Treating Dredged Sediments for Beneficial Use

Pilot Project Investigates the Feasibility of Using Dredged Material as Soil Product

A PILOT PROJECT was undertaken to investigate the feasibility of using dredged material as a soil product.

Dredging of harbors, ports, and waterways is required to maintain navigable depths, for construction, and for site restoration. These projects typically result in large volumes of dredged material (sediment) requiring disposal. Most dredged material is disposed of in the open ocean in designated disposal areas. However, some dredged material is not suitable for disposal in the open ocean due to the presence of contaminant chemicals and/or failed toxicity testing. Such unsuitable material must be disposed of in a controlled facility, such as a confined aquatic disposal cell or upland landfill (confined disposal facility (CDF)). These options are not only costly, but are becoming increasingly limited due to the lack of available space at many port locations. An option currently being explored is the use of dredged material as a construction material or soil product. Such alternative applications are called beneficial uses.

Some dredged materials can be placed directly into beneficial use applications if they do not contain contaminants at concentrations which would pose a risk for the intended use. For instance, sediments composed primarily of sand may be used to replenish beaches; sand is a relatively inert substance and contaminants do not adsorb to it strongly. The sand fraction can be separated from smaller dredged material particles using simple separation methods, and often used directly with no further treatment. Finer particles however, including silts and clays, can adsorb contaminants strongly. Dredged material with a high organic content can also adsorb contaminants strongly.

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The "problem" dredged materials, therefore, tend to be those which have a significant percentage of fines (silts/clays) and/or organic materials, and have failed chemical and/or toxicity testing. Depending on the type and concentration of contaminants and the intended beneficial use, such sediments may require treatment prior to beneficial use. If treatment is required, it must be cost effective due to the large volumes typically involved. This suggests "low-tech" treatment approaches. The sediment should also contain relatively low levels of contaminants which are either biodegradable and/or can be immobilized (bound to another material which limits their mobility and bioavailability) to be a candidate for this type of treatment. Fortunately, many dredged sediments fall into this category—particularly sediments which are regularly dredged to maintain navigable depths. These

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sediments typically receive contaminant loads from storm water runoff, which carries with it particulates from erosion in upland locations, eventually flowing into nearshore waters—including ports. One Navy location where such deposition is a significant sediment contamination mechanism is Pearl Harbor.

Pearl Harbor, like many Navy ports, requires regular maintenance dredging, but available space and regulatory constraints have made the disposal of dredged sediments increasingly challenging. To prevent interruption to the Navy mission, long-range planning for the management of sediments is necessary, and a variety of alternatives for sediment disposal, treatment, and beneficial use will comprise the overall solution.

A pilot project was undertaken by personnel from the Naval Facilities Engineering and Expeditionary

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside 6.4 Research, Development, Test and Evaluation program. The NESDI technology demonstration and validation program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Leslie Karr, the NESDI Program Manager at 805-982-1618, DSN: 551-1618 or leslie.karr@navy.mil.

Treatment cell after one year of plant growth.

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Warfare Center (NAVFAC EXWC)—formerly the Naval Facilities Engineering Service Center—to investigate the feasibility of using dredged material as a soil product. Funded by the Environmental Security Technology Certification Program and the Navy Environmental Sustainability Development to Integration (NESDI) program, the approach makes use of dredged material by blending it with a compost amendment, followed by bioremediation and phytoremediation. The compost not only improves the physical properties of the clay-like dredged material by increasing permeability, it also provides organic substrates to support diverse and dense microbial populations to degrade contaminants and/or decrease their bioavailability. Plant growth also contributes to the process by aiding microbial growth via transport of oxygen to the subsurface and release of beneficial plant root exudates. Plants also condition the soil by root penetration and addition of humic compounds into the soil, which decreases the bioavailability of non-degradable contaminants such as metals and difficult-to-degrade (refractile) organics.

The pilot project was preceded by laboratory testing and a greenhouse feasibility study carried out at NAVFAC EXWC in Port Hueneme, California from 2006 to 2008, which indicated that contaminants in dredged material from Pearl Harbor could be treated using a compost amendment in a phytoremediation cell. This feasibility testing was followed by the pilot study described below.

The pilot study, carried out at the Navy's Biosolids Treatment Facility (Kalaeloa) at the former Barbers Point Naval Air Station beginning in 2008, used dewatered dredged material excavated from the Pearl Harbor Naval Complex (PHNC) Waipio Peninsula CDF. Approximately 1,000 cubic yards of dredged material was excavated, screened for munitions of explosive concern, and transported to the Kalaeloa facility, where the Navy operates a biosolids composting operation using biosolids from wastewater treatment and green waste from landscaping activities. There the dredged material was mixed with compost at 40 percent compost by total weight. The amended dredged material was placed into a treatment cell which had been prepared by installation of a liner and a leachate collection system.

The compost-amended dredged material was flooded with fresh water to flush out residual salinity. The water was collected by the leachate collection system and pumped to a retention/evaporation pond. After the amended dredged material was desalinated by flushing with three volumes of water, seedling wetland plants were planted. Moisture content was maintained with regular watering (and occasional rainfall). The plants grew quickly in most areas, though high spots (due to uneven placement of the dredged material) did not support plant growth as well. This uneven growth was attributed to increased evaporation of soil moisture in the high areas, leading to stunting of plant growth.

A sediment/compost mixture after 13 months in treatment cell.
Distribution of soil particle sizes and organic content is indicative of a loam soil.

The sediment/compost mixture and plant stems/roots were sampled and analyzed on a regular basis. Total petroleum hydrocarbons (both middle distillate and residual range) degraded rapidly during the first 60 days and were reduced to Hawaii Department of Health Tier I action levels, which were used as cleanup goals. Polycyclic aromatic hydrocarbons were also degraded to acceptable levels during the first year. Metals (copper, lead and zinc were the metals of concern), also fell by 30 to 40 percent during the first 60 days to below cleanup goals, but then gradually rebounded the following year. The reason for this rebound is not entirely understood, but one explanation is that degradation of the organics in the compost over time resulted in an effective increase in concentration of residual metals. This idea is supported by the observed volume decrease in the sediment/compost mixture in the cell over time (taking into account the decrease attributable to compaction). Though the pilot test is still ongoing for experimental purposes, the intent of the treatment process is to treat the material for a year or less.

In addition to reduction of contaminants, the greatest benefit of treatment using this approach is the improved physical properties of the resulting soil, which resemble a high quality garden loam. The base landscaper inspected the soil and stated it appeared to be among the highest quality soil available on the island. The chemical testing of the soil showed that it is generally of high quality, but does retain a fairly high concentration of calcium (calcium is abundant in seawater). Perhaps the most indicative sign of the quality of the soil is that plants grew vigorously, including a stand of volunteer cherry tomato seedlings that produced a bumper crop (the fruit did not contain levels of contaminants of concern beyond control plants).

The material will soon be excavated from the treatment cell and used in a landscape application on base. The success of this project is encouraging for the development of a full scale process for the beneficial use of dredged material, not only at Pearl Harbor, but at other Navy ports where alternatives to disposal are needed to prevent interruptions to dredging operations and the Navy mission.

Steve Christiansen, Dennis Chang and Lonnie Felise from NAVFAC Hawaii's environmental office were critical to the success of this pilot project. ⚓

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