Reducing Risks and Uncertainties to Environmental Management Projects

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Introduction

- Progress made in EM cleanup mission with completion at Fernald and Rocky Flats; more expected over next few years.
- Nevertheless, challenges for continuing completions across complex needs to address major uncertainties and risks; some large and unique efforts needing untested technologies.
- Life cycle costs increases and schedule delays might arise from performance issues, technical and regulatory issues, emerging scope from programmatic risks, litigation, and other factors.

Objectives

- Establishing a disposition capability for radioactive liquid tank waste and spent nuclear fuel;
- Securing and storing nuclear material in a stable, safe configuration in secure locations to protect national security;
- Transporting and disposing of transuranic and low-level waste in a safe and cost-effective manner to reduce risk;
- Remediation of soil and groundwater in a manner that will assure long-term environmental and public protection; and
- Decontaminating and decommissioning facilities that provide no further value to reduce long-term liabilities while remediating the surrounding environment

New Scope

EM has been identified as the organization to take on additional cleanup work scope from other programs including:

- D&D of additional excess and unwanted science and nuclear security facilities at the Oak Ridge National Laboratory and Y-12.
- D&D of facilities at Argonne, Brookhaven, and other Office of Science national laboratories.
- D&D of facilities at the Los Alamos National laboratory consistent with the 2005 consent Order.
- D&D of excess facilities at the Idaho National Laboratory from the Office of Nuclear Energy.

EM now estimates that the life-cycle cost for the program could increase by $50 billion. Of this increase, approximately $10 billion is attributable to new scope not in EM's previous baseline and $40 billion is associated with existing scope.

Site Closure Schedule

Site	Completion Date (Fiscal Year)
Oak Ridge Reservation	2015
Los Alamos National Laboratory	2015
Portsmouth Gaseous Diffusion Plant	2025
Nevada Test Site	2027
Moab (Note 1)	2028
Paducah Gaseous Diffusion Plant	2030
Savannah River Site (Note 2)	2031
Idaho National Laboratory	2035
Waste Isolation Pilot Plant	2035
Hanford Site; excluding ORP	2035
Office of River Protection (Note 3)	2042

Note 1: The revised end date from 2011 is an estimate, pending validation of the baseline.
Note 2: Revised end date based on current tank waste processing estimates.
Note 3: The new Waste Treatment Plant baseline results in a seven-year delay to site completion

Key Program Issues

- Lifecycle costs
  - New work scope and increased quantities
  - Optimistic assumptions
- Technical
- Regulatory
- Performance vs. plan
  - Post-closure liabilities
- Risk-based priorities and regulatory compliance
- Contractor workforce and skills issues

Solving Cleanup Challenges Through Risk Reduction

EM LEGACY CLEANUP SCOPE		
Material	**Primary Locations**	**Current Disposition Plans**
Nuclear Materials		
Enriched Uranium	Idaho, Hanford, Savannah River Site	Blended down to low enrichment material, then used in fabricating fuel for commercial nuclear reactors
Plutonium	Hanford, Savannah River Site, Los Alamos National Laboratory and Lawrence Livermore National Laboratory	Proposed: Immobilization for disposal at a geologic repository
Depleted Uranium	Portsmouth and Paducah	Conversion of uranium hexaflouride into uranium oxide Disposal of uranium oxide offsite as low level waste
Radioactive Liquid Tank Waste		
Liquid Tank Waste	Idaho, Hanford, Savannah River Site, West Valley	Separation into low activity and high activity waste streams Immobilization (vitrification) of high activity waste for disposal at a geologic repository Immobilization of low activity waste for onsite disposal
Liquid Waste Tanks	Idaho, Hanford, Savannah River Site, West Valley	Disposed in place
Spent Nuclear Fuel and Solid Radioactive Waste in Storage		
Spent Nuclear Fuel	Hanford and Savannah River Site	Package in standardized canisters or Multi-Canister Overpacks, or process into High-Level Waste for disposal at a geologic repository
Transuranic Waste	Multiple Sites	Disposal at Waste Isolation Pilot Plant
Low-Level Waste	Multiple Sites	Disposal on site, Hanford, Nevada Test Site and commercial disposal sites
Contaminated Facilities, Soil and Groundwater		
Nuclear Facilities	Multiple Sites	Decommissioned to the appropriate end state: demolished; entombed; long term surveillance and maintenance; and deactivated/decontaminated for re-use
Radioactive Facilities	Multiple Sites	
Industrial Facilities	Multiple Sites	
Geographic Sites	Multiple Sites	Cleanup to regulatory standards for other uses

Solving Cleanup Challenges Through Risk Reduction

Corporate Performance Measures

	Performance Measure	Projected to be Completed Through FY 2007	Projected to be Completed Through FY 2008	Percent Projected to be Completed Through FY 2008	Lifecycle Total	Units
	Plutonium packaged for long-term disposition	Measure Complete		100%	6,314	Number of Containers
	Enriched Uranium packaged for disposition	6,972	7,192	97%	7,413	Number of Containers
	Plutonium and Uranium Residues packaged for disposition	Measure Complete		100%	107,828	kg Bulk
	Depleted Uranium and Uranium packaged for disposition	11,855	17,116	2%	698,243	Metric Tons
	Liquid Waste eliminated	.7 million	1.4 million	2%	88 million	gallons
	Liquid Waste Tanks closed	5	9	4%	239	Number of tanks
	High Level Waste Packaged for final disposition	2,675	2,861	14%	20,004	Number of Containers
	SNF Packaged for final disposition	2,127	2,127	88%	2,417	MT Heavy Metal
	Transuranic Waste disposed	43,701	54,466	40%	135,353	cubic meters
	Low Level /Mixed Low Level Waste disposed	987,249	1,004,386	76%	1,316,619	cubic meters
	Material Access Areas (MAAs) eliminated	11	11	85%	13	Number of MAAs
	Nuclear Facility D&D Completions	81	82	20%	407	Number of Facilities
	Radioactive Facility D&D Completions	322	337	40%	848	Number of Facilities
	Industrial Facility D&D Completions	1,417	1,560	47%	3,298	Number of Facilities
	Remediation Complete	6,532	6,781	65%	10,470	Number of Release Sites
	Geographic Sites Eliminated	86	89	82%	108	Number of Sites

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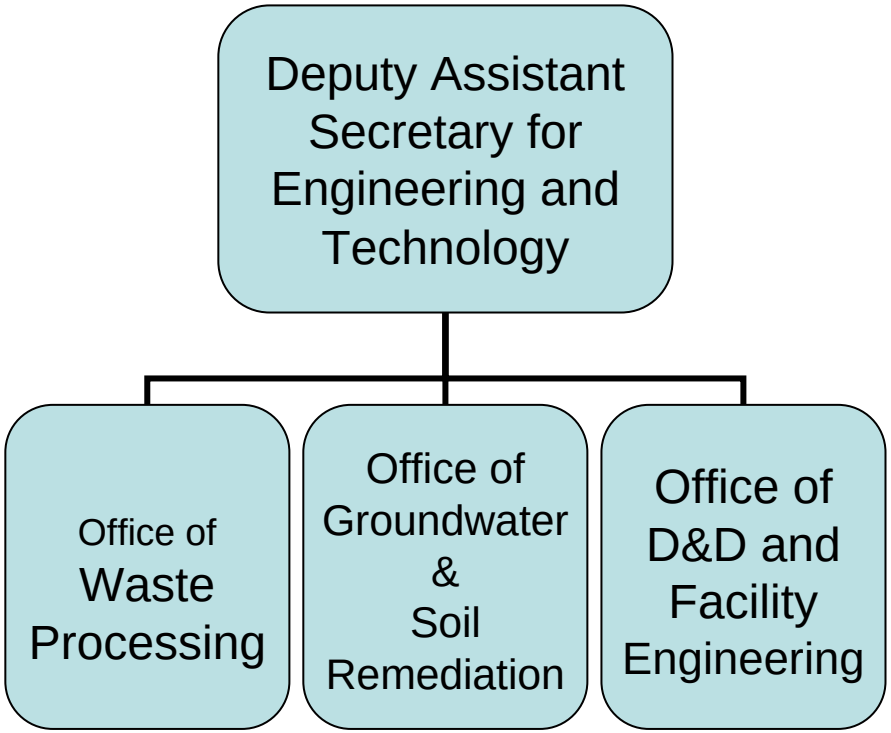


Established to Reduce Technical Risk and Uncertainty in the EM Program

Functions

- Develop policy and guidance
- Assess projects and programs through technical reviews and oversight
- Provide technical assistance and support to the field and other Headquarters offices
- Manage the EM Technology, Development and Deployment Program

Strategic Planning for Engineering and Technology Activities

- Office of Engineering and Technology has a lead role in supporting EM projects by reducing technical barriers and uncertainties.
- Strategic planning and approach
  - Selected critical, high-risk, high-payoff projects
  - Technical workshops and exchanges
  - External Technical Reviews
- Continue close collaboration with national laboratories and universities for innovative technologies and technical exchanges.

Reducing Risks from Technology Demonstrations and Deployments

- EM has been demonstrating and deploying innovative technologies to support its cleanup mission by cost-effective or enabling technologies.
- Non-Destructive Examination/Assay technology at Savannah River will allow for the certification of large container TRU waste to be disposed at WIPP while avoiding worker exposure from opening, characterizing and repackaging; this will result in savings of hundreds of millions of dollars.

Reducing Risks from Technology Demonstrations and Deployments (cont.)

- Advanced Remediation Technologies procurement has awarded twelve technologies for Phase I activities; downselect to Phase II demonstration and deployment efforts for technologies providing the greatest benefit to the Department's cleanup mission.

ART AWARDEES

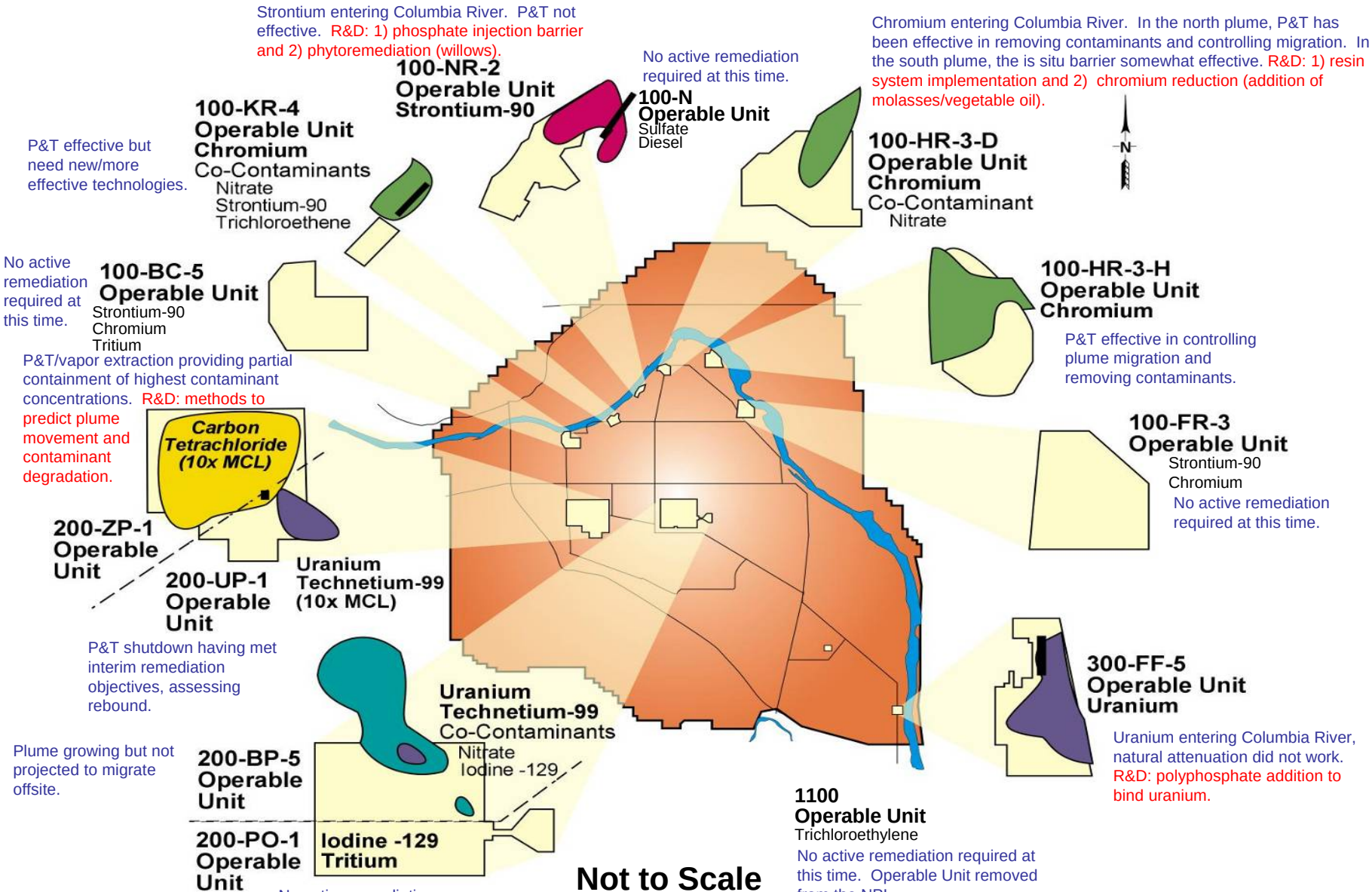
- AREVA (COGEMA) - Cold Crucible Induction Melter
- THOR Treatment Technologies – Steam Reforming
- Parsons – Near Tank Cesium Removal Using Advanced Ion Exchange
- Gas Technology Institute – Submerged Combustion Melting for LAW
- ARES Corporation – Pulsating Pump Advanced Retrieval Technology to SST Hard Heel Removal
- TMR Associates – Tank Removal Technologies (Advanced Water Lance)
- Parsons – Near Tank Continuous Sludge Leaching to Remove Al and Cr from HLW
- ARCADIS G&M – Enhanced Anaerobic Reductive Precipitation/ Enhanced Reductive Dechlorination
- North Wind – High Resolution Resistivity Subsurface Characterization
- Commodore Advanced Sciences – Metal Separations Employing Solvated Electron Technology
- AREVA (COGEMA) – Tank Waste Alumina Recovery
- University of Texas – Advanced Polymer Technology for Containing & Immobilizing Sr 90 in Groundwater

Columbia River Initiative

- Inject Micron-size Iron into Deteriorating Portions of the In Situ Redox Manipulation (ISRM) Barrier
- Field Test Electrocoagulation for Accelerated Cleanup of the Northeastern Plume in the 100-D Area
- Accelerated Bioremediation through Polylactate Injection
- Chromium Vadose Zone Characterization and Geochemistry
- Refine Location of the Chromium Source at the 100-D Area and Support a Geochemical/Mineralogical Study of Chromium in the Vadose Zone
- 100-N Area Strontium-90 Treatability Demonstration Project: Phytoremediation along the 100-N Columbia River Riparian Zone
- Sequestration of Sr-90 Subsurface Contamination in the Hanford 100-N Area by Surface Infiltration of an Apatite Solution
- 300 Area Uranium Plume Treatability Demonstration Project: Uranium Stabilization through Polyphosphate Injection
- Carbon Tetrachloride and Chloroform Attenuation Parameter Studies: Heterogeneous Hydrolytic Reactions

Groundwater Plume Remediation

CERCLA Operable Units



EM WORKSHOPS

- External Technical Review Lessons Learned Workshop – July 24-26, 2007.
- Columbia River Workshop – March 27-28, 2007 in Richland, WA.
- NAS Roadmap Workshop – March 13, 2007 in Washington, DC.
- Aluminum/Chromium Leaching Workshop - January 22-24, 2007 in Atlanta, GA.
- Cementitious Materials for Waste Treatment, Disposal, Remediation and Decommissioning Workshop – December 12-14, 2006 in Aiken, SC.
- Technical Exchange – May 16-18, 2006 in Richland, WA.
- Tank Closure Workshop - March 27-28, 2006 in Atlanta, GA.
- HLW Workshop – January 19-20, 2005 in Aiken, SC.

Project Management Activities

- Elevate level of attention on engineering and technology issues.
- Future ETRs can support Critical Decisions.
  - Tailored Review Process
  - Consistent with DOE M. 413.3-1 (Chapter 9.5)
  - HQ will review charter, statement of work, experts, lines of inquiry

External Technical Reviews as a Valuable Tool to Resolve Risks and Uncertainties

- **High degree of concern for EM projects prompted the use of External Technical Reviews.**
  - **Waste Treatment Plant (WTP) at Hanford**
  - **Tank 48 at Savannah River Site (SRS)**
  - **Demonstration Bulk Vitrification System (DBVS) at Hanford**
  - **Salt Waste Processing Facility (SWPF) at SRS**
  - **Groundwater and Soils Remediation at Hanford and Paducah**
- **Important to organize engineering and scientific expertise through a structured review process to address difficult technical problems or resolving project management issues.**

Recent External Technical Reviews Summary Results

- WTP at Hanford report issued 3/17/06; examined issues related to current flowsheet, identified one issue that could prevent plant operation (line plugging).
- Tank 48 at SRS report issued 8/10/06; assessed the viability of preferred path forward in disposition of tetraphenylborate, confirmed steam reforming as preferred technology.
- DBVS at Hanford report issued 9/28/06; reviewed status of DBVS program in meeting program objectives, no fatal flaws identified.
- SWPF at SRS report issued on 11/22/06; focused on determination if design was technically sufficient to support development of baseline cost and schedule, found that project ready for CD-2 review.
- Remediation systems at Hanford for ZP-1 Operable Unit; evaluation of existing remedial systems will support Feasibility Study for Record of Decision to be provided 5/31/07.

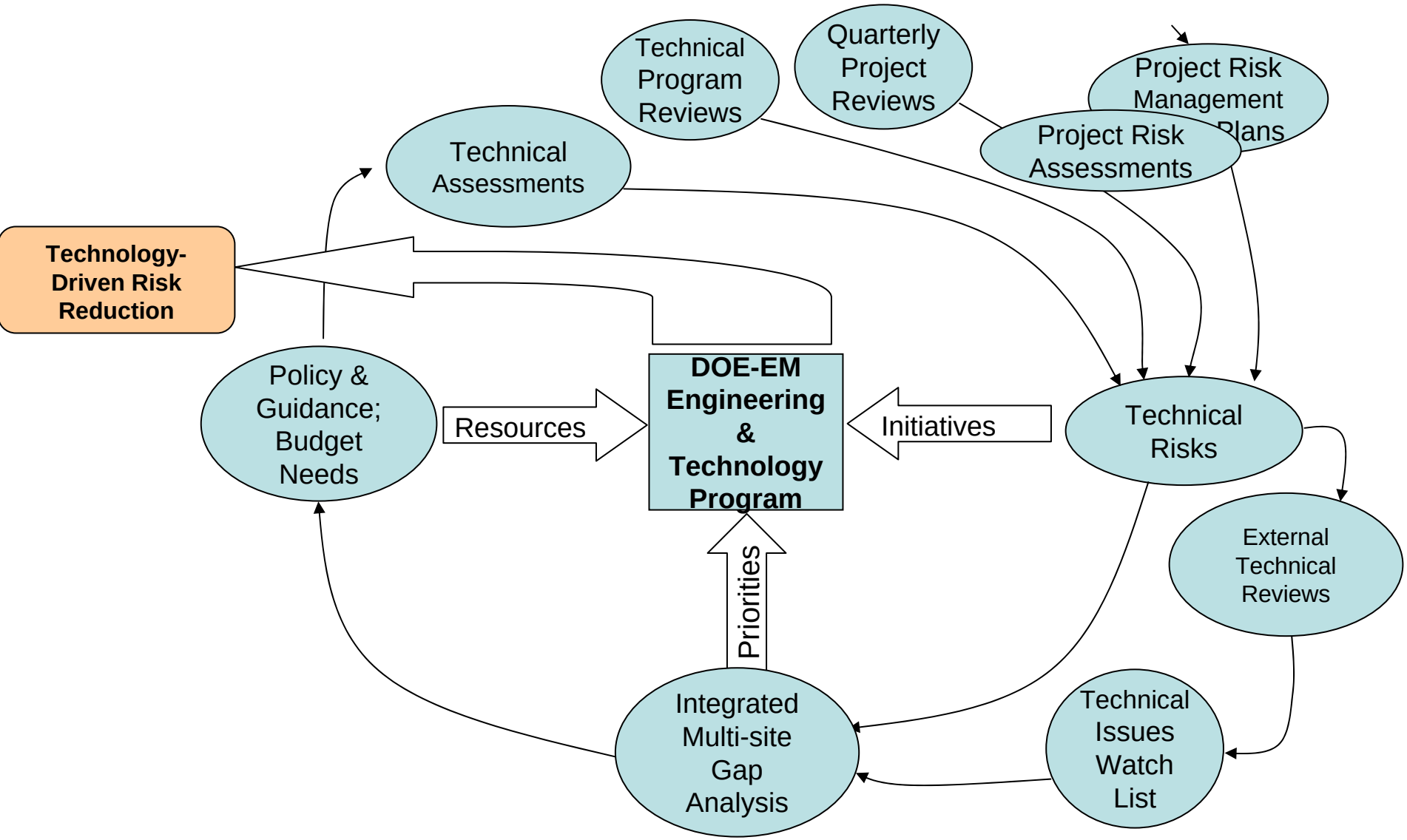
Proposed Future External Technical Reviews (ETR)

- ETRs being considered for FY 2007
  - Plutonium Disposition Plans at SRS
  - Calcine Disposition Project Alternatives at ID
  - High Flux Beam Reactor D&D at Brookhaven
  - West Valley Demonstration Project D&D
  - GDP D&D Project at Portsmouth
  - Groundwater monitoring at Paducah
  - Groundwater monitoring at Hanford

Path Forward

- Incorporate Lessons Learned and Response Plans into EM projects.
- Identify common issues and concerns for technical exchange workshops.
- Communicate with Federal Project Directors to lay out ETRs to support EM Projects Critical Decisions.
- Establish a procedures manual to guide future ETRs.

Office of Engineering and Technology Strategic Approach



Developing a Technology Roadmap to Address Technology Risks and Strategies

- "The Department of Energy (DOE) Strategic Plan is our roadmap to address the energy, environmental, and nuclear security challenges before us. The heart of our plan is founded on innovation through science-driven development of new technologies."
- Congressional Appropriations directed DOE to prepare an EM technology roadmap.
  - **Identifies technology risks**
  - **Strategic initiatives to address risks and expected outcomes when implemented**

Developing a Technology Roadmap to Address Technology Risks/Strategies (cont.)

- National Academy of Science report also recommended a targeted, aggressive, collaborative research program to develop and deploy needed innovative technologies.
- A technology forum held in October 2006 identified significant needs in the areas of Tank Waste Processing, Groundwater and Soils Remediation, and Deactivation and Decommissioning (D&D) which form the basis for strategic initiatives.

Technology Roadmap Status

- Collected risks and uncertainties across DOE complex.
- Strategic initiatives address risks by showing benefits/outcomes of investing in technologies.
- Draft coordinated with Federal staff and senior management.
- Concurrence within DOE and OMB for late March submittal to Congress.

Waste Processing

Technical Risk and Uncertainty

--Waste Storage

- Existing tanks provide limited storage and processing capacity, have exceeded their original design life, and will likely be in service for extended periods of time.
- Conservative assumptions regarding behavior of waste during storage, such as flammable gas generation and venting, restrict operations and increase costs**.**

--Waste Retrieval

- Current waste removal and retrieval operations and monitoring technologies are unreliable and inefficient and are limited by complicated internal tank design (e.g., obstructions) and conditions (e.g., past leak sites).

--**Tank Closure**

- Achieving acceptable levels of residual radioactivity in tanks and immobilization of residual material suitable for final closure has not been fully demonstrated.
- Final closure of a waste management area, including closure of ancillary equipment such as underground transfer lines and valve boxes, has **not been demonstrated.**

--Waste Pretreatment

- Achieving effective separation of low- and high-level wastes (HLW) prior to stabilization requires improved, engineered waste processes and more thorough understanding of chemical behavior.

--Stabilization

- Waste loading constraints limit the rate that HLW can be vitrified, and the tanks closed.
- Current vitrification techniques may require supplemental pretreatment to meet facility constraints**.**

Strategic Initiatives

--Improved Waste Storage Technology

- Develop cost effective, real-time monitoring of tank integrity and waste volumes to ensure safe storage and maximum storage capacity.
- Improve understanding of changing waste chemistry including flammable gas generation, retention, and release and behavior to eliminate conservative assumptions in safety analyses.

--Reliable & Efficient Waste Retrieval Technologies

- Develop optimization strategies and technologies to perform waste retrieval targeted toward successful processing and tank closure.
- Develop a suite of demonstrated cleaning technologies that can be readily deployed throughout the complex to achieve required levels of removal**.**

--Enhanced Tank Closure Processes

- Improve methods for characterization and stabilization (i.e., grouts) of residual materials.
- Develop cost-effective materials (e.g., grouts) and technologies to efficiently close complicated ancillary systems.
- Perform integrated cleaning, closure, and capping demonstrations.

--Next-Generation Pretreatment Solutions

- Develop in- or at-tank separations solutions targeted toward varying tank compositions and configurations.
- Improve methods for separation to minimize the fraction of waste processed as HLW**.**

--Enhanced Stabilization Technologies

- Develop next-generation stabilization technologies to facilitate improved operations and cost.
- Develop advanced glass formulations that simultaneously maximize loading and throughput.
- Develop supplemental treatment technologies**.**

Groundwater and Soil Remediation

Technical Risk and Uncertainty

--Sampling & Characterization

- Current sampling techniques and characterization technologies result in costly, time-consuming characterization programs, leave large gaps in plume delineation, and may lead to selection of inappropriate or inadequate cleanup strategies.
- Incomplete understanding of contaminant subsurface behavior results in long-term uncertainty regarding transport and fate of contaminants and resultant risks to human health and the environment.

--Modeling to Guide Cleanup

- Current models do not adequately represent complex hydrogeology, biogeochemistry and reactive transport. Thus, under complex subsurface conditions, the models may not adequately predict contaminant fate and reactive transport and provide a sound technical basis for optimizing selection, design and implementation of remedies.

--Treatment & Remediation

- In-situ treatment and stabilization technologies provide cost, human health and ecological benefits, but require additional development and demonstration to realize their full potential and be accepted by the regulatory community.
- Ex-situ technologies may be necessary to remove, treat, and dispose of contaminants in certain situations, but current ex-situ treatment technologies can result in high cleanup costs and unacceptable risks to workers.

Strategic Initiatives

--Improved Sampling and Characterization Strategies

- Develop advanced sampling and characterization technologies and strategies for multiple contaminants (organics, metals and radionuclides) in challenging environments (e.g., around subsurface interferences, at great depth, in low permeability/porosity zones, etc).
- Leverage basic and applied research to gain a better understanding of contaminant behavior in the subsurface and to provide defensible prediction of risk.

--Advanced Predictive Capabilities

- Develop advanced models that incorporate reactive transport, complex geologic features, and/or multiphase transport for multiple contaminants (organics, metals and radionuclides) in challenging environments to provide an improved technical basis for selecting and implementing remedies.
- Determine mechanisms and rates of mass transfer-limited release of contaminants from low porosity/permeability zones.
- Develop models that integrate data from various monitoring forms to design long-term monitoring systems

--Enhanced Remediation Methods

- Develop, demonstrate and implement advanced in-situ and ex-situ methods which reduce costs, increase effectiveness and reduce risks to human health and the environment.
- Improve understanding of in-situ degradation of chlorinated organics and immobilization of radionuclides and metals to facilitate development and use of advanced, cost-effective in-situ technologies and use of natural processes.
- Provide the technical basis for use of monitored natural attenuation (MNA) of organics, radionuclides, and metals in the subsurface, including use of MNA in conjunction with other methods (e.g., barrier technology)
- Develop safe, cost-effective strategies to handle legacy materials in historical waste sites and methods to treat and remediate these materials.

Deactivation & Decommissioning (D&D) and Facility Engineering

Technical Risk and Uncertainty

--Characterization

- Limited techniques for detection, quantification and localization of penetrating radiation, radioactive contamination (e.g. Pu, U, tritium), chemicals (asbestos, beryllium, metals, organics, caustic and acidic solutions, lead paint), and biological contaminants (mold, dead birds and rodents, and animal feces) increase the risk of personnel exposure to hazardous conditions.

--Deactivation, Decontamination, and Demolition

- Hazardous conditions involving radionuclides, heavy metals, and organic contaminants result in worker safety issues and lead to use of cumbersome personal protective equipment and D&D approaches.
- Inadequate historical knowledge of past operations and contamination (and other hazards) drive conservative and costly D&D approaches.

--Closure

- End-state requirements for D&D of process facilities are not adequately defined.

Strategic Initiatives

--Adapted Technologies for Site-Specific and Complex-Wide D&D Applications

- Develop and deploy improved characterization and monitoring technologies for detecting and quantifying penetrating radiation, radioactive, and biological contaminants.
- Develop and deploy improved deactivation, retrieval, size-reduction, and stabilization technologies that provide adequate personal protections and effectively achieve end-state requirement.
- Develop and deploy advanced remote and robotic methods to rapidly access and assay facilities to determine optimal D&D approach.
- Establish the scientific and technical basis for end-state conditions to satisfy federal, state, and local stakeholders

Integration and Cross-Cutting Initiatives

Technical Risk and Uncertainty

--Assessing Long-Term Performance

- Inadequate fundamental understanding of wasteform performance and contaminant release, transport, and transformation processes result in inadequate conceptual models potentially leading to selection and design of non-optimal remedial actions.
- Inadequate long-term monitoring and maintenance strategies and technologies to verify cleanup performance could potentially invalidate the selected remedy and escalate cleanup costs.

Strategic Initiatives

--Enhanced Long-Term Performance Evaluation and Monitoring

- Develop increased understanding of long-term wasteform performance integrated with transport of contaminants to support broad remedial action decisions and cost-effective design and operation strategies.
- Develop and deploy cost-effective long-term strategies and technologies to monitor closure sites (including soil, groundwater and surface water) with multiple contaminants (organics, metals and radionuclides) to verify integrated long-term cleanup performance.