U.S. DEPARTMENT OF ENERGY | Savannah River Site

Citizens Advisory Board
Facilities Disposition & Site Remediation
Committee Meeting

Area Completion Projects

New Technologies on the Horizon

Presentation By
CHRIS BERGREN
PROJECT MANAGER
AREA COMPLETION PROJECTS
Savannah River Nuclear Solutions, LLC

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List of Acronyms

DOE	Department of Energy
Ft	Feet
FY	Fiscal Year
I-129	Iodine-129
MicroCED	Micro-organism Chloro-Ethene Dechlorination
MSL	Mean Sea Level
PCE	Tetrachloroethylene
PPB	Parts Per Billion
PPM	Parts Per Million
SRNL	Savannah River Nuclear Solutions
SRS	Savannah River Site
TCE	Trichloroethylene
VOCs	Volatile Organic Compounds

Agenda

- **Purpose**
- **Overview of SRS Groundwater Strategy**
- **New Technologies**
  - **Source treatment** (high contaminant concentration)
  - **Intermediate treatment** (moderate contaminant concentration)
  - **Distal / low contaminant treatment** (low contaminant concentration)

Purpose

- **Provide an overview of SRS technology selection criteria with examples of new / emerging technologies**

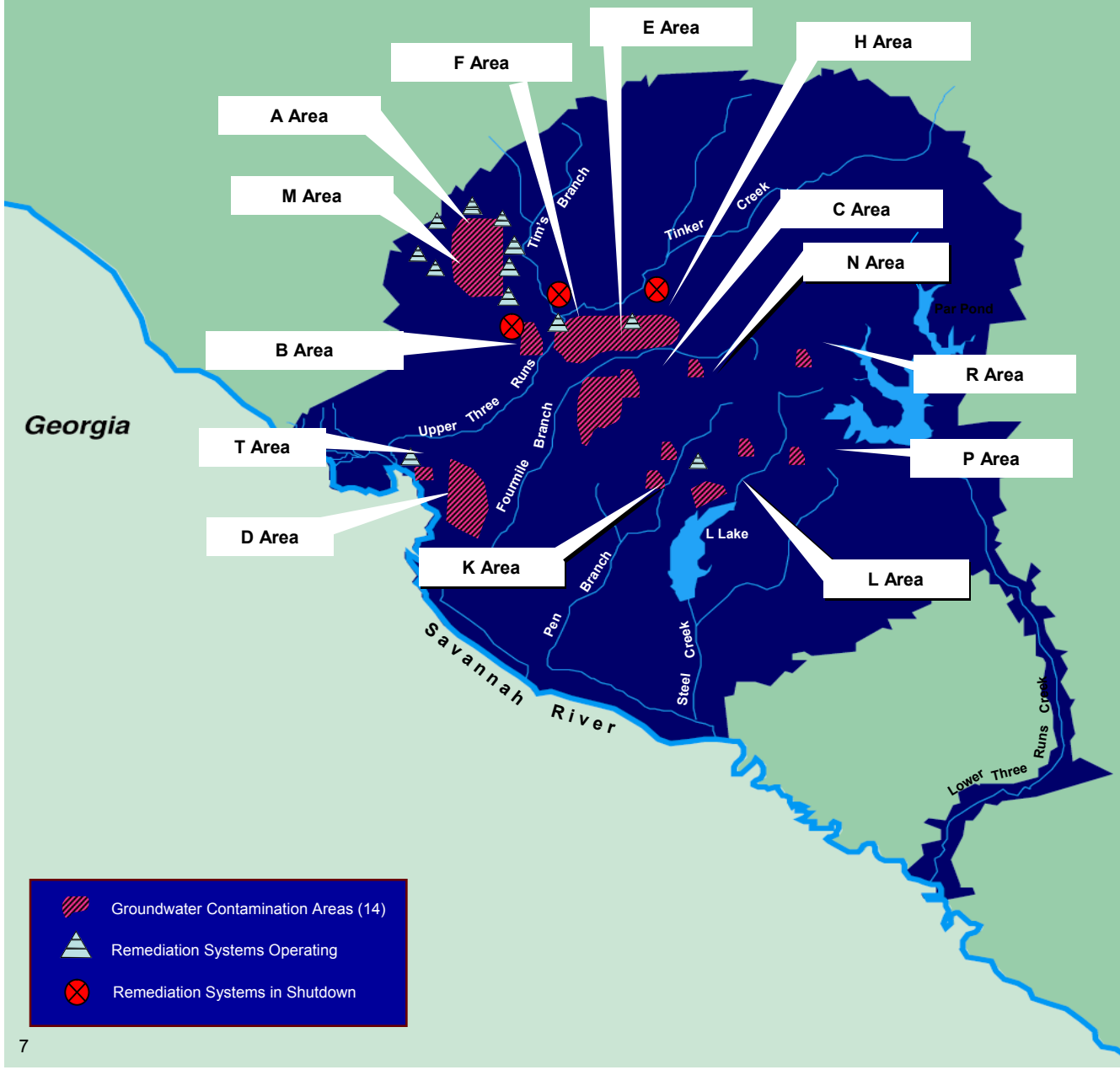
SRS Groundwater Strategy

- **Over the last 15 years, the SRS cleanup strategy has evolved into a mature and successful program recognized within the Department of Energy as a leader in environmental remediation. SRS selects remediation technologies that:**
  - **Remediate the worst first (high risk)**
  - **Are customized to the problem**
  - **Focus on source contamination**
  - **Are cost effective**
  - **Meet regulator and stakeholder expectations**
  - **Can be deployed within a needed timeframe**

Overview of Groundwater Conditions

- **Mature Groundwater Program**
- **All known / suspect plumes identified**
  - **14 Groundwater Contamination Areas**
    - **11 active**
    - **17 enhanced**
    - **9 passive**
    - **3 shutdown**
    - **4 pending final decisions**
- **Remedial actions ongoing since the mid-1980s**

Savannah River Site
Groundwater Contamination Areas



14 Groundwater Contamination Areas
A/M, F, H, G, B, T, E, P, L, K, C, N, R, and D Areas

11 Active Remediation Systems
Airstrippers (2), **Recirculation** (2), **Dynamic Underground Stripping, Soil Vapor Extraction Units** (A/M - 4), **Airstripper** (TNX), **Base Injection** (F-Hazardous Waste Management Facility)

17 Enhanced Systems
Baroballs {A/M, Miscellaneous Chemical Basin, P- and A-Burning Rubble Pits, Chemical, Metals, & Pesticides Pits - Field B, M-Area Inactive Process Sewer Lines (2)}
Microblowers {A- and C-Burning Rubble Pits, M-Area Inactive Process Sewer Lines (2), and Miscellaneous Chemical Basin}
Barrier walls (F&H Hazardous Waste Management Facility)
Phytoremediation (Mixed Waste Management Facility)
Edible Oil (T Area)
Silver Chloride Injection (F-Hazardous Waste Management Facility)

9 Passive Systems
Monitored Natural Attenuation (Chemical, Metals, & Pesticides Pits; D-Oil Seepage Basin; R-Reactor Seepage Basin; K-, C-, P-, and L-Burning Rubble Pits, Sanitary Landfill, and L-Area Southern Groundwater)

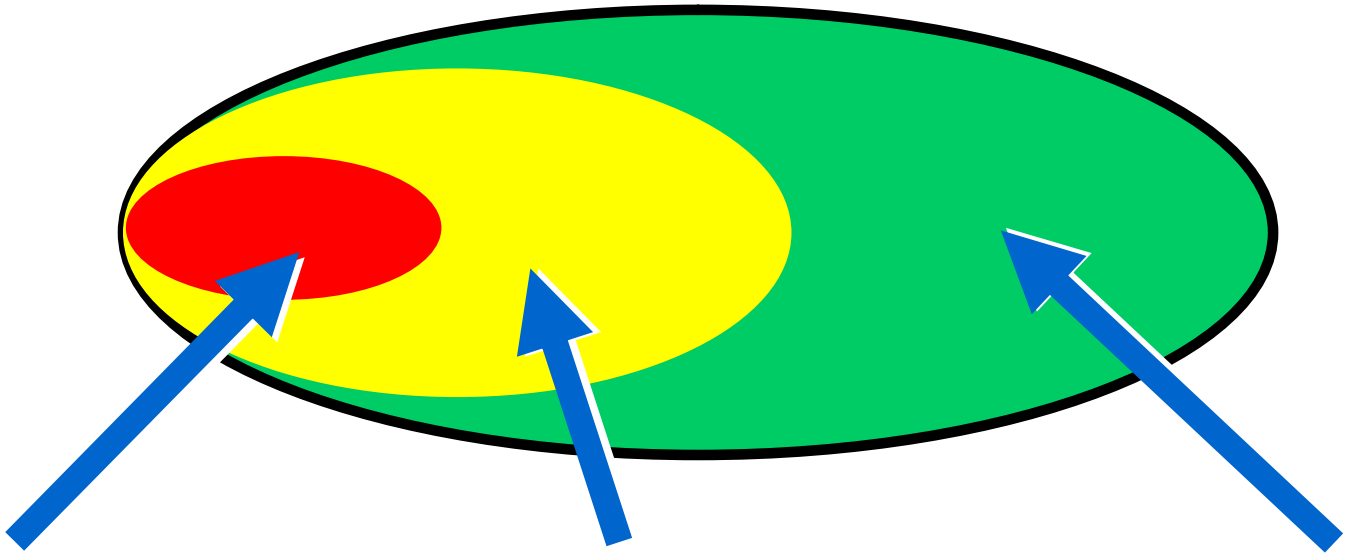
3 Systems In Shutdown
Biosparge (Sanitary Landfill)
Groundwater Waste Treatment Units (F&H)

4 Systems Pending

Technology Deployment

- Develop and implement alternative technologies
- Regulator support using innovative technologies
- Allows SRS to evaluate technology effectiveness in the field
  - Technologies developed specifically for SRS
  - Technologies "borrowed" from industry
- Serves as "proving ground" for future implementation
- Successful history of sharing technologies with regulators, industry, and other federal facilities

Remediation Strategy / New Technologies



Source Area

Physical Processes:

- Thermal Detritiation
- Chemical Oxidation

Primary Plume Zone

Biological Processes:

- Edible Oil Injection
- MicroCED

Dilute Plume Zone

Polishing Steps:

- I-129 capture with silver material
- Solar SVE MicroBlowers

MAXIMIZE RISK REDUCTION - PROTECT THE SITE BOUNDARY

New Technologies / Source Area

- **Chemical, thermal, and physical processes**
  - **Thermal Detritiation at D Area**
  - **Chemical Oxidation of Volatile Organic Compounds (VOCs) at A-14 and P Area**

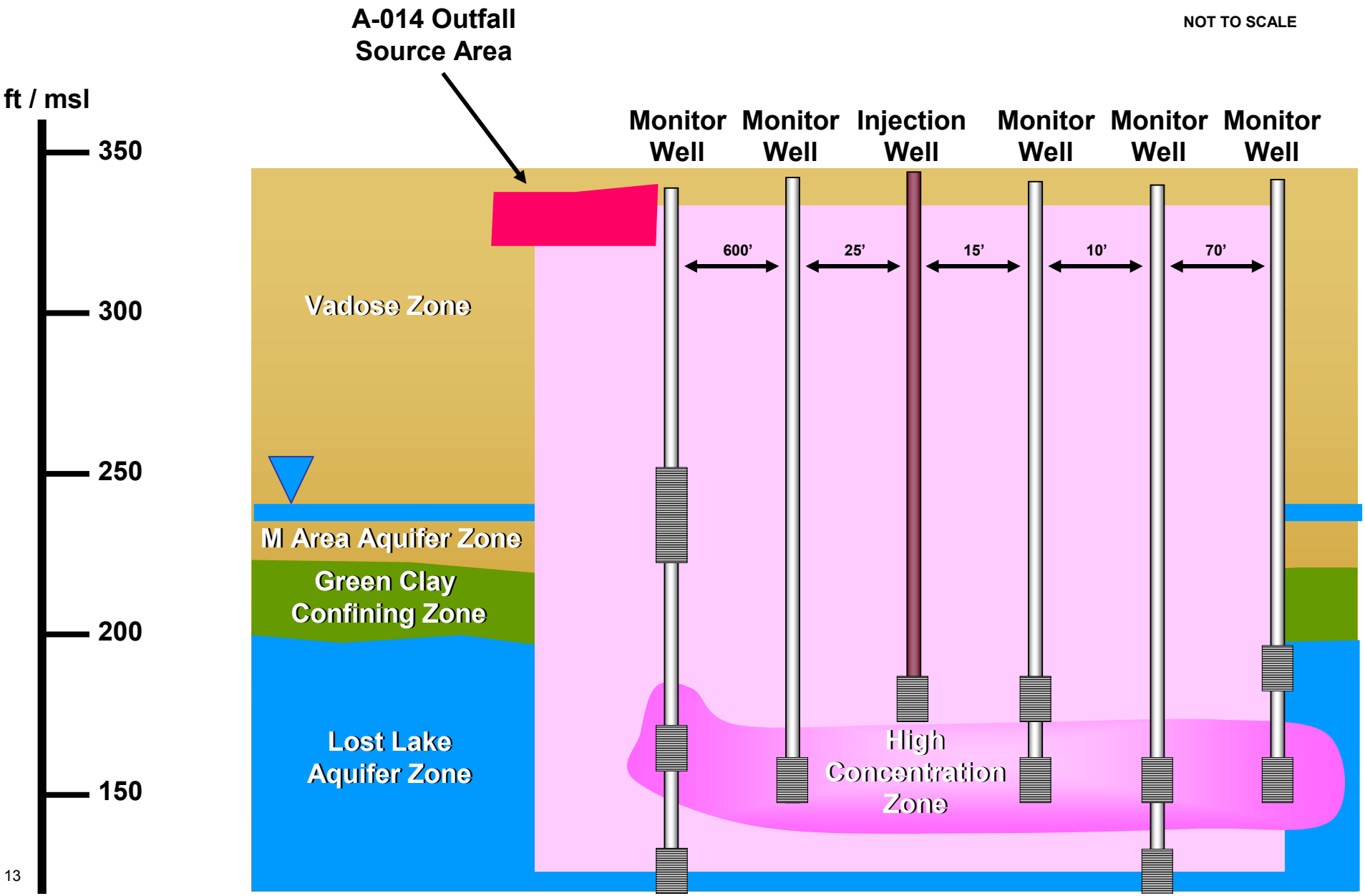
D Area Operable Unit - Thermal Detritiation Pilot

- Approved Treatability Study Plan to treat tritium contaminated concrete
- Thermal Treatment Unit consists of concrete block walls, electrical heating elements, and roof structure
- Loaded 77 cubic yards of tritium contaminated concrete and soil (45 Curies) from 420-D slab
- Maintained 815 degrees Celsius for 30 days to drive tritium from concrete
- Post operational testing underway
- Offers potential cost savings alternative for treatment / burial of tritiated media elsewhere at SRS and the DOE Complex

Chemical Oxidation

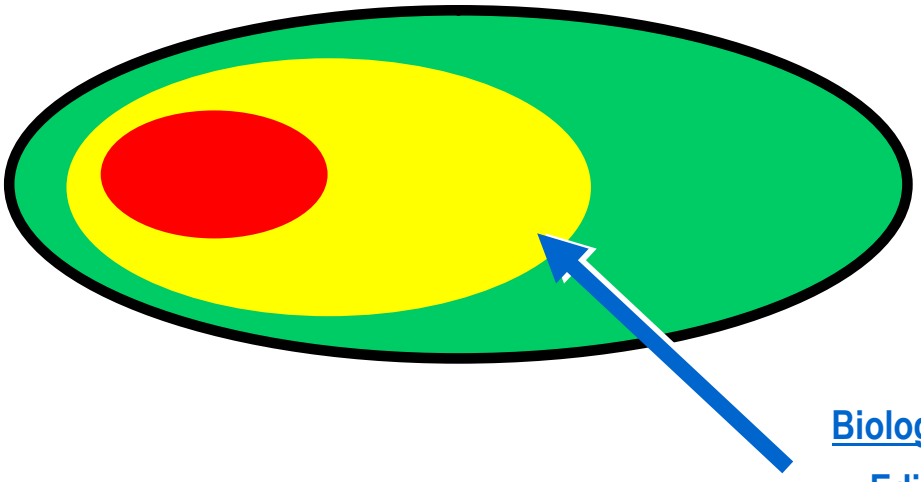
- In situ technology to remediate solvents within vadose zone / aquifers
- Previously demonstrated in M Area using hydrogen peroxide (over 98 percent destruction)
- New deployments in A and P Areas will utilize sodium persulfate
  - Safer
  - Less toxic byproducts (carbon dioxide, sulfate, chloride, sodium, hydrogen ions)
  - Longer lasting (treatment time)
  - Bench scale results were positive
- Partnering with experienced commercial vendor
- A Area deployment (aquifer)
  - Inject approximately 9250 pounds of sodium persulfate (5000 gallons)
  - Inject in small batches over one-week period
  - Monitor groundwater concentrations over time

Chemical Oxidation with Persulfate at A-14 Outfall



Primary Plume Zone

- **Biological Processes**
  - **Edible Oil Injection at T Area**
  - **MicroCED at P Area**



Primary Plume Zone

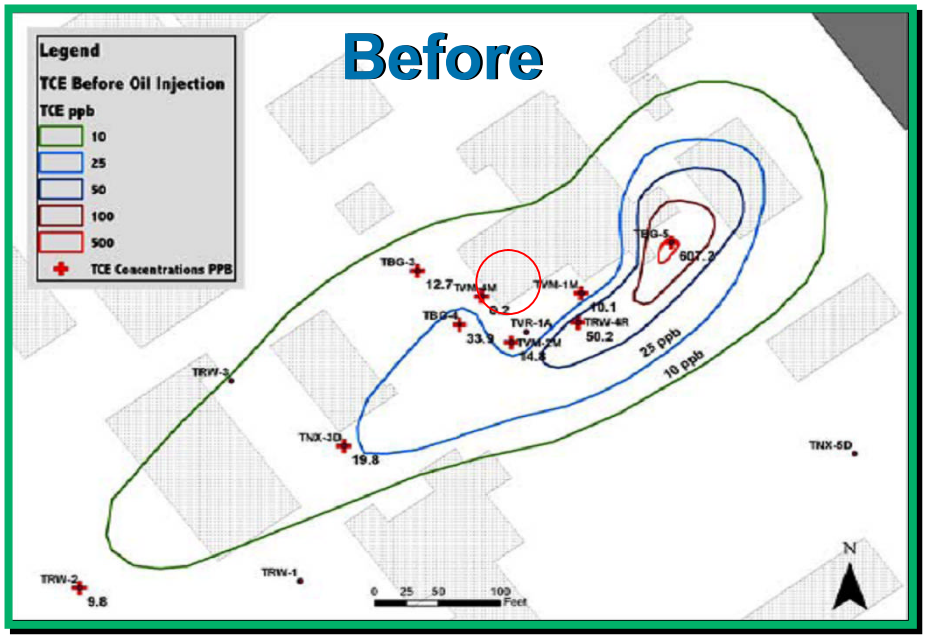
Biological Processes:

- **Edible Oil Injection**
- **MicroCED**

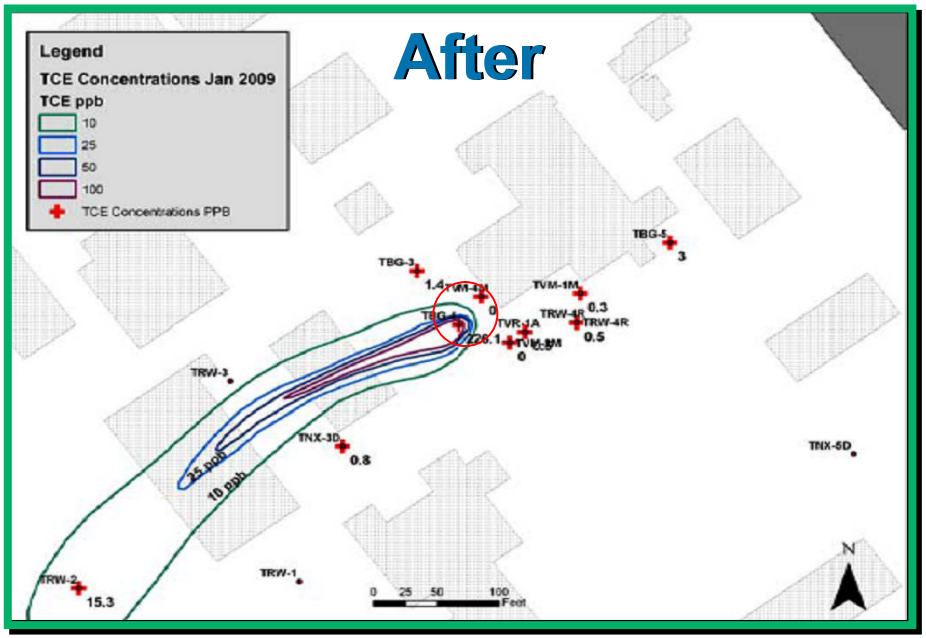
Edible Oil Deployment

- Recently deployed in T Area to remediate solvent contaminated groundwater
- Promotes enhanced attenuation
  - Aquifer becomes anaerobic, initiating reductive dechlorination
- Positive test results
  - Solvent (TCE) plume size decrease
  - Biological / chemical parameters confirm reductive dechlorination is occurring (i.e., methane generation)
- Allows shutdown of existing pump-and-treat system

T Area Edible Oil Injection



Plume before oil injection



Plume after oil injection

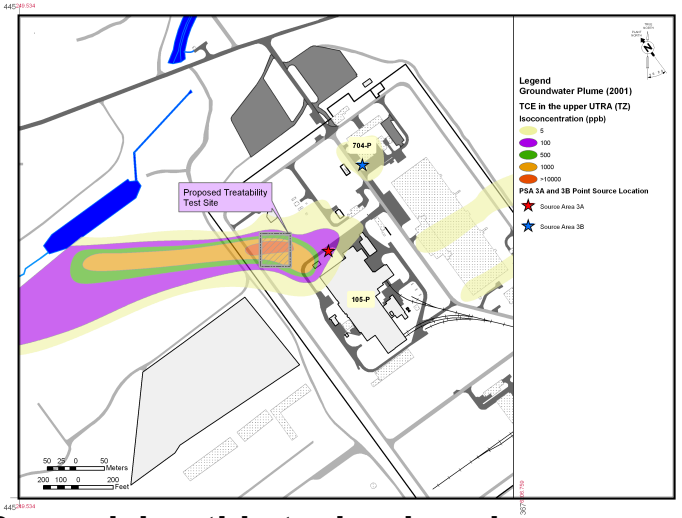
Future Technology Development - MicroCED

- **What is MicroCED?**
  - **Micro-organism Chloro-Ethene Dechlorination**
  - **Indigenous bacteria discovered at SRS**
  - **Robust, highly active dehalogenating culture**
  - **Injected into the subsurface to promote bioremediation of solvents**

MicroCED Deployment Test: P-Area Groundwater

- Previous operations resulted in groundwater being contaminated with trichloroethylene (TCE) and tetrachloroethylene (PCE)
- Groundwater plume is long and narrow; flow is relatively slow
- High concentrations {17-22 parts per million (ppm)} near the source zone
- Groundwater depth is less than 50 feet
- Evidence of limited dechlorination associated with natural attenuation

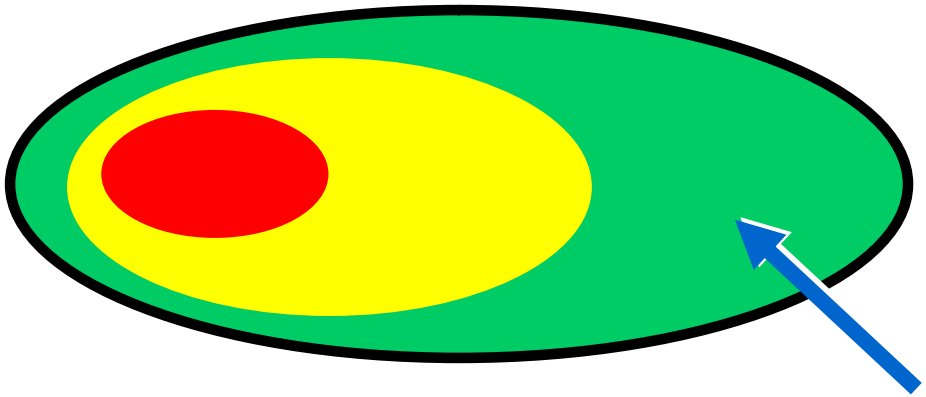
The characteristics of the groundwater system at P Area provides an excellent condition in which to evaluate and apply this technology.



By applying this technology in conjunction with source reduction measures, the impact to groundwater will be reduced in a cost effective approach.

Dilute Plume

- **Polishing Steps**
  - **Iodine-129 (I-129) capture with silver material**
  - **MicroBlowers**



Dilute Plume Zone

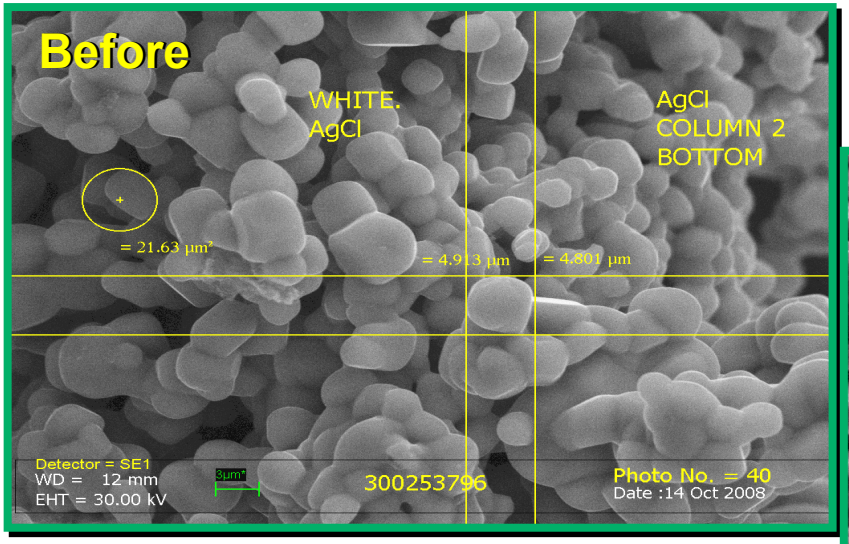
Polishing Steps:

- **I-129 capture with silver material**
- **Minimizing impact on operations (e.g., solar powered MicroBlowers)**

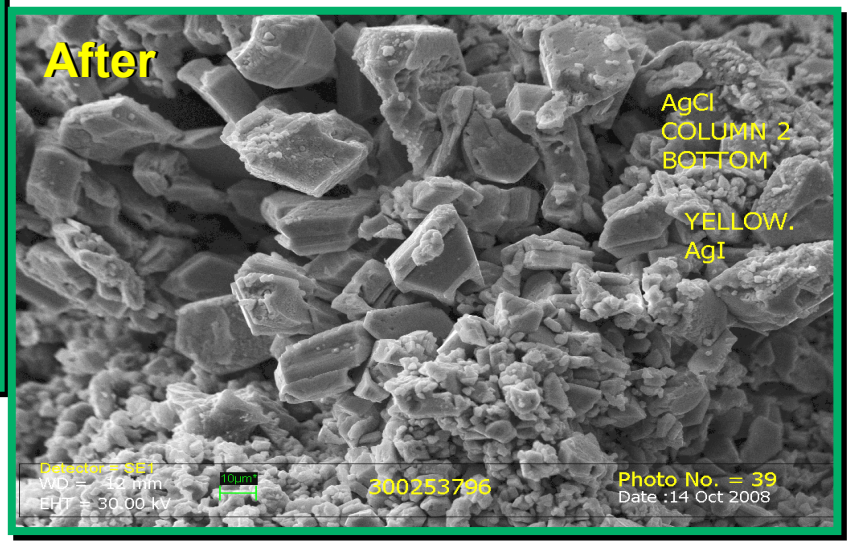
Radioactive Iodine Capture with Silver Bearing Materials

- Initiated first application in the F-Seepage Basin groundwater
- I-129 can be captured with silver chloride to form silver iodide which has a very low solubility
- Bench scale studies indicate that the materials developed are very effective
- Savannah River National Laboratory (SRNL) will patent the invention for use

Electron Photomicrographs



Morphology of silver material before capture of iodine



Morphology of silver materials in a soil matrix after capture of iodine (crystal structure change)

Solar Powered SVE MicroBlowers

- **Semi-passive Soil Vapor Extraction source remediation**
- **Solar power minimizes impact on facilities and operations**
- **“Green” technology – no fossil fuels utilized / no carbon (greenhouse gas) emissions**

Typical Solar Powered MicroBlower Well

Conclusion

- Continue to explore application of new technologies
  - Chemical Oxidation
  - Soil Fracturing
  - Edible Oil Injection
  - Bioremediation
- Aggressively pursue remedial optimization

  Active → Passive → Natural
- Protect human health and environment