A/M Area Groundwater Cleanup
Status Update

A Presentation to the
Citizens Advisory Board

Chris Bergren

Project Manager

Savannah River Nuclear Solutions

Upper Three Runs and Reactors

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Acronyms

DOE	Department of Energy
DUS	Dynamic Underground Stripping
ERT	Electrical Resistance Tomography
RCRA	Resource Conservation and Recovery Act Permit
SCDHEC	South Carolina Department of Health & Environmental Control
SVE	Soil Vapor Extraction
VOCs	Volatile Organic Compounds
VOS	Vadose Oil Substrate

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Agenda

- A/M Area Remediation History
- Cleanup Progress
- A/M Groundwater Remediation Framework
- Technology Application – examples
- New Technologies
- Path Forward

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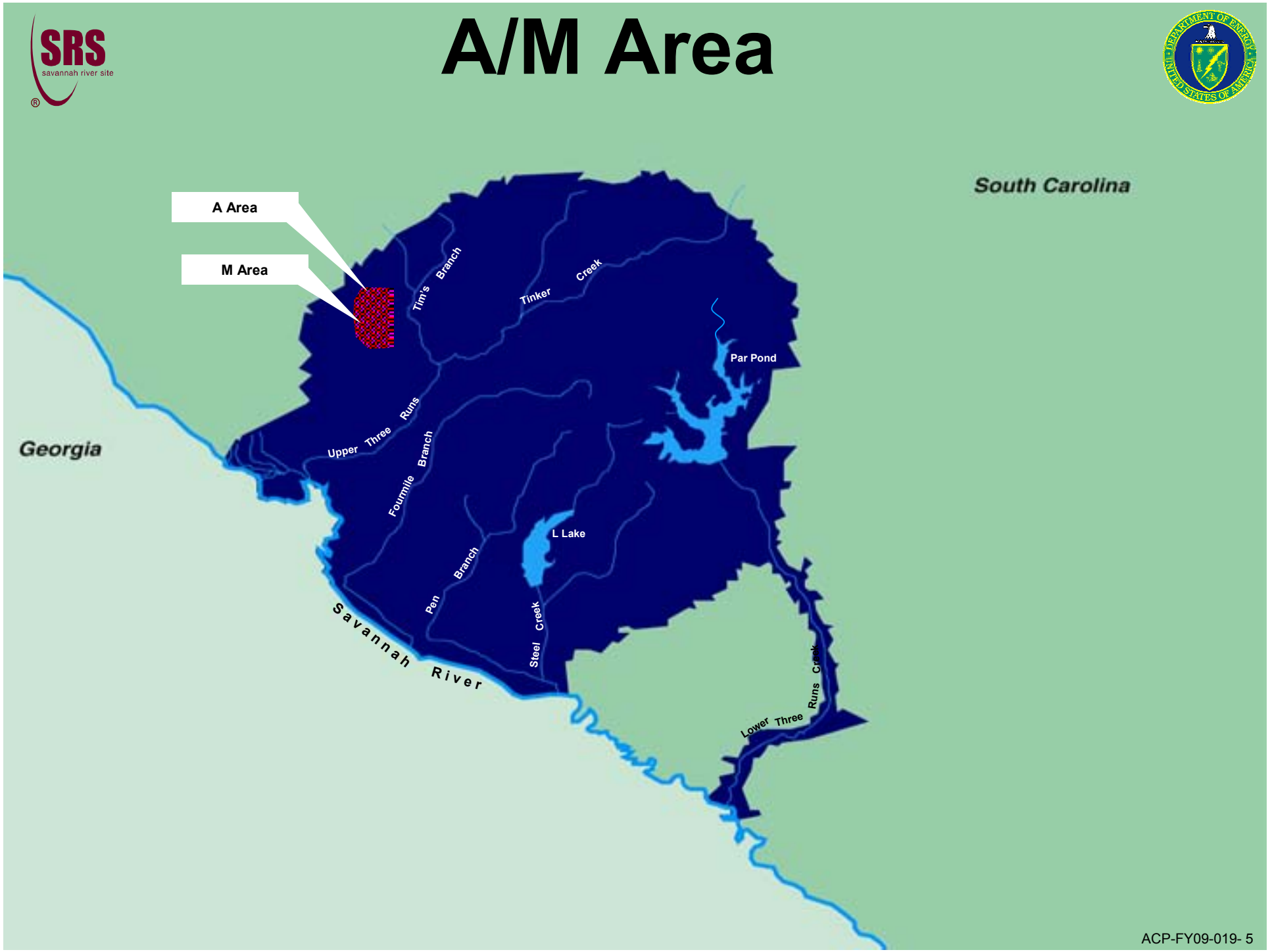
Purpose

- **Provide an update on the A/M-Area Groundwater remediation to the Citizens Advisory Board**

A/M Area


A Area
M Area
South Carolina
Georgia
Tim's Branch
Tinker Creek
Par Pond
Upper Three Runs
Fourmile Branch
L Lake
Pen Branch
Steel Creek
Savannah River
Lower Three Runs Creek

Remediation History of A/M Area

- 3.5 million pounds of solvents released to multiple sources that seeped into soils and groundwater (1950s to 1980s)
  - Large contaminated groundwater plume approximately 1500 acres
  - Contained to SRS; no offsite contamination
- Cleanup is conducted under South Carolina Department of Health & Environmental Control (SCDHEC) Resource Conservation and Recovery Act Permit (RCRA) - issued in 1987
- Multiple treatment technologies in use, include:
  - Airstripping
  - Soil vapor extraction
  - Recirculation wells
  - Dynamic Underground Stripping
  - Baroballs
  - Microblowers

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Remediation History of A/M Area
(continued)

- **Groundwater remediation efforts refocused over time:**
  - **Early: Plume control**
  - **Today: Source removal**
- **Over 4.8 billion gallons of groundwater treated; 1.4 million pounds of solvents removed from the subsurface since 1983**

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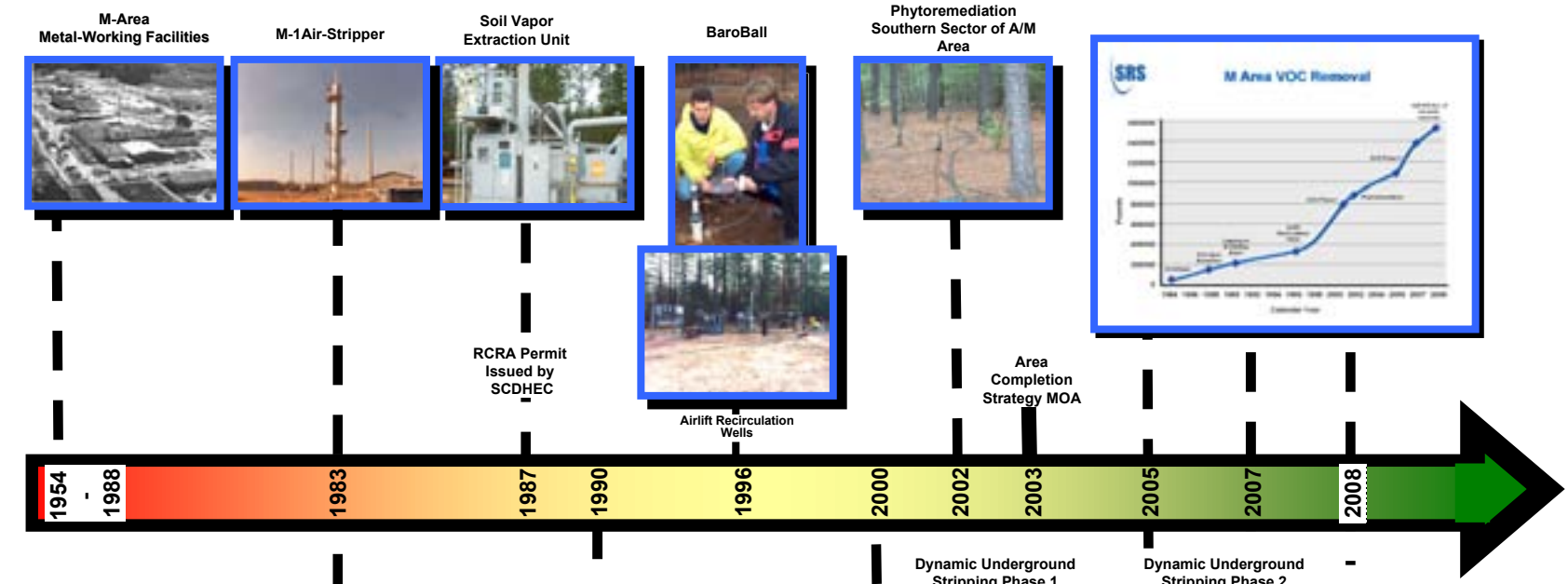
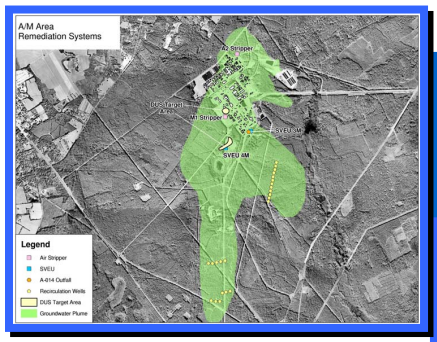
M Area Historical Timeline





A/M Area Plume - 1500 Acres

M Settling
Basin

Lost Lake

Sludge Removal

Capping

Dynamic Underground
Stripping Phase 1

Dynamic Underground
Stripping Phase 2

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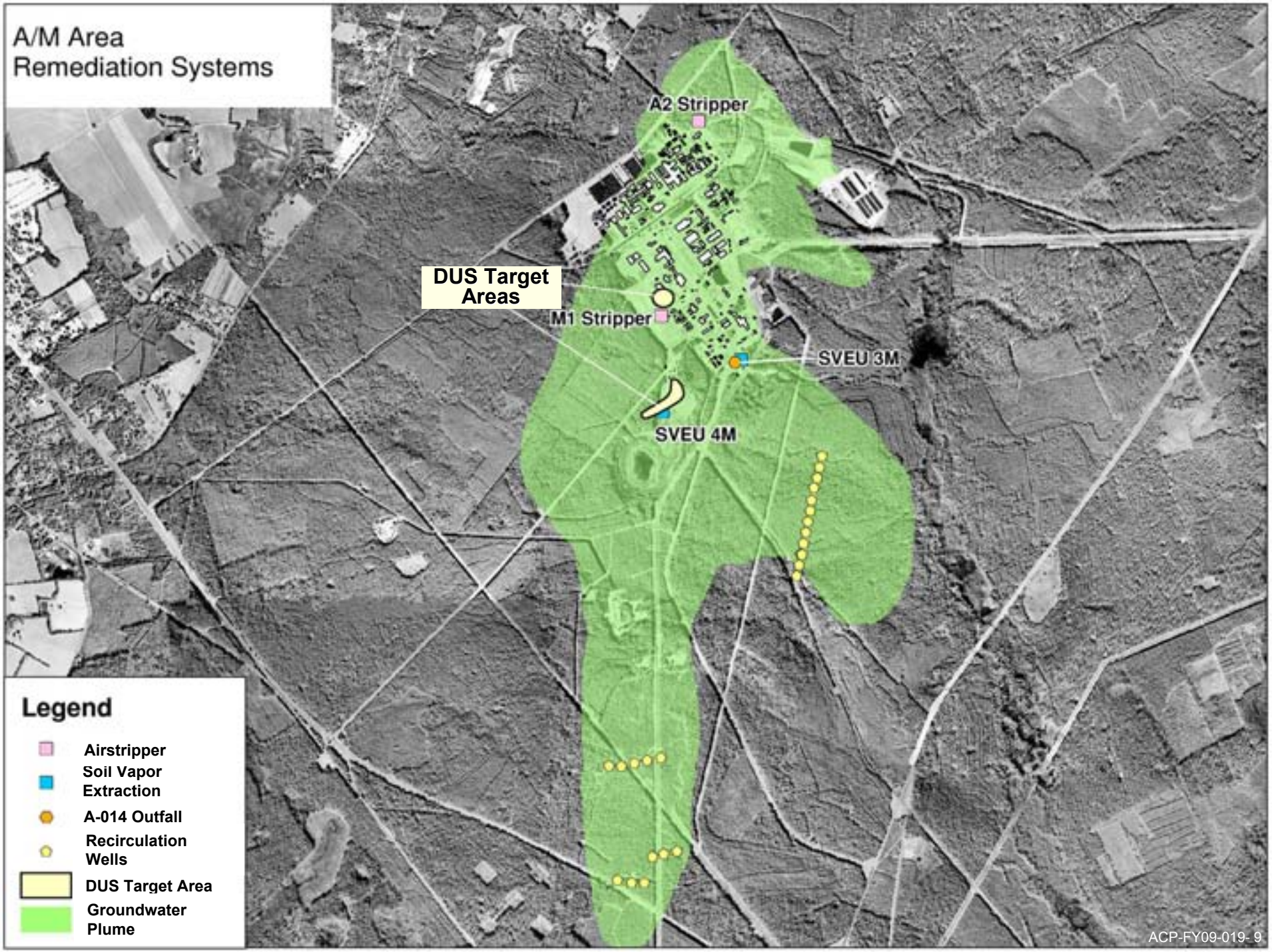
A/M Area
Remediation Systems
A2 Stripper
DUS Target Areas
M1 Stripper
SVEU 3M
SVEU 4M
Legend
Airstripper
Soil Vapor Extraction
A-014 Outfall
Recirculation Wells
DUS Target Area
Groundwater Plume
ACP-FY09-019- 9

A / M Groundwater Remediation Framework

- Protect groundwater from further degradation
- Reduce plume migration minimizing impacts to:
  - Surface water
  - Deeper groundwater
  - Ecological community
- Focus on source remediation, including vadose zone
  - Significant reductions in time to reach cleanup goals
- Optimize groundwater projects to improve remediation effectiveness

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A / M Groundwater Remediation Framework
(continued)

- **Develop and implement alternative remediation technologies**
  - **Transition from active remediation systems to passive processes as contaminant concentrations decrease**
- **Monitor effectiveness of remediation systems to determine if necessary changes or enhancements are needed or possible**
- **Optimize groundwater monitoring to reduce long-term costs**
- **Conduct all groundwater activities with regulatory involvement and approvals**

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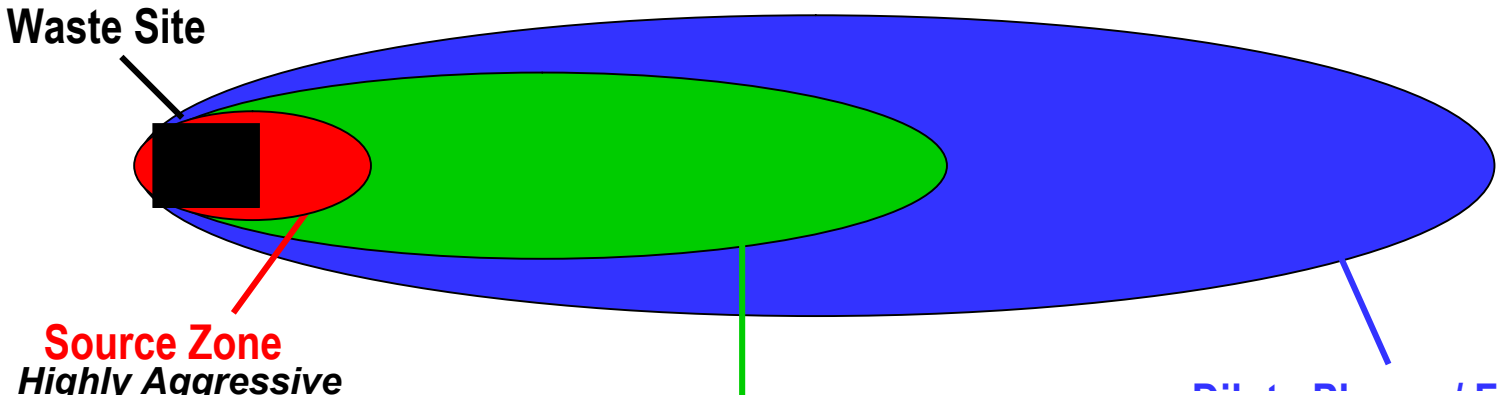
Remediation Strategy

Treating a Contaminated Site



Highly Aggressive Technologies:

Excavation

Heating (Dynamic Underground Stripping or Electrical Resistance Heating)

In situ chemical oxidation

Active Soil Vapor Extraction

Less Aggressive Active Technologies:

Air stripping

Recirculation wells

Hydraulic barrier / Phyto-irrigation

Base injection

Low Energy Technologies:

Phytoremediation

Passive Soil Vapor Extraction (baroballs)

Monitored Natural Attenuation

Enhanced Attenuation alternatives can apply to all zones to supplement Monitored Natural Attenuation (MNA):

Capping, Oil Partitioning | Permeable Biotreatment Wall | Constructed Wetland

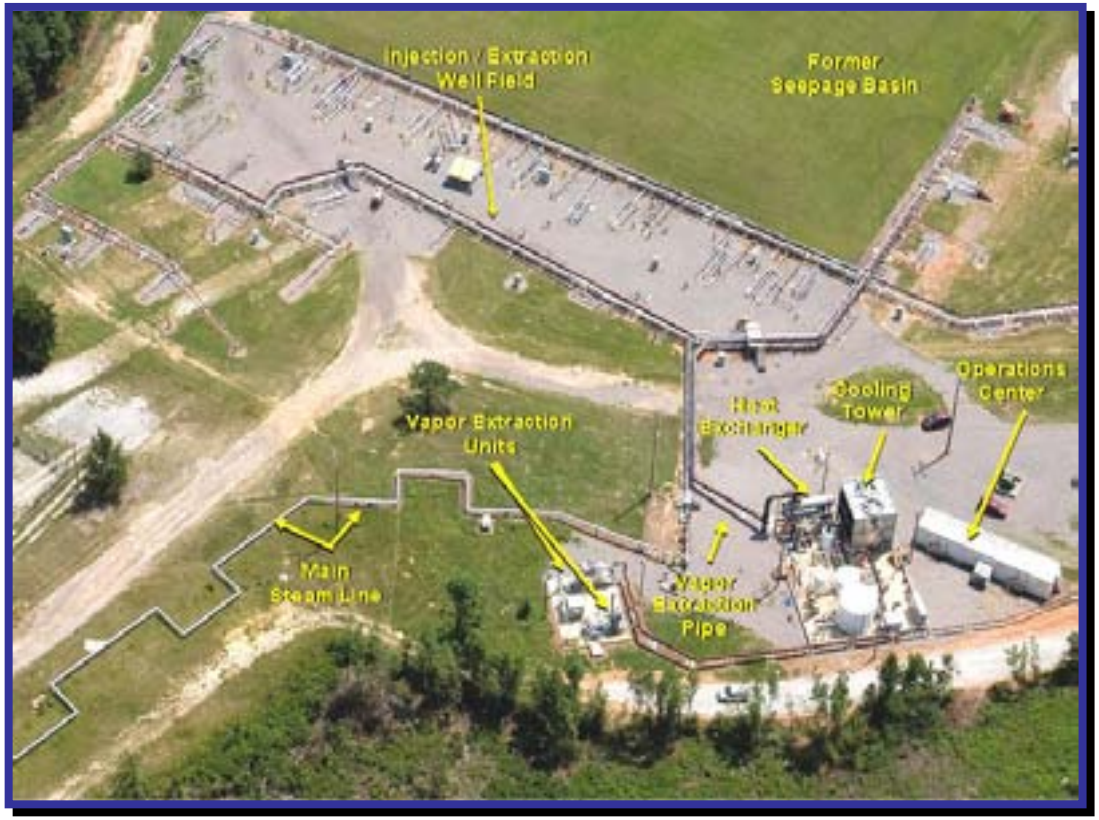
Highlighted technologies above represent those being utilized at A/M Area

Technology Application - Examples

- **Source Remediation**
  - **Dynamic Underground Stripping**
- **Passive Systems**
  - **Baroballs**
  - **Microblowers**

Dynamic Underground Stripping at the M Area Settling Basin

- Utilizes steam to heat / vaporize solvent contaminants
- 12,000,000 cubic feet targeted over three acres, to depths of 160 feet
- Over 425,000 pounds of solvents removed to date
- Significant reduction in time to reach cleanup goals (75 times faster than pump and treat)



Originally used by the petroleum industry for secondary oil and gas recovery

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Dynamic Underground Stripping
(continued)

- Steam is injected into subsurface
- VOCs captured by extraction wells and brought to the surface
- Utilize horizontal and angled wells to access contaminants
- Subsurface probes monitor heating progress
- Greatly accelerates groundwater cleanup

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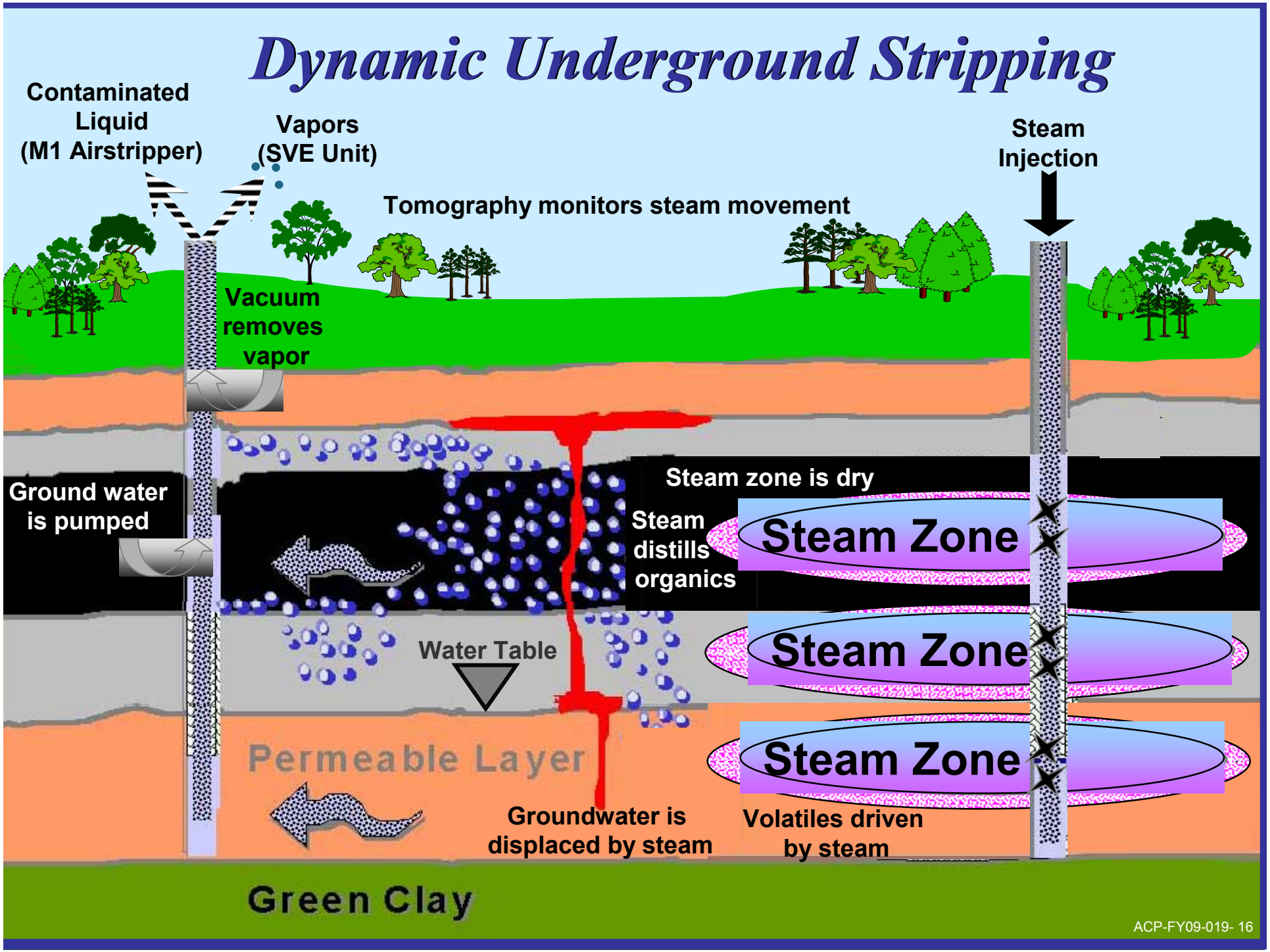
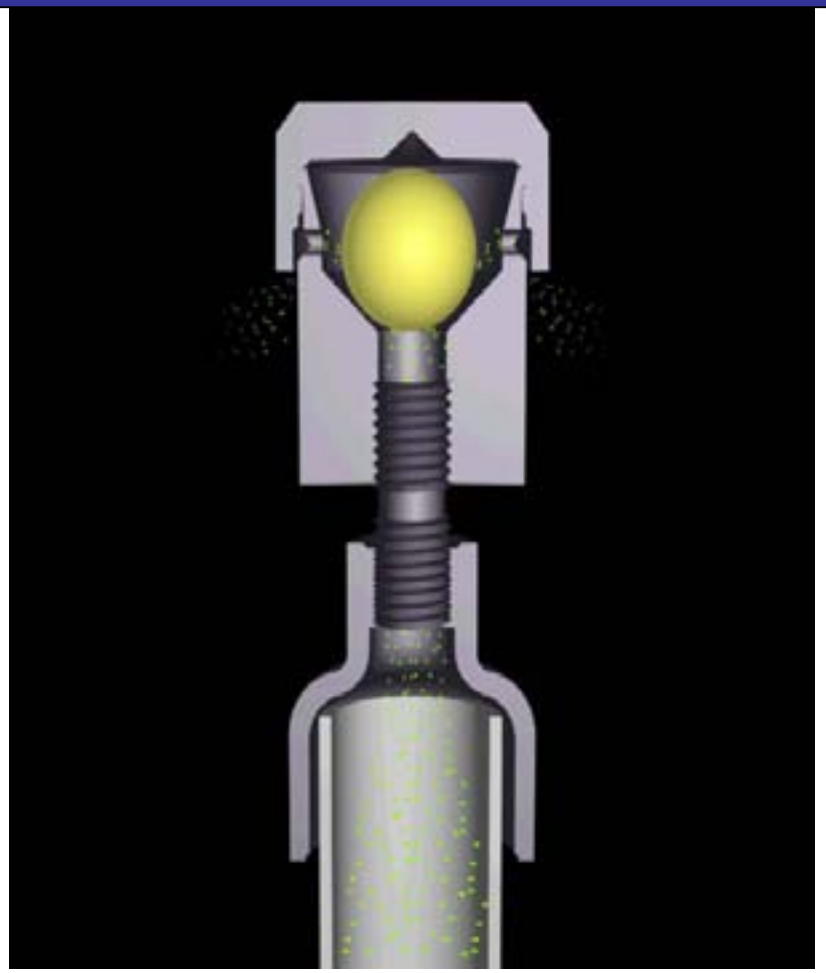

Dynamic Underground Stripping
Contaminated Liquid (M1 Airstripper)
Vapors (SVE Unit)
Steam Injection
Tomography monitors steam movement
Vacuum removes vapor
Ground water is pumped
Steam zone is dry
Steam distills organics
Steam Zone
Steam Zone
Steam Zone
Water Table
Permeable Layer
Groundwater is displaced by steam
Volatiles driven by steam
Green Clay
ACP-FY09-019- 16

Baro Ball



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Microblower

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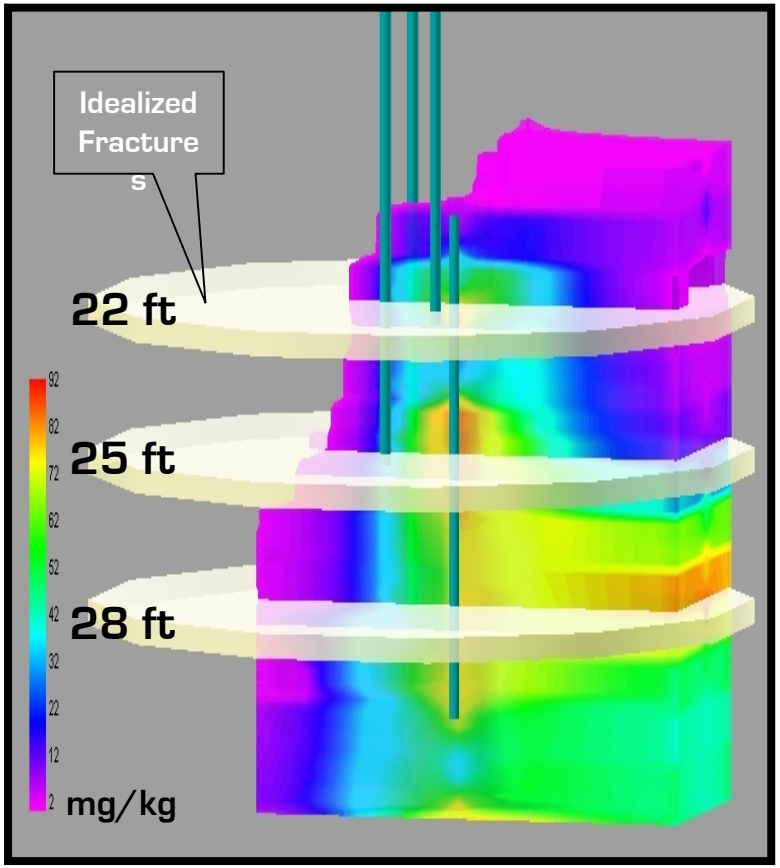
New Technologies

- **Soil Fracturing to enhance Soil Vapor Extraction (SVE)**
- **Edible Oil Induced Partitioning and Degradation in the Vadose Zone (passive replacement of SVE)**

Soil Hydraulic Fracturing



- Deployed in 2008
- High pressure "notching" of formation initiates fracture (vadose zone)
- Inject sand, water, and guar slurry into formation
- Creates horizontal fractures with radius approximately 10 ft.; fractures can be made at any depth
- SVE flow rates increased by an order of magnitude

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Fracturing

Soil notching using a high pressure jet – initiates fractures horizontally

Mixed guar/sand slurry loading into the pumping hopper

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Proposed Vadose Oil Substrate (VOS) Field Test (Injection Location)

- VOS (patent pending) is a mixture of edible oil and water with nutrients, buffers and microbes
- Designed to be easily injected in the vadose zone
- VOS sequesters the solvents by diffusion and partitioning and creates an efficient bioreactor for degradation for long-term enhanced attenuation and flux reduction

Path Forward

- Continue to explore application of new technologies
- Aggressively pursue remedial optimization

Active → Passive → Natural

- Continued monitoring to ensure protectiveness of human health and environment is maintained