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Department of Energy Soil and Groundwater Science and Technology Needs, Plans and Initiatives

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ABSTRACT

This paper presents the process used by the Department of Energy (DOE) Environmental Management (EM) Program to collect and prioritize DOE soil and groundwater site science and technology needs, develop and document strategic plans within the EM Engineering and Technology Roadmap, and establish specific program and project initiatives for inclusion in the EM Multi-Year Program Plan. The paper also presents brief summaries of the goals and objectives for the established soil and groundwater initiatives.

INTRODUCTION

The mission for the EM-20 Groundwater and Soil Remediation Program is to identify problems and subsequent needs of the Federal cleanup projects and to provide applied research and development (R&D) solutions to the Federal project managers that reduce life-cycle technical risk and uncertainty for EM soils and groundwater programs and projects. Applied research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. The vision is to provide safe, cost-effective solutions that are accepted by regulators and implementable by technical end-users and that protect human and ecosystem health over the life-cycle of both environmental and legacy management missions.

In FY2006, EM-20 developed an Engineering and Technology Roadmap to define a long-term strategy for reducing life-cycle technical uncertainty for EM. To kick off this effort, an EM-20 sponsored Environmental Management Technical Integration Workshop was held in Washington, DC on October 18 and 19, 2006. This workshop provided an opportunity for the DOE sites to provide needs and to engage the National Laboratory Advisory Group in the formulation of the EM Engineering and Technology Roadmap and

subsequent EM Multi-Year Program Plan. The relationship between these activities is shown in Figure 1.

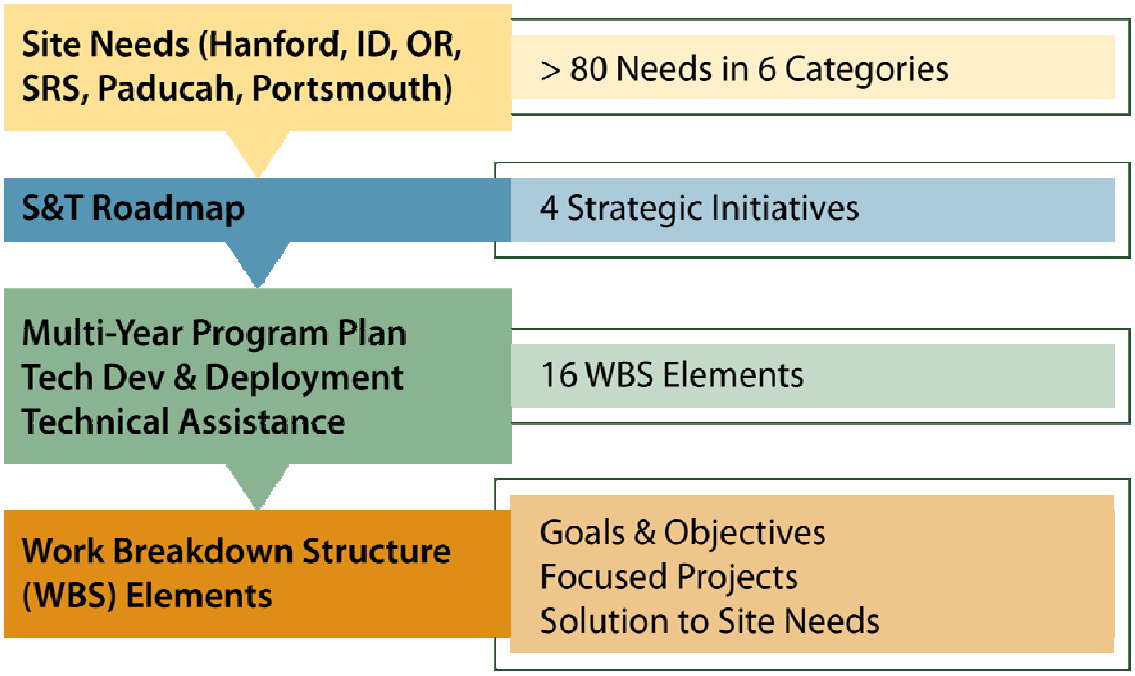

Figure 1: Solving Site Priority Needs

The following sections of this paper describe the Soil and Groundwater Remediation Program that resulted from these efforts.

NEEDS FOR REDUCING TECHNICAL UNCERTAINTY AND RISK FOR EM

The Department of Energy (DOE) EM sites identified needs in six areas: sampling/characterization technology, basic and applied research, modeling, *in situ* technology, *ex situ* technology, and long-term monitoring. Common needs were identified for each of these areas and became the focus for defining four Strategic Initiatives that comprise the Soil and Groundwater Remediation Program as shown in Table I. The basic and applied research needs were dispositioned in two ways. Basic research was referred to the Office of Science and applied research was incorporated into the four Strategic Initiatives. *Ex situ* technology needs are to be addressed through technical assistance and the Small Sites Program.

Table I: EM Needs and Strategic Initiatives

Need Categories	Common Needs Across Complex	Strategic Initiatives
Sampling/Characterization Technology	➢ Low cost field characterization & monitoring techniques, including non-invasive detection techniques, that are acceptable to regulators	Improve Sampling & Characterization Strategies

	➢ Characterization in and around piping/storm drains	
Basic and Applied Research	➢ Understand biogeochemical and hydrologic processes affecting fate and transport of metals, radionuclides, and chlorinated hydrocarbons	(a)
Modeling	➢ Improved conceptual models and incorporation of science into modeling ➢ Reactive transport models that account for unique subsurface characteristics, e.g., physical features such as fractured rocks or tight zones and biogeochemical features impacting transformation, mobility, and coupled transport	Advanced Predictive Capabilities
in situ Technology	➢ Cost-effective techniques during remedial action and post-closure, i.e. transition cost-effective solutions to LM ➢ MNA and long-term monitoring	Enhanced Remediation Methods
ex situ Technology	➢ Cost-effective pump and treat technology ➢ Real-time soil characterization	(b)
Long-term Monitoring	➢ Low cost monitoring tools to reduce lifecycle costs ➢ Long-term monitoring for MNA ➢ Long-term monitoring of barrier performance	Enhanced Long-Term Monitoring Strategies

[a]Basic science needs referred to Office of Science and applied research needs incorporated into four Strategic Initiatives
[b]Response to *ex situ* technology needs considered for technical assistance and Small Sites Program

STRATEGIC INITIATIVES

The EM Engineering & Technology Roadmap identified four strategic initiatives associated with groundwater and soil cleanup in the Groundwater and Soil Remediation and Integration and Cross-Cutting areas.

1) Improve Sampling & Characterization Strategies
2) Advanced Predictive Capabilities
3) Enhanced Remediation Methods
4) Enhanced Long-Term Monitoring Strategies

For each of these initiatives, national technology development and deployment (TDD) technology alternative projects were established to initiate implementation of the Multi-Year Program Plan (MYPP). The MYPP is organized by WBS element. Initial funding was provided in FY07 for specific elements within the first three strategic initiative areas, with the intent of continuing these projects and including additional TDD projects within all four strategic initiatives in FY08 to fully implement the MYPP. Other WBS elements were also identified in order to capture EM-22 Groundwater and Soil Program Management needs, high priority site specific projects, and other necessary program areas such as Technical Assistance for rapid direct technical support to sites with immediate problems or needs. Current WBS elements for EM-22 are depicted in Figure 2.

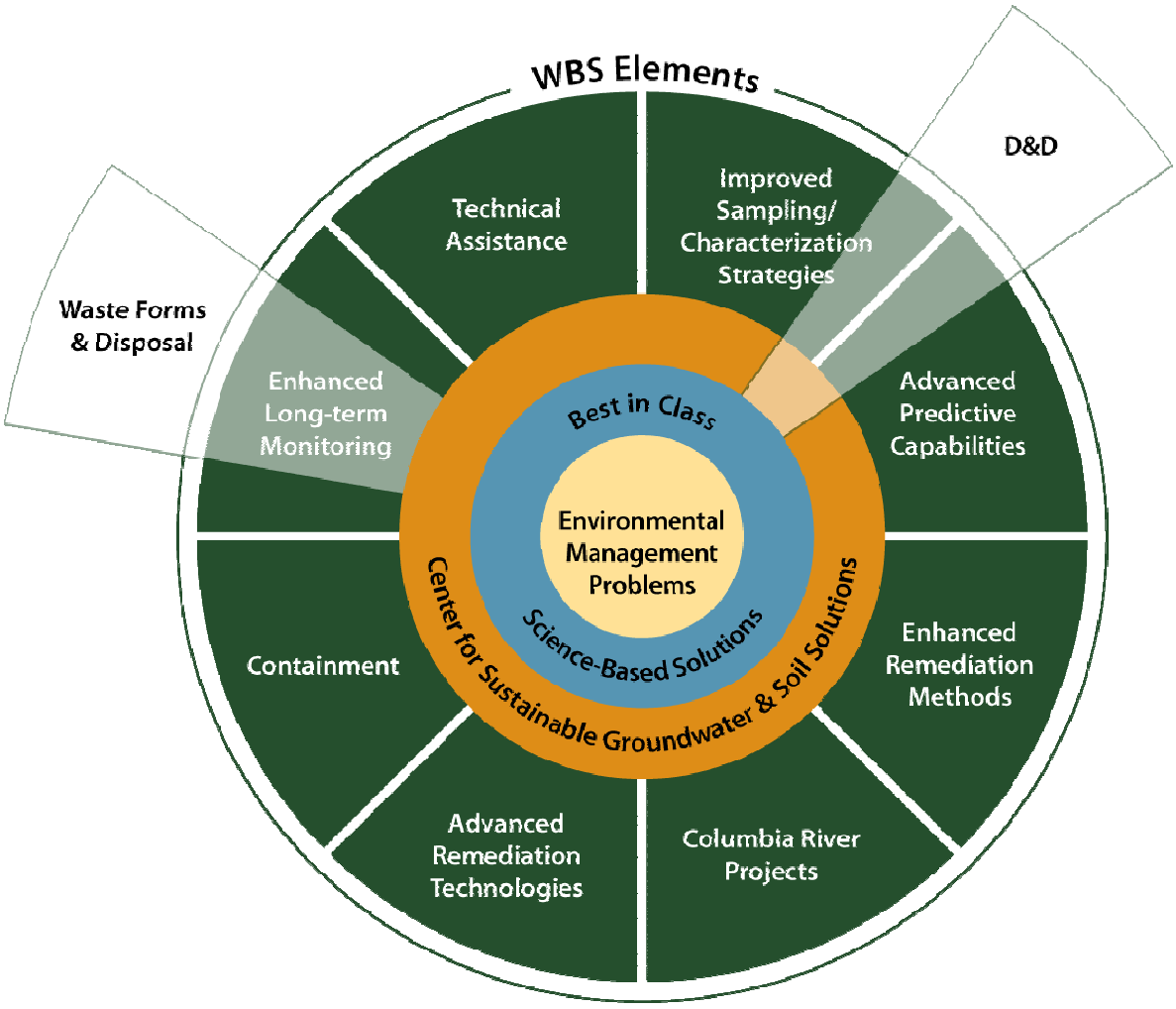

Figure 2: WBS Elements for EM-22

Specific strategic goals and objectives associated with implementation of this Multi-Year Program Plan for the EM-22 Groundwater and Soils Remediation Program include:

- Define and deliver a multi-year program that provides applied research, technology, and engineering solutions that reduce technical uncertainty and risk for EM.
- Ensure integration with and across the sites that results in delivery of products and outcomes that meet multiple site needs (i.e., provide products that are used and make an impact).
- Identify and use scientific and technical experts at multiple institutions to perform the work.
- Leverage current and emerging science from DOE-BER, BES Geosciences, ASCR, etc.
- Leverage site activities in the field to best advantage.
- Keep a keen eye to ensuring a series of important 'wins' starting as soon as possible and extending over the next 5 years while staying consistent with the Strategic Initiatives within the EM Roadmap.
- Execute the MYPP and implementation plans as an integrated team, which includes integration between WBS elements.
- Help identify other Federal agencies, universities, etc. that comprise the communities of practice that can help provide solutions, act as peer reviewers, etc.

TECHNICAL WORKING GROUP

In order to effectively achieve the specified goals and objectives, the individual TDD projects have adopted a project structure based upon a successful approach implemented by the EM-22 Monitored Natural Attenuation and Enhanced Attenuation (MNA/EA) for Chlorinated Solvents Technology Alternative Project (as depicted in Figure 3).

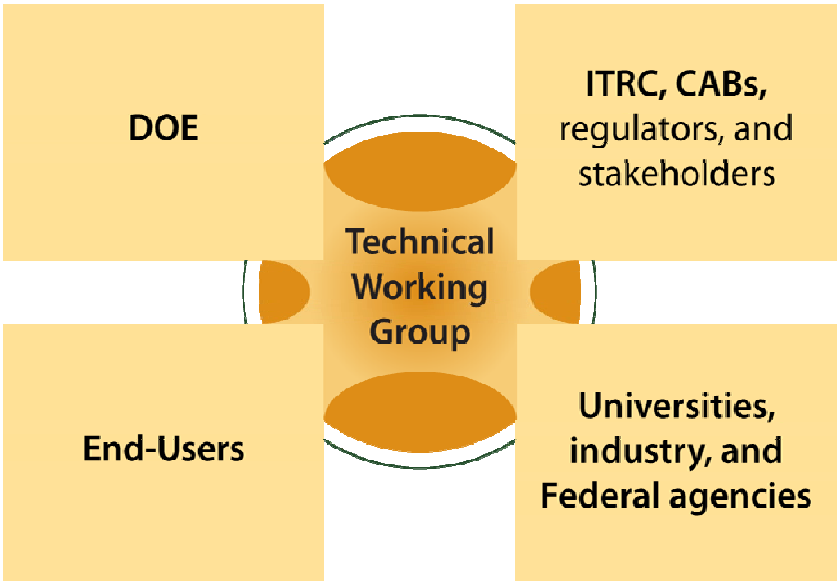

Figure 3: Technical Working Group

The Technical Working Group (TWG) is a core group of nationally recognized scientists who set the technical direction, lead the technical development for the project, and select researchers who develop specific technical tools and processes based on the technical needs identified by the core technical group. The TWG is tasked with establishing a set of technical targets for each technology initiative that represent the scientific underpinnings of the EM Program. The TWG also has the responsibility to communicate with regulators, stakeholders, and end users throughout the life of the project to ensure the technical products of the project are deemed acceptable and implementable. An additional communication objective is to provide status on the technical progress of the project to general technical and public audiences. This is accomplished through presentations of the work at meetings/conferences, papers in journals, and an electronic newsletter or other publicly available forum.

SUMMARY OF PROGRAM INITIATIVES

A brief description of goals and objectives for each of the EM-22 Groundwater and Soil Remediation Program initiatives follows.

EM Center for Sustainable Groundwater and Soil Solutions

As previously stated, the mission for the EM-20 Groundwater and Soil Remediation Program is to identify problems and subsequent needs of the Federal cleanup projects and to provide applied research and development (R&D) solutions to the Federal project managers that reduce life-cycle technical risk and uncertainty for EM soils and groundwater programs and projects. The Savannah River National Laboratory (SRNL), as the EM Corporate Laboratory and the premier applied science laboratory for DOE, is uniquely positioned to serve as a focal point for this mission, in collaboration with other DOE national laboratories and sites, federal agencies, universities and industry, regulators, and public stakeholders.

The *EM Center for Sustainable Groundwater and Soil Solutions* at SRNL provides comprehensive and coordinated applied science and engineering resources and actively fosters collaboration among DOE laboratories and sites, federal agencies, universities and industry, regulators, and public stakeholders. As an applied science center of DOE, the products and support will:

- serve as a bridge to bring advances in basic research into practical use;
- develop, test and support technologies that employ natural and enhanced attenuation where appropriate;
- support the matching of technologies to site specific problems and the follow-on implementation;
- develop, test and support environmental remediation technologies that reduce energy use and minimize collateral damages -- develop new strategies for soil and groundwater cleanup that incorporate metrics related to the environmental impacts associated with the action; and

- serve as a clearinghouse for information and a central forum for technology innovators and environmental service providers.

Annual activities associated with the *EM Center for Sustainable Groundwater and Soil Solutions* include:

- Leadership and facilitation of national Technology Development and Deployment (TDD) alternative projects such as Enhanced Attenuation for Chlorinated Solvents and Attenuation Based Remedies for Metals and Radionuclides.
- Identification of emerging issues and putting science to work to facilitate policy development that is both highly protective and rational. Engaging panels, "Policy Councils," each year to identify and address emerging issues. These councils would not be one-time workshops, but rather would consist of recognized senior policymakers (EPA, Nuclear Regulatory Commission Board, recognized scientists), other innovators in government agencies, industry, and academia.
- Coordinating technical workshops for the purpose of technology information exchange and for collaboration with DOE partners/other federal agencies (e.g., DOD, EPA, ITRC, etc.).
- Technical Assistance and independent peer review of environmental activities at DOE sites (e.g., Paducah remedy and remedial optimization reviews, Oak Ridge mercury characterization and remediation strategies, Hanford River Protection project selection).
- Establishing an EM-20 Applied Field Research Site (AFRS) at the Savannah River Site F-Area Seepage Basins for the benefit the DOE Complex and for the purpose of performing applied technology research and improve the fundamental understanding of radionuclide and metal contaminant behavior in the subsurface over space and time (in conjunction with enhancements identified within Attenuation Based Remedies for Metals and Radionuclides).

Technical Assistance

Over the last ten years, the U. S. Department of Energy has realized consistent success in providing national technology resources to solve specific environmental problems. Through the Technical Assistance and Technical Solutions programs, nationally recognized experts have taken on pressing and challenging problems and have provided high quality support to small sites and closure sites including Paducah, Portsmouth, Ashtabula, Mound, Kansas City Plant, as well as to large sites such as Oak Ridge, Hanford, and Savannah River. The program has proven effective and has efficiently provided high value solutions to DOE sites that face challenging environmental and technical problems.

The Technical Assistance Program will be managed/coordinated through the *EM Center for Sustainable Groundwater and Soil Solutions* at the Savannah River National Laboratory. Technical Assistance requests submitted by DOE site managers will be reviewed by EM-22 and the Center for one of three potential levels of support.

- Quick Win consulting which provides rapid technical advice or evaluation, generally requiring 1 or 2 experts and may or may not include site visit.

- Technical Solutions which address specific technical issues at DOE sites that significantly impact cost and schedule and addressing a critical site need, with the goal of providing a technical improvement over an existing technology or strategic baseline.
- Technical Programs which are longer-term technical projects that should be considered for inclusion in the Multi-Year Program Plan.

Improved Sampling & Characterization Strategies: Develop Next Generation Characterization Technologies & Strategies

The primary goal/objective of this initiative is to identify high-risk, complex-wide characterization needs within DOE and then to use the core technical team concept to develop technical toolboxes and approaches that can be used to address the problems at a specific waste site. These toolboxes and technical approaches will then be applied to similar problems at other DOE waste sites within the complex. The preliminary product of this exercise will be a series of contaminant-specific matrixes of characterization sensors and tools with recommendations that address specific high-risk needs applicable to multiple sites within the complex. These solutions will be developed in a collaborative manner with site contractors, regulators and stakeholders. At a minimum, the key aspects and issues for implementation of each technology will be addressed including technical effectiveness, regulatory and public acceptability, issues with implementation, sensitivity, health and safety, cost and technical maturity. Three specific target problems have been selected from the needs documentation that will be addressed through the lifetime of this project. Each technical solution/approach will be implemented at least at two sites within the DOE complex.

Advanced Predictive Capabilities: Develop Advanced Fate & Transport Models

The goal of this initiative is to develop conceptual models and apply advanced numerical models to enable the DOE EM cleanup mission. The initiative has three main objectives.

- *Build the technical framework:* Scientific investigations funded at the Sites by DOE Environmental Management and the DOE Office of Science (SC) have provided a wealth of information on subsurface biogeochemical transformations to identify key processes and parameters. Initial efforts will be focused on in-depth reviews and integration of data on technetium-99 (linked to the Advanced Remediation Methods for Metals and Radionuclides Initiative) and uranium. These reviews will produce information that will be compiled into “handbooks” that can be used by sites for updating conceptual models at DOE sites.
- *Methodologies for conceptual model development and assessment for sites with high uncertainty:* A framework and guidance for developing and assessing uncertainty in conceptual models will be demonstrated. The initial target will be evaluation of alternate conceptual models of groundwater flow and contaminant transport through Gable Gap on the Hanford Site. This activity requires a systematic approach to address the uncertainty in flow through the gap and will lead to a general approach for DOE EM to develop realistic estimates of predictive uncertainty, target investments in data collection to minimize

uncertainty, and produce defensible outcomes to further the cleanup mission. Other areas of focus for science integration and development of the framework for conceptual model development include technetium-99 in the deep vadose zone, uranium, plutonium, strontium-90, chlorinated organics, and mercury.

- *Acceptance of advanced numerical models:* At sites where DOE EM has identified intractable issues associated with contaminant fate and transport, advanced numerical models will be employed to solve these pressing problems. Technical targets will be defined across the DOE complex to leverage DOE EM, DOE SC, and ASCR investments. Protocols and guidance for using advanced numerical models will be developed with sites and regulators.

Enhanced Remediation Methods: Enhanced Attenuation (EA) for Chlorinated Solvents Technology Alternative Project

To aid practitioners in implementing enhanced attenuation, the primary objective of this initiative will be to develop technical guidance for a variety of technologies deployed under the enhanced attenuation (EA) concept that will provide end users with the tools for assessing, designing, implementing, and monitoring sites with chlorinated solvent contaminated groundwater, as well as provide regulators a technical basis on which to evaluate proposed implementation of selected technologies under the EA paradigm. The elements of this work are:

- Evaluate past datasets to assess effectiveness and sustainability of attenuation remedies under varying conditions.
- Perform focused field studies of enhancements with detailed monitoring and a sufficient period of record to document sustainability.

Supporting objectives for this initiative include:

- Development and implementation of an outreach program to disseminate the products from this project to those responsible for implementation and approval of the remedies, as well as the public stakeholders.
- Through demonstration of EA technologies, support site owners in solving technical and regulatory challenges.

Specific goals of the project include:

- Maintain focus on providing clear, concise guidance that end users can apply when designing, implementing, and monitoring an EA remedy.
- Select a breadth of technologies that would provide a reasonable representation of technologies that would be implemented via an EA strategy. Use real-world data from full scale remediation.
- Emphasize approaches that provide relevant data while maintaining costs at a realistic level.
- Ensure approaches are consistent with the Interstate Technology Regulatory Council (ITRC) developed Decision Flowchart and EA definition.

Enhanced Remediation Methods: Demonstrate Methods to Reduce Transport Rate of Chlorinated Organics through the Deep Vadose Zone

This project will examine vadose zone transport processes for chlorinated organics, identify improved remediation approaches, and provide guidance and methods to support remediation objectives. Feasible remediation approaches for chlorinated organics in the deep vadose zone and groundwater will be identified that bridge from active remediation used in current baseline through alternative approaches and finally to MNA. The project objectives are:

- Identify and provide technical information necessary to implement methods for remediation of chlorinated organics in the vadose zone that are more effective than baseline soil vapor extraction at reducing transport through the vadose zone over the short and long term. Key considerations for the remediation method include compatibility with Enhanced Attenuation and MNA, ability to address lower-permeability zones and areas with slow mass transfer processes to the vapor phase, ability to implement at reasonable cost in deep/thick vadose zones over large areas, possibility for long-term sustainable implementation, and effectiveness for mass reduction.
- Identify and provide technical information necessary to support approaches for setting and monitoring remediation objectives for chlorinated organics in the vadose zone. Key considerations include the capability to sufficiently define transport processes, linkage of vadose zone objectives to groundwater objectives, both short- and long-term objectives, monitoring strategies that provide the information necessary to support verification of objectives, and ability to implement at reasonable cost in deep/thick vadose zones over large areas.

Enhanced Remediation Methods: Scientific & Technical Basis for In Situ Treatment Systems for Metals & Radionuclides

This initiative will provide improved methods to control, reduce, and/or remove troublesome metals and radionuclides in the vadose zone. It will generate both scientific information and cost effective *in situ* remediation technologies needed to treat metals and radionuclide contamination at a number of waste sites in which the capacity of the natural system to attenuate the contaminants is exceeded. Activities and products will support the following key objectives.

- Increase the scientific and technical knowledge base to better understanding the behavior of specific metals and radionuclides in subsurface environment.
- Introduce innovative remedial approaches for in situ treatment of specific metals and radionuclides in the subsurface environment including monitoring based on this knowledge.
- Reduce the overall technical risk related to the Department of Energy’s cleanup mission and gain regulatory concurrence for remediation decisions.

Enhanced Remediation Methods: Scientific Basis for Attenuation Based Remedies for Metal and Radionuclide Contaminated Groundwater

This initiative will provide the scientific and policy support to facilitate implementation of appropriate cleanup strategies relying on natural attenuation processes at DOE metal and/or radionuclide contaminated sites. Guidance on natural attenuation of metals and radionuclides will be developed to allow waste site managers to leverage the broad base of scientific information on specific contaminant attenuation mechanisms and predict the long-term efficacy of attenuation based strategies. Incorporation of natural attenuation strategies into long-term stewardship planning will greatly reduce costs and increase efficiency of site closure by providing a science-based approach for transitioning waste sites from active to passive remediation, as well as encouraging the use of sustainable remediation technologies.

The implementation activities and overall structure of this initiative, along with the specific science selected for systematic deployment and documentation will support the following key objectives.

- Advance the science and broaden the understanding of attenuation based remedies for metals and radionuclides and how they should be used in long-term stewardship planning.
- Expand the concept of enhanced attenuation to the area of metal and radionuclide contaminants and how it should be used in long-term stewardship planning.
- Gain regulatory concurrence in the states and regions overseeing Department of Energy sites by working with interstate and national regulatory partners to contribute to a national effort that will provide guidance on implementing attenuation based remedies for metals and radionuclides.
- Establish and document new monitoring paradigms that provide high levels of performance for reduced costs.

Enhanced Remediation Methods: Idaho Sr-90 Immobilization/Uncertainty Reduction Project

The proposed investigations are closely aligned with complementary research being conducted through the DOE Office of Science Environmental Remediation Science Program (ERSP), which are focused on the scientific basis of the immobilization techniques and the coupling between biogeochemical processes and flow. Understanding and predicting the consequences of this coupling are critical for effective design of engineered remediation systems, which rely on the advective delivery of reagents. This EM program will focus on the more practical aspects of amendment delivery, and determining the spatial distribution and fate of the amendments after delivery. Methods to monitor Sr-90 in the environment to evaluate mobility and the effectiveness of remedial actions will also be developed. *In situ* monitoring, as opposed to sample collection and analysis, provides a major cost savings for long-term stewardship.

This initiative is developed around three premises that form the basic elements of the project. These three project elements as applied to Sr-90 are:

- Process-based characterization and computer simulation can significantly reduce the uncertainty in risk assessment, and thereby significantly reduce programmatic risks faced by EM.
- *In situ* vadose zone remediation can provide significant cost reduction and enhanced environmental protection over current remediation techniques.
- *In situ* or field quantification of contaminants provide long-term cost reduction for characterizing sites and verifying performance or remedial actions.

Columbia River Projects

300 Area Uranium Plume Treatability Demonstration – U Polyphosphate Stabilization: This project is performing laboratory tests using long-chain polyphosphate material to stabilize uranium. A field test has been designed to determine if it is possible to treat groundwater in the aquifer and lower the concentration of uranium contamination. Finally, this project will determine if this approach can be implemented on a large scale and if it would be cost-effective.

100-N Area Sr-90 Treatability Demonstration (Phytoremediation): This project is investigating how a specific plant (Coyote willow) may be used along the Columbia River corridor to extract or isolate strontium-90 from the soil and incorporate it into above ground biomass. The project will identify the best way to grow and fertilize these plants so that they generate the greatest biomass possible while protecting the Columbia River. Greenhouse studies and field tests will be utilized. This technology can be used with other methods of remediation and be a polishing step specific to the very near river shoreline.

Refine Location of Chromium Source: This project will determine the leaching characteristics of chromium from contaminated sediments from the 100 Area spill sites. Possible chromium mineral and/or chemical associations that may be responsible for chromium retention will be determined through the use of macroscopic solubility studies and microscale characterization of contaminated sediments. A conceptual model will be constructed of chromium geochemistry in the Hanford 100 Area vadose zone.

Advanced Remediation Technologies: Cost-effective *In Situ* Groundwater Remediation of DOE High-level Sites with Enhanced Anaerobic Reductive Precipitation/Enhanced Reductive Dechlorination

The objective of this work is to demonstrate that a commercially available, *in situ* remediation technology, Enhanced Anaerobic Reductive Precipitation (EARP)/Enhanced Reductive Dechlorination (ERD) can provide cost effective groundwater remediation for Department of Energy (DOE) High Level Waste Sites. This technology has already been

used at 190 sites, including 21 Federal sites, for a wide variety of metals, energetic materials, chlorinated volatile organic compounds (CVOC), nitrate and uranium. Geochemical laboratory measurements and limited field tests have shown that this technology can be applied to other key radionuclides. However, this technology has yet to be applied at field scale for radionuclides at a DOE facility.

The initial phase of this project includes:

- In-situ bioreductive process to immobilize contaminant metals and radionuclides within the subsurface at Hanford.
- Injection of a biodegradable substrate into the subsurface to stimulate native microorganisms that will couple the oxidation of the degradable substrate.

Enhanced Long-Term Performance Evaluation and Monitoring: Develop Technical Basis for Paradigm Shift for Life-Cycle Monitoring

This initiative will develop improved and optimized long term monitoring systems to document the transition to, and sustainability of, DOE EM contaminant stabilization and remediation actions. One element of this activity will be to encourage integrating the waste sites within an area (the area closure concept), both for remediation decisions and monitoring, to maximize the overall risk reduction and promote synergistic decision-making. This approach is already being done at a variety of DOE sites as exemplified by the area ROD concept implemented within EM at the Savannah River Site. In particular, the initiative proposes using alternative and improved performance objectives, such as basing performance metrics primarily on plume stability/shrinkage rather than simply measuring a large number of "point" concentrations. It also proposes to link plume stability to broad scale controlling factors, such as weather, ecological or geochemical conditions/changes, and the like. Once this objective and linkage is made, the proposal will be to replace a substantial portion of the current monitoring well measurements with other types of measures – ones that will provide demonstrably better monitoring at a substantially reduced cost. Such a significant paradigm shift requires careful development and documentation, including new types of modeling and statistics to show that the approach will be able to handle real-world challenges such as un-transitioned facilities within an area ("doughnut holes"). Engineering developments will be required to address system responses and robustness to extreme events, climate changes, and intruders. To meet all of the goals, a research portfolio will be developed that will solicit the best concepts from industry and universities in the following four broad themes.

- spatially integrated monitoring tools,
- onsite and field monitoring tools and sensors,
- engineered diagnostic components, and
- integrated risk management and decision support tools.

Enhanced Long-Term Performance Evaluation and Monitoring: Develop Approaches for Integrating Life-Cycle Monitoring Data into Site Models

Alternative options for monitoring are emerging. These options include use of tools that can provide volumetric or flux data that better delineate the contaminant plume and

measures its behavior. Although these tools are beginning to be demonstrated for sampling and characterization, there is a computational component that is needed to interpret the signal and correlate it to concentrations of species of concern. Additionally, emerging biosentinel or biomarker approaches are being developed that provide earlier and more direct indicators of ecosystem health than contaminant concentration alone. The goal with these types of indicators is to identify functional changes within an ecosystem early enough to take corrective action before damage occurs. Finally, there are other aerial/remote monitoring techniques that can precede changes over wide geographic area. The combination of these different types of data (volumetric measure of plumes, biomarkers or biosentinels, GIS/vegetation changes, etc) are useful because they provide non-point source monitoring and the multiple lines of evidence of the impact on human and ecosystem health. The ability to interpret non-point source monitoring signals and collect and use heterogeneous data sets, however, requires use of computational statistics and modeling for diagnostics.

The major objectives of this initiative are to:

- Provide the technical basis to shift the existing paradigm of point source monitoring to spatially integrated monitoring tools incorporating onsite field monitoring and sensors.
- Development of integrated risk management and decision support tools for a more system-based monitoring paradigm.

The above EM-22 Program initiatives make up a science-based, best in class applied research program that will provide solutions to all sites within the DOE complex as well as other federal agencies. The *EM Center for Sustainable Groundwater and Soil Solutions* will provide technical leadership to accomplish the stated goals and objectives, peer-reviewed technical targets developed by the technical working groups within these initiatives will serve as the scientific technical basis for the program, and the highly successful Technical Assistance Program will serve to facilitate technology transfer.