ERDC TN-DOER-C12
February 2000

Reclamation and Beneficial Use of Contaminated Dredged Material: Implementation Guidance for Select Options

PURPOSE: The purpose of this technical note is to provide implementation guidance for select options for the reclamation and beneficial use of contaminated dredged material. Previous technical notes have discussed the characterization tests that can provide information necessary to assist in the determination of the suitability of dredged material for beneficial uses and the application of these characterization tests to case studies of beneficial uses of dredged material. This technical note will build on the previous technical notes and give perspective to their implementation.

BACKGROUND: Beneficial use of dredged material is not a new concept. For years, relatively clean dredged material has been used for numerous beneficial uses. Beneficial uses of dredged material have been discussed in many forums such as the North Atlantic Regional Conference in 1987 (Landin 1988). Engineer Manual (EM) 1110-2-5026 (Headquarters, U.S. Army Corps of Engineers, 1987) discusses numerous beneficial uses of dredged material from aquatic, island, wetland, and upland habitat to strip-mine reclamation and construction and industrial/commercial uses. Most of the sites discussed have used relatively clean dredged material containing low levels of contaminants. Guidelines for disposal area reuse (DARM) have been discussed by Montgomery et al. (1979). Planning and implementing productive land use of dredged material containment areas was discussed by Walsh and Malkasian (1978). Guidance for land improvement using dredged material was published as a synthesis report by Spaine, Llopis, and Perrier (1978).

While much has been written about beneficial uses of dredged material and containment areas, little has been related to contaminated dredged material. However, contaminated dredged material has also been shown recently to have beneficial use through emerging, innovative technologies. Dredged material can be combined with other ingredients to engineer products for specific uses, such as manufactured topsoil, engineered soil capping material, flowable construction fill, or building blocks. The U.S. Army Corps of Engineers is still required to remove 229,366,470 cu m (300 million cubic yards) of sediment from waterways and harbors each year. Even with improved soil erosion control on land, massive amounts of soil find their way into the waterways of this Nation and require removal. Facilities for placing and confining these sediments are filling up and new facilities are difficult to establish. Consequently, removal and use of dredged material from these facilities will allow storage space for future dredging projects. Some removal of relatively clean sand for construction purposes has occurred in the past. New technologies can allow for the removal and use of dredged material in a wide range of products. Some demonstrations have been conducted such as manufactured topsoil at Toledo Harbor, Ohio, and at New York/New Jersey Harbor, New York. The successful completion of the Toledo Harbor demonstration has resulted in a commercialization plan to be developed to remove up to 611,644 cu m (800,000 cu yd) of dredged material from Cell 1 per year for 10 years. This will empty Cell 1 and allow an additional 10 years of storage capacity for the dredging of Toledo Harbor. This plan is being considered for implementation and will have a cost avoidance saving of at least 50 percent of a new confined placement facility or ~$50 million. A pilot-scale field demonstration at New York/New Jersey Harbor has

been extremely successful and has impressed interested parties that contaminated sediment can be used beneficially in both a manufactured topsoil for use on restricted sites such as landfills, mineland restoration sites, and Superfund site restoration and in construction materials such as building blocks and flowable fill. However, additional concerns have been raised related to the risk of producing these kinds of materials for these specific uses. Additional environmental testing has been requested prior to implementation of these beneficial uses.

INTRODUCTION: In order to determine the suitability of dredged material for beneficial uses, some basic data are required. Characterization tests described in Winfield and Lee (1999) can provide data that could determine the suitability of a dredged material for a specific use. A framework for testing and evaluating beneficial uses of dredged material was presented in Winfield and Lee (1999) that expands Figure 3-4 of the U.S. Army Corps of Engineers (USACE)/U.S. Environmental Protection Agency (USEPA) Technical Framework (USACE/USEPA 1992). That framework will be further expanded in this technical note as shown in Figure 1. Case studies on the application of the characterization tests to determine beneficial uses were described in Lee (1999). Manufactured soil technology as a beneficial use of dredged material was described in Sturgis and Lee (1999). Testing the potential for reclamation of contaminated dredged material has been described in Price and Lee (1999) and Price, Lee, and Simmers (1999) for phytoreclamation and Frederickson et al. (1999) for bioreclamation processes. These technical notes give the details on how to test contaminated dredged material to determine if contaminants can be processed so that the dredged material could then be used for beneficial purposes. A working group of experts that was convened concluded that phytoreclamation was achievable for certain contaminants currently and that additional research and demonstration were required for other contaminants (Price, Lee, and Simmers 1999).

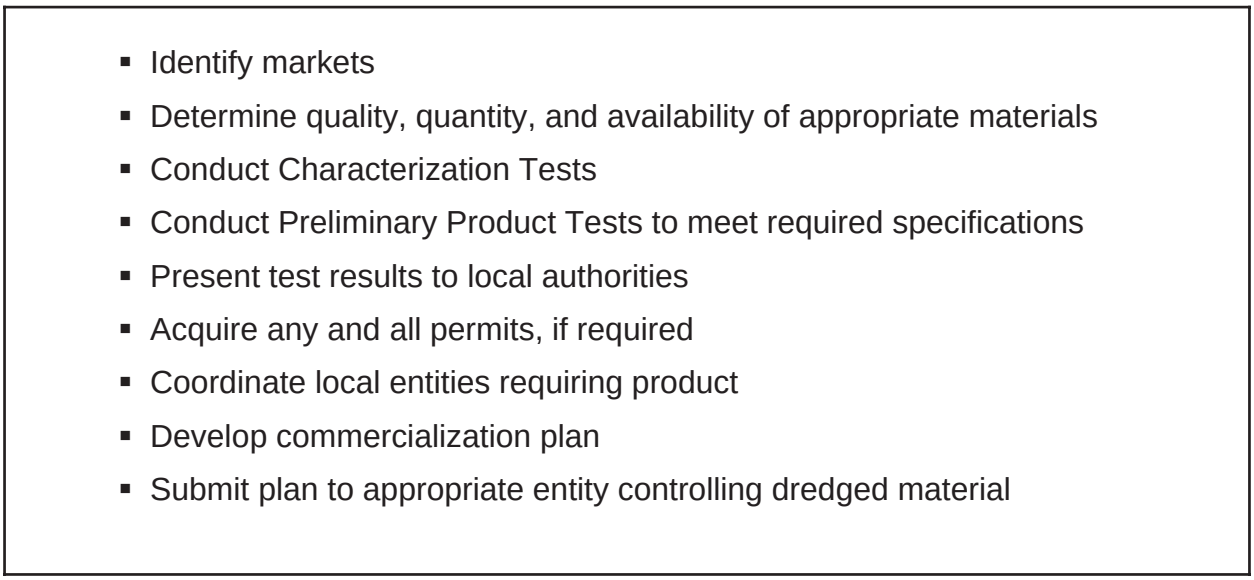

Figure 1. Flowchart for implementation

Implementation of these innovative technologies for reclaiming and using contaminated dredged material will be discussed in this technical note. It is important to assess the potential markets for manufactured products and the availability of local waste materials for the implementation of

beneficial uses such as manufactured topsoil, engineered soil capping material, building blocks, or flowable fill. The following discussion will explain how to approach the evaluation of specific beneficial uses of dredged material.

ENGINEERED PRODUCTS

Manufactured Topsoil: To evaluate the potential for manufactured topsoil in a particular location, local sources and types of cellulose and biosolids will need to be identified. Cellulose can be in many forms, such as yard waste, sawdust, wastepaper, storm debris, shredded paper, etc. Biosolids can be animal manures, such as dairy cow, beef cow, chicken, turkey, or swine manures, and/or sewage sludge biosolids. The quality, quantity, and availability of these materials must be determined. Potential markets for the soil products will need to be identified. Potential markets could include, but not be limited to, landscaping, nurseries, bagged soil products, highway construction rights-of-way, parks, ball fields, golf courses, etc. Characterization tests of the dredged material should be conducted in accordance with Winfield and Lee (1999) and Lee (1999). Screening tests of blends of the dredged material, cellulose, and biosolids should be conducted as described in Sturgis and Lee (1999).

Results of the characterization and screening tests should be presented to local authorities for their review, comment, and approval as a potential acceptable product. There are no universal soil contaminant concentration standards that are acceptable in all situations. A number of states have or are attempting to establish acceptable contaminant screening levels for soils used for residential and industrial purposes. The basis for these screening levels varies from state to state. In some cases, background concentrations of contaminants in local soils are considered, while other screening levels are related to risk assessments. In either case, local regulatory authorities will decide the acceptability of manufactured soil products and their uses for residential, industrial, or any other purposes. The USEPA has established maximum levels of metals in agricultural soils receiving biosolids derived from sewage sludge (Table 1, USEPA 1997). These soil concentrations have been derived from risk assessments of various soil to plant to animal scenarios. It would appear that manufactured topsoil with metal concentrations below those listed in Table 1 could be used for agriculture, or restoration of abandoned minelands, landfill covers, and Superfund sites that will be developed for wildlife habitat. Coordination with local entities, such as municipal, county, State, and Federal agencies, that have requirements for topsoil should be conducted to identify potential markets for topsoil. A commercialization plan should be developed using available resource materials. Participants in the development of the commercialization plan will vary from location to location. Participants can be, but are not limited to, commercial entities possessing patented technology (such as Recycled Soil Manufacturing Technology) or a properly licensed commercial entity, sources of available cellulose and biosolids, and other interested entities. The plan should then be submitted to the appropriate entity(ies) with authority over the dredged material to be reclaimed.

Table 1
Maximum Allowable Metal Concentrations in Sludge Amended Soils USEPA 503 Regulations (USEPA 1997)

Metal	Concentration ppm
Arsenic	41
Cadmium	39
Chromium	3,000
Copper	1,500
Lead	300
Mercury	17
Nickel	420
Zinc	2,800

Issues that may require resolution prior to implementation can be, but are not limited to, real estate issues of ownership of the dredged material and/or confined placement facility where the dredged material is stored; fees to the owner of the dredged material required for the removal of dredged material; fees to the contractor for the removal of the dredged material; mechanisms used to implement a commercialization plan such as contract or bidding or sole source contract; technology licensing mechanisms such as who is required to obtain the license; liability for products produced and/or uses of the dredged material derived products; acquisition of any and all permits that may be required; and any warrantees and quality assurances for successful performance of manufactured products.

Engineered Soil Products: To evaluate the potential for producing engineered soil products such as landfill low permeable capping material in a particular location, local sources and types of residual waste materials will need to be identified. Residual waste materials can be in many forms, such as fly ash, gypsum, spent lime, etc. The quality, quantity, and availability of these materials must be determined. Engineered soil products could be used to produce low permeable soil capping material for most landfill closure needs or in brownfield redevelopment. Characterization tests of the dredged material should be conducted in accordance with Winfield and Lee (1999) and Lee (1999). Preliminary tests of blends of the dredged material, available waste materials, and binders should be conducted to meet requirement specifications for product use. Various commercial entities that have patented formulations or proprietary processes can conduct appropriate tests.

Results of the characterization and preliminary tests should be presented to local authorities for their review, comment, and approval as a potential acceptable product. There are no universal contaminant concentration standards for capping soil material that are acceptable in all situations. A number of states have or are attempting to establish acceptable contaminant screening levels for capping soil materials used for landfill cover. The basis for these screening levels varies from state to state. In some cases, background concentrations of contaminants in typical local soils are considered, while other screening levels are related to risk assessments. In either case, local regulatory authorities will decide the acceptability of engineered capping soil materials and their uses for landfill cover or any other purposes. Coordination with local entities, such as municipal, county, State, and Federal agencies, that have requirements for impermeable soil capping material should be conducted to identify potential markets other than landfill closures. A commercialization plan should be developed using available resource materials. Participants in the development of the commercialization plan will vary from location to location. They can be, but are not be limited to, commercial entities that have appropriate proprietary technology or a properly licensed entity, sources of available residual waste materials, and other interested entities. The plan should then be submitted to the appropriate entity(ies) with authority over the dredged material to be reclaimed.

Issues that may require resolution prior to implementation can be, but are not limited to, real estate issues of ownership of the dredged material and/or confined placement facility where the dredged material is stored; fees to the owner of the dredged material required for the removal of dredged material; fees to the contractor for the removal of the dredged material; mechanisms used to implement a commercialization plan such as contract or bidding or sole source contract; technology licensing mechanisms such as who is required to obtain the license; liability for products produced and/or uses of the dredged material derived products; acquisition of appropriate permits that may

be required; and any warrantees and quality assurances for successful performance of manufactured products.

Building Blocks or Similar Products: To evaluate the potential for manufacturing building blocks in a particular location, local sources and types of solid wastes will need to be identified. Waste materials can be in many forms, such as foundry sand, slag, waste glass, stone dust, fly ash, gypsum, spent lime, etc. The quality, quantity, and availability of these materials must be determined. Potential markets for the building blocks will need to be identified. These could include, but are not limited to, security walls, walk-through gardens with walls and planters, garden patios and walkways, and buildings. Characterization tests of the dredged material should be conducted in accordance with Winfield and Lee (1999) and Lee (1999). Preliminary tests of blends of the dredged material, available waste materials, and binders should be conducted. Various commercial entities that have patented formulations or proprietary processes can conduct appropriate tests.

Results of the characterization and preliminary tests should be presented to local authorities for their review, comment, and approval as a potential acceptable product. There are no universal contaminant concentration standards for building blocks that are acceptable in all situations. A number of states have or are attempting to establish acceptable contaminant screening levels for some soil materials used for residential and industrial purposes. The basis for these screening levels varies from state to state. In some cases, background concentrations of contaminants in typical local soils are considered, while other screening levels are related to risk assessments. Concerns have been raised regarding the environmental safety of building blocks that may contain contaminants. The leachability and migration of contaminants out of the blocks and into the environment have been questioned. Some leachate testing of the blocks could be conducted to provide supportive data for the environmental safety of the product. Controls for such testing would most likely be locally available concrete building blocks. Risk assessments of the manufactured blocks and their use can also be conducted to support the potential safe use of the product. In either case, local regulatory authorities will decide the acceptability of the building blocks and their uses for any and all construction purposes. Coordination with local entities, such as municipal, county, State, and Federal agencies, that have requirements for building blocks or similar products should be conducted to identify potential markets. A commercialization plan should be developed using available resource materials. Participants in the development of the commercialization plan will vary from location to location. They can be, but are not limited to, commercial entities that have appropriate proprietary technology or a licensed entity, sources of available residual waste materials, and other interested entities. The plan should then be submitted to the appropriate entity(ies) with authority over the dredged material to be reclaimed.

Issues that may require resolution prior to implementation can be, but are not limited to, real estate issues of ownership of the dredged material and/or confined placement facility where the dredged material is stored; fees to the owner of the dredged material required for the removal of dredged material; fees to the contractor for the removal of the dredged material; mechanisms used to implement a commercialization plan such as contract or bidding or sole source contract; technology licensing mechanisms such as who is required to obtain the license; liability for products produced and/or uses of the dredged material derived products; acquisition of any and all appropriate permits that may be required; and any warrantees and quality assurances for successful performance of manufactured products.

Flowable Fill: Flowable fill is any semiliquid blend of dredged material, residual waste material, and binders that forms a slurry that can be poured into a cavity or structural form and solidifies rapidly into a cementitious-like material. To evaluate the potential for producing flowable fill in a particular location, local sources and types of residual waste materials will need to be identified. Residual waste materials can be in many forms, such as foundry sand, slag, waste glass, stone dust, fly ash, gypsum, spent lime, etc. The quality, quantity, and availability of these materials must be determined. Flowable fill could be used to produce construction fill for most construction needs. Figurines and statues could be made from flowable fill.

Characterization tests of the dredged material should be conducted in accordance with Winfield and Lee (1999) and Lee (1999). Preliminary tests of blends of the dredged material, available waste materials, and binders should be conducted. Various commercial entities that have patented formulations or proprietary processes can conduct appropriate tests.

Results of the characterization and preliminary tests should be presented to local authorities for their review, comment, and approval as a potential acceptable product. There are no universal contaminant concentration standards for construction fill that are acceptable in all situations. A number of states have or are attempting to establish acceptable contaminant screening levels for some soil materials used for residential and industrial purposes. The basis for these screening levels varies from state to state. In some cases, background concentrations of contaminants in typical local soils are considered, while other screening levels are related to risk assessments. Concerns have been raised regarding the environmental safety of construction fills that may contain contaminants. The leachability and migration of contaminants out of the fill and into the environment have been questioned. Some leachate testing of the flowable fill could be conducted to provide supportive data for the environmental safety of the product. Controls for such testing would most likely be locally available construction fill. Risk assessments of the manufactured construction fill and its use can also be conducted to support the potential safe use of the product. In either case, local regulatory authorities will decide the acceptability of the flowable fill and its uses for any and all construction purposes. Coordination with local entities, such as municipal, county, State, and Federal agencies, that have requirements for building blocks or similar products should be conducted to identify potential markets. A commercialization plan should be developed using available resource materials. Participants in the development of the commercialization plan will vary from location to location. Participants can be, but are not limited to, commercial entities that have appropriate proprietary technology or a licensed entity, sources of available residual waste materials, and other interested entities. The plan should then be submitted to the appropriate entity(ies) with authority over the dredged material to be reclaimed.

Issues that may require resolution prior to implementation can be, but are not limited to, real estate issues of ownership of the dredged material and/or confined placement facility where the dredged material is stored; fees to the owner of the dredged material required for the removal of dredged material; fees to the contractor for the removal of the dredged material; mechanisms used to implement a commercialization plan such as contract or bidding or sole source contract; technology licensing mechanisms such as who is required to obtain the license; liability for products produced and/or uses of the dredged material derived products; acquisition of any and all appropriate permits that may be required; and any warrantees and quality assurances for successful performance of manufactured products.

APPROACH TO IMPLEMENTATION: A flowchart is presented in Figure 1 to describe the process presented in this technical note. This flowchart expands the framework presented in the block labeled "Evaluate Physical and Engineering Suitability for Proposed Uses" in Figure 3-4 of USACE/USEPA (1992).

After information on potential markets and the quality, quantity, and availability of materials has been evaluated, preliminary screening tests should be conducted to determine what can be produced that will meet required performance standards and specifications. After appropriate blends have been determined in the preliminary screening tests, then either a field demonstration could be conducted to scale up the process and actually demonstrate the products for initial public acceptance or a commercialization plan could be developed if a demonstration is not necessary. Prior to the initiation of the field demonstration or the development of a commercialization plan, the public and all other interested parties should be brought together to discuss what will be demonstrated or commercialized. All comments and concerns from the interested parties should be considered and incorporated into the demonstration or commercialization plan as appropriate. With or without a successful demonstration, a commercialization plan should be developed utilizing all appropriate and applicable licensing agreements for patented technologies or proprietary technologies involved. This commercialization plan should be submitted to the appropriate entities having control of the dredged material or confined placement facility containing the dredged material. The commercialization plan should describe any and all cost avoidance savings to the entity that controls the dredged material or confined placement facility containing the dredged material.

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