

BENEFICIAL USE OF DREDGED SEDIMENTS AS A FEEDSTOCK IN CONVENTIONAL PORTLAND CEMENT PRODUCTION

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Key words: contaminated sediments, beneficial use, cement

Sediments contain a significant amount of a valuable commodity that is actively mined in this country on a massive scale: quartz (SiO_2). With rapidly depleting natural quantities of SiO_2 , industries like the Portland cement manufacturing industry are constantly seeking alternative sources. Against this background, the primary goal of the sediment management approach being proposed is to capitalize on the inherent properties of dredged sediments to produce a valuable and marketable commodity: Portland cement (Portland cement is an extremely fine, gray powder manufactured from some of the earth's minerals. After mixing with water, Portland cement is the glue that binds sand and gravel together into the rock-like mass known as concrete).

This research project is progressing along two fronts: First, study of cement manufacture using contaminated sediments as a partial feedstock is being conducted, and the resulting cement characteristics are being investigated. Second, the fate of organic and inorganic contaminants initially present in the sediments is being investigated, particularly the mineralogical form of heavy metals that remain in the cement matrix and the concomitant leaching properties.

This presentation will focus on the justification for this approach, including an economic analysis that will highlight the conditions (e.g. transportation situation, tipping fees, sediment water content) for which this approach may be feasible. Preliminary cement mix ratios, cement quality, and pH-dependent leaching results will also be presented based on work using sediments from NEW YORK Harbor.

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SITING A CONFINED DISPOSAL AND TREATMENT FACILITY WITHIN A
REGIONAL FRAMEWORK FOR MANAGING CONTAMINATED SEDIMENT:
LESSONS LEARNED AND REMAINING CHALLENGES T

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Key words: confined disposal, contaminated sediment, treatment

The need for a comprehensive sediment management program in the Puget Sound region was recognized more than twenty years ago. A cooperative program to effectively manage cleaner dredged material was established in 1988. Sediment management standards promulgated in 1991 define requirements for cleaning up contaminated sediment and controlling continued discharges. However, remediation of contaminated sites identified since 1996 has often been delayed because of inadequate regional confined disposal capacity.

Seven federal, state and quasi-public parties are now participating in a joint effort to site and build regional capacity to manage contaminated dredged material by a combination of beneficial uses, treatment and disposal. Thus, challenges encountered in the multi-user disposal site or "MUDS" project include funding feasibility studies, reaching consensus on technical and policy issues, generating public interest prior to choosing preferred types of facilities and sites, and identifying a willing facility owner. Many of these challenges have been or are in the process of being resolved, but other significant hurdles remain. Key issues remaining include demonstrating a reliable flow of contaminated material, identifying methods to accelerate cleanup activities, determining the appropriateness of using public lands for aquatic disposal and evaluating the long-term safety and liability of products manufactured from sediment treatment processes.

The authors also describe the need to create a public entity with all the legal authorities needed to form a partnership with one or more private companies to develop confined disposal and treatment capacity. This "MUDS authority" will need to cooperatively define the optimum partnership, secure adequate funding, obtain technical and policy assistance, generate legislative interest and public acceptance in order to select, design, build and permit a regional facility.

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ETHEC CONTAMINATED SEDIMENT TREATMENT

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Key words: hazardous cleanup, recyclable

Technology Description: ETHEC technology integrates electrical, thermal, and chemical techniques for economical treatment and recycling of contaminated marine sediment, hazardous sludge or water/solid compositions. Contaminated and hazardous waste are used, as a raw material for ETHEC's products manufacturing and are cleaned up using energy accumulated in the processed materials and system. During this process ETHEC cleans up and recycles the waste material and also the contaminants themselves (i.e. integrated organic and/or inorganic contaminants). ETHEC modular systems are configured for one stage, two stage, or three stage operation.

During stage 1 ETHEC efficiently concentrates on water the solid residue by extracting water in vapor form from marine sediment. During Stage 2 the solidified, organically contaminated residue, is cleaned up using, again, thermal energy for extracting the organics in vapor. Hazardous organics, such as PCBs, dioxin, carbon disulfide, etc. are vaporized for further treatment. Nonhazardous petroleum-based organics are condensed into fuel products. During Stage 3 the heavy metals are stabilized by a thermo-chemical reaction, as a result of high temperature processing. High temperature heating is a part of ETHEC manufacturing process which converts organic-free sediment (solid) into baked construction filler, or cementitious (pozzolanic) material. The vaporized hazardous organics are on-site thermally decomposed into industrial chemicals.

Environmental Benefits includes both on-site waste processing, and in-line recycling of the treated material and contaminants provide the zero-discharge operation. Integrating the ETHEC systems into industrial-type production lines, using waste heat, as energy source, and using closed loop system configuration prevents pollution.

Application may include contaminated marine sediment, technological sludge, ground water and soil, wastewater, and mineral solid waste compositions.

Depending on the required beneficial products, the necessary ETHEC stages are the following:

- Stage 1: concentrated solid residue, distilled water-dewatering (volume reduction)
- Stage 2: organics free solid (soil) _ vapor extraction and recovery of nonhazardous organics
- Stage 3: baked fill and aggregate materials, cementitious (pozzolanic) material, industrial chemicals_thermo-chemical stabilization of heavy metals and thermal decomposition of hazardous organics.

CLAREMONT CHANNEL DEEPENING: A PUBLIC PRIVATE PARTNERSHIP
SUCCESS STORY
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Key words: beneficial use, public-private partnership, capping, brownfield, abandoned mine

The Claremont Channel Deepening project is a partnership between the State of New Jersey, the City of Jersey City, Hugo Neu Schnitzer East (HNSE), Consolidated Technologies Inc. (CTI) and Liberty National Development Corporation.

The project encompasses:

- major site improvements in the Hugo Neu Schnitzer East metal scrap processing facility on the Claremont Channel in Jersey City, NJ;
- the dredging of 1.25 million CY from the Channel to increase the depth from the current 26 feet to 32 feet (plus 2 ft overdredge);
- the construction of a multi-project dredged material processing facility to serve NY-NJ Harbor;
- the use of an innovative mixture of dredged material with PROPAT®, a recycled product manufactured by HNSE, for the bulk fill and grading of a new golf course at Port Liberte, a residential development adjacent to the Channel;
- the use of amended dredged material for capping and grading additional acres of the golf course;
- filling portions of an abandoned mine in Pennsylvania with amended dredged material;
- the use of dredged to construct an intertidal habitat at the head of the channel; and
- disposal at the Newark Bay Confined Disposal Facility.

The estimated cost of this project is approximately \$52 million. Hugo Neu Schnitzer East's contribution will be \$30.5 million, or 60% of the total cost. The dredging and beneficial use have an estimated cost of approximately \$40 million or \$32 per CY. This is comparable to other disposal options in NY Harbor, such as the CDF in Newark Bay.

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IDENTIFICATION AND EVALUATION OF STRESSORS IN TOXIC SEDIMENTS AND DREDGED MATERIALS

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Identification of stressors in aquatic systems is critical to sound assessment and management of our nation's waterways for a number of reasons. Identification of specific classes of toxicants (or stressors) can be useful in designing effective sediment remediation methods and reasonable options for sediment disposal. Knowledge of which stressors affect benthic systems allows managers to link stressors to specific dischargers and prevent further release of the toxicant. In addition, identification of major causes of toxicity in sediments may guide programs such as sediment quality guidelines and pesticide registration, while knowledge of the causes of toxicity which drive ecological changes such as community structure would be useful in performing ecological risk assessments. To this end, the US Environmental Protection Agency has developed tools (Toxicity Identification and Evaluation (TIE)) that allow researchers to characterize and identify chemical causes of acute toxicity in sediments and dredged materials. Development of these methods for both interstitial waters and whole sediments is nearly complete, and a guidance document is expected by the end of 2001.

To date, most sediment TIEs have been performed on interstitial waters. Preliminary evidence from the use of interstitial water TIEs reveals certain patterns in causes of sediment toxicity. First, among all sediments tested, there is no one predominant cause of toxicity; metals, organics and ammonia all play a role in about equal amounts in causing toxicity. Second, within single sediment there are usually multiple causes of toxicity; not just one chemical class is present. Finally, if sediments are divided into marine or freshwater sediments, TIEs performed on freshwater sediments indicate a variety of toxicants in fairly equal proportions, while TIEs performed on marine sediments have identified only ammonia and organics as toxicants, with metals playing a minor role. However, it is necessary to keep in mind that a very small number of interstitial water TIEs have been performed, and these trends may change as larger numbers of TIEs (both interstitial and whole sediment) are performed.

Results from interstitial water TIEs will be discussed. Methodology and results from whole sediment TIEs will also be discussed along with advantages, limitations and application of these methods.

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DREDGING AND DISPOSAL OF CONTAMINATED SEDIMENTS IN THE
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Key words: Netherlands, remediation, dredging, separation, CDF

The results of the Dutch research program on the development of remediation techniques for contaminated sediments (POSW) were published in 1997. One of the key conclusions was that complete processing of contaminated sediments to re-usable products was not economically feasible at that moment. Based on the results of this program politics decided to focus remediation on dredging and storage of the contaminated sediments in regional Contained Disposal Facilities (CDF). The first priority based on the available budgets is to remove the contaminated sediments out of the water system and to store them safely in these CDFs.

Dredging techniques have been developed to dredge selectively the contaminated sediments with minimal negative impact on the surrounding environment. Optimization of the use of the CDF by minimizing the volumes to be finally stored is a key item. This will be achieved by a combination of surgical dredging of the contaminated sediments and the use of low-cost treatment techniques such as sand separation, ripening, land farming and CDF-management.

Actually CDFs are in different stages of development between operation, construction and design in combination with public outreach programs. In order to optimize the total remediation process, it is essential that all stages between pre investigation, dredging, treatment and final storage fit together. For each project the aspects of importance must be recognized and implemented in the selection of the working method. Based on the experiences with the execution of various remediation projects key items of this process will be addressed.

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EVALUATION OF DREDGING TECHNOLOGIES FOR PROJECT SPECIFIC NEEDS
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Key words: contaminated sediments, dredging technology, pilot studies, performance parameters, environmental monitoring, dredged material disposal

The ongoing remedial design for sediment dredging and disposal at the New Bedford Harbor Superfund site will be based on prior site characterization and pilot dredging and disposal studies. From these it has been learned that selection of the dredging technology must address needs for accurate dredging, high production, and minimal resuspension of sediments during dredging. Also, for successful completion of the project it is important to dredge and transport sediments minimizing water addition to the waste stream and to dredge efficiently in water depths from zero to three feet.

To develop current information on the capabilities of state of the art dredging equipment and verify the performance of the equipment a detailed technology evaluation was performed. New Bedford specific screening criteria were used in the technology evaluation. Two types of dredge systems were selected from the technology screening . It was decided to perform an on-site pilot dredging study of one of the dredge systems to monitor and verify dredging performance. The dredging study included monitoring of the dredging for performance parameters and environmental affects. Monitoring was done for sediment resuspension and transport (water quality), air emissions from dredging and disposal, and confirmation of clean-up goals. Mass balance calculations were performed to develop full-scale dredging performance parameters and to evaluate alternatives for dredged material disposal.

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MODEL OF PAH AND PCB BIOACCUMULATION IN MYA ARENARIA AND APPLICATION FOR SITE ASSESSMENT

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In areas of sediment contamination, quality guidelines are often used for remediation and/or restoration decisions. To supplement each set of sediment quality guidelines, bioaccumulation models have been used to estimate higher trophic level contamination. Although various models address the bioaccumulative property of contaminants, none are both accurate and easily implemented. To address this issue, a new bioaccumulation model for polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) from sediment to *Mya arenaria* was developed. Basic equilibrium partitioning theory, i.e. contaminant partitioning between organism lipid and sediment organic carbon (Bierman 1990) was used as the model foundation. The model was then augmented by adding PAH and PCB partitioning into mollusc protein and PAH partitioning into the sedimentary soot fraction. Data on the PCB and PAH concentrations in sediment and *M. arenaria* from Massachusetts Bay, along with estimates of animal protein and sediment soot content were used to test this new model. The model predicts PCB concentrations in *M. arenaria* with only a slight variation from observed data. Predicted PAH concentrations are more accurate than concentrations predicted by other model types, but organism burdens still remain slightly greater than observed concentrations. To determine its accuracy, the model should be tested with data sets in which all parameters are measured.

Bierman, V. 1990. Equilibrium Partitioning and Biomagnification of Organic Chemicals in Benthic Animals. *Environmental Science and Technology* 24(9):1407-1412

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RISK-BASED DECISIONS FOR DREDGED MATERIALS MANAGEMENT:
CONSIDERATION OF SPATIAL AND TEMPORAL PATTERNS IN EXPOSURE
MODELING

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This paper addresses the interactions of various aspects of foraging behavior, habitat characteristics, site characteristics, and the spatial distribution of contaminants in developing exposure of winter flounder to PCBs from a hypothetical open water dredged material management site in the coastal waters of New York and New Jersey (NY-NJ). It then considers the implications of these interactions on human health risk estimates for local recreational anglers who fish for and eat those flounder. We also address the advantages of such spatially explicit modeling in environmental decision making at dredged material management sites.

The models implemented in this study are a spatial model to account for realistic exposures and a probabilistic adaptation of the Gobas bioaccumulation model that accounts for temporal variations of concentrations of hydrophobic contaminants in sediment and water. We estimated the geographic extent of a winter flounder sub-population offshore of NY-NJ based on the species biology and its vulnerability to local recreational fishing, the foraging area of individual fish, and their migration patterns. We incorporated these parameters and an estimate of differential attraction to a management site into a spatially explicit model to assess the range of exposures within the population. The output of this exposure model, flounder PCB tissue concentrations, provided exposure point concentrations for an estimate of human health risk through ingestion of locally caught flounder. The analysis shows that for the model to obtain median risks close to the prediction for the spatially non-explicit case, all spatial parameters would have to be taken at conservative extremes simultaneously. This practice "defaulting" to certain conservatism in the face of uncertainty ill serves the decision-making process. Consideration of realistic spatial and temporal scales in food chain models can help support management decisions regarding dredged material disposal by providing a quantitative expression of the confidence in risk estimates.

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EVALUATION OF ENVIRONMENTAL EFFECTS ON METAL TRANSPORT FROM CAPPED CONTAMINATED SEDIMENT UNDER CONDITIONS OF SUBMARINE GROUNDWATER DISCHARGE

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Previous studies conducted in our laboratories have shown that submarine groundwater discharge (SGD) can significantly increase metal fluxes from capped contaminated sediment to the overlying water. Five columns were set up in the laboratory to evaluate the effects of environmental factors such as groundwater pH, sediment depth, and groundwater flow rate on metal transport from capped contaminated sediment under conditions of SGD. Acidified groundwater discharge was shown to enhance the mobility of all metals tested except Mo. Although much of the released metal was adsorbed by the capping material, increased metal fluxes to the overlying water were observed for all other metals except Cr, and Cd. Additional sediment depth enhanced fluxes for all of the metals except Cd and Pb, due to speciation changes resulting from the lowered redox condition. Increased SGD rates did not significantly decrease the volume-normalized fluxes for all the metals except for Cr and Mo. However, all metal releases were higher due to the greater flow at increased SGD rates. The residence time and the redox conditions may be important in evaluating capping efficiency under different combinations of environmental effects.

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CAPPING EFFICIENCY FOR METAL-CONTAMINATED MARINE SEDIMENT UNDER CONDITIONS OF SUBMARINE GROUNDWATER DISCHARGE

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Theoretical estimations and laboratory studies suggest that capping can effectively retard contaminant transport under undisturbed conditions. However, contaminated near-shore areas, commonly selected as capping sites, are frequently subjected to Submarine Groundwater Discharge (SGD). Four columns were set up in the laboratory to simulate metal transport through sediment and capping material in the presence and absence of SGD. In the absence of SGD, capping enhanced Mo flux and initial Mn flux while having no effect in retarding Fe flux, presumably due to altered redox conditions. This effect was more pronounced in the presence of SGD (4.7×10^{-4} m/hr specific discharge). Capping enhanced Cd flux and initial fluxes of Ni, Cu, and Zn under conditions of simulated SGD, which may be caused by co-transport with Mn and Fe and oxidation of sulfide. Capping retarded Cr and Pb fluxes and steady-state Ni, Cu, Zn, and Fe fluxes in the presence of simulated SGD. However, capping efficiency decreased relative to no SGD. Elevated Mn concentration was detected at the capping surface with simulated SGD. Results indicate that advective flow may lead to significantly higher metal fluxes than under undisturbed conditions.

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CORE ANALYSIS: IS IT A GOOD INDICATOR OF METAL RELEASE AND CAPPING EFFICIENCY?

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Analysis of core samples is commonly used to detect contaminant transport from capped sediments. This paper evaluates the effectiveness of the core analysis technique as an indicator of metal release and capping efficiency. The first set of experiments evaluated metal concentration in capping material as a function of time and depth under the minimal disturbance. The results suggested that the metal concentration gradient in sediment pore water may not be easily recovered by analyzing the metal concentrations in the sediment. No significant metal concentration change was detected over time in the experimental range. The second set of experiments was designed to evaluate the metal concentration profile in the capped sediment and capping material in relation to the metal flux to the overlying water. Results suggested that metal concentration gradients in the sediment or capping material may not be good indicators of metal transport under conditions of advective flow. Direct measurement of contaminant fluxes is needed to better evaluate contaminant release and capping efficiency.

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NUMERICAL SEDIMENT QUALITY GUIDELINES: HOW WELL DO THEY
ACCURATELY PREDICT ACUTE TOXICITY AND BENTHIC EFFECTS IN
SALTWATER? E. Long*

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Key words: sediment quality guidelines, contaminated sediments, sediment toxicity, benthic infauna

Data were compiled from chemical analyses and acute toxicity tests of 1513 saltwater sediment samples to evaluate the performance of empirically-derived sediment guidelines. The purpose of the study was to objectively quantify the degree to which sediment guidelines accurately predicted either toxic or non-toxic responses in laboratory tests. Data were analyzed to both determine the percentages of samples in which acute toxicity was observed and calculate average survival within ranges in the numbers of sediment quality guidelines (SQGs) exceeded and mean SQG quotients. Within four ranges in contamination, the percentages of samples that were toxic were: <10%, 20-30%, 50-60%, and =75%. Average percent amphipod survival in the same samples decreased sequentially from =92%, to 79-88%, to 59-70%, and to 37-46%. Numerous other data sets were compiled to also determine how frequently benthic infaunal communities were altered when the SQGs were exceeded. The data analyses indicated that adverse alterations to the infauna occurred at concentrations approximately an order of magnitude lower than those associated with acute toxicity. Therefore, the data indicated that numerical guidelines for saltwater sediments are useful in estimating the probabilities that future samples would be toxic either in laboratory tests or in nature.

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