In-place Remediation Technologies for Contaminated Sediments

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One of the most fundamentally important and productive area of investment by SERDP and ESTCP has been in the development and demonstration of in-place remedial management. Environmental restoration of active and formerly used military installations poses a major challenge for the Department of Defense (DoD) due to the sheer number and diversity of facilities and past activities that have released contaminants into the environment. While soil and groundwater issues tend to dominate installation restoration programs at DoD facilities, contaminated sediment issues can be significant for installations located near or containing ecologically sensitive aquatic environments.

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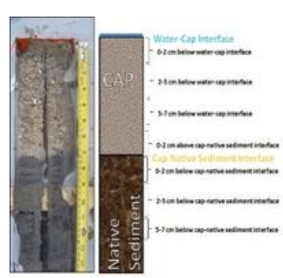
The projects funded by SERDP and ESTCP are a direct response to the DoD's strategic plan to improve the cost-effectiveness of sediment remediation by advancing the science and engineering of in-place sediment management approaches (**SERDP and ESTCP 2004**).

Monitored Natural Recovery and Enhanced Natural Recovery

Monitored Natural Recovery (MNR) is a remedial practice that "relies on un-enhanced natural processes to protect human and environmental receptors from unacceptable exposures to contaminants" (**NRC 2001**). The suitability of MNR—both as a primary remedy and in combination with other remedies—for sediment sites has been established by several studies and affirmed by the EPA, and other regulatory authorities (**USEPA 2005 (http://semspub.epa.gov/src/document/HQ/174471)**). Under appropriate site conditions, MNR is associated with low implementation risk and a high level of remedy effectiveness and permanence. Under ESTCP, a national guidance document for implementing MNR was developed (**ER-200622**). This document is a technical guide for project managers and management teams evaluating and implementing MNR at contaminated sediment sites. It establishes principles and evaluation criteria for MNR use as a remedial option and provides a framework for the design, implementation, and monitoring of MNR. This guidance document is the most frequently cited document by DoD RPMs, EPA, and other regulators.Enhanced Monitored Natural Recovery (EMNR) technology relies on a combination of monitored natural recovery "enhanced" by the placement of a thin (15-30 cm) layer of clean sediment over contaminated sediment with an effective characterization and monitoring program to project and verify recovery. The thin layer cap (TLC) is not intended to provide a complete seal over the contaminated sediment as in a conventional isolation capping operation. Instead, the TLC provides a surface layer of cleaner sediment, resulting in an immediate reduction in surface contaminant concentrations that facilitates the re-establishment of benthic organisms, minimizes short term disruption of the benthic community, and effectively accelerates the process of physical isolation continued over time by natural sediment deposition. ESTCP-funded both a case study review of EMNR (**ER-200827**) and a demonstration and validation of the EMNR and the accompanying monitoring at a DoD remedial site (**ER-201368**). This case study review is a resource for site managers who are considering EMNR as a remedy. The demonstration and validation project was conducted as part of the post-remedial monitoring efforts of the sediment remediation implemented at an embayment at the Quantico Marine Corps Base, Quantico, VA. The final site reports address key technical issues including (1) the utility of available monitoring tools to address EMNR performance; (2) short-term implementation success; (3) the ability to project the potential for long-term remedy success; and (4) mechanisms and processes that regulate EMNR effectiveness.

Activated Carbon



Activated carbon (AC) as an in-place remedial alternative is a broadly accepted in-place remedial management tool, and is a direct result of work done under SERDP and ESTCP. AC works by stripping and tightly binding organic contaminants such as PCBs, PAHs and pesticides from sediment porewater water. Research funded by SERDP demonstrated that adding precise doses of AC into sediments has the same effect; organic contaminants are bound up and are then not available for uptake into organisms. Field demonstrations funded by ESTCP showed that additions of as little as 2% AC resulted in ten- to 100-fold reductions in PCB uptake into marine organisms. AC is a sediment remedial alternative that is now being applied in many types of aquatic environments—rivers, lakes, wetlands, and deeper water in active channels and piers.

Based on the success of the initial bench-scale work sponsored by SERDP, the work was extended into field demonstration and validation in ESTCP. While the laboratory-scale demonstrations were relatively easy, developing engineering solutions for applying the AC into sediments in the field required work on multiple levels. AC floats, so one of the early

ESTCP developments was to formulate the carbon into a pelletized form that would sink and could be applied using conventional equipment, achieving an even distribution on the sea floor with the pellet then dissolving to release the AC into the contaminated sediments. Completed or ongoing demonstrations at DoD sites have included the Army's Aberdeen Proving Ground (ESTCP Projects **ER-200835**, **ER-200825**, and **ER-201580**), Hunters Point Naval Shipyard (SERDP Project **ER-1207**), Naval Air Station Dallas (SERDP Project **ER-1493**), and the Puget Sound Naval Shipyard (ESTCP Project **ER-201131**).

A new training tool is scheduled to come on-line in early 2018. This web site will include pages that present the overall science of AC sequestration, function and design criteria, construction considerations, and case studies of sites where AC is being used to managed contaminated sediments.

Metals Sequestrating Amendments

SERDP and ESTCP are also funding work to develop amendments for sequestering metals. Ongoing efforts include minerals such as apatite, zeolites, bauxite, and alumina for metals or metalloids; ion exchange resins for metals or other inorganic contaminants; and lime for pH control or nitroaromatics degradation. Other related work includes mixtures of permeable concrete and chemically active amendments to produce caps that prevent the migration of sediment contaminants while being stable on sloping shorelines and environments subject to dynamic forces.

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In-place Biodegradation of HOCs

ESTCP is funding research on the ability to introduce microbes capable of degrading in-place hydrophobic organic compounds. Bench-scale testing has shown promise; demonstration and validation of at least one of the methods is on-going.

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