

USING BIOSOLIDS TO RECLAIM DREDGED MATERIAL RECYCLED SOIL MANUFACTURING TECHNOLOGY

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Introduction

The US Army Corps of Engineers is responsible for maintaining navigation of this Nation's waterways. In order to accomplish this mission, the CE dredges approximately 300 million cu yd of dredged material annually. Sites to place the material is becoming difficult as confined disposal facilities (CDFs) become filled and new CDFs are difficult to site and establish. The beneficial use of dredged material has gained more interest in recent years with the evolution of new innovative technologies such as Recycled Soil Manufacturing Technology (RSMT). The US Army Corps of Engineers Waterways Experiment Station established a Cooperative Research and Development Agreement (CRDA) with Mr. Paul Adam, RSMT, to apply this innovative technology to Corps dredged material problems. Dredged material can be removed from existing CDFs and converted into topsoil for use in landscaping, parks, athletic fields, golf courses, wetland construction, landfill cover, Superfund restoration, Brownfield redevelopment and even the restoration of disturbed minelands. This technology has been applied to numerous dredging projects (Table 1) including Toledo Harbor, OH, (Sturgis et al 2000a, Lee et al 1998), New York/New Jersey Harbor (Sturgis et al. 1999a and Lee et al. 1999), Jacksonville Harbor, FL, (Sturgis et al. 2000b) and Mobile River and Harbor, AL (Sturgis et al 1999b). Similar technology has been applied to Hamlet City Lake sediment in NC (Skogerboe et al. 1992) and at Lake Okeechobee on the Herbert Hoover dike. In each case, dredged material was blended with locally available cellulose and biosolids according to the patented formulation of RSMT (Sturgis and Lee 1999). Manufactured soil using dredged material containing certain contaminants, such as PAHs, can be made acceptable by phyto-remediating the contaminants through degradation to CO₂ and water by plant roots and associated microbes (Price et al. 1999, Price and Lee 1999, Lee and Myers, 2000, Lee et al. 1999). The total recoverable petroleum hydrocarbons (TRPHs) in the manufactured topsoil from Hamlet City Lake sediment was phyto-remediated and reduced from over 3,300 ppm to 800 ppm in 6 months and 150 to 300 ppm over a 18 month period. The plants did not take up the organic contaminants, but rather these contaminants were degraded in the soil adjacent to plant roots by microbes associated within the root zone of the plants. Based on the greenhouse bench scale testing of Hamlet City Lake manufactured soil, approximately 60,000 cu yd of sediment was dredged and placed in a upland placement site and is presently being phyto-remediated to reduce PAHs and TRPHs. After phyto-remediation of the PAHs, the topsoil will be used to landscape the grounds adjacent to the lake from which the sediment was removed. A similar project is currently being conducted where a City park lake will be dredged to restore water quality and recreational fishing. The dredged material (50,000 cu yd) will be converted into topsoil using available yard waste from the city and manure from mounted police horse stables and the City zoo according to RSMT. After phyto-remediation of PAHs, the topsoil will be use for reconstruction of athletic fields and as enhanced wildlife habitat. Other contaminants such as Pb can be immobilized by applications of phosphate materials to form an inert lead phosphate mineral (Ruby et al. 1994, Ma et al. 1995, Cotter-Howells, 1996, Cotter-Howell and Caporn, 1996). This eliminates the potential for bioavailable forms of Pb in the environment and renders the Pb harmless (Price et al 1999). Through a combination of recycling materials through manufacturing topsoil and phyto-remediating contaminants present, most dredged material and even contaminated soils can be managed in such a way as to produce benefits for society.

Purpose

This paper will discuss RSMT and its application to dredged material as well as other applications such as mineland restoration. Examples will be cited and discussed briefly. The potential of this innovative technology in mineland restoration will also be described.

Recycled Soil Manufacturing Technology

A patent has been issued to Mr. Paul Adam for recycling residues and materials and converting them into fertile topsoil. The Federal Government encouraged Federal Research Laboratories to locate new innovative technologies that could help solve problems for the Federal government. The CE needed assistance on what to do with dredged material and the USEPA was interested in promoting the use of biosolids. RSMT uses both these materials plus other residual materials to produce useable fertile topsoil. Consequently, the ERDC-WES established a cooperative research and development agreement with Mr. Adam to evaluate and apply RSMT to Corps dredged material problems. A number of projects have been cited above. Some of these projects will be discussed below.

Toledo Harbor, OH

Dredged material from the Toledo Harbor confined disposal facility (CDF) was blended with available yard waste and N-Viro class A biosolids to produce a fertile topsoil to landscape the entrances of the University of Toledo and the Toledo Botanical Gardens. Bench scale greenhouse screening tests were conducted to determine the blend of dredged material, cellulose and biosolids that produced the best plant growth (Sturgis et al. 2000a). Four plant species were tested, tomato, ryegrass, marigold and vinca according to procedures established by a nationally known bagged soil company. Seed germination and initial 7 week plant growth evaluations were conducted. Based on these test results, a field demonstration was conducted in which 650 cu yd of fertile topsoil was manufactured. The dredged material contained relative low concentrations of contaminants and produced a topsoil that was approved to be used unrestricted in the Toledo, OH area. A commercialization plan was developed to remove 800,000 cu yd of dredged material from the CDF per year for ten years to empty the CDF and provide storage space for ten years of dredging.

New York/New Jersey Harbor

Dredged material from Newtown Creek was blended with yardwaste and Bionsoil biosolids to produce a fertile topsoil. The dredged material contained 35 parts per thousand salt and elevated concentrations of metals, polycyclic aromatic hydrocarbons (PAHs), PCBS, and Dioxins. Bench-scale tests were conducted to determine the blend that produced the best growth of ryegrass (Sturgis et al. 1999a). A field demonstration was conducted in controlled lined cells to evaluate migration of contaminants from the manufactured soil into plants and into leachate (Lee et al. 1999). Three approaches to phyto-reclamation of the dredged material blended topsoil were evaluated; contaminant containment, contaminant uptake by plants and contaminant degradation (Cunningham and Lee, 1995). Test results indicated that the manufactured topsoil immobilized metals and organic contaminants and resulted in little leaching from the manufactured soil. The addition of large amounts of organic matter as yardwaste adsorbed the contaminants tightly resulting in leachate containing below detection limits of contaminants. Salt was the only constituent that was observed in the leachate. Plants did not take up large amounts of contaminants. Degradation of PAHs was observed over a 15 month period. For example, Flouranthene concentration in the manufactured topsoil went from 15 ppm to below 1 ppm. PCBs and Dioxin did not show degradation or reduction in concentrations over this time period. Use of

this manufactured soil was recommended for restricted sites such as landfills or the restoration of superfund sites.

Herbert Hoover Dike System

Dredged material from Lake Okeechobee was used to construct a 175 mile long, 35 foot high dike around the lake for hurricane flood control. The dredged material was predominantly sand and marl, with a pH of 8.5. This dike soil was droughty and difficult to vegetate. RSMT was applied to the soil to improve the fertility and vegetative growth for dike stabilization. Bench-scale tests were conducted to determine the blend of available cellulose and biosolids that would produce a fertile topsoil. Field demonstration plots were established using available cellulose and biosolids. Cellulose evaluated included bagasse, yardwaste, melaleuca compost, and lake debris. Biosolids included bionsoil (reconditioned dairy cow manure) and N-Viro biosolids (reconditioned sewage sludge). All blends improved the fertility of the dike soil.

Potential Application of RSMT in Mineland Restoration

Two scenarios exist for the application of RSMT for mineland restoration: 1. application of manufactured topsoil from dredged material, cellulose, biosolids, etc. and 2. application of RSMT formulation of cellulose, biosolids, etc. to existing overburden soil at minelands. The selection of the approach will depend on the availability of dredged material. New York Harbor dredged material is currently being blended into topsoil and applied to abandoned acid coal mineland in PA. If dredged material is not available, then RSMT can be applied using existing overburden soil blended with available cellulose and biosolids.

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Table 1. Demonstrated Manufactured Soil Projects

Location	Quantity cu yd			Salinity	Contamination	Use
	Test	Demo	Commercial			
Toledo Harbor, OH	1	660	800,000*	Fresh	Low	Landscaping U of Toledo Botanical Gardens
Hamlet City, NC	11		60,000+	Fresh	High PAH	Phyto-rem. Landscaping
Newtown Creek, NY	1	10		Estuar.	High PAH Metals, PCBs, Dioxins	Phyto-rem. Landfills Minelands
Mobile, AL	1		120,000+ 240,000+	Brackish	Low	75 acre Landfill Cover
Jacksonville, FL	1			Estuar.	Low	Landscaping
Lake Okeechobee, FL		1,600		Fresh	Low N, P	Dike Restoration
Bridgeport, CT	1	20,000		Estuar.	High PAH Metals, PCBs	3.4 Acres plots
St. Lucie, FL	1			Brackish	Low, Muck	Topsoil

*proposed

+ currently being done