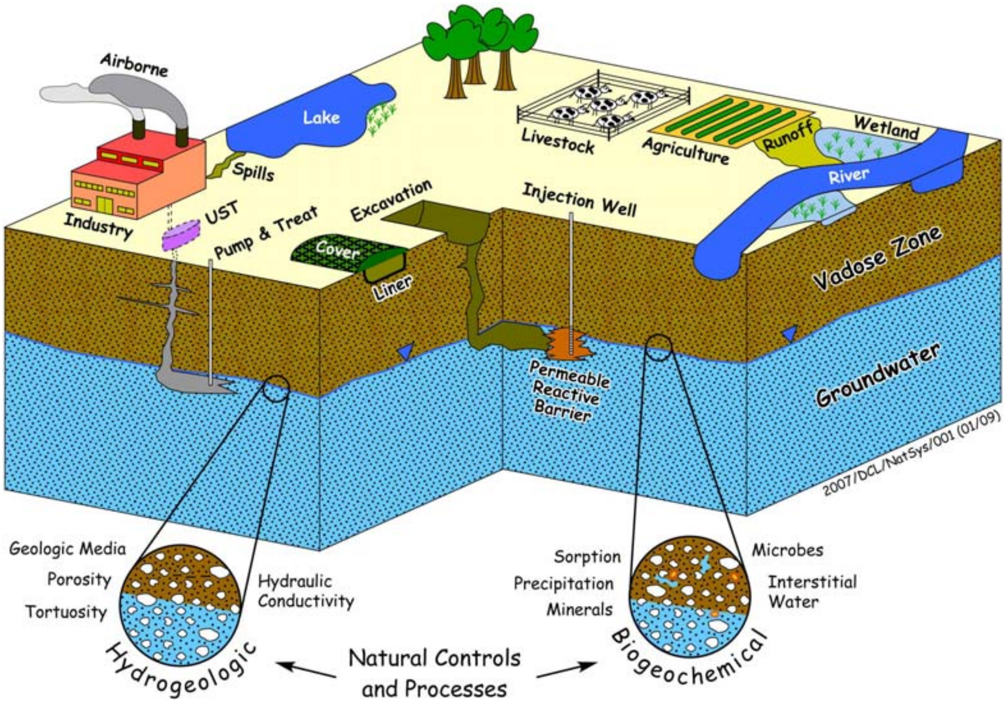
U.S. DEPARTMENT OF ENERGY OFFICE OF ENVIRONMENTAL MANAGEMENT

EM-22 PROGRAM REVIEW: INDEPENDENT PROGRAM REVIEW PANEL REPORT

October 2008



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EM-22 PROGRAM REVIEW
Independent Program Review Panel Report

1.0 INTRODUCTION

The Department of Energy (DOE) created the Office of Environmental Management (EM) in 1989 to clean up the legacy wastes generated during the Cold War. Since 1989, DOE has made great progress, including closure of significant sites, but much remains to be done. The types of challenges remaining include waste processing, groundwater and soil remediation, decontamination and decommissioning, and spent nuclear fuel management.

To address these challenges, EM has tasked the Office of Engineering and Technology (OET) to identify and advance technologies, processes, and technical practices that improve the performance of environmental management projects over their entire lifecycle, from planning to disposal. OET investments will provide the engineering foundations, technical assistance, new approaches and new technologies that contribute to significant reductions in risk (technology, safety, and health), cost, and schedule for completion of the DOE EM mission.

Within OET, the Office of Groundwater and Soil Cleanup (EM-22) mission is to use the best science and technical resources to find solutions that reduce life-cycle technical risk and uncertainties associated with contaminated soil and groundwater across the DOE Complex. In September of 2008, EM-22 held their first program review to bring together the Groundwater and Soil Cleanup Community of Practice to review 2008 accomplishments and plans for the next few years, including discussion of areas of collaboration. As part of the program review, EM-22 commissioned an Independent Program Review Panel (IPRP) to provide independent review and verification of the EM-22 Groundwater and Soil Remediation Program to assess progress and current plans against the OET Engineering & Technology Roadmap and the EM-22 Multi-Year Program Plan (MYPP).

As part of the IPRP review process, EM-22 provided the following lines of inquiry to the IPRP to be addressed as part of their response.

1. Are the existing and proposed initiatives consistent with DOE complex-wide needs and program objectives as established in the EM Roadmap and EM-22 MYPP?

2. Are there missing applied scientific and technology objectives within the existing and proposed initiatives that should be considered as these initiatives move forward? How might these initiatives be enhanced?

3. Is the vision for the future program (FY09/FY10) clearly laid out and how might that vision be enhanced?

4. Are there applied science and technology areas that are not adequately covered through existing and planned program initiatives that should be considered in the program planning process?

2.0 APPROACH

Following an initial review of the Roadmap and MYPP, the IPRP attended the three-day EM-22 Program Review held September 23–25, 2008 in Denver, Colorado, where presentations of ongoing and future initiatives were made. At the end of the workshop, the IPRP provided an oral briefing of their preliminary observations and recommendations. After the workshop, the IPRP reviewed additional documentation, such as implementation plans and technical targets, and conducted follow-up communication with the principal investigators for some of the projects. This report serves to document the IPRP observations and recommendations for improving or enhancing the overall program. Areas of review include groundwater and soil characterization, metals and radionuclide treatment, chlorinated solvent treatment, modeling, and long-term monitoring.

3.0 INDEPENDENT PROGRAM REVIEW PANEL OBSERVATIONS AND RECOMMENDATIONS

The IPRP observations and recommendations provided in this report are based solely upon very limited information provided at the program review, as well as the Roadmap and the MYPP, and implementation plans/technical targets for some of the projects.

3.1 INDEPENDENT PROGRAM REVIEW PANEL OBSERVATIONS

The following observations were made by the IPRP as a result of the limited review of the EM-22 Program.

1. The IPRP recognizes the need for an Engineering and Technology Program to address the complexity and enormity of EM's cleanup problems, as identified in the NAS review of the roadmap (NAS, 2008). As stated by NAS (2008), "Congress and DOE have provided substantial funding for EM's investments in scientific research and technology development since EM was created in1989. However, this funding has varied substantially." The IPRP recognizes that the OET Program bridges the gap between basic and applied research conducted by the Office of Science and the EM cleanup program. Yet, OET's funding level is far below that of both Office of Science and EM. Without a substantial addition to the OET budget, it may be difficult to transfer the results of scientific research from the Office of Science to practical applications within the EM Program and to develop other solutions to meet DOE EM unique needs.

2. The EM-22 Program was planned based upon a much larger budget (~$25M) than was allocated in 2007 and 2008. Thus, there are serious limitations to practical implementation of the numerous projects that are currently funded or planned within a severely constrained budget (~$3.5M).

3. Program planning for the $25M funding level was based upon a workshop in late 2006, where representatives from many of the DOE sites identified needs in the following areas:

   a. basic and applied research involving understanding of contaminant fate and transport (metals, rads, and chlorinated solvents)
   b. sampling/characterization technology
   c. modeling
   d. enhanced remediation methods (in situ and ex situ)
   e. long-term monitoring.

   Common needs were categorized into these topic areas. From these, four Strategic Initiatives were developed to form the foundation of the Soils and Groundwater Remediation Program: Improved Sampling and Characterization Strategies; Advanced Predictive Capabilities; Enhanced Remediation Methods; and Enhanced Long-Term Performance Evaluation and Monitoring.

4. According to the Roadmap, the overall objective of the OET Program is to reduce the technical risk and uncertainty in the Department's cleanup programs and projects. However, the needs identification process did not appear to include assessment of risk reduction for each strategic initiative or the individual needs.

5. EM-22 has accomplished a large amount of work with a very limited budget in a short amount of time, but much more remains to be done. The amount of leveraging of work is excellent, but it is difficult to understand what the contribution of EM-22 is for some of the projects.

6. Not all projects have produced significant results. Current funding levels are likely appropriate for planning purposes but are not sustainable for project implementation. More money is needed to continue progress with each project.

7. The EM-22 Program currently only partially addresses changing needs within DOE EM and variable needs within the EM Program itself.

   a. EM needs have should have changed over time, as sites characterized their problems over the last twenty years and remediation systems advanced from simple pump and treat to combinations of in situ and ex situ treatments. Some of the needs appear to be the same or similar to those identified years ago.

   b. In situ remediation is likely to be a high-priority need, but this need should also have changed over time, e.g., from active to passive to natural attenuation systems, which are now included in the EM-22 portfolio. Solutions may have been developed for problems that are shared with others, such as EPA Superfund, Department of Defense, and commercial sites.

c. Unique DOE remediation needs, such as radionuclides in the vadose zone and mercury at Oak Ridge, remain a significant problem that should be and are now being addressed by EM-22.

d. Attenuation-based projects, which are currently part of the EM-22 Program, represent a new way of thinking that appears to fill a high-priority need for multiple DOE sites and has tremendous potential to impact the EM cleanup program, as natural attenuation will be used as a part of nearly every groundwater remedial system.

8. The EM-22 Program focuses on three demonstration sites (Savannah River F-Area, Hanford BC Cribs and Trenches, and Oak Ridge). However, this was not emphasized during the Program Review.

9. The IPRP is encouraged by the emphasis on communication and collaboration. The 2008 Program Review was not adequate to show the breadth of collaboration between the Office of Science and EM-22.

10. Current EM-22 projects generally don't possess performance metrics or a quantitative system for performance evaluation.

3.2 INDEPENDENT PROGRAM REVIEW PANEL RECOMMENDATIONS

The IPRP provides the following recommendations, based upon their review.

1. **Program direction should account for the successes of the last twenty years of investments, the need for engineering and scale-up to ensure successful implementation, and the schedule for technology insertion**. Over the last twenty years, many new technologies for characterization and remediation of groundwater and soil have been developed and applied in the field at DOE, other government, and commercial sites. Many of the DOE sites have been characterized to an appropriate level. However, remediation challenges, many of which involve scale up and engineering of relatively new technologies, still exist. Bridging the gap from laboratory and field research to practical, full-scale implementation remains a significant need.

   We recognize the collaboration with site end users for some of the projects, e.g., SRS MNA of Metals and Rads, but also recognize that for the Program in general more emphasis should be placed on how and when new technologies/approaches will be inserted into the cleanup schedules for the engineering and technology projects.

   a. To strengthen the linkage between the technology developers and the site end users, EM-22 should consider development of a collaborative program, where there is a requirement for site end users to actively participate in a project, possibly as a member of the Technical Working Group or preferably in a greater role. In this way, project scope can recognize ongoing site EM activities, such as a Treatability Test, and target activities to fill gaps or provide technical support.

b. Should funding be increased, EM-22 should consider initiation of a program similar to the former Accelerated Site Technology Deployment (ASTD) Program, instituted in the late 1990s. The ASTD Program required proposals to be submitted by site cleanup managers with a commitment to provide leveraged funds to conduct a project that could be completed within the required schedule. This project structure ensured that the projects were needed and that they would be completed in time. The IPRP recognizes that such a program may not be feasible until the EM-22 budget is increased.

2. **The EM-22 Program should include a balanced portfolio that includes: 1) "quick win" activities, such as technical assistance, as well as 2) short-term engineering and technology projects that can meet EM cleanup schedules, and finally 3) a focus on future improvements, such as long-term monitoring.** This type of portfolio, should it exist, was not clearly presented during the program review. Each of the parts of the portfolio should have appropriate funding associated with it. For example, technical assistance should have funding set aside, perhaps managed by the Center at SRNL. Technical assistance must be managed to allow ready access to outside experts from industry and academia to ensure appropriate resources are utilized.

3. **Because of the limited budget, the current EM-22 Program should be phased using a prioritization process, so that sufficient funding can be allocated to selected projects that have the most potential to impact needs associated with highest risk reduction and maximum value, while also allocating a portion of the budget to "quick wins."**

   a. The IPRP recommends a detailed quantitative assessment of each of the strategic initiatives (and their individual projects) be conducted to determine the potential for risk, uncertainty, schedule, or cost reduction using a quantitative evaluation. Prioritization could then be accomplished based upon these criteria, while also giving consideration to other issues including items in #1 and 2 above (e.g., scale-up, schedule, balanced portfolio). With future budget increases, any strategic initiatives and projects placed on hold could be phased back into the program.

   b. As part of the prioritization process, further assessment of specific needs should be performed by examining what has and is being done in industry, at EPA Superfund sites, and at Department of Defense facilities. This information should then be compared with what is unique to DOE, and where gaps, such as engineering application of innovative approaches and technologies, exist. For problems also faced outside DOE, EM-22 should pursue collaborations to bring new or existing solutions to DOE.

   c. **EM-22 should consider funding a limited number of projects, while providing a multi-year commitment for funding.** For example, three projects, each addressing one of the three top needs could be funded at the $800-1000K level, while technical assistance could be funded at the $500K level and a couple of workshops could be held each year. A commitment for multi-year funding, similar to what was done with the MNA-EA for Chlorinated Organics Project, would enable better planning and project execution.

d. **Technical assistance should be promoted to actively engage the sites.** The Center could manage the technical assistance program, but should be required to easily access industry and university experts as part of all technical assistance teams. More active communication between the Center and multiple DOE sites is needed to grow this effort.

e. **Innovative approaches to awarding projects could be pursued to ensure the best technical experts are awarded the work.** Further thought about this topic is needed. One possibility would be a competitive process for the national labs.

4. IPRP recommendations relative to the structure of specific Strategic Initiatives include the following.

a. Specific technical challenges within the in situ remediation problem area recognized by the IPRP as needing further development include 1) remediation of radionuclides, 2) delivery of amendments to the subsurface, 3) scale-up of innovative engineered systems to consider site heterogeneity, 4) incorporation of natural attenuation solutions into active remedial systems, and 5) performance monitoring. Research supporting improved understanding of natural attenuation as well as a process for demonstrating that it is working at a particular site should continue to be supported as a component of the program.

b. The IPRP recognizes that characterization and modeling are important tools needed to fully implement remediation, but recommends these types of activities be incorporated into the problem-focused remediation projects or be implemented using a technical assistance approach.

c. The IPRP believes that a small effort in the area of long-term monitoring should be initiated in collaboration with the Office of Legacy Management. The panel supports this initiative, because it needs to be started now to have an impact in the future. The IPRP fully supports the plan for next year’s workshop, which will convene scientists with expertise in this field and leverage the work of others to plan a path forward. The long-term monitoring effort should consider collaboration with ongoing remediation projects, so they could provide assistance with that component of the remediation.

5. **All projects conducted within EM-22 should be required to develop performance metrics, which can then be monitored through the project lifecycle.** Technical reviews should be an important part of the management process. These reviews should include Go/no-go decision points, so that project management can be effectively accomplished to ensure the best investment of limited dollars. Clear definition of project deliverables and products should be included in all project documentation.

6. **EM-22 should consider formalization of the Communities of Practice concept and the development of Best Practices to share information across the DOE Complex.** EM-22 should look for ways to enhance communication and collaboration between project teams, Office of Science, Federal Project Managers, site contractors, etc. The workshops planned for next year should facilitate effective communication to support long-term program planning and could be utilized to further develop the Communities of Practice concept. However, the number of workshops should be limited to accommodate the constrained budget.

7. **EM-22 should continue to incorporate the Earmark Programs into the Program**, because their budgets are higher than EM-22's and technical resources do exist. EM-22 should consider the model utilized by the EM -21 International Program where a national laboratory representative works closely with the International Program principal investigator to develop the scope of work and acts as technical monitor for the individual project. This collaboration between the co-Principal Investigators promotes the Community of Practice.

8. **Guidelines for future Program Reviews should be enhanced** to ensure that individual presenters provide sufficient detail on the project, including written documentation on plans and accomplishments, as well as project justification or benefits that include information on how the project can reduce risk, uncertainty, and/or cost. Although the PI's were given guidelines for the presentations, it was challenging for the IPRP to compare projects. The independent panel should be given more detailed information and more time for review.

9. **EM-22 Program Management should work closely with DOE Federal Project Managers and Contractors at key DOE sites to engage them in the Program**, obtain ongoing feedback as to program direction, and encourage leveraging with existing site activities. Individual Project Managers or Principal Investigators should work closely with their Federal Project Manager counterparts at the specific DOE site(s) where their project is focused to encourage communication, collaboration, and leveraging of resources.

10. **The Technical Working Group (TWG) structure is valuable**, because it promotes broad capabilities be brought to the project; it should be continued. As the projects focus on delivery of solutions to the field, experts with remedial engineering experience, as well as site representatives, should be included on all of the TWG's. The IPRP recognizes that some of the current TWG's currently contain site representation.

3.3 INDEPENDENT PROGRAM REVIEW PANEL RESPONSES TO THE LINES OF INQUIRY

The following represents the IPRP responses to the lines of inquiry.

1. The goals of the current EM-22 Program are consistent with DOE complex-wide needs and program objectives as established in the March 2008 Roadmap; however, it must be recognized that the Roadmap was developed with the expectation for a much higher budget. As such, the current program may need some adjustment to target the highest value (risk and/or cost) problems and balance the portfolio to meet both short and long-term needs.

a. Considering the small amount of funding available, a phased approach to funding each of the strategic initiatives may enable better allocation of resources. This approach should be based upon risk reduction and cost benefit to DOE.

b. When the program budget increases in the future, resources should be allocated to revisit the Roadmap. At that point in time, additional initiatives, such as improved technologies for containment, might be considered. The NAS report reviewing the Roadmap identified two distinct settings for groundwater and soil contamination: waste burial grounds and surface/subsurface contamination. No information on activities related to waste burial grounds was provided to the IPRP, although members have knowledge of an October workshop on landfills and a technical assistance/independent review provided to multiple DOE sites. This seems to be disconnected from the program that was presented at the annual review.

c. Each of the initiatives should be evaluated in terms of risk, uncertainty, and cost reduction and applicability. Applicability across the DOE complex and contribution to site closure should be a consideration. This will require a quantitative process and associated resources.

2. There may be additional or missing applied scientific and technology goals and objectives within the existing and proposed initiatives, but the IPRP cannot evaluate specifics within each of the initiatives given the information that was provided and the time allocated for our review.

3. The panel needs more information to clearly understand the vision for the future program or to provide recommendations as to how to enhance specific initiatives. It is difficult to comment given the information received.

4. The panel has not had enough time or information to determine if there are additional applied science and technology focus areas that are not adequately covered within the existing program. The IPRP recognizes that waste burial ground issues are not highlighted in the program, although they were identified by the NAS Roadmap review.

4.0 REVIEWS OF SPECIFIC PROJECTS

Appendix A contains individual reviews of specific projects presented at the 2008 Program Review, outlined in the following format. These reviews were performed with limited information, which, in some cases, lacked much detail.

- Introduction to the Project
- Expected Outcomes
- Information Sufficient to Conduct Review
- Fit with Program Goals
- Performance Metrics

- Project Deliverables
- Technology Deployment
- Collaboration/Leveraging
- Budget
- References.

In general, there is great variability among the projects. Some have made progress and have produced real deliverables, others have not. Some have significant collaboration and leveraging, others do not. Some, which have struggled with defining their scope of work, may be considered for phasing into the program at a later date.

5.0 REFERENCES

DOE. 2008. Engineering and Technology Roadmap: Reducing Technical Risk and Uncertainty in the EM Program, March 2008.

NAS. 2008. Technical and Strategic Advice for the Department of Energy, Office of Environmental Management's Development of a Cleanup Technology Roadmap. Interim Report. February 2008.

APPENDIX A

Project Reviews

Next-Generation Characterization Technologies to Support Conceptual Model Development

(SRNL Carol Eddy-Dilek)

Introduction – Objectives and Goals

The goal of the project is the development of next-generation characterization strategies and tools to reduce technical uncertainties and improve conceptual model development. Use of applied geophysics and sensors was highlighted.

The presentation began with a reference to EM's 20-year history of innovative characterization technology development and the observation that "Matching of technologies to problems can be difficult. Deployment of innovative technical solutions especially at small sites requires technical support." An incomplete listing of characterization technology deployments from 1989 through 2001 was provided.

The need for improved characterization technologies was illustrated through information provided for the Miamisburg site closure where $476 million in unanticipated costs were encountered, because data were not available for better estimates of 1) soil volumes that required excavation and 2) associated quantities of low-level waste generated.

Information was also provided with respect to DNAPL characterization approaches that had been developed through collaborative efforts and utilized at other DOE and DOD sites.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

The presentation lacked detail with respect to specific outcomes in terms of risk, cost and uncertainty reduction. The project would focus on the Oak Ridge Integrated Facility Disposition Project and "assist the site to refine the conceptual model to reduce technical uncertainty" through identification of geophysical techniques (technology matrix), implement field deployment of selected techniques, and provide a technical working group (recommended participants were identified) to review the results.

Sufficient Information

As mentioned above, the presentation lacked sufficient information to assess the impact of the project on risk, cost and uncertainty reduction. Having said that, the IPRP believes that the project and site selected (Oak Ridge IFDP) would clearly benefit in all of these aspects from innovative characterization technology and an improved conceptual model.

Fit with Program Goals – Links to Roadmap

While not discussed explicitly, the project appears to link to the Groundwater and Soil Remediation portion of the EM-20 Roadmap through the improved sampling and characterization strategic initiative.

Metrics

No information was provided on performance metrics that would be used to track the progress and success of the project.

Deliverables/Products

Project deliverables consist of technology identification and selection for field demonstration followed by a technical working group review.

Gaps

Not discussed in the presentation.

Technology Deployment (Implementability)

Not discussed in the presentation except in the schedule. Field deployment of the selected technology scheduled for 2010.

Collaboration/Leveraging

While past collaborations were discussed in the examples, no information was provided with respect to anticipated collaborations for this project.

Budget

The following funding information was presented:

FY09 $300K
FY10 $500K

The IPRP believes the project was funded in late 2007 and 2008, but no specific progress has been made, because it took significant time to develop the project objectives and scope. Funding should only be continued within tasks of the remediation projects or individual technical assistance efforts that are managed by the Center.

Advanced Predictive Capabilities
(PNNL – Mark Freshley)

Introduction – Objectives and Goals

The Initiative for "Develop Advanced Fate and Transport Models – Conceptual and Numerical Model Development for High-Risk Contamination and Site(s)" seeks to identify technical targets to improve strategies and methodologies for addressing modeling issues at complex EM waste sites, including needs generated by specific sites and scientific and technical gaps that underlie these needs.

The objectives and goals include:

- improve the process of developing and applying conceptual and numerical models to complex DOE EM problems and integrate modeling activities across different WBS elements;
- provide guidance and tools to assist DOE EM with conceptual and numerical model development at complex sites;
- make science-based fate and transport models accessible for use in DOE EM management decisions;
- gain regulatory acceptance of modeling framework and results for use in regulatory decisions.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

The high-level targets of this initiative include incorporation of coupled biogeochemical processes into transport models, modeling the appropriate degree of heterogeneity and evaluating alternative conceptual models. Outcomes of this initiative include a better understanding of the environmental systems with reduced uncertainty leading to better cleanup initiatives.

Sufficient Information

The lines of inquiry and technical targets (Freshley et al, 2008) along with the presentation provide sufficient information to review the initiative.

Fit with Program Goals – Links to Roadmap

The Initiative is consistent with DOE complex-wide needs and program objectives as established in the EM Roadmap. It appears that the project has struggled with developing a specific direction in attempting quick wins focusing on conceptual model uncertainty. These efforts were not completed apparently due to site operations issues. The IPRP recommends that some portion of this work may be more appropriately managed within the scope of one of the remediation projects or as technical assistance managed by the Center.

Metrics

There are no hard and fast metrics by which this initiative is judged. There are several lines of inquiry associated with this Initiative, each of which leads to better understanding of the various complexities associated with remediation.

Deliverables/Products

The products of this Initiative include case studies and approaches towards tackling the various site complexities. A summary workshop will be conducted and guidance documents will be created to disseminate information from this Initiative.

Gaps

The scientific and technology goals and objectives of the existing and proposed Initiative are adequate and cover a wide range of topics including incorporating fundamental to field-scale characterization data into models; characterizing biogeochemical reactive transport processes; investigating methods of representing the governing field scale heterogeneities; developing methods for assessing alternative conceptual models and uncertainty; developing relationships between readily available data and model inputs; developing guidance and protocols for implementing a graded computational approach of increased complexity as appropriate; developing strategies for implementing flexible models on supercomputers; evaluating protocols for multiphase modeling; developing methods to identify sources through inverse modeling; and developing guidance for parameterizing high-resolution models.

An additional science and technology goal not adequately covered within the existing program that may be considered is the data fusion methodology (Porter et al, 2000) to integrate inverse modeling of geostatistics, hydrogeology, and contaminant transport using soft information and hard data for parameterizing models. The panel was recently informed that this is a current area of research by the Office of Science. The IPRP recommends EM-22 consider collaboration with the Office of Science and site end users on this area of research.

Technology Deployment (Implementability)

The Initiative is readily implementable with available computational technology and computational methods. The schedule for the Initiative is aggressive considering the budget.

Collaboration/Leveraging

Each element of the Initiative includes linkages to several other Initiatives with collaboration among the technical working groups.

Budget

The budget for the Initiative seems sparse for the broad array of work products it contains. The budget distribution between technical implementation of the Initiative and management seems appropriate. Funding was received in FY07 and FY08, but little progress has been made since funds were received late in the year. The funding is being carried over into FY09 to advance the Initiative.

References

Freshley, M., V. Freedman, S. Yabusaki, G. Flach, and H. Huang, 2008. Develop advanced fate and transport models initiative: lines of inquiry and technical targets, Prepared for the U.S. Department of Energy under Contract DE-AC05-76RL01830.

Porter, D.W., B.P. Gibbs, W.F. Jones, P.S. Huyakorn, L.L. Hamm, G.P. Flach, 2000. Data fusion modeling for groundwater systems, Journal of Contaminant Hydrology, Volume 42, Issue 2-4, pp 303-335.

Advanced Remediation Methods for Metals and Radionuclides
(PNNL – Dawn Wellman)

Introduction – Objectives and Goals

The Initiative for "Advanced Remediation Methods for Metals and Radionuclides," identifies technical targets that improve methods to control, reduce, and remove troublesome metals and radionuclides from the vadose zone, and provides a means to demonstrate and gain regulatory acceptance of MNA in the vadose zone.

The objectives and goals include:

- Improve the state of the knowledge for behavior of specific metals and radionuclides in the subsurface;

- Based on the improved understanding, introduce innovative remedial approaches for in situ treatment of specific metals and radionuclides in the subsurface, if needed to supplement MNA;

- Reduce overall technical risk to DOE and gain regulatory acceptance for remediation decisions.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

The high-level targets of this Initiative include gaining a better understanding of coupled controlling processes in the vadose zone to effectively execute, control, and monitor advanced remediation methodologies for specific metals and radionuclides. The greatest risk reduction from this project and applicability is at the Hanford site where there is extensive contamination by metals and radionuclides in a deep vadose zone. Outcomes of this Initiative include a better understanding of metals and radionuclides in the vadose zone with reduced uncertainty leading to better remediation systems.

Sufficient Information

The work breakdown structure document (PNNL, 2007), along with the presentation, provide sufficient information to review the Initiative.

Fit with Program Goals – Links to Roadmap

The Initiative is consistent with DOE complex-wide needs and program objectives as established in the EM Roadmap.

Metrics

There are no hard and fast metrics by which this Initiative is judged. There are several challenges including a research component to this Initiative, including obtaining a better state-of-knowledge of Tc chemistry in geologic settings and coupled biogeochemical impacts.

Deliverables/Products

The products of this Initiative include a number of reports describing the results of each work activity. The technetium-99 subsurface environmental review and in situ technology / vadose zone transport review will provide a state of the knowledge regarding biogeochemical behavior and transport processes for technetium-99 and the relevant science for design of enhanced remediation methods applicable to the vadose zone. Other deliverables will include a remediation and monitoring strategy guidance for the vadose zone, documentation of individual research, development, and application projects that are a part of this Initiative, a communications / site web interface for appropriate input and dissemination of results, and a final comprehensive project report describing the activities and accomplishments of the project.

Gaps

The scientific and technology goals and objectives of the existing and proposed Initiative are adequate and involve understanding the science that would help develop effective and sustainable solutions for treatment of metals and radionuclides in the vadose zone, evaluating methodologies for successful access and delivery of treatment or containment agents under various site conditions, developing techniques and technologies for improved monitoring to support characterization, and understanding biogeochemical processes at various scales that would affect plume management. For this initiative, the review panel does not see any additional science and technology goals that are not adequately covered within the existing program that should be considered.

Technology Deployment (Implementability)

There are various engineering and scientific challenges that are being addressed by this initiative. The BC Cribs at Hanford provide the setting for technology deployment including subsurface characterization of heterogeneities, modeling, a review of technologies for subsurface delivery, and monitoring. The Initiative is currently on schedule with appropriate schedules provided for remaining activities up to FY-2010.

Collaboration/Leveraging

The Initiative leverages as much as possible, the advanced understanding of Tc in the subsurface at the BC Cribs. There is collaboration among TWG members from various national laboratories and industry with various backgrounds to meet the diverse needs of this Initiative. Because modeling is a crucial part of the project goal and technical targets, the panel suggests reactive transport modeling experience to be included in the TWG instead of in a technical support role.

Budget

The funding profile for this Initiative seems appropriate. The project should be prioritized as recommended in the body of the report.

References

PNNL, 2007. Develop advanced remediation methods for metals and radionuclide – scientific and technical basis for in-situ treatment systems for metals and radionuclides (WBS 2.3.1.1), Pacific Northwest National Laboratory, Prepared for United States Department of Energy.

Natural Attenuation Based Remedies for Metals and Radionuclide Contaminated Groundwater

(SRNL – Miles Denham)

Introduction – Objectives and Goals

Provide support to facilities to facilitate the application of natural attenuation processes for metals and or radionuclide-contaminated groundwater. The support will come in the form of tools and guidance documents. The tools will improve the monitoring, measurement, modeling, and evaluation of natural attenuation mechanisms and potential for them.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

In concept, this project has the potential to have significant payback to the DOE. Natural attenuation must be, at least, a component of the remedy for almost all metals and radionuclide sites. But little information is currently available on the natural attenuation mechanisms of metals and radionuclides, so it is difficult to model and make the case for it to the regulators.

Sufficient Information

The presentation and the text in the EM-22 Multi-Year Program Plan do not provide a sufficient amount of information to do a detailed assessment of the specific tasks and their priority, especially given the very tight budgets.

Fit with Program Goals – Links to Roadmap

In general, the project can contribute to the Roadmap Program Area—Enhanced Remediation Methods. Even though it is not an active remediation method, it should be a very important component of most remediation strategies.

Metrics

No specific metrics were provided. It might be appropriate to have a metric of producing a guidance document by a target date, for example.

Deliverables/Products

There is some discussion about preparing a guidance document jointly with ITRC. However, we were not provided sufficient information on this effort. This document should be the centerpiece of this project. This document should have a section on uncertainties, and the uncertainties identified should provide the focus and priority for the further research.

A number of tasks are discussed in the slides presented, but it is not clear what the deliverables will be for these tasks.

Gaps

It is difficult to evaluate gaps in the approach without more information.

Technology Deployment (Implementability)

From the presentation, it is difficult to understand the schedule. It appears to be out of date.

Again, the natural attenuation approach is very applicable and related to the design/engineering of remediation systems.

Collaboration/Leveraging

This project has significant opportunity for collaboration with various groups, especially the DOE Office of Science. Much of the detailed research on natural attenuation processes should be conducted with Office of Science budgets. The focus of this EM-22 effort should be on implementation and field demonstrations. Specific field projects should be sought out for leveraging (e.g. Hanford chromium and Tc-99 sites). Collaboration with EPA (e.g. John Wilson) should also be sought out.

Budget

The budget is probably not practical to accomplish the work described. The specific tasks, as well as the project as a whole, need to be prioritized as recommended in the body of the report.

Idaho Sr-90 Project
(INL – Larry Hull)

Introduction – Objectives and Goals

In 1972, high ionic strength, low pH, radioactively contaminated solution, with the activity of 16,000 Ci of Sr-90, was released at a depth of 500 ft above the water table. It is assumed that about 30% of Sr-90 initially migrated with a K_d of ~ 0 mL/g. However, current spatial distribution of the high ionic strength contamination is not known. The INL proposed an *in situ*, amendment-stimulated process based upon formation of mineral phases and biomass to effectively reduce the transport of metal contaminants in subsurface porous and fractured systems. The project team identified three Technical Targets:

1. Uncertainty reduction: How far and how fast did the Sr-90 migrate?
2. In situ treatment: How can we deliver amendments to the vadose zone to reduce mobility of contaminants?
3. Verification: How do we verify that amendment delivery was effective?

Focus in FY-08 was on Technical Target 1, Uncertainty reduction. The main goals of the project are:

- measure distribution of Sr-90 between cation exchange sites and secondary carbonates – remobilization potential
- measure cation exchange assemblage for Na/Ca ratio – plume perseverance
- model Sr-90 transport to and through perched water zones using TOUGHREACT to predict fate

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

INL has a Record of Decision (ROD) for Sr-90 and this project was developed as a "backup option" if recharge controls fails.

Based on the presentation, accomplishments related to Technical Target 1, Uncertainty reduction, are as follows:

- saved cores of contaminated alluvium and interbeds from destruction, and subsampled cores to obtain material for testing
- began first round of extractions
- developed a cation exchange model in TOUGHREACT.

The focus of the project was changed in March 2008, apparently due to a tight budget. The project was then redirected to Technical Targets 2 and 3, including:

- Support the Metals and Radionuclides Project at PNNL
- Tc-99 transport at Hanford.

It was assumed that Technical Targets 2 and 3 are relevant to investigations of Sr-90 migration at INL. Accomplishments from March to September FY08 for Technical Target 2, In situ Remediation, are as follows:

- planning of Tc-99 investigations at Hanford *(this is vague and sounds like the item below)*
- development of Technical Target Task Proposal in collaboration with the *Metals and Radionuclides in the Vadose Zone* Project
- development of FY09 and FY10 plans.

This project could be carried out as a case study for the Metals and Radionuclides in the Vadose Zone Project.

Sufficient Information

Insufficient information was presented to assess the technical and scientific merits of the project. It is not clear how the TOUGHREACT model was developed, if no experiments were conducted to assess the type of the cation exchange model and its parameters. It is not understandable how a numerical model was developed, if no conceptual model of flow and transport in the sediments-fractured basalt was developed. There was insufficient information provided about the March-September 2008 accomplishments and how they fit within the budget.

Fit with Program Goals – Links to Roadmap

Generally, the project fits the Roadmap Program Area *Groundwater and Soil Remediation*. Because of the limited funds available in EM-22, the plan to incorporate components of this project and personnel into the Metals and Radionuclides in the Vadose Zone Project led by PNNL is good.

Metrics

No metrics for evaluation of the project progress were given in the presentation. The Implementation Plan includes milestones and schedule metrics for the FY09-FY13 timeframe. These milestones and schedule could only be accomplished if sufficient funding is provided.

Deliverables/Products

Developed *Technical Target Task Proposal* in collaboration with the *Metals and Radionuclides in the Vadose Zone* Project.

No other deliverables have been completed, although the budget has been spent.

Gaps

The presentation does not include a review of extensive long-term investigations, which have been conducted at INL since the beginning of the 1980-90s by USGS and INL scientists. For example, the results of investigations of fast flow paths, regional hydraulic conductivity variations in the Snake River Plain Aquifer, broad isotopic studies, infiltration tests, and modeling at INL are presented in publications cited below. The INL project team did not incorporate any of this knowledge into the project.

Technology Deployment (Implementability)

Apparently, no new technology was deployed. Investigations of a new technology of manipulating the vadose zone geochemistry are planned for FY09-FY10. This technology will be based on delivery of amendments to the vadose zone to maintain suitable Eh and pH conditions. The status of this technology supports its development under the Office of Science and NOT under EM-22.

Collaboration/Leveraging

Established collaboration with PNNL Metals and Radionuclides Working Group. Collaboration with the Advanced Predictive Capabilities and Next Generation Characterization Technologies teams is recommended, if funding is available.

Budget

Budget appears to be insufficient to conduct full-scale field and laboratory investigations as an independent project. FY07-08 funding was spent with no significant deliverable beyond a short proposal. Project funding should not be continued unless it demonstrates a high priority during the prioritization process. There is some concern about duplication of effort, as the project is currently funded at a higher level by Office of Science. The Office of Science is an appropriate funding source because of the research nature of the work. As the Office of Science project develops, it may be appropriate to transition some of the work to EM-22, should funding be available. In the interim, staff participation on the Metals and Radionuclides in the Vadose Zone Technical Working Group is recommended to ease a future transition to the EM-22 funding source.

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Mercury Stabilization Project in Oak Ridge, TN
(ORNL- Liyuan Liang)

Introduction – Objectives and Goals

The mercury problem at Oak Ridge has been known, but poorly understood, for many years. The magnitude of the contamination combined with stakeholder concerns and increasingly stringent cleanup targets have put this cleanup challenge at the top of the list at the Oak Ridge Site and as one of the most pressing challenges for DOE EM-22 and the DOE BER Environmental Remediation Science Division (BER ERSD). Research, development and demonstration projects to stabilize and remediate mercury in subsurface soils and sediments are currently underway at Oak Ridge National Laboratory. Leveraged funding for these efforts comes principally from the EM-22 Soils and Groundwater program ($300K in FY 08) and the DOE BER ERSD (approx. $1.5M in FY 08).

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

Execution of the Oak Ridge Mercury Stabilization Project should result in significant reductions in risk due to immobilization of mercury and reduction in the overall source term. Major uncertainties related to the speciation of mercury and the chemical transformation of mercury to organomercury are addressed in this work.

Sufficient Information

The Oak Ridge presentation was thorough, but when reviewed in more detail, a number of questions related to the program scope, technical details, etc. were identified. A request was sent to the PI for additional information and answers to a number of specific questions were received promptly, making it much easier to evaluate this project. The cooperation of the principal investigator, Liyuan Liang, was well appreciated and should be noted.

Fit with Program Goals – Links to Roadmap

EM-22 support for Mercury Stabilization focuses on decreasing mercury deposition to streams, removal of mercury from sediments through reduction to Hg^{+0}/vaporization along with other chemical controls, source identification and modeling and techniques for soil treatment. These goals are well aligned with those established in the EM-22 Roadmap. The breakdown of activities in support of these goals is also logical and strategic.

Metrics

Several near-term evaluation metrics were established, i.e., two “Quick Win” projects in FY 08 (diversion of contaminated flow and $SnCl_2$ reduction and volatilization of Hg) – which were both useful and realistic. Longer-term metrics spanning FY 09 – FY 12 are not well defined and should be made more specific. The challenge in doing so, however, is the uncertainty in the level of future funding. This could be solved by establishing specific activities and completion metrics based on several funding scenarios.

Deliverables/Products

Other than the near-term "Quick Wins," there are no obvious deliverables, products or milestones. The OR project would be significantly improved by better definition of longer-term future deliverables, e.g., topical reports, workshops, demonstrations, technology deployments. This is critical to successful continuation of the project.

Technology Deployment (Implementability)

> **Engineering:** The FY 08 "Quick Wins" were excellent examples of applying existing technology solutions to begin to solve the very complex problems related to mercury contamination in soils, sediment, groundwater, ecology and food chain. Combining existing techniques with new state-of-the-art technologies that are being or can be developed is the most appropriate use of EM-22's limited budget. The project would benefit from clearly establishing criteria for selection/implementation of technologies.
>
> **Schedule:** Considering the late start in June 2008, the Oak Ridge project has made significant progress in a short period of time.

Collaboration/Leveraging

The project effectively leverages support from several areas within DOE as discussed above. The Technical Working Group and Review Team include experts from the DOE Complex, including national laboratories and the BER Science Focus Area (which also includes collaborators from universities). These collaborations are encouraged and will help ensure that mercury problems are addressed in an optimized fashion. The Office of Science and EM-22 collaborations under this topic should include regular communications, e.g., conference calls, sharing of data, and participation in progress meetings to benefit both organizations.

Budget

Similar to other EM-22 projects currently supported, the budget for research, development, testing and implementation of mercury treatment techniques is woefully inadequate. The subsurface mercury contamination issues associated with this project have high visibility at the local, regional, and national levels, and lead to immediate and traceable health effects due to mercury bioaccumulation. The project should be evaluated by the prioritization process as described in the body of the report; it is likely it will be identified for continued funding due to the large, unique scope of the problem.

Advanced Remediation Technologies (ART) Project - Enhanced Anaerobic Reduction Precipitation (EARP)

Arcadis, Chris Lutes

Introduction – Objectives and Goals

The goal of the project is to demonstrate that a commercially available, in situ remediation technology (EARP) can provide cost-effective groundwater remediation of radionuclides at DOE facilities. Specifically, the treatment of uranium, technetium, and nitrate will be evaluated.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

This project has the potential to have a reasonable payback to the DOE. EARP approaches may make sense at a number of sites within the DOE Complex. There are some uncertainties with this technology that need to be evaluated (e.g. the re-oxidation of Tc-99). The distribution of biological substrates to the subsurface is always another major uncertainty with this type of in situ technology, but that will be a site-specific issue. Because there are 100s of field applications, EM-22 should determine the best of use of money towards development of the technology to bridge the gap for implementation at DOE sites. Enhanced methods for amendment distribution could be a good research topic.

Sufficient Information

The presentation provides sufficient information to do a high-level review, but not a detailed assessment of the specific tasks.

Fit with Program Goals – Links to Roadmap

This project can contribute to the Roadmap Program Area—
Enhanced Remediation Methods. It is a very promising approach for these types of issues.

Metrics

No specific metrics were provided, other than the proposed schedule.

Deliverables/Products

It is mentioned that publications and presentations will be prepared, but no specifics on what will be prepared and when is provided. This may come later.

Gaps

The biggest potential gap that seems apparent from the information available is the long-term effectiveness of EARP on Tc-99. This same issue is being considered by the Metals and Radionuclides in the Vadose Zone Project conducted at PNNL. As currently proposed, Tc-99 was the most important contaminant -to be addressed in this study, but because of budgetary and schedule constraints, the project was moved from Hanford to SRS, where there is little Tc-99 at the demonstration site. Should other sites, such as Paducah, be considered for the project or should the focus be changed to other contaminants? The site selected at SRS (F-Area) might be considered a strange choice, as it has had an active remedial system in place for years.

The re-oxidation of Tc-99 would be a perfect question to evaluate in the lab and field. Perhaps this could be considered by the PNNL vadose-zone project.

Long-term monitoring of this site after the ART demonstration is completed is currently not planned, but perhaps it could be a case study conducted under the Long-Term Monitoring Initiative, should funding be available. In this way, collaboration between two projects would ensue.

Technology Deployment (Implementability)

Engineering design parameters should be developed from this study.

Collaboration/Leveraging

The project team needs to make sure it is collaborating with others to verify which of these technical questions have already been addressed by others (e.g. Tc-99 re-oxidation).

The results should be leveraged to other DOE field sites where this type of approach might be applicable.

Budget

The budget seems reasonable considering the full scope.

This project should be prioritized as recommended in the body of the report, even though it has been funded for the outyears already. A Go/No Go review could be held, because of the change in project location.

Enhanced Attenuation for cVOCs in Groundwater
(SRNL – Karen Vangelas and Brian Looney)

Introduction – Objectives and Goals

Summary Objectives

- Further the acceptance of EA for Chlorinated Solvents by regulators and end users.
- Provide technical guidance for selected EA technology design, implementation, monitoring and assessment.
- Advance the development process based on full scale projects performed in collaboration with site owner. *A "Case Study Approach*"

Goals

- 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 project costs at a realistic level – team with real-world remediation projects
- Ensure approaches are consistent with the ITRC developed Decision Flowchart and EA definition.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

In concept, this project has the potential to have significant payback to the DOE. Natural attenuation must be, at least, a component of the remedy for almost all organics sites. This is a follow-on project to the successful MNA of Chlorinated Organics Project.

Sufficient Information

Sufficient information was provided for review.

Fit with Program Goals – Links to Roadmap

In general, the project can contribute to the Roadmap Program Area—
Enhanced Remediation Methods. EA should be a very important component of most remediation strategies.

Metrics

No specific metrics were provided. But detailed deliverables and a schedule were developed.

Deliverables/Products

- Demonstrations
  - Leverage existing efforts
- Design/User Guides
  - Emphasize mass balance and sustainability
  - Supports use of technologies as transition step
- Communication
  - Technical Advances
  - Training – traditional and new approaches

There will be three case studies, each of which will have a user guide and training material developed, as well as some field activities.

Gaps

None identified.

Technology Deployment (Implementability)

This project is well organized, scoped and scheduled. It is a follow-on from the MNA project and uses the same model and lessons learned. Thus, it is likely it will be very successful.

Again, the natural attenuation approach is very applicable and related to the design/engineering of remediation systems.

Collaboration/Leveraging

This project has significant opportunity for collaboration with various groups, many of which have already been identified. The co-PI's worked on the MNA project with the ITRC and they will likely be a big player in this project as well.

Budget

The budget is well thought out and planned.

Chlorinated Organics in the Vadose Zone
(PNNL – Mike Truex)

Introduction – Objectives and Goals

At many sites, current remediation technologies, including soil vapor extraction (SVE), are not effective or are difficult to apply, especially when the contaminant sources are present in heterogeneous subsurface media. Simulations of SVE performance would be useful for designing and implementing an SVE system for remediation of the vadose zone. The project is aimed at (a) contaminant flux estimation to support remediation end point and transition decisions, (b) flux measurements to support decisions and long-term monitoring, and (c) evaluation of how to control flux in the presence of the persistent contaminant sources in the vadose zone. The Hanford Site is selected to accomplish the project goals. The ultimate target for the project is flux estimation, measurement, and control in the deep vadose zone beyond the influence of SVE systems.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

SVE in the vadose zone has been extensively and successfully applied at Hanford. For example, between 1991 and 2006, about 79,000 kg of CCl_4 were removed at the Hanford site using a multiple-well SVE system. Between 1994 and 2006, the pump and treat system removed 10,200 kg of CCl_4 from the unconfined aquifer (White et al., 2008). As you can see, the SVE system removed more contaminants in a shorter time.

The results of field and modeling studies of CCl_4 distribution through the vadose zone and into the groundwater were also reported by Oostrom et al. (2004, 2006, 2007). Numerical simulations were conducted with layered and heterogeneous geologic models to predict the subsurface distribution of CCl_4, using a scalable version of the STOMP-WOA simulator (White and Oostrom, 2006), which solves the multifluid flow and transport equations for conservation of water, oil, and air mass transported through geologic media in the aqueous, NAPL, gas, and solid phases, assuming isothermal conditions. These papers provide useful information for assessing potential vadose zone remediation approaches.

It is not clear to the IPRP how the results of evaluation of contaminant flux associated with application of SVE could be used for assessing risk, cost, and uncertainty reduction using different remediation approaches.

Sufficient Information

The presentation does not provide a sufficient amount of information to assess the technical merits of the project, including the risk, cost, and uncertainty reduction, as well as its applicability at Hanford and other DOE sites.

Fit with Program Goals – Links to Roadmap

In general, the project can contribute to the Roadmap Program Area—Groundwater and Soil Remediation, Technical risk and uncertainties—Modeling to guide cleanup, and

Strategic initiatives—Advanced predictive capabilities (See Table 1 "Summary of DOE-EM Technical Risks and Strategic Initiatives" of the Roadmap).

Taking into account that SVE has already been successfully applied at Hanford, this project can contribute to the development and verification of advanced models that incorporate chemical reactions, complex geologic features, and/or multiphase transport for multiple contaminants in complex environments. However, if prioritizing projects, this project would likely rank lower than many of the others considering that the contaminant is not unique to DOE and successful remediation of the vadose zone has already been demonstrated.

Metrics

Metrics based upon the Schedule of Activities for FY08-10 were provided in the Implementation Plan (Figure 1). The tasks identified herein were not discussed in the presentation.

Deliverables/Products

According to the Schedule of Activities (Figure 1 of the Implementation Pan), the following tasks were scheduled for FY08: WBS Element 2.3.2.2.1—Analysis of methods, WBS 2.3.2.2.2—Monitoring, WBS 2.3.2.2.3—Remediation. The presentation does not provide a clear understanding about the work performed and the deliverables to be produced under these tasks.

The presentation indicates that a manuscript was submitted in FY08, and other manuscripts are planned for FY08-FY10, but no specific references were included in the presentation.

Gaps

No existing methods of assessing the contaminant flux through the vadose zone are reviewed or analyzed in the presentation. For example, the application of tracers and isotopic methods has recently proved to be an effective method for the determination of the contaminant flux in the vadose zone at different sites, including Hanford. No advanced methods of modeling, which were already applied at Hanford (see references) were discussed in the presentation. For example, it is not clear how a 2D modeling approach presented at the review will advance the existing 3D modeling approaches and will lead to risk, cost, and uncertainty reduction.

Technology Deployment (Implementability)

No information is presented regarding the technology deployment.

Collaboration/Leveraging

According to the Implementation Plan, the Hanford carbon tetrachloride plume in the ZP-1 Operable Unit is a prime candidate for this project. Other target sites will be determined by the Technical Working Group, which should enable collaboration and leveraging with other programs and other DOE sites. Collaboration is already planned with the Savannah River Site T-Area activities being conducted under the Enhanced Attenuation Project. It is the opinion of the Review Panel that this project can better contribute to the Remediation Implementation Plan, if presented as a case study showing the effectiveness of SVE at Hanford and other DOE sites.

Budget

FY07-08 investigations were conducted under a very limited budget. The planned budget is insufficient for a full-scale field testing at either Hanford or Savannah River (Implementation Plan, p. 24). The planned FY09-10 budget would be appropriate, if this initiative were developed as a case study for the Advanced Predictive Capabilities and Next Generation Characterization Projects. When this project is prioritized as described in the body of the report, it may score as a lower priority, because of technology development outside DOE (i.e., not a unique DOE problem).

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MSU-ICET Tasks in Support of EM-22 Soil and Groundwater Program

(Long-Term Monitoring of Selected Heavy Metal and Radionuclide Contaminants by Remote Sensing of Associated Vegetation: Yi Su, Fengxiang X. Han and David L. Monts)

Introduction – Objectives and Goals

MSU-ICET is one of the "earmark" programs assigned to EM-22, i.e., their funding is independent of the EM-22 budget. Mississippi State University has established a Center (ICET) that does research to support the DOE EM Program.

The overall goal of this project is to combine remote sensing and bio-sentinel and biomarkers (i.e., vegetation) for cost-effective long-term monitoring. Specific activities include:

- Study the correlations between metal accumulation, physiological changes, and spectral reflectance.
- Search for metal - related spectral signatures for remote monitoring.

MSU capabilities include:

- Spectral range from UV, visible, near-IR, to long-wavelength IR.
- Ground truth study for remote sensing: Leaf structural and spectral study, laboratory set-up, and field study.
- Spectral analysis, vegetation index searching

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

If new methods for long-term monitoring can be developed based upon remote sensing methods, significant costs can be saved. This type of monitoring has applicability at all DOE sites and is especially useful because of the large size of most of the sites. Specific customers include: Oak Ridge and Savannah River Site.

Sufficient Information

The information provided was sufficient to perform a high-level review.

Fit with Program Goals – Links to Roadmap

This project addresses the following DOE needs identified in the Roadmap:

1. Develop Integrated Methods for Long-Term Monitoring selected heavy metal and radionuclide contaminants.

2. Develop Next-Generation Characterization Technologies and Strategies, i.e., sentinels and biomarkers.

Metrics

No metrics were identified for this project by the project team. But project scope for 2008-09 includes:

- continue to investigate the correlations between leaf internal structure changes, accumulated metal concentration in leaves, and leaf / canopy spectral reflectance;
- search for spectral signatures specifically sensitive to selected contaminants;
- combine conventional remote sensing indices, such as NDVI and the specific metal related signature(s), to provide a non-intrusive and continuous long-term monitoring method for the impact and content of selected contaminants in soil and ground water;
- physical and chemical characterization of contaminated soils of selected Oak Ridge and SRS sites.

To support Oak Ridge mercury needs, the following activities are also proposed:

- Possible biogeochemical conditions (pH, Eh, Cl concentrations, presence of organic molecules, and microbial) triggering an increase in mercury solubility and bioavailability in Oak Ridge flood plain.
- The potential effects of soil minerals (Fe/Mn oxides) on oxidation of HgS in flood plain soils.
- Metal uptake mechanisms, such as root uptake of soil contaminant and foliar accumulation from ambient air, toxicity of heavy metals in selected plants.
- Search for the best combination of plant species, soil amendments, and rhizosphere bacteria for high efficient and cost-effective phytoremediation of contaminated Oak Ridge and SRS sites.
- Development of a UV diode laser ringdown mercury detector.
- Characterization of mercury-contained soils and water solutions under simulated situations and evaluation of the system performance in terms of sensitivity, accuracy, and matrix effect.
- System optimization and preparation for field demonstration.
- Field test and technical report.

Deliverables/Products

- Studied the physiological impact of heavy metal and radionuclide contaminants, such as Hg, Cd, Zn, Cu, As, Cr, Cs, Sr, U, etc. in soil and water on various plant species.

- A unique metal-related spectral index was developed and applied with other remote sensing indices.

- A number of papers published in refereed international journals, multiple presentations at DOE and other national / international conferences in the past few years.

Technology Deployment (Implementability)

MSU researchers are working with SRNL researchers to ensure the technology can be practically deployed at DOE sites.

Collaboration/Leveraging

MSU is collaborating with SRNL and will be participating in the 2009 long-term monitoring workshop. If the LTM project is initiated by EM-22, MSU should be integrally involved.

Budget

No information was provided on budget for this project, because of the earmark nature of the funding.

MSE Tasks in Support of EM-22 Soil and Groundwater Program
(Jeff Lefevre)

Introduction – Objectives and Goals

MSE is one of the "earmark" programs assigned to EM-22, i.e., their funding is independent of the EM-22 budget. MSE is an engineering development and testing company and its projects are related to demonstrating at pilot-scale the feasibility of new technologies to determine their efficacy and cost-effectiveness prior to field deployment. MSE presented an overview of EM-related projects, some related to soils and groundwater and others that support other issues, e.g., waste processing, D&D. The soil and groundwater projects included technology evaluations, identification of technologies for pre-treatment of Hg during D&D, demonstration of SP Flux technology (use of electrical potential for monitoring groundwater contamination), development/testing of techniques for lowering methyl mercury levels in fish, water treatment systems for Hg and Tc, and pilot-scale testing of a nano-particle zero-valent iron injection process.

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

Testing at pilot- and field-scales prior to deployment is a critical step in the application of remediation technologies and MSE is well-equipped and located to assist EM-22 in this regard. This level of testing provides important information about feasibility, cost-effectiveness, and technical uncertainty. Because funding MSE is outside EM-22's budget, the cost of these projects is not considered in this review.

Sufficient Information

The MSE presentation covered a broad range of topics (some not directly related to Soils and Groundwater), but did not provide much detail or results on specific projects. The presentation would have benefitted by staying better focused on the Soils and Groundwater Program and its issues and presenting more detailed information in this subject area. Thus, it is difficult to assess the quality of the work performed.

Fit with Program Goals – Links to Roadmap

The projects that related to the Soils and Groundwater Program support the EM-22 program/roadmap and provide assistance in evaluating technologies for implementation.

Metrics

Metrics for success of technology evaluation are ultimately based on whether the evaluation properly predicts the efficacy, costs, risks, etc. While it appears that MSE is well positioned to assist EM-22 in this regard, additional details on technology evaluations and the metrics used for those evaluations would be helpful in reviewing these efforts.

Deliverables/Products

The MSE program produces reports that evaluate technologies and pilot-scale demonstrations that simulate field conditions and how well specific technologies can be implemented for remediation. These are valuable and useful products for EM-22.

Technology Deployment (Implementability)

MSE has worked on or is currently working on implementation feasibility for a number of soil and groundwater technologies including: demonstration of SP Flux technology (use of electrical potential for monitoring groundwater contamination), development/testing of techniques for lowering methyl mercury levels in fish, water treatment systems for Hg and Tc, and pilot-scale testing of a nano-particle zero-valent iron injection process.

Collaboration/Leveraging

MSE has established effective collaborations with EM problem holders (e.g., Hanford, Oak Ridge, Fernald) national laboratories (e.g., ORNL, SRNL, INL, LLNL) universities (e.g., U of OK), private companies (e.g., Redus & Assoc) and other federal agencies (e.g., EPA).

Budget

The MSE budget is independent of EM-22. In FY-07 they received a total of $4M and in FY-08 just under $2M. The projected budget for FY 09 is $4M. Pilot-scale feasibility studies are cost intensive and if thus spent, the MSE budgets are appropriate to this type of scope.

Advancing Integrated Long-Term Monitoring: Implementing a New Paradigm (SRNL- Brian Looney) and Develop Approaches for Integrating Life-Cycle Monitoring Data into Site Models (PNNL-Ann Miracle)

Introduction – Objectives and Goals

These projects appear to be related and will be discussed together.

SRNL- “Develop improved and optimized long-term monitoring systems to document the transition to, and sustainability of, DOE EM containment stabilization and remediation actions.”

PNNL- “Develop advanced computational tools that extend emerging geophysical and biomarker/biosentinel tools; develop advanced computational tools that integrate heterogeneous data sets from environmental monitoring to support multiple lines of evidence for protection of human and ecosystem health; understand needs for data storage, access and archival; provide guidance for incorporating computational tools into life-cycle monitoring for site models.”

Outcomes – Risk, Cost, and Uncertainty Reduction, Applicability

The SRNL presentation provided information on five” technical targets”: ecosystem principles, boundary condition monitoring, perturbation monitoring, built-in engineered diagnostic monitoring technologies and increased use of integrating measurements (remote sensing, geophysics, horizontal wells/trenches. flux, etc.).

Sufficient Information

The presentations lacked detail with respect to outcomes and the ways in which the projects would provide reductions in risk, cost, and uncertainty. Specific information about the potential cost reduction using innovative long-term monitoring approaches should be provided in any presentation.

Fit with Program Goals – Links to Roadmap

While not discussed explicitly, the project appears to link to the Groundwater and Soil Remediation portion of the EM-20 roadmap through the improved sampling and characterization and possibly the advanced predictive capability strategic initiatives.

Metrics

No information was provided on performance metrics that would be used to track the progress and success of the projects.

Deliverables/Products

Additional specifics would have been very helpful in the conduct of this review. Reference was made to a workshop, technical working group, preparation of technical documents and guidance.

Gaps

Not specifically discussed in the presentations.

Technology Deployment (Implementability)

Not specifically discussed in the presentations.

Collaboration/Leveraging

Partnerships with other parties were proposed along with leveraging of funding proposed by PNNL. Participation from earmark technical centers and scientists would be encouraged. Collaboration with EPA, ITRC and others was proposed through a workshop to be held in February. Technical documents would also be developed.

Budget

SRNL – approximately 5 projects at $200K each; test bed $6000K, technical working group $1000K, reporting and collaboration $600K, management $100K. Total $9600K.

PNNL – Project management and Technical Working Group Activities $350K ($60K) Solicitations: $1050K, Report on Guidance for End Users $100K ($100K).

*These projects are proposed to begin in FY09 and the above budgets are simply requests or estimates. The budgets are impossible given the current budget scenario.

APPENDIX B

Independent Program Review Panel Biographies

Dr. James H. Clarke is Professor of the Practice of Civil & Environmental Engineering, Professor of Earth & Environmental Sciences, and Director of Graduate Studies for graduate degree options in environmental engineering, environmental science, and environmental management at Vanderbilt University. He is also a participant in a University Consortium led by Vanderbilt (CRESP). His research interests include risk analysis and risk-informed regulation, investigation, remediation, and long-term management of legacy chemical and radioactive waste sites and assessment of the risks and environmental impacts of conventional and emerging energy technologies and approaches. Prior to joining Vanderbilt University, Jim spent 25 years in private practice leading a nationally known consulting and engineering firm specializing in the investigation and remediation of contaminated sites, risk analysis, and industrial wastewater treatment. Dr. Clarke is a consultant to the Nuclear Regulatory Commission (NRC) Advisory Committee on Reactor Safeguards and was a member of their former Advisory Committee on Nuclear Wastes and Materials. He provides consulting and expert witness services to the private sector and government and serves as a peer reviewer for the USDOE, NRC, U.S. Environmental Protection Agency, the National Academies, and several journals and book publishers. Dr. Clarke received a BA in Chemistry with honors (Rockford College) and a PhD in Theoretical Chemistry (The Johns Hopkins University). james.h.clarke@vanderbilt.edu

Dr. Boris Faybishenko is Staff Scientist in the Earth Sciences Division of Lawrence Berkeley National Laboratory. He has conducted field and modeling investigations of coupled water and air flow and chemical transport (organics, radionuclides, and metals) in unsaturated soils and fractured rock and groundwater related to environmental protection, bioremediation, natural attenuation, long-term monitoring, and optimization of a coupled energy-water system under present-day and future climatic conditions. Dr. Faybishenko has conducted field investigations at several contaminated sites in the USA (Lawrence Berkeley National Laboratory, Berkeley, CA; Lawrence Livermore National Laboratory, Livermore, CA; Idaho National Laboratory, Idaho; McClellan Air Force Base, Sacramento, CA; Yucca Mountain, NV; Hanford, WA) and in other countries—Ukraine, Russia, Uzbekistan, and Argentina. He has authored and co-authored 55 peer-reviewed scientific papers, 11 books and book chapters, and holds 8 patents. He has served as a peer reviewer for US DOE, National Science Foundation, and several journals and book publishers. BAFaybishenko@lbl.gov

Dr. Dawn S. Kaback has more than 30 years of experience in a technical and management role in research and technology development for environmental and energy issues. She has a reputation for successful implementation of innovative solutions for environmental problems for a wide range of problems, primarily focused on contaminated groundwater and soil investigation/remediation. Her work has spanned from research through practical applications, technology assessments, and strategic planning. She has dedicated significant efforts to transfer of innovative technologies from government laboratories to commercial practice and holds three patents for an innovative remediation system for in situ groundwater treatment. Dr. Kaback has provided technical advice for unique environmental problems at numerous DOE sites, ranging from retrieval/treatment of radioactive waste to in situ groundwater treatment. She has successfully demonstrated project management skills through management of multi-million dollar government environmental programs, including six years at the Savannah River Laboratory. Dr. Kaback has served as a technical advisory expert and on numerous expert panels/peer reviews for the DOE, its contractors, and the National Academy of Sciences. She has taught numerous workshops for the National Ground

Water Association (NGWA), served on their Board of Directors, served as an editor of Ground Water Monitoring and Remediation for 10 years, and as editor of Ground Water News and Views. Dr. Kaback has shared results of her work through delivery of more than 50 presentations at various nationally recognized conferences and related venues. She recently received the prestigious Keith O. Anderson Award from NGWA for her continuing service to the organization. dawn.kaback@amec.com

Paul D. Kalb is a Senior Research Engineer at Brookhaven National Laboratory (BNL). He has a bachelor's degree in mechanical engineering from the State University of NY at Binghamton and a master's degree in nuclear engineering from Polytechnic Institute of NY. Paul has been employed at BNL for 28 years and has concentrated his efforts in the areas of hazardous/radioactive waste management, environmental restoration, and health and safety aspects of emerging energy technologies.

His current responsibilities include Division Head for the Environmental Research and Technology Division in BNL's Environmental Sciences Department and Principal Investigator (PI) for programs on waste form development and environmental remediation for the DOE and industry. He is a co-inventor on eight U.S. patents for treatment of waste and environmental remediation. He has served as a member of several national technical support groups on waste encapsulation for the US DOE and EPA, co-authored several books and numerous peer reviewed publications on innovative technologies, and is a member of the Program Advisory Committee for Waste Management Symposia, Inc. kalb@bnl.gov

Dr. Tom Simpkin has 22 years of experience in the areas of site investigation, feasibility studies, remediation planning, remediation design, remediation construction, and remediation operation. He has experience with a large number of remediation technologies, including in situ chemical oxidation and bioremediation. As global remediation practice director for CH2M HILL, Dr Simpkin coordinates technology transfer across the firm and the development of Best Practices for site characterization and remediation. He also leads the efforts of the firm in the development of new tools and new technologies for improved delivery of site characterization and remediation projects.

Dr. Simpkin is currently assisting in the development of a Technical Practices Manual for In Situ Chemical Oxidation. He and others from CH2M HILL are working with Colorado School of Mines in the development of the manual. As part of this effort, the team is presenting short courses on in situ oxidation. Tom.Simpkin@ch2m.com

Dr. Sorab Panday is recognized as a leader in his field, Dr. Panday brings 20 years of experience in water resource analysis and groundwater flow and transport modeling to address a variety of issues including conjunctive surface-water groundwater use and management; hydrogeologic and contaminant plume characterization; remediation, containment, and persistence/attenuation analyses for dissolved contaminants, waste munitions, petroleum products, and volatile organics; radionuclide fate and transport; TMDL implementation; management operations for environmentally sensitive ecosystems; agricultural, industrial, mining and urbanization impacts on flow and water quality; impacts of climate and land use changes on flooding and groundwater recharge; saltwater intrusion in surface and subsurface systems; and water rights/permitting/litigation support. He has conducted and managed hundreds of projects of varying complexity, size and duration, including model development and application;

data, model and document reviews; and expert panel participation. Further, he has provided leadership to projects and staff; developed technical scope and workplans; provided technical training and guidance; conducted project organization, planning and staffing; handled personnel and technical issues; monitored schedule and cost of projects; and maintained effective communication with clients.
Sorab.panday@amec.com