Managing Contaminated Sediments

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Sediment contamination is a significant liability for the Department of Defense (DoD), with overall liabilities estimated to approach $2 billion. Historic releases at current and former DoD facilities resulted in source to environmental receptors. Contaminants include PCBs, PAHs, metals, per- and polyfluoroalkyl f substances (PFASs), and military-unique munitions constituents. Environmental restoration and closure of these contaminated sediment sites is a top priority for DoD. These on-going closure activities include completing feasibility studies, designing and implementing remedies, or engaging in the long-term monitoring of implemented alternatives at sediment sites. Developing cleanup levels that consider point and non-point contaminant loading remains a significant challenge.

(http://map.serdp-estcp.org/index.html?Subprogram=contaminated_sediments)

Location of Managing Contaminated Sediments Projects (click image to launch map)

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SERDP and ESTCP have invested in research and demonstration projects supporting DoD restoration goals since 1996. These projects develop sound science and effective restoration tools to characterize, remediate, manage, and monitor these sites in a manner that reduces risks. To prioritize the investments, quadrennial workshops began in 2004 that identified high priority needs for research, development, field demonstrations, and technology-transfer that would facilitate both long-term management decision making and long-term monitoring of these sites. The most recent workshop, **Workshop on Research and Development Needs for Long-Term Management of Contaminated Sediments** (2016) provides a summary of the work conducted by SERDP and ESTCP to date, provides a review of where DoD facilities are in their restoration implementation, contains input from the Remedial Project Managers (RPMs) what specific research, demonstration, or technology transfer needs will facilitate both restoration decision making and long-term monitoring of these sites, and input from the regulators on what needs to be demonstrated in those tools to encourage broad implementation and acceptance. The Workshop Report is utilized to develop sediment Statements of Need (SONs).

SERDP and ESTCP investments are addressing a wide variety of issues relevant to managing contaminated sediments in place and assessing the processes that govern ecological and human health risks. Work is supported to advance the science and technology in the topic areas listed below.

Bioavailability of Contaminants

Reliable methods for measuring and reporting the bioavailability of chemicals at contaminated soil and sediment sites has been a major focus for SERDP and ESTCP over the last 15 years. Bioavailability assessment tools directly measuring these processes are critical to assessing the potential for human and ecological exposure and contribute directly to developing site-specific remedial action objectives.

Bioavailability in sediments and soils is a Featured Initiative of SERDP and ESTCP. Program investments in bioavailability resulted in passive sampling tools that measure the bioavailable fraction of contaminants in porewater and surface water. Demonstrated passive sampling tools for contaminants to date include PCBs, dioxins, metals, and munitions constituents. SERDP and ESTCP, along with EPA, developed National Guidance documents on the use and application of passive samplers. As part of the Sediment Bioavailability Initiative (SBI), SERDP and ESTCP also participated in the Interstate Technology & Regulatory Council (ITRC) technical and regulatory guidance document on sediment bioavailability, and in the Society of Environmental Toxicology and Chemistry (SETAC). These documents and projectspecific reports are available on the **Bioavailability** home page.

In-place Remediation Technologies

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. Under SERDP and ESTCP, a national guidance document for implementing Monitored Natural Recovery (MNR) was written. That document is often cited by the EPA and has been used for MNR remedies at multiple DoD sites. A successful demonstration of Enhanced Natural Recovery (ENR) has recently been completed; that report offers important "lessons learned" on how to implement and monitor ENR remedies.

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. Research funded by SERDP showed 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.

Other work includes identification of materials capable of in-place sequestration of other metals and metalloids, and research on the ability to introduce microbes capable of degrading in-place hydrophobic organic compounds.

Reducing the Impact of Stormwater Discharge on Sediment Recontamination

Stormwater discharge of contaminants remains a critical challenge for protecting DoD investments in sediment cleanup as well as in the prevention of future contaminated sediment liabilities. Stormwater control and treatment is at the nexus of this challenge, spanning virtually every DoD coastal site, and linked to every aspect of regulatory compliance. At DoD sites, concentrations of contaminants of concern in stormwater particulates often exceed sediment cleanup levels. This places the burden on DoD to deal with unregulated discharges and watershed-wide diffuse surface runoffs.

Identified as a critical investment need in the **2016 Workshop Report**, SERDP and ESTCP have begun funding basic research for stormwater assessment and management. From a **FY18 SON**, four novel systems that integrate stormwater capture and treatment to prevent sediment recontamination were identified and will begin work, with results expected to be on-line by 2022. A potential benefit identified in two of these new start projects is that improved stormwater control and treatment practices would also allow for ways to harvest stormwater for aquifer recharge. A properly designed system that can harvest, treat, and reuse stormwater will not only remove contaminants, which can cause sediment and/or surface water recontamination, but can provide additional water for improving the urban environment. This would increase existing water supplies at DoD facilities and reduce costs and environmental impacts of discharge.

Site Characterization and Long-Term Monitoring

Site characterization and long-term monitoring remain a significant part of remediation lifecycle costs for all DoD sites. The need to develop environmentally-protective and costefficient characterization tools for remedial investigations was highlighted in the first **Workshop Report (2004)**. Over time, SERDP and ESTCP investments broadened to include research and demonstrations that could significantly improve the ability to address contaminant source exposure, transport and fate challenges at DoD coastal sites. Projects to date include means to measure in-place contaminants, tools to monitor the flux of contaminants in groundwater to sediments, improved ways to measure and predict beddedsediment stability, forensics approaches to fingerprint PCB sources, additional tools to link off-site sources to sediment recontamination, and in-place tools to assess ecological risks in sediments.

Occurrence, Fate and Transport

Numerous processes (e.g., diffusion, advection, bioturbation, and degradation) affect the fate and transport of contaminants in aquatic environments. In aquatic environments, many toxic chemicals, including PCBs, PAHs, metals and munitions constituents bind to finegrained particles and concentrate in bottom sediments. Transport and fate of such contaminants in aquatic ecosystems is largely controlled by processes that take place in or near the sediment bed. Funded projects identified important physical, chemical, microbiological, and biological processes that affect the fate, bioavailability, and effects of contaminants within the sediment column. A description of the SONs and related projects may be found **here**.

More recent concerns are on the fate and transport in sediments for emergent contaminants including per- and polyfluoroalkyl substances (PFASs), munitions constituents, and 1,4-dioxane. Currently SERDP and ESTCP are vesting heavily into the identification, fate, transport, and risks associated with PFASs in groundwater, surface water, soils and sediments. Several projects have been initiated to better understand the occurrence, fate and transport of PFASs; a description of the Statements of Need and related projects can be found in the overall program description **here**.

Munitions Constituents

Accurately identifying ecological risks associated with military-unique compounds has been a Program priority since inception. SERDP and ESTCP have been involved in developing methods to improve the assessment of the environmental fate and transport, and ecological risks associated with existing and new military-unique munitions constituents.

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