



EM-22 Office of Groundwater and Soil Remediation

2009-2011 Strategic Plan and Integration with Office of Science and DoD Research Programs



EM *Environmental Management*

safety ❖ performance ❖ cleanup ❖ closure

Groundwater & Soil Remediation Program Drivers

- **OE&T Roadmap: Reducing Technical Risk & Uncertainty in the EM Program (2008)**
- **EM-22 Strategic Plan (2009)**
- **Science Opportunities to Reduce Risk in Groundwater & Soil Remediation (PNNL 2009)**
- **Draft Computational Applied Research Program in Subsurface Science Action Plan (2009)**
- **NAS Review of OE&T Roadmap (2009):**
 - Relevant NAS Review Gaps:
 - Contaminant subsurface behavior poorly understood (**High Risk**)
 - Long-term ability of cementitious materials to isolate waste (**High Risk**)
 - Site & contaminant source characteristics limit usefulness of baseline approaches
 - Long-term performance of reactive barriers, liners, and caps cannot be assessed with current knowledge
 - Leverage R&D investments of others
 - DOE Site Operations, DOE SC, DOD, EPA, USGS, DuPont, and other industrial partners

Roadmap Initiatives

1. **Improved sampling and characterization technologies** in challenging environments
2. **Advanced predictive capabilities** incorporating chemical reactions, complex geology, multiphase transport
3. **Enhanced remediation methods** based on in situ technologies and natural processes that improve cost-effectiveness, efficiency, risk
4. **Enhanced long-term evaluation and monitoring** for cost-effective verification of cleanup performance in soil, surface water, groundwater

Action Area 1 – SRS F-Area

Attenuation-Based Remedies for Metals and Radionuclides in Groundwater

EM-22 Program \$1.3 M Attenuation-Based Remedies for Metals and Radionuclide Contaminated Groundwater	SRNL	Office of Science	SRS Operations	Universities/ Industry	Direct- Funded Organizations	Other National and Federal Laboratories	Regulators
Characterization							
Subsurface Properties	●	●	●	●	●		▲
Attenuation Processes	●	●		●			▲
Attenuation Capacity	●			▲			▲
Predictive Capabilities							
Decision/Screening Tools	●			▲		▲	
Uncertainty Tools	●			▲		▲	
Predictive Tools		●		●		▲	
Monitoring							
Subsurface Properties			●	●			
Attenuation Processes and Capacity			●	●			
Remediation							
Attenuation-Based Remedies	●		●				▲
Active Treatments			●	●			▲
Tech Transfer	●			▲		▲	▲

● Contributing Funds and Participating ▲ Participating

Action Area 1

Attenuation-Based Remedies for Metals and Radionuclides in Groundwater

Attenuation-based remedies for groundwater reduce or eliminate contaminant migration using naturally-occurring processes, either alone or enhanced, to provide sustainable remediation.

Deliverables and associated Roadmap initiative:

•FY09

- Publish Science and Technology Report setting the technical basis for the action area.
- Provide mass balance generated for the F-Area Applied Field Research Site to the SRS operating contractor to support remediation decisions ([Characterization](#)).

•FY10

- Publish Scenarios Tool and transfer to the public. This tool will be developed in collaboration with the ITRC ([Prediction](#)).
- Publish ITRC Tech. Reg. document. This document will be a collaborative effort between personnel from state regulatory agencies, EPA, DOE, and industry.

•FY11

- Make publicly-available the training based on the ITRC Tech. Reg. document.
- Surface complexation model for uranium, strontium and iodine (to be developed by LBNL with ERSP funding) will be used to validate the simplified approaches to field measurement of sorption developed through this initiative. These field approaches will support development of applied tools for site characterization ([Characterization, Prediction](#)).

Action Area 2 – Hanford BC Cribs/Trenches Advanced Remediation Methods for Metals and Radionuclides in the Vadose Zone

EM-22 Program Enhanced In Situ Remediation of Metals and Radionuclides	\$550 K	PNNL	Office of Science/ Universities	PNNL LDRD	Operations	Direct- Funded Organizations	Other National and Federal Laboratories	Regulators
Controlling Processes								
Mass Balance and Flux		●	●		●	●	▲	▲
Biogeotransformations			●			●	▲	
Conceptual Model Development		▲	●		●	●	▲	▲
Characterization								
Multi-Scale Reactive Facies		●	●				▲	
Geochemical Characterization		●	●		●			▲
Geophysical Exploration		●	●		●	▲		
Subsurface Delivery								
Desiccation					●			▲
Foam Technology		●		●	▲	●		▲
Mesoscale Testing		▲			●	●		
Modeling								
Multi-Component STOMP Code		●		●				
Biogeochemical Transport Model		▲	●					
Monitoring								
Geophysical Response			●			▲	●	
Attenuation Processes and Capacity		●	●		●			▲
Mesoscale Testing		▲				●		

● Contributing Funds and Participating ▲ Participating

Action Area 2

Advanced Remediation Methods for Metals and Radionuclides in the Vadose Zone

Controlling contamination sources is integral to meeting remedial objectives for mitigating direct exposure to contamination and limiting contaminant flux to groundwater.

Deliverables and associated Roadmap initiative:

•FY09

- Conduct laboratory- and intermediate-scale tests to evaluate and develop foam-based delivery of remedial amendments developed with LDRD funding at PNNL. Investigations (through FY10) will focus on key physical issues of foam-based delivery including foam quality, injection pressure, mass transport and distribution, and shear thinning (Enhanced Remediation).
- Prepare a literature review of foam transport in porous media to provide the technical basis for development of a mathematical model of foam transport through unsaturated media (Prediction).

•FY10

- Develop a numerical model for subsurface foam transport and incorporate into the existing water-air mode of the STOMP code. STOMP's foam simulation capability will help identify critical design parameters for laboratory- and field-scale applications. The revised BC Cribs and Trenches model will be published to support design of active remedies and enhanced attenuation (Prediction).
- Publish a review of existing approaches and technologies for monitoring performance of foam-based delivery of remedial amendments. This will provide the technical basis for further development of vadose zone remediation performance monitoring methods (Long-Term Monitoring).

•FY11

- Publish a Science and Technology Report providing the technical basis and recommendations regarding the utility and efficacy of foam-based delivery of remedial amendments for metal and radionuclide treatment in the vadose zone. (Enhanced Remediation).

Action Area 3 – SRS & Hanford

MNA & Enhanced Attenuation for Chlorinated Organics in Groundwater & Deep Vadose Zone

EM-22 Program	\$1.2 M	SRNL	PNNL	Office of Science	Operations	Universities/ Industry	Direct-Funded Organizations	Other National and Federal Laboratories	Regulators
MNA and Enhanced Attenuation (EA) for Chlorinated Solvents Chlorinated Organics in the Deep Vadose Zone									
Attenuation Capacity									
Mass Balance/Flux		●	●		●	●		▲	▲
Field Tools		●	●	●	●	●		▲	▲
Predictive Tools		●	●	●		▲		●	▲
Remediation									
Decision/Screening Tools		●	▲			▲	●	▲	▲
Vadose Treatments		●	●	●	●	▲		▲	▲
Enhanced Attenuation		●	●		●	●		▲	▲
Monitoring									
Subsurface Properties		●	●	●	●	●			
Attenuation Processes and Capacity		●	●		●	●			
Tech Transfer									
User Guides		●	●			▲	●		▲
Training		●	▲			▲	●		●
Journal Articles		●	●			▲			▲

● Contributing Funds and Participating ▲ Participating

Action Area 3

Attenuation-Based Remedies for Chlorinated Solvents in the Vadose Zone and Groundwater

Remediation challenges at chlorinated solvent sites include persistent sources in low-permeability zones, geochemical environments that are non-conducive to monitored natural attenuation (MNA), and difficulty in developing technical justification for transitioning from active to passive treatment or MNA.

Deliverables and associated Roadmap initiative:

•FY09

- Publish a user guide to facilitate application of technologies for chlorinated solvent remediation in the vadose zone. This guide, to be developed in coordination with ITRC and SERDP-ESTCP, will complement the recently-published ITRC Technical Regulatory document on Enhanced Attenuation of Chlorinated Organics ([Enhanced Remediation](#)).

•FY10

- Publicize the training module for the FY09 user guide.
- A supplement to the USACE SVE Design Manual will provide added guidance for quantifying vadose zone contaminant flux and selecting a remediation endpoint when persistent contamination is present (coordination with USACE, SERDP-ESTCP and ITRC) ([Enhanced Remediation, Prediction, Characterization](#)).

•FY11 ([Enhanced Remediation](#)).

- Publish a user guide for technologies for addressing chlorinated solvents in the saturated zone. This guide also complements the abovementioned ITRC Enhanced Attenuation document and will be developed in coordination with ITRC and SERDP-ESTCP.
- Publish an application guide for vadose zone remediation of persistent contamination to complement the ITRC guide and ESTCP-SERDP chlorinated solvent source zone remediation guidance (coordination with USACE, SERDP-ESTCP and ITRC).

Action Area 4 – Oak Ridge Y-12 Mercury Characterization and Remediation

EM-22 & EM 23 Program \$450 K Oak Ridge Integrated Facilities Disposition Project	ORNL	Office of Science	SRNL	MSE	FIU	MSU-ICET	Oak Ridge Operations
Characterization							
GIS Base	●				●		
• Slabs			●				
• Pipe			●				
• Karst			●			●	
Sustainable Remedial Strategies							
Mercury in soils	●	●					
Outfall treatment	●						
Sediments	●						
Bio-Geochemical							
Geophysical						●	
Bioavailability						●	
D&D							
Sumps				●			
Slabs				●			
Surface Water/ Groundwater Interface							
GIS data					●		
Surface water studies					●		
Methyl/Mercury Transformation							
Transformation of mercury		●					
Field conditions under which transformation occurs		●					

MSE MSE Technology Applications, Inc.
FIU Florida International University
MSU-ICET Mississippi State University—
 Institute for Clean Energy Technology

Action Area 4

Mercury Characterization and Remediation

Contaminants such as mercury impact groundwater and surface water quality during site operation and D&D activities. Planning and coordination among site remediation efforts, D&D programs, and groundwater and soil programs will provide a holistic strategy to improve DOE operation, infrastructure, and environmental quality.

Deliverables and associated Roadmap initiative:

•FY09

- Perform longer-term pilot studies of flow management and stannous chloride addition with enhanced volatilization for mercury flux control (Characterization, Enhanced Remediation, Prediction).
- Review literature and feasibility reports for controlling mercury release from soil. This review will identify new technologies and their potential use at ORNL and Y-12 facilities.
- Use a GIS platform to integrate physical and chemical data to identify areas of highest risk and uncertainty (e.g., contaminant migration potential) at Oak Ridge D&D sites (Prediction, Characterization).

•FY10-11

- Outline a detailed implementation strategy for upscaling flow- and chemistry-based mercury control measures if FY09 pilot studies proved promising. This strategy package will provide specific options to the site contractor.
- Prioritize, evaluate, and demonstrate new soil treatment technologies for mercury and uranium at Oak Ridge sites (Enhanced Remediation).

Action Area 5

Center for Sustainable Groundwater and Soils Solutions at Savannah River National Laboratory

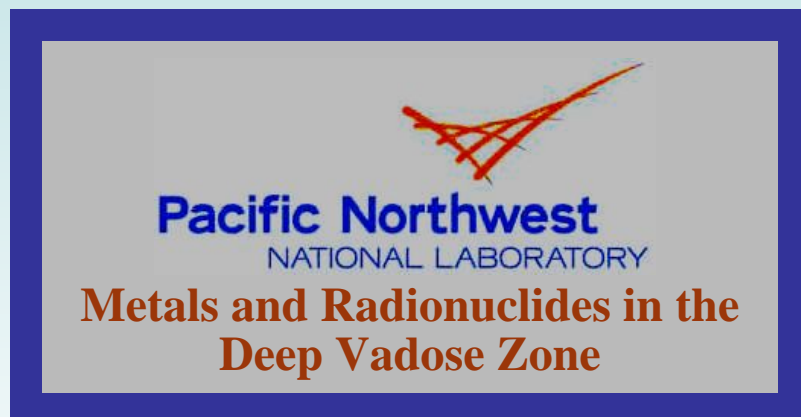
The Center is the focal point for technology transfer and research integration for the Office of Groundwater and Soil Remediation.

Deliverables:

- Establish a groundwater and soils program website through MSE
 - Repository of reports
 - Blog/discussion forum for each action area
 - Online collaboration
- Conduct an EM-22 program review in September 2009
 - Assemble interagency review team
 - Set up solicitation for FY10
 - Invite FPDs and contractors
- Technical Assistance
 - LLNL
 - Paducah
- Fact sheets, other literature
- Co-sponsor conferences

EM-22 Applied Field Demonstration Sites

SRS, Hanford, and Oak Ridge applied research sites will support a cohesive, robust applied research program founded on action areas and targeted solicitations that address DOE's remediation needs.



EM and DoD linkages by action areas

Action area	Activities Red indicates high tech-transfer potential to the EM-22 program.	
	<i>EM</i>	<i>SERDP-ESTCP programs</i>
1. Attenuation-Based Remedies for Metals and Radionuclides in Groundwater	<ul style="list-style-type: none"> • Understand, characterize, and predict the role of biogeochemical gradients and reactive facies in controlling metal and radioisotope migration, reaction, and stabilization in situ. • Develop characterization tools based on surface complexation models. • Develop scenarios-based conceptual models. 	<p><i>FY09:</i> Understand impact of environmental parameters & sampling methods on groundwater contaminant concentrations.</p> <p><i>FY10:</i> Develop improved understanding of mechanisms and permanence of contaminant binding to soil components.</p>
2. Advanced Remediation Methods for Metals and Radionuclides in the Vadose Zone	<ul style="list-style-type: none"> • Lab- & intermediate-scale testing for foam-based delivery of remedial amendments in vadose zone environments (FY09-10). • Develop numerical model for foam transport. 	<p><i>FY10:</i> Mechanisms and permanence of contaminant binding to soil components.</p>

EM and DoD linkages by action areas

Action area	Activities Red indicates high tech-transfer potential to the EM-22 program.	
	<i>EM</i>	<i>SERDP-ESTCP programs</i>
3. Attenuation-Based Remedies for Chlorinated Solvents in the Vadose Zone and Groundwater	<ul style="list-style-type: none"> •Vegetable oil applications for biostimulation and flux control. •Electrical resistance heating. •Passive treatments (e.g., Geosiphon). •Enzyme activity probes to assess aerobic cometabolism. •Transitioning from active to passive remediation technologies. •Predict solvent transport at Hanford. •Analysis and prediction of soil vapor extraction behavior & use of performance data in decision making. 	<p><i>FY08:</i> Develop cost-effective methods for assessing DNAPL source zone architecture.</p> <p><i>FY08:</i> Develop guidelines for determining level & type of required site characterization.</p> <p><i>Previous and ongoing:</i> Focus on in situ chemical oxidation, thermal technologies, surfactant-enhanced remediation, and reagent delivery and treatment in low-permeability zones.</p> <p><i>FY09:</i> Reduce uncertainty and costs for managing large, dilute contaminant plumes.</p> <p><i>FY10:</i> Improve the ability to measure & predict remediation performance for dissolved-phase plumes with contaminant sources in low-permeability zones.</p>
4. Mercury Characterization and Remediation	<ul style="list-style-type: none"> •Long-term monitoring of metal speciation and flux. •Remote, real-time monitoring. •Control of mercury flux to surface water 	<p><i>Ongoing projects:</i> improved monitoring methods.</p> <p><i>FY10:</i> Determine how bioavailability is affected over time by key biological and chemical processes (esp. for metals including mercury).</p>