock, sand, clay and silts/clays mixtures, are currently used beneficially at the Historic Area Remediation Site (HARS) and at offshore fishing-reef locations. Contaminated sediments currently are being beneficially used at upland sites in New Jersey or Pennsylvania or, in some limited cases, disposed at the Newark Bay Confined Disposal Facility. New York is developing an upland demonstration project at the Pennsylvania landfill.

The dredging and disposal processes are changing in character since material has been directed to HARS and upland locations for beneficial use. A number of areas of difficulty have arisen during the dredging and material processing, specifically: regulatory uncertainty, shallow cuts, debris, water management, low production rates, heavy vessel traffic, discontinuous operational requirements and public opposition. These problems are causing dredging costs to rise and project schedules to be threatened. Resolving these and other issues are critical to the Port's ability to deliver the promise of 15-meter channels and to maintain these channels in the future. This paper describes the Port Authority of New York and New Jersey's activities to ameliorate or to resolve each of these difficulties in concert with its dredging contractors and ocean carrier customers.

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PLACEMENT OF SEDIMENTS FROM CHANNEL DEEPENING IN SUB-CHANNEL CELLS

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Key words: dredging, beneficial use, contaminated sediments, disposal, ports

Historically, about 5.5 million m3 of sediment have been dredged annually to maintain and to improve the navigable waterways and berthing facilities in the Port of New York and New Jersey. Some of these estuarine sediments contain contaminants introduced by upstream or local industrial, municipal, or stormwater discharges. Since 1914, the Port has depended almost exclusively on a single disposal site for placement of its dredged material. This site, the Mud Dump, was located approximately 10 kilometers off the New Jersey Coast. In September 1997, the disposal site was closed, and a new kind of site was opened -- the Historic Area Remediation Site (HARS). Discharges at the HARS are limited to the placement of uncontaminated material suitable for remediating the former disposal site. During this same period, the ships carrying oceanborne cargo have increased in overall size and depth of draft. The requirement to dredge deeper channels to accommodate these new ships is a pressing need for the economic life of the Port.

In order to dredge new channels, however, disposal sites must be identified and available for all excavated material, both HARS suitable and contaminated. The first site to open (1996) was the Newark Bay Confined Aquatic Disposal (CAD) facility for contaminated sediment unsuitable for placement at the HARS. Several upland sites have opened since then that beneficially use the sediment for construction purposes. Approximately 2 million m3 have been placed in upland areas. Beneficial use is the preferred regional approach for placement of dredged materials.

Another potential option, although not a beneficial use option, is the construction of CAD facilities under the channels to be deepened. This approach has been designated the sub-channel cell alternative and is proposed as an option for the Kill Van Kull/ Newark Bay deepening project. Approximately 10 million m3 of material will be removed. The sub-channel cell concept is being investigated as a contingency when beneficial use options are not available or appropriate for contaminated sediment from the project. Initial evaluations suggest that the construction of cells could lower the project cost and shorten the construction time frame over upland options. This paper explores the application of the sub-channel cell concept for providing disposal capacity for channel deepening projects in the Port of New York and New Jersey.

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EVALUATING DREDGED MATERIAL IN A SUB-CHANNEL CONFINED AQUATIC DISPOSAL ENVIRONMENT: EXPERIENCE FROM THE BOSTON HARBOR NAVIGATION IMPROVEMENT PROJECT

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Key words: confined aquatic disposal (CAD), consolidation, shear strength, bulk density, core logger, geographic information systems (GIS)

The Boston Harbor Navigation Improvement Project (BHNIP) provided an opportunity to evaluate the efficacy of capping dredged material considered unsuitable for offshore disposal in a confined in-channel environment. One of the main challenges of the project was to maximize cap coverage of coarse-grained sand over fluid dredged material excavated by an environmental bucket. Sequential monitoring surveys were conducted and used by the Technical Advisory Committee to modify operational methods of cap placement to improve cap coverage during each successive phase of the project.

An intensive geotechnical study was conducted to evaluate the impact of consolidation time on the resulting capped deposit during phase II. Sediment samples were collected from one of the Boston Harbor in-channel confined aquatic disposal (CAD) cells prior to and after cap placement. A suite of physical properties was measured that would allow assessment of the change in strength of material resulting both from self-weight consolidation, and the overlying load of the sand cap. In addition to the geotechnical study a series of multibeam surveys were collected at the different stages of capping. These data combined with current Geographic Information Systems (GIS) applications provide a clearer understanding of CAD cell functions. The data indicated that the in situ cohesion and strength of the sediment was altered by the dredging process, resulting in sediment with high water content and low shear strength. In the short-term, results were used to develop field protocols to assess sediment strength in future CAD projects. In the long-term the data will be useful in developing quantitative guidelines for assessing geotechnical "cap-readiness" of disposed dredged material in a confined environment.

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BENEFICIAL USE OF DREDGED MATERIAL TO ENHANCE THE RESTORATION TRAJECTORIES OF FORMERLY DIKED LANDS

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Throughout the United States, coastal wetlands are being restored from formerly diked lands, whether salt hay farms, impoundments, or lands drained for agriculture. A common problem with the restoration of these sites is their low elevation associated with long-term lack of tidal inundation and sediment accretion, compaction by heavy equipment, and oxidation associated with exposure to the atmosphere. When sites have been diked for extended periods, elevations may subside by several meters, and with the reintroduction of tidal flow, these areas may become open water and tidal flats for a century or more before they return to wetland habitat. Different levels of subsidence also result in a wide range of marsh planforms with little or no semblance to the geomorphology of natural systems. The potential use of dredged materials for several aspects of the marsh restoration process -- enhancing the sediment budget at low elevations, accelerating the restoration trajectories toward acceptable endpoints, improving the geomorphology of the marsh planform, remediating contaminated areas, providing high marsh elevations for species that depend on this habitat type for survival, reestablishing upland dike elevations for off-site protection of people and property, and stabilizing shorelines to reduce erosion rates -- are the subjects of this paper. The abundance of dredged materials from channel deepening projects that will occur nation-wide, the maintenance dredging of major ports, and other projects provide a wealth of opportunities to combine dredging needs with coastal marsh rehabilitation and restoration.

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CASE STUDY - USE OF SEDIMENT TOXICITY TESTING METHODS TO EVALUATE DREDGED MATERIAL MANAGEMENT GUIDELINES AT PORTO MARGHERA, VENICE, ITALY

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Key words: sediment quality guidelines, Venice, dredged material management, effects-based testing

The current system of dredged material assessment/management at port facilities located at Porto Marghera in Venice, Italy is based on numerical sediment quality criteria. Dredged material is classified into one of three categories (A, B, or C) depending upon the concentrations of heavy metals, total PAHs, total PCBs and organochlorines. Dredged material containing chemical concentrations less than or equal to those identified under category 'A' may be removed and disposed in open water without restriction. Dredged material classified as category 'B' is managed in the aquatic environment subject to management restrictions (e.g., silt curtains, confined aquatic disposal, etc.). Dredged material classified as category 'C' must be disposed in a properly managed confined disposal facility.

It is anticipated that future assessments of dredged material in Italy will likely use the Venetian numeric-based approach. To assess the potential implications of shifting from the current numeric-based approach to effects-based testing on dredged material management activities, a comparative evaluation was conducted between the Venetian numerical-based approach and the U.S. effects-based approach. Sediments representing each of the three dredged material management categories were collected from navigation channels within the Port of Venice. Sediment from an aquatic disposal site located in the Lagoon was collected as reference material. Sediments were analyzed for bulk sediment chemistry and evaluated using Tier III testing procedures described in the U.S. Inland Testing Manual. Results of Tier III sediment toxicity and bioaccumulation testing were compared to the Venetian numeric-based approach. The degree of concordance between the numeric classification and the observed effects/bioaccumulation in each category of dredged material are discussed in light of the potential implications for future dredging and dredged material management in the Venice Lagoon.

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