Evaluating the Impact of Activated Carbon on the Engineering Properties and Leaching Potential of Portland Cement-Stabilized Contaminated Dredged Sediment

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Background/Objectives. Solidification and stabilization (S/S) has the potential to turn large volumes of contaminated dredged sediments unsuitable for aquatic placement into beneficially usable materials. Since the 1950s, Portland cement has been the primary binding agent used in sediment S/S projects in the United States, effectively encapsulating soil and/or sediment fine fractions and reducing the mobility of contaminants. As S/S and beneficial use applications have grown more common in practice, so has the awareness of unique challenges facing their success. Two such challenges include the reduced strength gain of highly organic sediment and the need to immobilize new or emerging contaminants of concern. Though several studies have been conducted to assess the impact of activated carbon on contaminant mobility in S/S applications, very few also evaluate the engineering properties (such as shear strength) of the stabilized material. Studies that address the reduction in shear strength associated with highly organic sediments generally focus on humus and humic acid, rather than activated or other solid forms of carbon. For sediment management and beneficial use decision-making, it is important that the potential benefits provided by activated carbon in reducing contaminant mobility be understood within the context of the material's strength gain. The objective of this study was to evaluate the impact of activated carbon on the engineering properties and leaching potential of Portland cement-stabilized contaminated dredged sediment, while investigating its potential to immobilize contaminants of emerging concern for beneficial use applications.

Approach/Activities. Historically contaminated sediment was sampled from five locations in the United States and Norway: three locations within New York/New Jersey Harbor in the United States and two locations in Norway. Triplicate laboratory samples were generated for each of the five sediment types at various mixing ratios for stabilization/solidification (S/S). New York/New Jersey Harbor sediments were mixed with 0, 1, and 3% (by wet weight of sediment) powdered activated carbon (PAC) and 8% Portland cement (PC). Norwegian sediments were mixed with 0, 1, and 3% (by wet weight of sediment) PAC and 0, 4, 8, and 12% PC. The samples were cured at a constant temperature (20° C) for 28 days, after which time they were tested for unconfined compressive strength (UCS) and the leaching potential of target contaminants. The leaching concentrations of metals, polycyclic aromatic hydrocarbons (PAHs), and tributyltin were evaluated via the Synthetic Precipitation Leaching Procedure (SPLP).

Results/Lessons Learned. The results of the study indicate that, though it may marginally decrease the material's strength gain, activated carbon has the potential to aid in the effectiveness of sediment S/S techniques for beneficial use by reducing contaminant mobility. Statistically significant ($\alpha = 0.05$) reductions in strength between 13% and 52% were observed for soft, fine-grained sediments for mixtures of 8% PC with 1% and 3% doses of AC. However, the addition of AC was instrumental in reducing the leaching concentrations of contaminants below standard criteria, in many cases to non-detectable values. It was particularly effective in reducing the leaching potential of PAHs and tributyltin in cases where PC alone was not effective. The results suggest that AC can be useful in sediment S/S applications, however the exact ratios of AC and PC required to produce optimal strength and leaching characteristics will be defined by the sediment type, target contaminants, and beneficial end use.