Presentation to
Citizens Advisory Board
Facilities Disposition and Site Remediation Committee

Technology Development Support

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Purpose

Provide the SRS CAB FD&SR Committee with information on DOE HQ groundwater and soil remediation technology programs and interactions, augmenting SRS and national cleanup programs

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Acronyms

ASCEM	Advanced Simulation Capability for Environment Management
Cr	Chromium
CSGSS	Center for Sustainable Groundwater and Soil Solutions
D&D	Deactivation and Decommissioning
DOE-HQ	Department of Energy - Headquarters
EFPC	East Fork Poplar Creek
EM-32	Environmental Management Office of Groundwater and Soil Remediation
ID	Idaho
NAS	National Academies of Science
OR	Oak Ridge
PAs	Performance Assessments
PSVE	Passive Soil Vapor Extraction
S&T	Science & Technology
Sr	Strontium
Tc	Technetium
U	Uranium
WBS	Work Breakdown Structure

Presentation Outline

Technology Challenges and Needs Assessment

EM-32 Groundwater and Soil Remediation Program

- **Strategic Initiatives**
- **Current Budget**

EM-32 Funded Initiatives and Benefits

Applied Field Research Sites

EM Center for Sustainable Groundwater and Soil Solutions at SRNL

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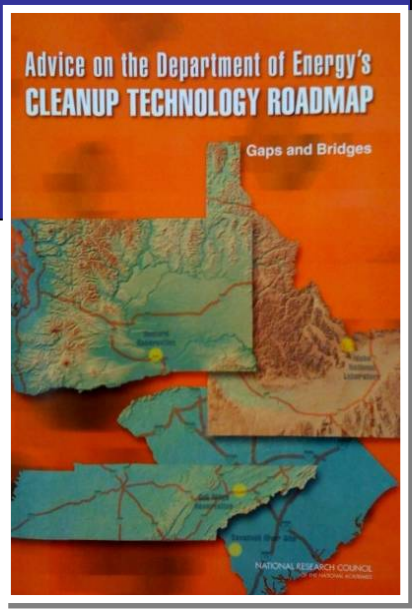
Technology Challenges



- EM Technology Roadmap issued March 2008 (based upon a 2006 national needs assessment; SRS participation)
- National Academies of Science reviewed and validated the EM Technology Program: *Advice on the Department of Energy's Cleanup Technology Roadmap: Gaps and Bridges* (2009)

NAS prioritization of needs for the Groundwater and Soil Remediation Roadmap Area

GS#	Gap	Priority
GS-1	Contaminant behavior in the subsurface is poorly understood	high
GS-2	Site and contaminant source characteristics may limit the usefulness of baseline subsurface remediation technologies	medium
GS-3	Long-term performance of trench caps, liners, and reactive barriers cannot be assessed with current knowledge	medium
GS-4	Long-term ability of cementitious materials to isolate wastes is not demonstrated	high

Solving Highest Priority Site Needs (SRS and National Perspective)

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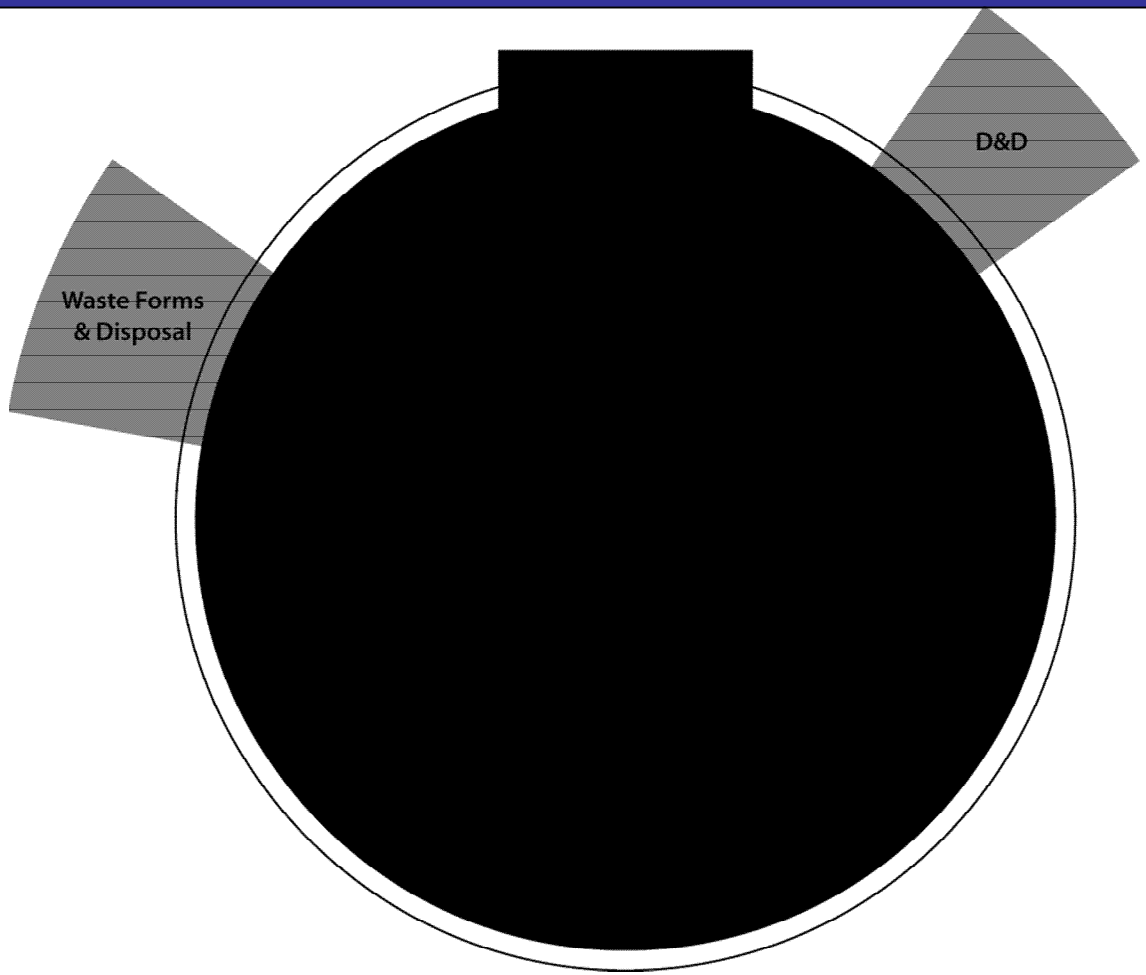
Elements of the EM-32 Groundwater and Soil Remediation Program



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EM-32 Groundwater and Soil Remediation Budget and Benefits

- $15M for fiscal year 2010 for the EM-32 national Groundwater and Soil Remediation Program

- ~$3M provided to SRS for technology initiatives for SRS and national groundwater and soil remediation support activities

- EM-32 Program benefits SRS and multiple other DOE sites:
  - transitioning basic science developments into cleanup solutions
  - importing and exporting technologies and expertise

- Leveraging of basic science, applied science, and cleanup program resources maximizes return on investments

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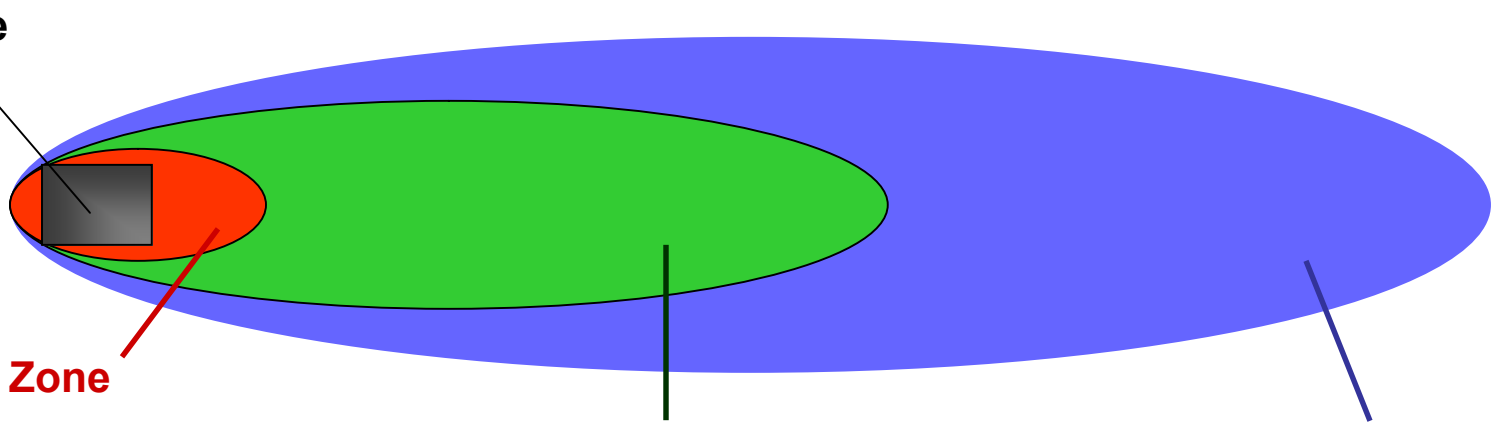
Anatomy of a Contaminated Site



Source Zone

Characteristics:
High concentrations
Significantly perturbed geochemistry

Need:
Aggressive technologies to remove and/or destroy contaminants and limit long-term damage

Primary Groundwater / Vadose Zone Plume

Characteristics:
Moderate to high contaminant concentrations, transitional geochemistry

Need:
Baseline methods or moderately aggressive alternatives to interdict contamination

Dilute Plume / Fringe

Characteristics:
Low contaminant concentrations, large water volume, natural geochemistry

Need:
Sustainable low energy concepts – "Green Technologies"

Matching remediation technologies to the real world is the applied science opportunity and is key to transformational environmental management

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EM-32 Funded Initiative (SRS): Attenuation-based Remedies for Metals and Radionuclides in Groundwater

Challenge

Unless maintenance is performed in perpetuity, all active in situ remedies eventually rely on attenuation-based processes to ensure the health and safety of the public and the environment. However, regulators and stakeholders are reluctant to approve attenuation-based remedies in the absence of the solid applied science required to optimize them and prove their effectiveness.

Solution

Attenuation-based remedies that are sustainable for long time-frames can be implemented to reduce risk through understanding the relation between natural attenuation of contaminants and long-term geochemical evolution of the waste site. This requires new approaches, tools, and guidance.

Accomplishments

- **Field studies to document the geochemistry of the F-Area Seepage Basins Groundwater Unit.**
- **Laboratory and field studies to develop methods to measure key geochemical properties in situ is ongoing.**
- **Development of treatment technologies based on sustainable stabilization of contaminants.**

Impact

- **Sustainable, low-energy approaches to clean up will minimize risk to receptors without removal, excavation, transport and disposal.**
- **Enhances regulator and stakeholder acceptance for attenuation of metals and radionuclides.**

Lawrence Berkeley researcher viewing soil samples from site

Savannah River scientist collecting water samples from wetlands

EM-32 Funded Initiative (Hanford): Advanced Remediation Methods for Metals and Radionuclides in the Deep Vadose Zone

Challenge

- Vadose zone environments serve as sources (^{99}Tc, U, Cr, and ^{90}Sr) and primary conduits for contaminant transport to groundwater.
- Source contamination (^{99}Tc, U, Cr, and ^{90}Sr) is located in tightly packed low permeability zones
- Baseline remedial methods are highly constrained, costly, and inefficient for deep vadose zone environments.

Solution

- Increase scientific and technical understanding of metals and radionuclide behavior in the subsurface environment.
- Introduce innovative remedial & monitoring approaches for in situ delivery, treatment, and monitoring for remediation in deep subsurface environments based on this knowledge.
- Provide framework to gain regulatory concurrence for remediation decisions.
- This action area is leveraging and integrating research being conducted through industry and DOE-SC.

Accomplishments

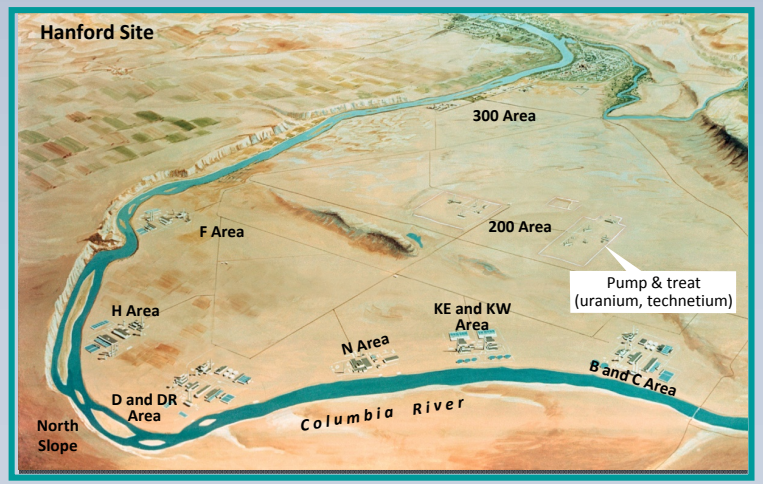
- Reviewed contaminant biogeochemistry, and remediation and monitoring methods, and vadose zone transport.
- Characterization of BC Cribs Site at Hanford to support ongoing geophysical, geochemical, and modeling assessments.
- Transforming foam technology to provide a novel method of delivery for reactive agents to the deep vadose zone.
- Developing advanced monitoring strategies to evaluate remedial implementation and performance.

Impact

- Transform state-of-the-art science and engineering into best-practice technical solutions into remedial strategies for metals and radionuclides in deep vadose zone environments.

Provide:

- Minimally invasive delivery and emplacement methods as viable alternatives to conventional techniques,
- Life-cycle science and technology framework for remedial action decisions on metals and radionuclides in vadose zone environments,
- New approaches to measure, predict, and monitor the long-term impacts of remedial strategies, and
- Reduce overall risk, cost, timeline to bring sites to closure and facilitate regulatory concurrence for remedial decisions.



EM-32 Funded Initiative (SRS and Hanford): Attenuation-based Remedies for Chlorinated Solvents in Groundwater and the Vadose Zone

Challenge

Residual contaminants in low permeability zones continue to produce long-term, low-concentration, secondary contaminant sources that afford a long-term risk to receptors.

Solution

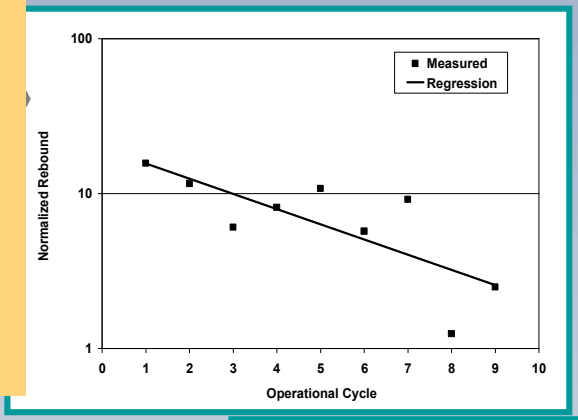
Approaches, tools and technologies that integrate a mass flux-based approach to remediation, fostering transition from "active" treatments to more passive approaches and ultimately achieve cleanup.

Accomplishments

- Regulators and stakeholders accepted a technical framework that integrates enhanced attenuation into the existing regulatory process.
- Completed the first EA user guide providing a means to evaluate the viability of passive soil vapor extraction (PSVE) and assisted PSVE as a transition technology for a waste site.
- Developing an EA approach for residual contaminants using the Savannah River Site T Area as the field demonstration site.

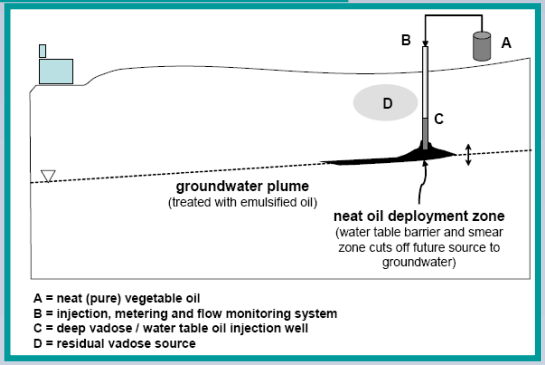
Impact

- Provide a viable path to end pump and treat.
- Technical basis for transition to passive approaches.
- Ability to integrate vadose zone remedies with groundwater goals.



Quantifying Vadose Source Strength Over Time

SRS T-Area Enhanced Attenuation Treatment



EM-32 Funded Initiative (Oak Ridge): Mercury Characterization and Remediation

Challenge

- The ecosystem of East Fork Poplar Creek (EFPC) in Oak Ridge, TN remains contaminated with mercury, despite remedial actions at Y-12 that have reduced mercury inputs into EFPC by more than 90%.
- Spatial subsurface mercury distribution at Y-12 is poorly known, which poses high risk to mercury remediation. The current estimated cost for mercury removal is $1B.

Solution

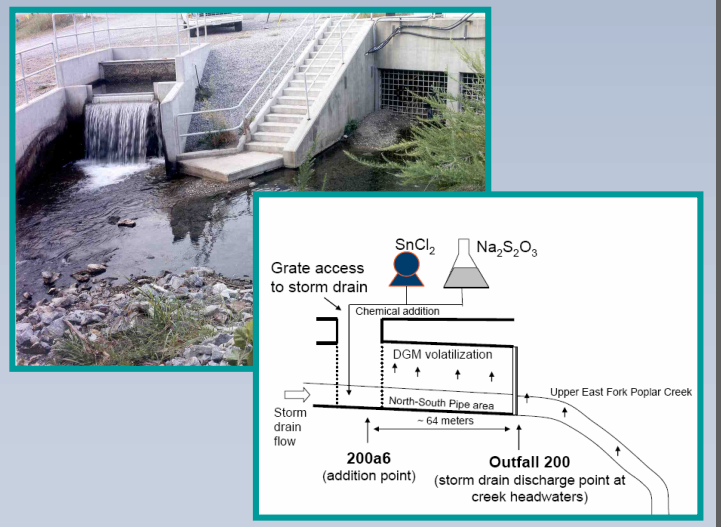
- Conceptual models for mercury in EFPC and Y-12 are being refined to identify highest risk and uncertainty.
- Novel, cost-effective characterization methods are being assessed for site application to assess mercury spatial distribution and hydrological connection between groundwater, the karst system, and streams.
- Innovative approaches are being tested to reduce mercury contamination in EFPC water and to stabilize soil bound mercury.

Accomplishments

- Evaluated current mercury fluxes contributing to stream pollution by working closely with Oak Ridge Operations. Delineated key domains of mercury problems.
- Chemical reduction was implemented to convert aqueous mercury to the volatile form at the headwater of EFPC, further decreasing contaminant input to the creek.

Impact

- Removal of >50% flow augmentation at headwater can eliminate up to 20% of the mercury input to EFPC from the Y-12 site at essentially no cost.
- Refinement of chemical reduction methods for converting mercury to the volatile form has the potential to achieving compliance with the designated uses of EFPC under the Clean Water Act.



Pilot tests in the Y-12 storm drain system, the headwater of East Fork Poplar Creek.

EM-32 Funded Initiative (multiple national labs): Advanced Simulation Capability for Environmental Management (ASCEM)

Challenge

Current performance assessments (PAs) do not always provide realistic estimates of cleanup time and costs due to poor understanding of contaminant fate and transport processes in the subsurface and difficulties in predict long-term performance of engineered barriers.

Solution

Develop an integrated, high-performance computer modeling capability for waste degradation and contaminant release; multiphase, multi-component, multiscale subsurface flow and contaminant transport; and environmental exposure and risk assessment, with systematic uncertainty analyses, to support the next generation of PAs.

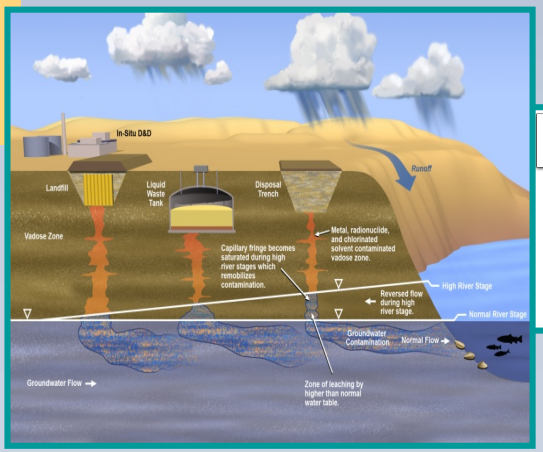
Approach

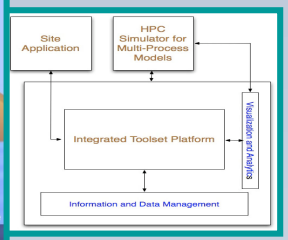
Progress in SciDAC, SBRP, and EFRC (SC) research on subsurface processes; recent advancements in high-performance computing technologies; similar advanced modeling and simulation programs of NE and FE; and RW's total system performance assessment provide essential building blocks and valuable lessons learned for developing ASCEM.

Teaming with SC, NE, RW, and FE as well as other Federal agencies enables full leveraging of existing work for mutual benefits.

ASCEM Description

ASCEM is a state-of-the-art scientific tool and approach for understanding and predicting contaminant fate and transport in natural and engineered subsurface systems. The modular and open source high performance computing tool will facilitate integrated approaches to modeling and site characterization that enable robust and standardized assessments of performance and risk for EM cleanup and closure activities. Use of ASCEM will help EM better estimate cleanup time and costs, and reduce uncertainties and risks.



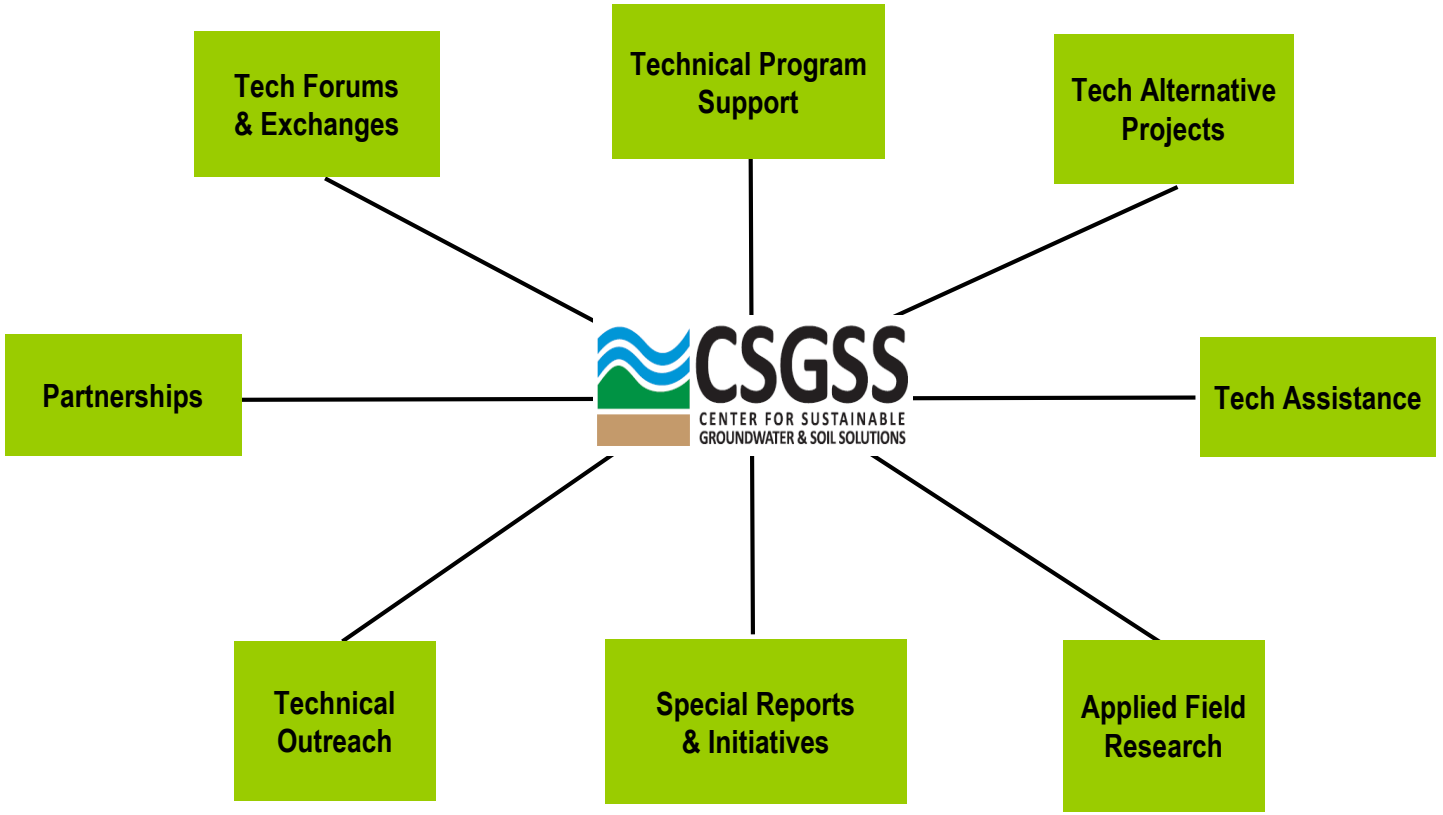


Applied Field Research Sites

Applied field research sites provide a means to investigate and test new concepts and technologies that could enhance or develop new SRS and national cleanup baselines

- **Savannah River Site**
  - **Biogeochemical Processes for Applied Subsurface Science Program at Savannah River, F-Area Seepage Basins**
- **Hanford Site**
  - **Deep Vadose Zone-Groundwater Applied Research Program at the Hanford Site, BC Cribs**
- **Oak Ridge Site**
  - **Characterization and Remediation Program at Oak Ridge, Y-12**

SRNL is the EM Center for Sustainable Groundwater and Soil Solutions



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Conclusions

- Funding provided by DOE HQ (EM-32) complements / enhances the SRS Technology Program
- Advances in cleanup strategies and predictive capabilities (modeling) reduce risk, cost, and time for SRS closures
- EM-32 applied science program provides a link between basic science and cleanup programs
- Leveraging of multiple programs results in the importing and exporting of technology solutions