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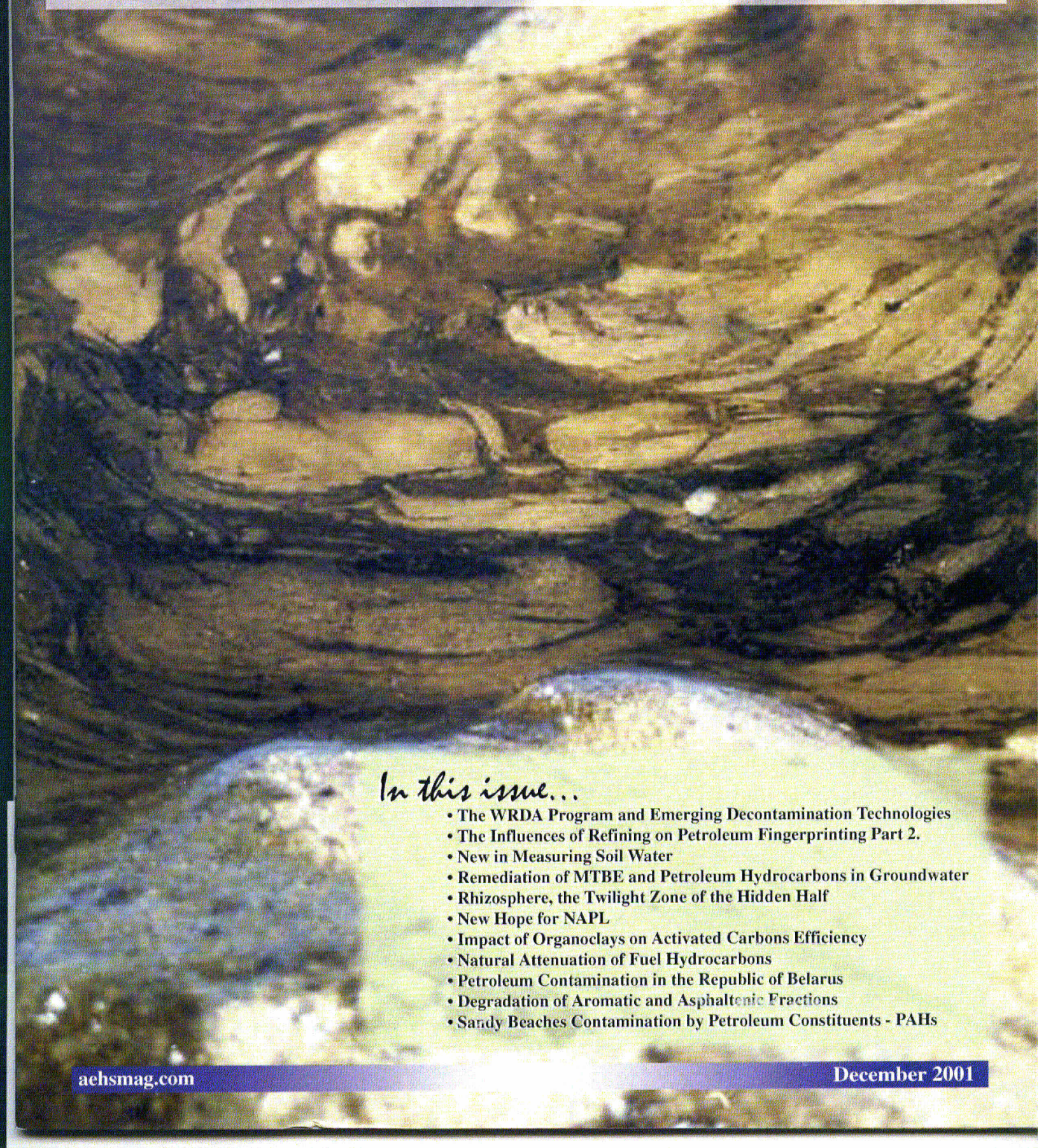

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The WRDA Program and Emerging Decontamination Technologies for Contaminated Sediments

By Richard J. Wenning, Eric A. Stern, Keith W. Jones and W. Scott Douglas

More than 400 million cubic yards of sediments are dredged from U.S. waterways each year, and close to 60 million cubic yards are disposed in the ocean. The need to fully understand the potential effects of sediment dredging and disposal, particularly for contaminated sediments, is gaining increased attention from federal and state environmental agencies, port and harbor authorities, environmentalists and citizens groups.

The handling of contaminated sediments in New York/New Jersey (NY/NJ) Harbor exemplifies this problem. On average, the U.S. Army Corp of Engineers' (USACE) New York District, the Port Authority of New York and New Jersey, and private companies dredge between four and seven million cubic yards of sediment each year to maintain navigation channels and ship berths.

Like most heavily industrialized coastal estuaries, dredged material from NY/NJ Harbor typically contains a wide range of chemical contaminants, which may include metals, chlorinated pesticides, polynuclear aromatic hydrocarbons, polychlorinated biphenyls and dioxins/furans. The distribution of chemicals in sediment can be extremely variable, both vertically and spatially. At some locations in NY/NJ Harbor, several organic chemicals and metals occur at concentrations that are known or suspected to be toxic to aquatic life. At other locations where contaminants may occur below toxic thresholds in the sediment, some chemicals have been detected both in sediment and in fish and shellfish tissues, prompting commercial and recreational fishing advisories.

Alternatives to Ocean Disposal

In 1997, the recognition of contaminated sediment conditions in NY/NJ Harbor drew a sudden and drastic response from the White House. On September 29, then-Vice President Albert Gore directed USEPA Region 2 to terminate ocean disposal of dredged material. At the same time, the Vice-President directed the Agency to designate the former ocean disposal site located five miles off the coast of Manhattan Island as the Historic Area Remediation Site (HARS).

This Vice-President's actions, followed shortly afterwards by other related tough new requirements, created an operational crisis for the Port Authority of NY/NJ, which is by far the largest port authority in the region. Within a few short years, changes in New York, New Jersey and federal environmental regulations resulted in more stringent requirements governing ocean disposal of dredged material in the New York Bight and few viable disposal alternatives.

At present, HARS is permitted to receive only dredged material classified as "Material for Remediation." This material is defined in accordance with USACE specifications as uncontaminated dredged material; that is, dredged material that meets current USACE Category I standards and will not cause significant undesirable effects, including those caused by bioaccumulation. An interim evaluation framework addressing handling of dredged material proposed for use as remediation material is currently undergoing review and revision by New York, New Jerse, and federal environmental authorities. In the meantime, implementation of the current interim framework has resulted in a greater than 75% reduction in material suitable for ocean placement.

For dredged material otherwise designated as contaminated, environmental authorities have committed considerable financial and technical resources to finding viable placement options. Current proposed solutions to the regions dredged material disposal crisis include the use of confined disposal facilities (both upland facilities and containment islands); construction of confined subaqueous disposal facilities; and, development of technologies for processing and treatment of contaminated materials.

These and other disposal alternatives will likely be subject to some of the same stringent environmental regulations that govern ocean disposal, and which contributed to the current disposal crisis in NY/NJ Harbor. Technical experts and decision-makers in the region readily acknowledge that a comprehensive solution to the regions dredged material disposal crisis must include a combination of several technical solutions and management options.

Confined Aquatic Disposal A Short Term Solution

The Port Authority of NY/NJ, in partnership with the State of New Jersey has constructed a confined aquatic disposal facility in Newark Bay capable of holding 1.5 million cubic yards of dredged material. Referred to as the NBCDF, the facility is characterized as a short-term solution to the regions disposal crisis, providing much needed disposal capacity while longer-term solutions are under development. There are several additional proposals to expand the regions in-water disposal capacity, including construction of an additional one million cubic yard CAD facility in Newark Bay.

Environmental groups in the region have made it well known to both state and federal authorities that the construction of CAD facilities provides only temporary relief, and should not detract from efforts to find longer-term, more permanent solutions. Their reasons are two-fold. First, there is limited additional space available for sitting subaqueous disposal pits. What little shallow water habitat is left in Newark Bay and elsewhere is needed to support and re-establish fisheries in the region. And, second, the presence of a management option perceived as relatively inexpensive discourages efforts to justify and promote upland disposal scenarios.

The WRDA Team Approach

The U.S. Congress responded to the crisis in NY/NJ Harbor by authorizing the Water Resources Development Act (WRDA) of 1992 (section 405C) and 1996 (section 226) and 1999 (section 218). WRDA earmarked funds to explore the feasibility of developing technologies for decontamination of dredged material and contaminated sediments from NY/NJ Harbor.

Implementing this on-going effort is a multi-disciplinary group, the WRDA Team, comprised of technical and policy experts representing government, industry, academia and local citizens groups. USEPA Region 2 and the USACE New York District jointly administer the WRDA Program. The Department of Energy's Brookhaven National Laboratory (BNL) provides technical project management support. The State of New Jersey, represented by N.J. Department of Transportations Office of Maritime Resources, is the newest member of the WRDA Team.

The Office of Maritime Resources was established in 1995 specifically to address the dredging crisis and administer nearly $270 million to support dredging and dredge materials management research in the region. To date, the Office has allocated $20 million to support several different sediment decontamination technologies and to evaluate their role as one of several possible options for management of navigational dredged materials.

The WRDA Vision

The goal of the WRDA Program is to develop several different sediment decontamination technologies as part of a comprehensive sediment "treatment train" capable of annually handling and processing a minimum of 500,000 cubic yards of contaminated sediment. The conceptual model for this treatment train includes the use of advanced sediment assessment methods such as 3-D visualization to identify and classify different levels of contamination, a materials handling process for different contaminant conditions, a suite of decontamination technologies and several options for beneficial use of post-treated dredged material.

The WRDA Team acknowledges that sediment decontamination options must be environmentally safe and cost-effective. New sediment treatment technologies must be capable of handling the many different physical and chemical characteristics of sediments found in NY/NJ Harbor. And in particular, the WRDA Team envisions the development of decontamination processes especially applicable to areas in NY/NJ Harbor where contaminant levels in sediment are believed to pose an unacceptable ecological or human health risk.

A second important aspect of the WRDA vision is to encourage the production of value-added commercial products from decontaminated dredged materials. The sale of these products is envisioned to help defray the costs of treatment and disposal of the residual contamination (if any) and preserve cost-competitiveness with conventional management strategies.

Exploring Economical Alternatives

To date, nearly $20 million has been spent under WRDA to conduct 12 bench-scale studies, five pilot-scale projects and, most recently, three additional demonstration projects, two full-scale tests and one manufacturing test project. WRDA funds have been used to support USACE Waterways Experimentation Station activities, large-scale sediment collections, sediment assessments involving three-dimensional sediment visualization, engineering designs, public outreach events, analytical testing programs, materials handling reviews, conceptual treatment designs and beneficial use demonstration projects.

Bench-scale testing of several different technologies was completed in December 1996. The technologies included thermal destruction and desorption processes, stabilization/solidification, sediment washing, advanced chemical treatment, solvent extraction methods and manufactured soil production.

The WRDA Programs step-wise approach to development of new technologies has relied on a set of specific selection criteria to identify promising technologies. A promising sediment decontamination technology must demonstrate an ability to achieve its stated performance specifications, and provide detailed information for independent peer-review on demonstration costs, public-private cost sharing requirements, options for beneficial use of the treated material, and private sector evaluations of the long-term economic viability of the technology.

Three Innovative Decontamination Technologies

The WRDA Program is now progressing towards the final design phase for selected technologies. Federal funding available under WRDA provides assistance for private sector commercialization of successful technologies. However, the private sector must provide the capital needed for facility construction and operation. Initial construction of three

full-sized commercial-scale facilities is currently underway.

In October 1998, USEPA awarded contracts to support three decontamination technologies that successfully completed bench-scale testing. The contracts, valued at more than $2 million altogether, were awarded to The Gas Technology Institute/Endesco of Des Plaines, Ill.; BioGenesis Enterprises of Milwaukee, Wisc.; and, Westinghouse Science & Technology Center of Pittsburgh, Penn. Funding also was awarded to the USACE Waterways Experiment Station to further evaluate similar low- to high-temperature thermal technologies for production of manufactured soil from contaminated sediments.

BioGenesis Enterprises has developed a patented sediment-washing technique that uses high-pressure water jets and proprietary chemical additives to extract both organic and inorganic contaminants from sediment. The washed material can be used to produce manufactured soil for commercial and, in some cases, residential landscaping applications. BioGenesis anticipates scaling up its treatment process to handle 250,000 cubic yards per year in 2002.

The Gas Technology Institute/Endesco has pioneered the application of a natural gas-fired thermo-chemical manufacturing process operating at high temperatures to destroy organic contaminants. Metals are immobilized within the resulting product matrix, after mixing with Portland cement. The blended cement produced by GTIs Cement Lock technology exceeds the American Society for Testing and Materials (ASTM) requirements for Portland cement. A joint venture between Endesco and Clean Harbors, Inc. will begin work on a 500-ton pilot scale project in Bayonne, N.J. in mid-2002 capable of treating 10,000 cubic yards per year. The plans for the facility include expanding treatment capacity to over 100,000 cubic yards per year within the next 18 months.

Westinghouse Science & Technology Center has developed a high-temperature vitrification process to destroy organic contaminants and incorporate metals into a glassy matrix. Westinghouse completed a bench-scale testing at a Milwaukee facility in 1999, where they successfully produced an array of high gloss colored glass tiles. Westinghouse is exploring opportunities for developing a commercial-scale joint venture with a tile manufacturer in the NY/NJ Harbor region.

The goal for each sponsor of the selected technologies is to evaluate the technical and economic feasibility of building and operating large-scale treatment facilities for dredged material. Each of the three technologies currently under consideration have demonstrated destruction, removal or immobilization of organic chemicals and metal contaminants and production of uncontaminated material that could be used in one or more commercial products such as manufactured cement, glass and ceramic tiles, façade bricks and topsoil.

Other Promising Technologies

Several other technologies for treatment of contaminated sediments also show promise.

Jay Cashman, Inc. of Boston and Upcycle Aggregates of New Jersey have teamed to utilize dredged materials as feedstock for the manufacture of lightweight aggregate (LWA). Their process utilizes existing LWA kilns modified for accepting dredged material to destroy organic contaminants and immobilize metals. LWA is manufactured using ultra high temperature rotary kilns, which produce a "bloated" rock that is utilized in the production of lower density concrete for construction of bridges and high-rise office towers. A four cubic yard pilot study conducted in early 2001 successfully demonstrated that this technique could be modified to produce LWA from dredged material that exceeds ASTM specifications.

BEM Systems of Chatham, N.J. has proposed utilizing its patented Georemediation™ technology to decontaminate sediments and produce manufactured soil for redevelopment and environmental restoration projects. Georemediation utilizes a chemical oxidation reaction to reduce organics and a mineralization process to immobilize metals. Bench scale testing involving 800 gallons of dredged material was completed at the Rutgers Center for Advanced Infrastructure and Technology earlier this year. Results of the project are due in late 2001.

NUI of Elizabeth, N.J. and their partner Parsons Brinkerhoff have proposed utilizing a relatively straightforward oxidation technique to reduce organic contamination in sediment. Potassium permanganate and superionized water are mixed with dredged material to create a sediment slurry that is dried and augmented to meet specific soil structural property requirements. The resulting manufactured soil, depending on its chemical and physical properties, could be used in construction and remedial projects, much the same as BEM Systems or BioGenesis products. The pilot scale test runs were conducted earlier this year at NUIs Elizabethtown, N.J. gas facility. Results are expected in late 2001.

Sediment Management Strategy

The WRDA Team envisions these, and perhaps other, new technologies serving as a critical component in an overall long-term sediment management strategy for the Port of NY/NJ. These same technologies also may provide the foundation for a viable strategy for smaller ports and marinas in the region and elsewhere in U.S.

The availability of a cost-effective solution for treatment of highly contaminated sediments is considered a critical component of the overall restoration and brownfield redevelopment strategy for heavily polluted portions of NY/NJ Harbor such as the Passaic River in N.J. and the Gowanus Canal in N.Y. Providing a permanent facility with renewable capacity could be instrumental to managing the long-term costs of navigational dredging. It is anticipated that navigational dredging contracts will benefit from a centralized sediment decontamination facility, which could, in turn, help support reasonable costs for environmental dredging projects.

Anticipated Commercial Operations

Large-scale treatment facilities that achieve WRDA Program goals are expected to become operational within the next 12 to 30 months. From the outset, each facility will

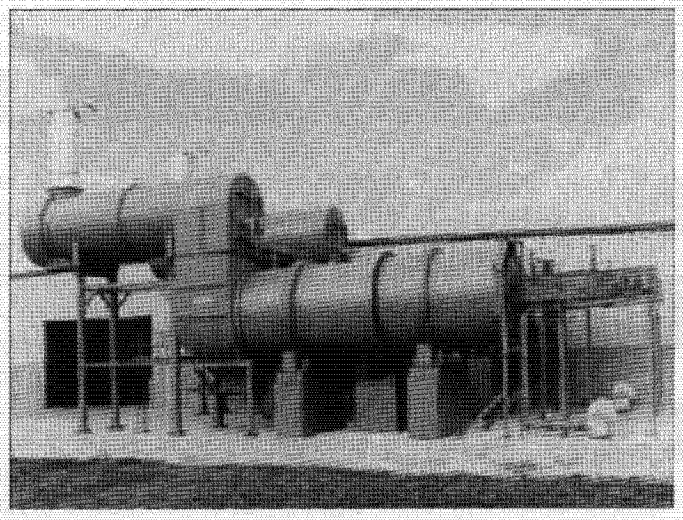

Photo 1. The Gas Technology Institute/Endesco has pioneered the application of a natural gas-fired thermo-chemical manufacturing process for treatment of contaminated sediments. Photo courtesy of USEPA and the Gas Technology Institute/Endesco.

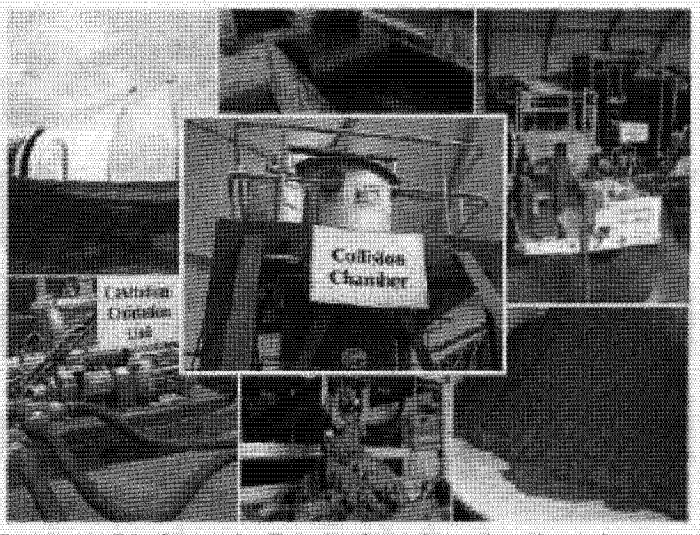

Photo 2. BioGenesis Enterprises has developed a patented sediment-washing technology that uses high-pressure water jets and proprietary chemical additives to remove both organic chemicals and metals. Photo courtesy of USEPA and BioGenesis Enterprises.

be required to conform to state and local environmental regulations. The permit process for sediment washing is anticipated to be relatively straightforward, since there are few, if any, air emissions. For contaminant residues collected in effluents, standard water treatment processes have been shown to be effective. For both low- and high- temperature processes such as the technologies developed by GTI, Upcycle Associates, Westinghouse and other companies, air permits and associated monitoring strategies will likely be required prior to full-scale operation.

Currently, dredged material is stabilized with Portland cement or incinerator fly ash, and used as construction material and capping material at several locations in New Jersey. The total cost of dredging, stabilization and disposal ranges, on average, between $40 and $50 per cubic yard. Dredging costs are highly variable, depending on the availability of equipment, time of year, environmental restrictions, and volume of dredged material. Current disposal costs in the Newark Bay confined disposal facility are approximately $29 per cubic yard.

To achieve the long-term solutions advocated by environmental groups, environmentally safe decontamination technologies must be proven as economically viable. The WRDA Team is confident that the costs of sediment washing and cement production will be competitiveat or below $29 per cubic yard when full-scale operation gets underway over the next two years.

Closing

Decontamination is only one component of a comprehensive dredged material management strategy. Technologies that eliminate, encapsulate or remove chemicals can reduce the volume of potentially highly toxic dredged material and, thereby, reduce the costs associated with expensive disposal requirements. The detoxified material can become a resource with commercial value, which could further offset the costs of decontamination and disposal of the residual material.

The day may soon come when contaminated sediment in NY/NJ Harbor is dredged from the bottom of the Harbor, treated to remove toxic contaminants, and turned into useful products such as potting soil, cement, façade brick or tiles, and aggregate. These technologies could one day help reduce perceived or actual ecological impacts and human health threats by turning contaminated sediment into marketable products.

More information is available from the USEPA Region 2s WRDA Program Manager, Eric A. Stern. His address is 290 Broadway, New York, NY 10007-1866. Mr. Stern can be reached by telephone at (212) 637-3806, and by e-mail at stern.eric@epamail.epa.gov. You can follow the progress of the WRDA Team on the Internet at www.wrdacon.bnl.gov and get the latest information on program activities, as well as technical reports, meeting dates, and technology profiles. Additional information is available on the Internet at the New Jersey Department of Transportation website located at www.state.nj.us/transportaton/maritime.

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