U.S. DOE Hanford Site
Remediation Opportunities and Challenges

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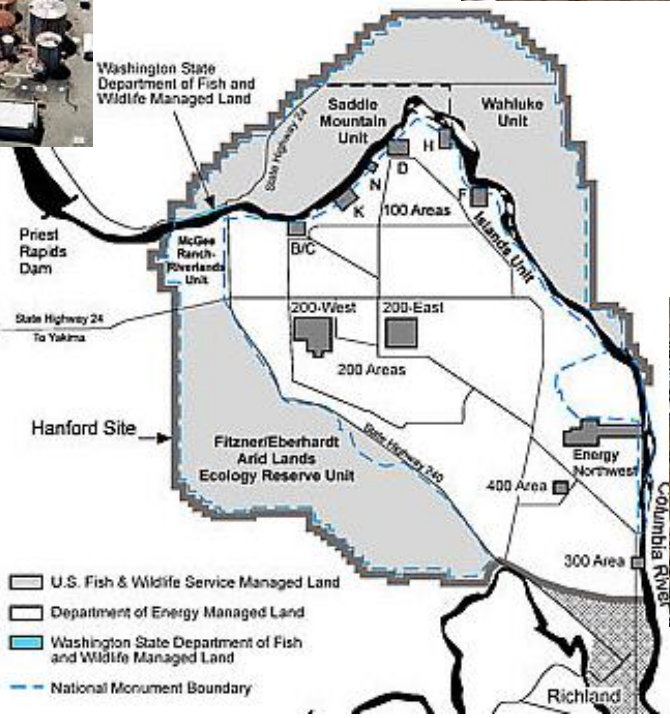
Outline

- Hanford Background
  - Multiple cleanup issues
  - Focus on subsurface contaminants
- Holistic Approaches for Complex Sites
  - Recent DOE efforts
- Hanford Examples
  - Successes
  - Challenges
- Concluding Remarks

Hanford Background

Irradiate Fuel Elements

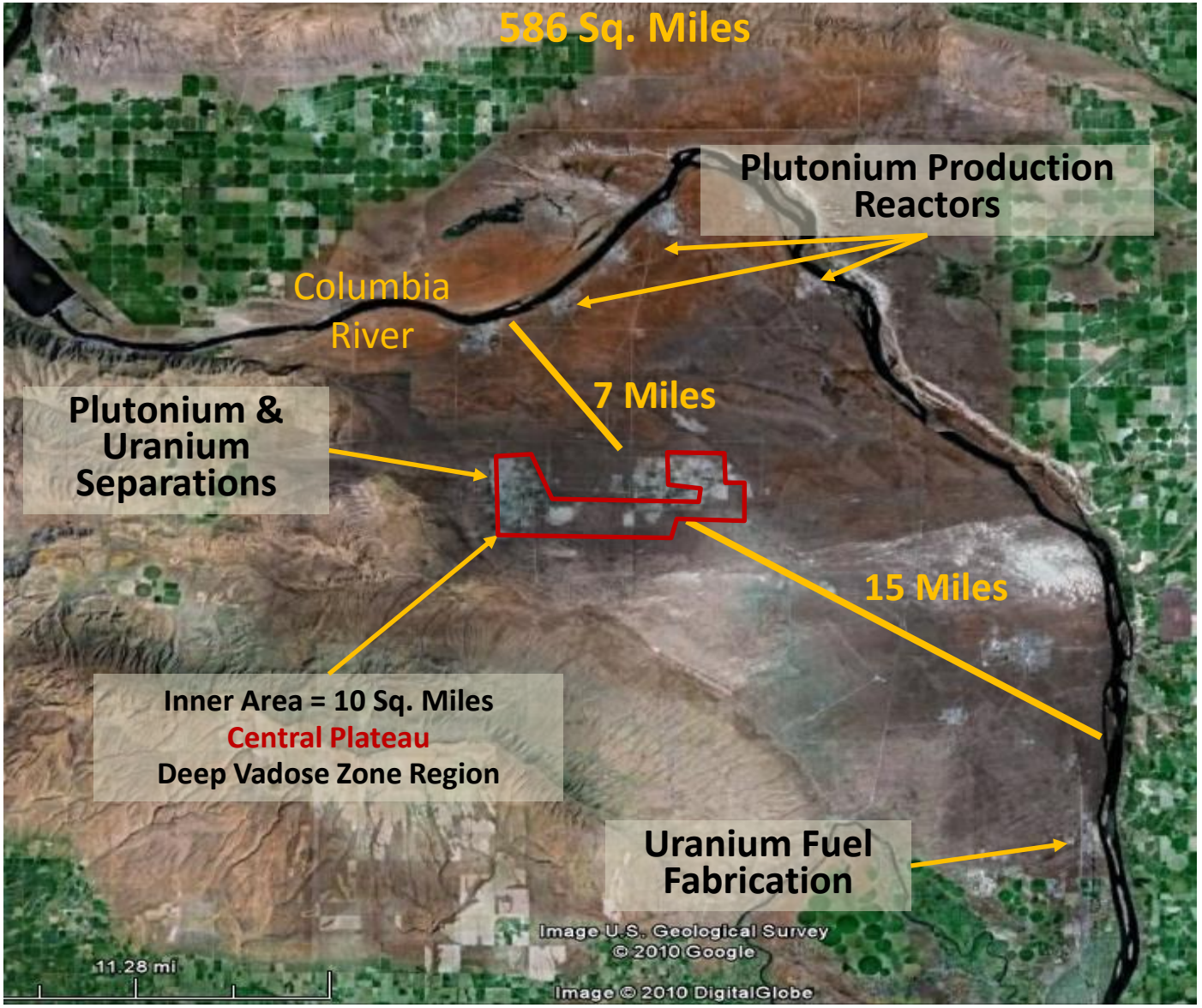
Chemical Separations



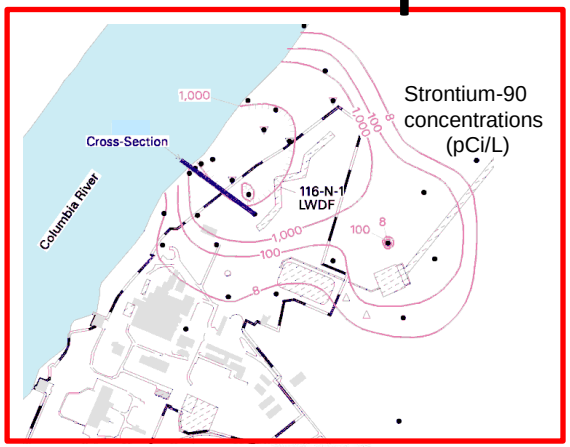
Plutonium Finishing

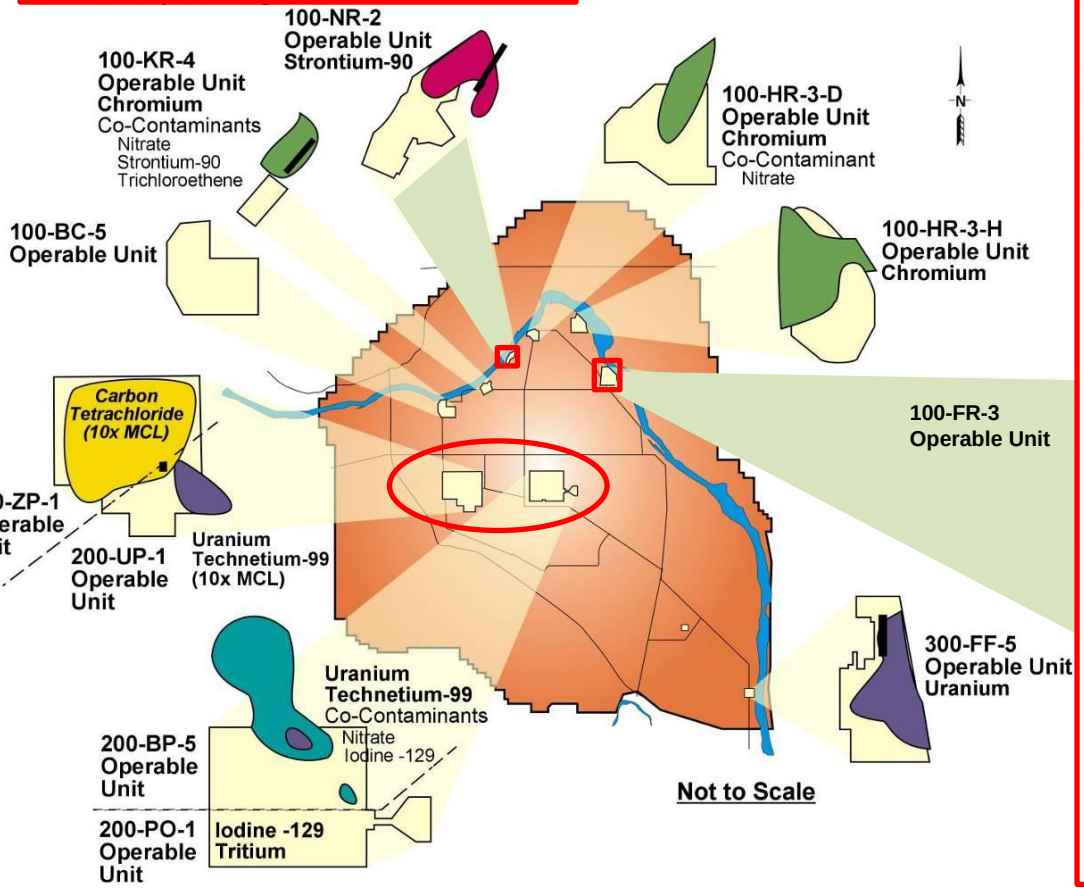
Manufacture Fuel Elements

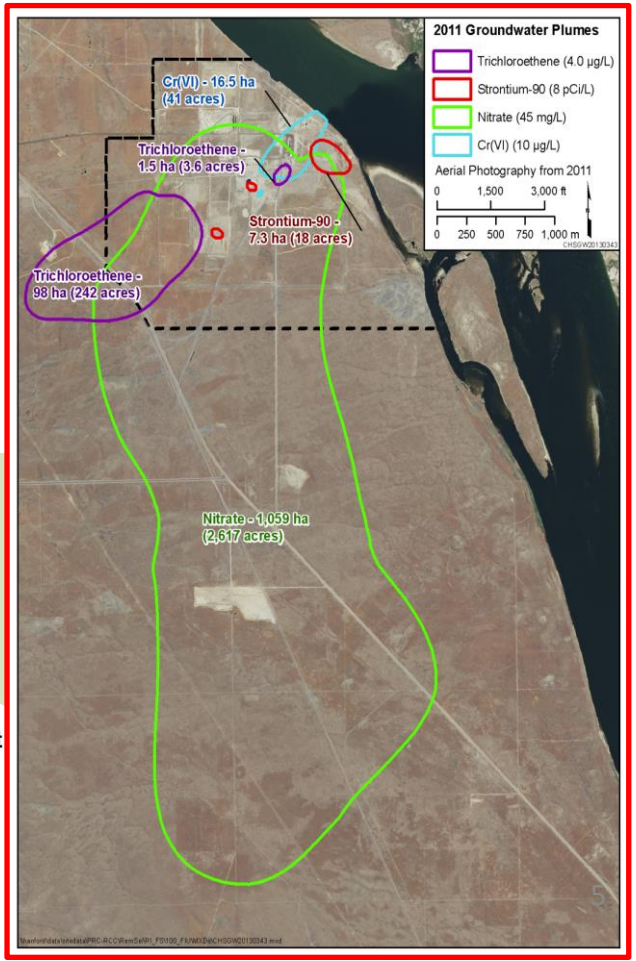
The Hanford Site and Surroundings



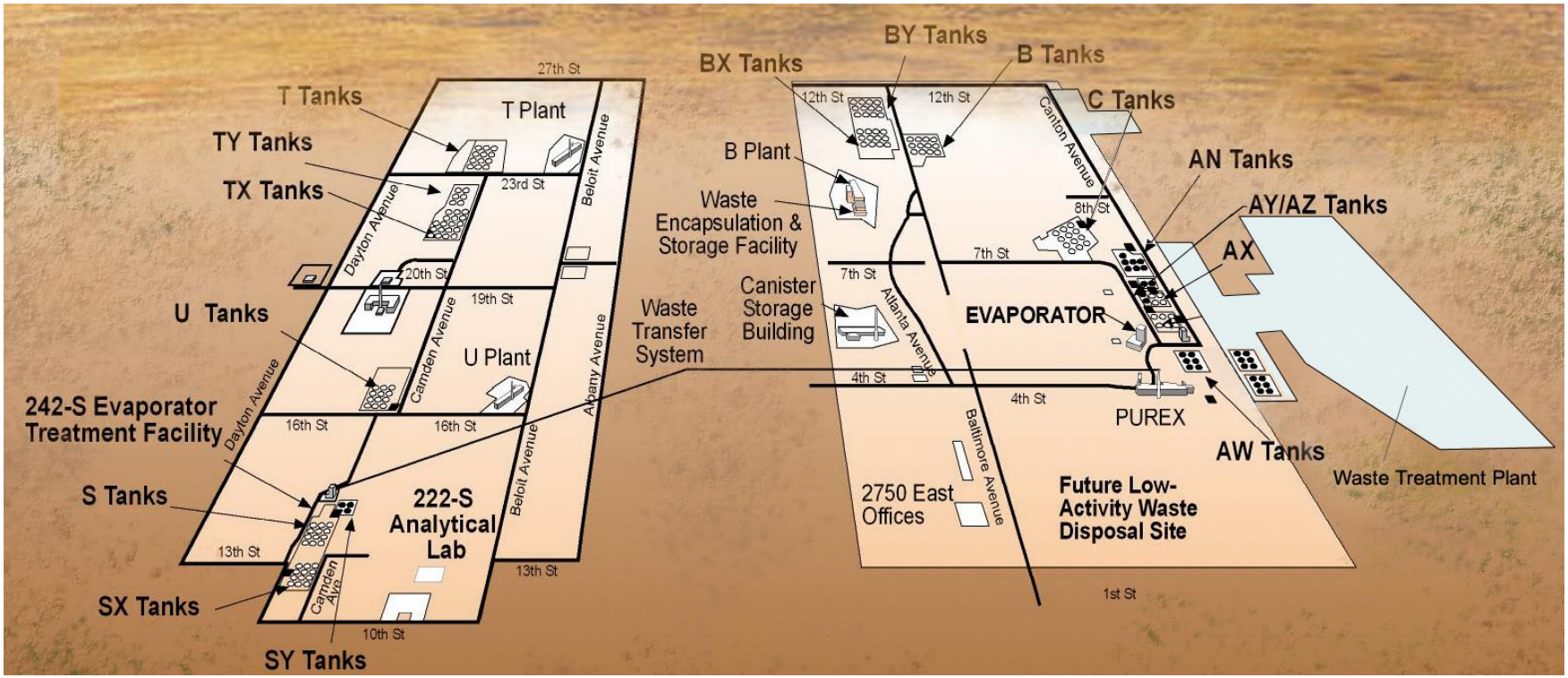
Example Groundwater Plumes







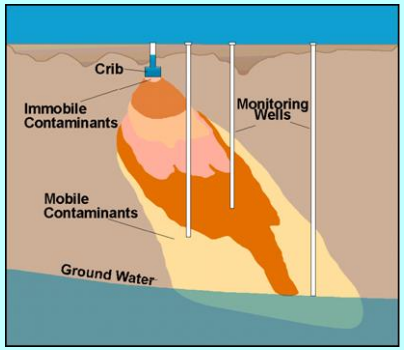
Central Plateau: Hanford Tank Farms



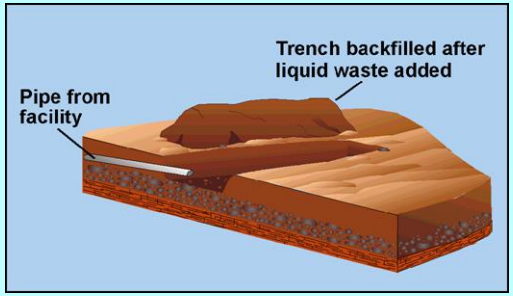
- 149 Single Shell Tanks (SSTs) and 28 Double Shell Tanks (DSTs)
- ~ 67 SSTs are known or suspected to have leaked.
- Interim actions have been taken to reduce migration of subsurface contamination.
- Final remedial actions will be coordinated with tank farm closure and deep vadose zone remediation elsewhere on the Central Plateau

Methods of Planned Liquid Releases to the Ground

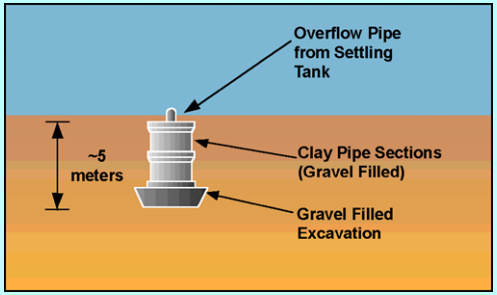
Cribs
1944-1990s



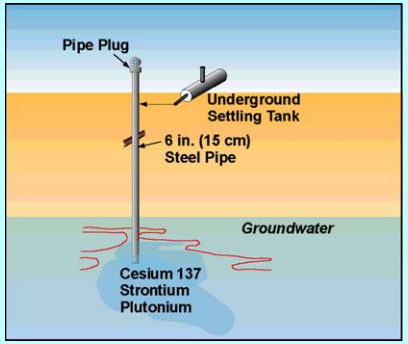
Specific Retention Trenches
1944-1973



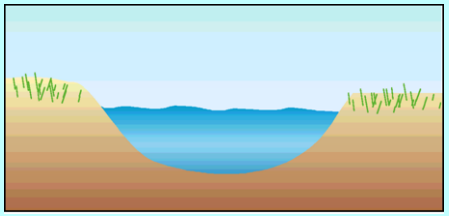
French Drains
1944-1980s



Reverse Wells
1945 - 1955
(one to 1980)

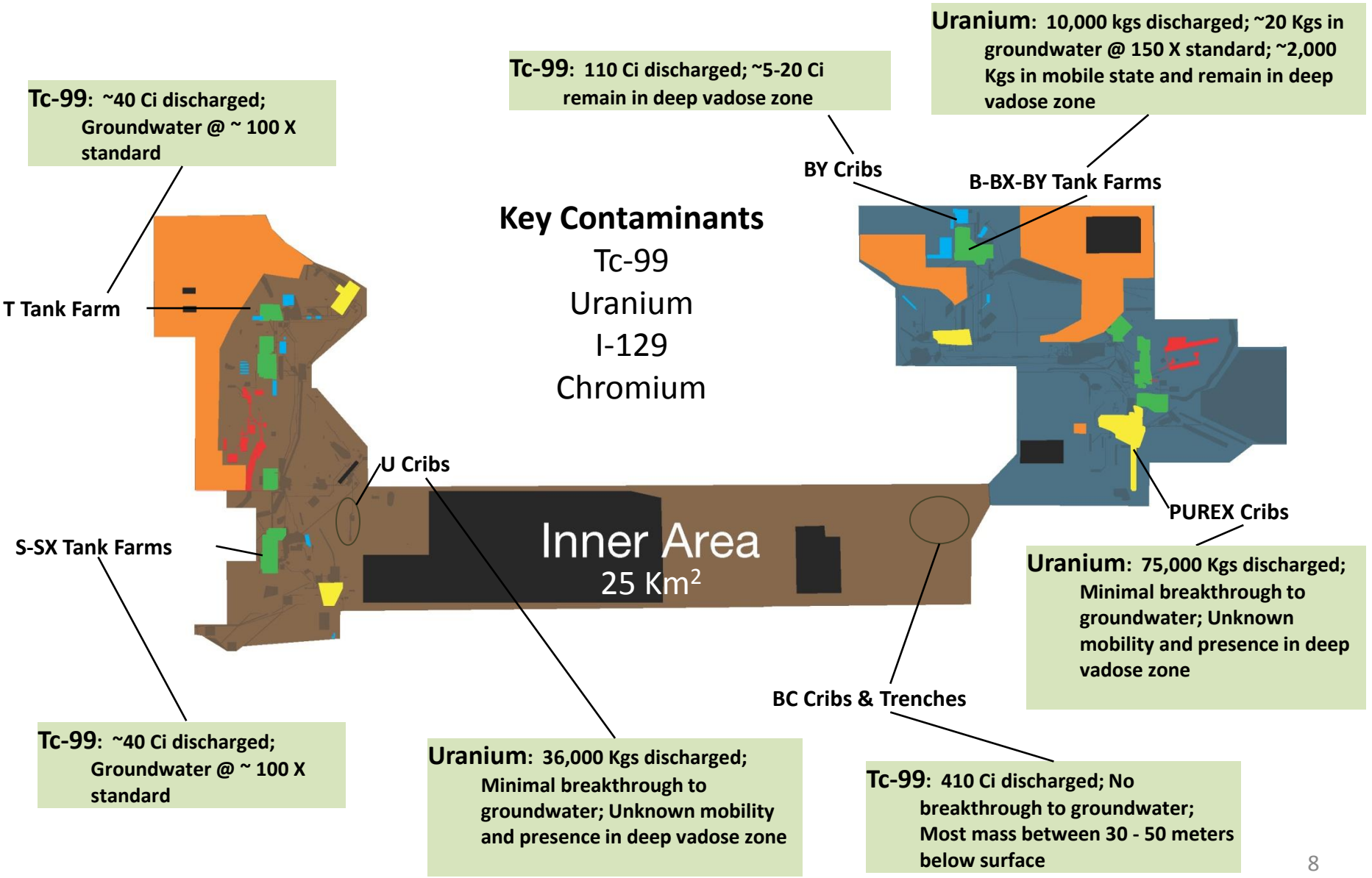


Ponds
1944-1990s



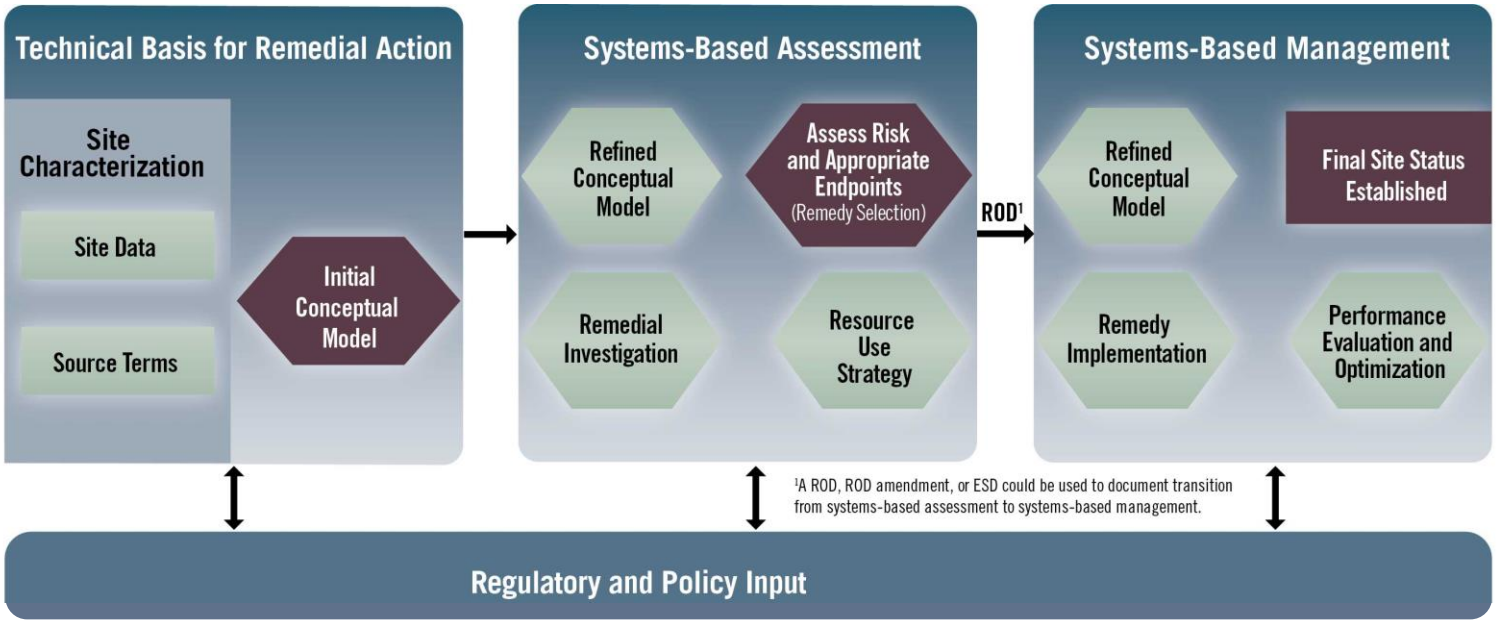
In addition to the planned releases to these engineered structures, unplanned releases, including spills and tank, pipeline and diversion box leaks, have also contributed to the liquid releases to the ground.

Central Plateau: Deep Vadose Zone Sites



Holistic Remediation Approaches

- Conceptual models are a foundation for technical efforts and communication
- The subsurface system and site context can inform remedy approach and timeframe
- Maintain protection while addressing future risk and cleanup
- Adaptation may be needed as plume evolves and responses to actions unfold over time – enable adaptation/transition and allow time

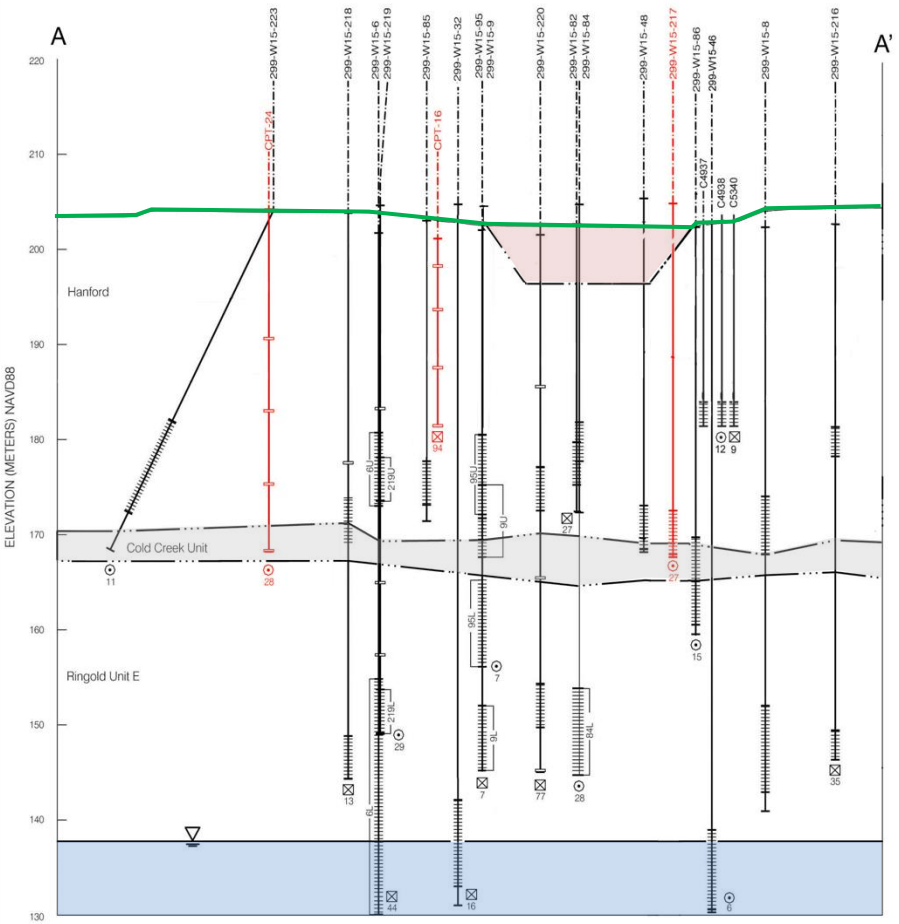


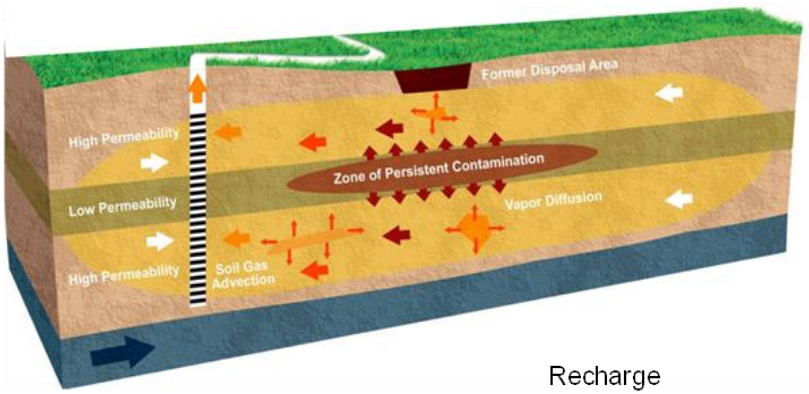
Hanford Examples

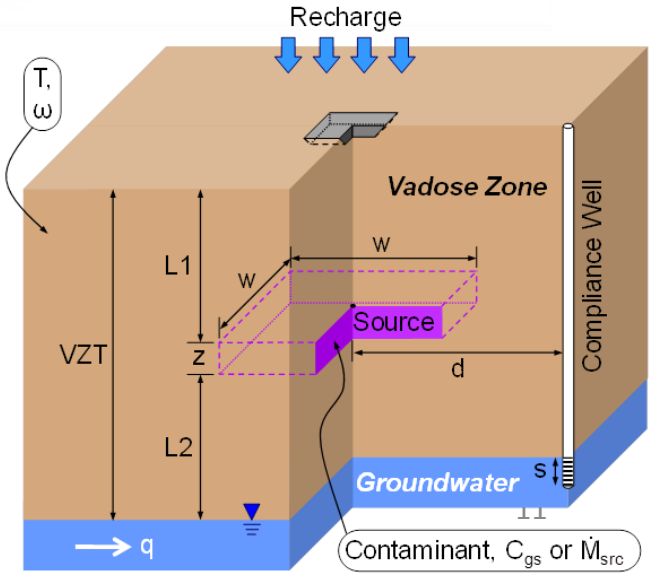
- Soil Vapor Extraction for Carbon Tetrachloride
- 100-N Area: Strontium Plume
- 100-F Area: Multiple Groundwater Plumes
- Central Plateau Coupled Vadose Zone-Groundwater System

Soil Vapor Extraction
Risk-Informed Remediation Cleanup

- Conceptual model basis
- Flux-based measurements to quantify source strength
- Assess transport for risk-informed cleanup

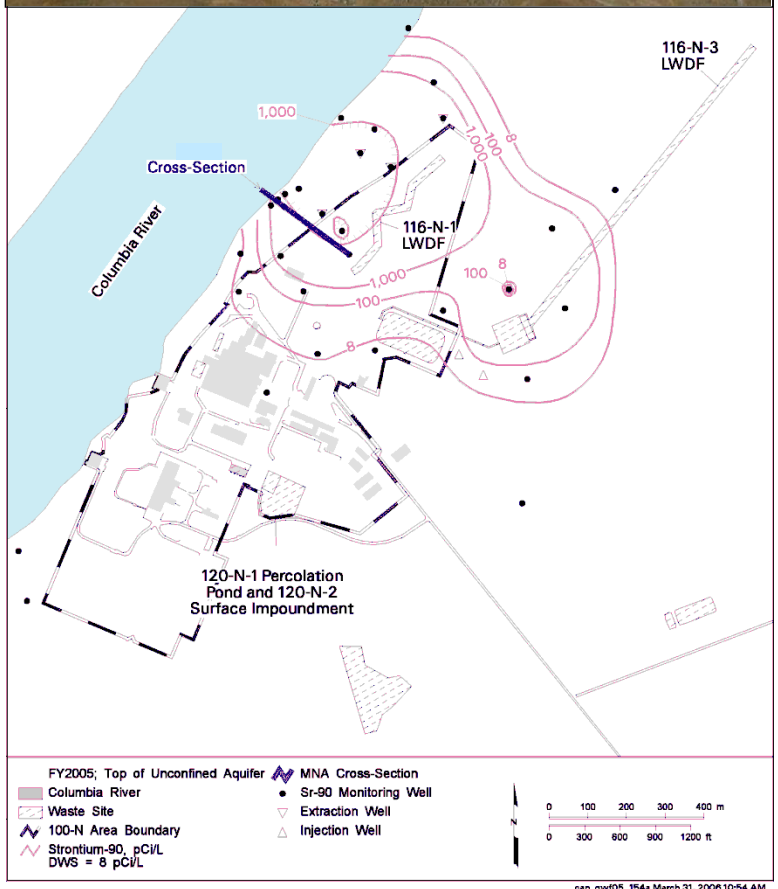






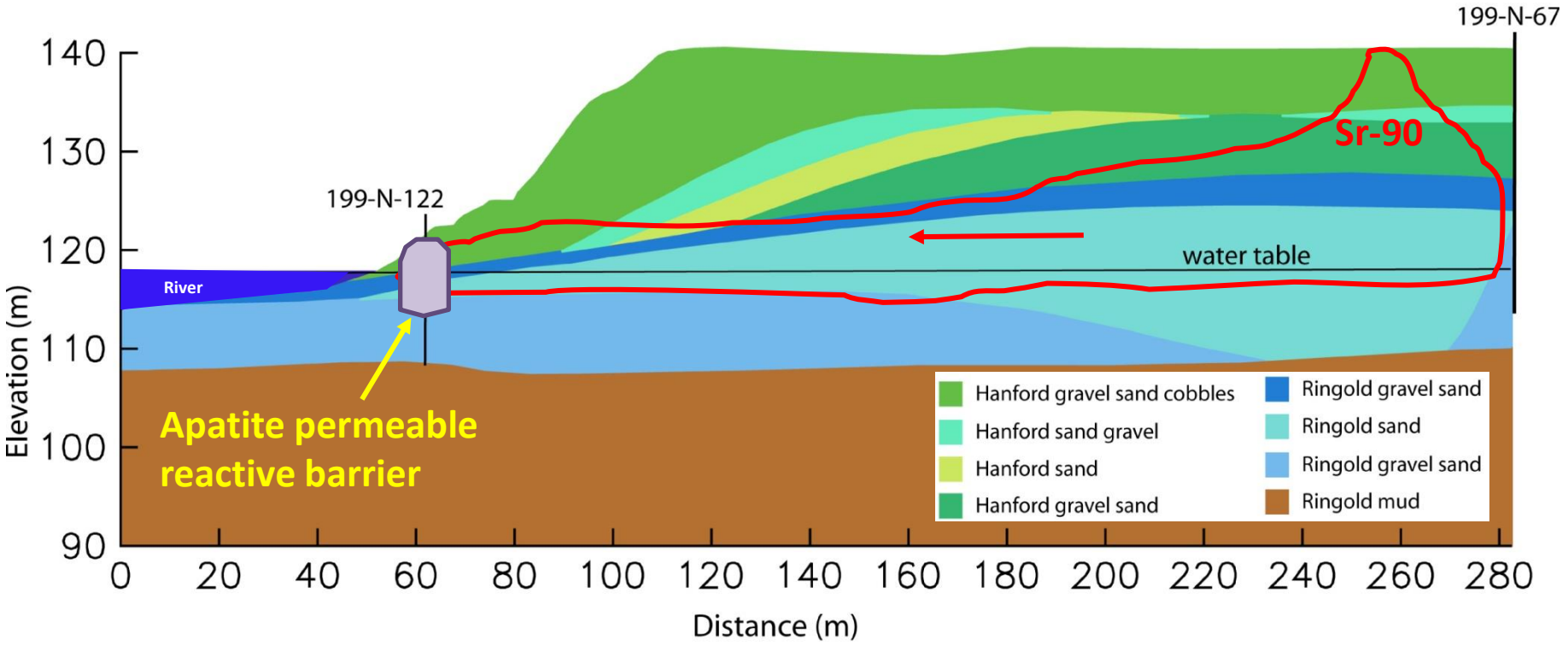
100-N Strontium

- Conceptual model basis
- Assess transport with respect to exposure
- Consider natural attenuation (radioactive decay) and sorption in conjunction with protective measures



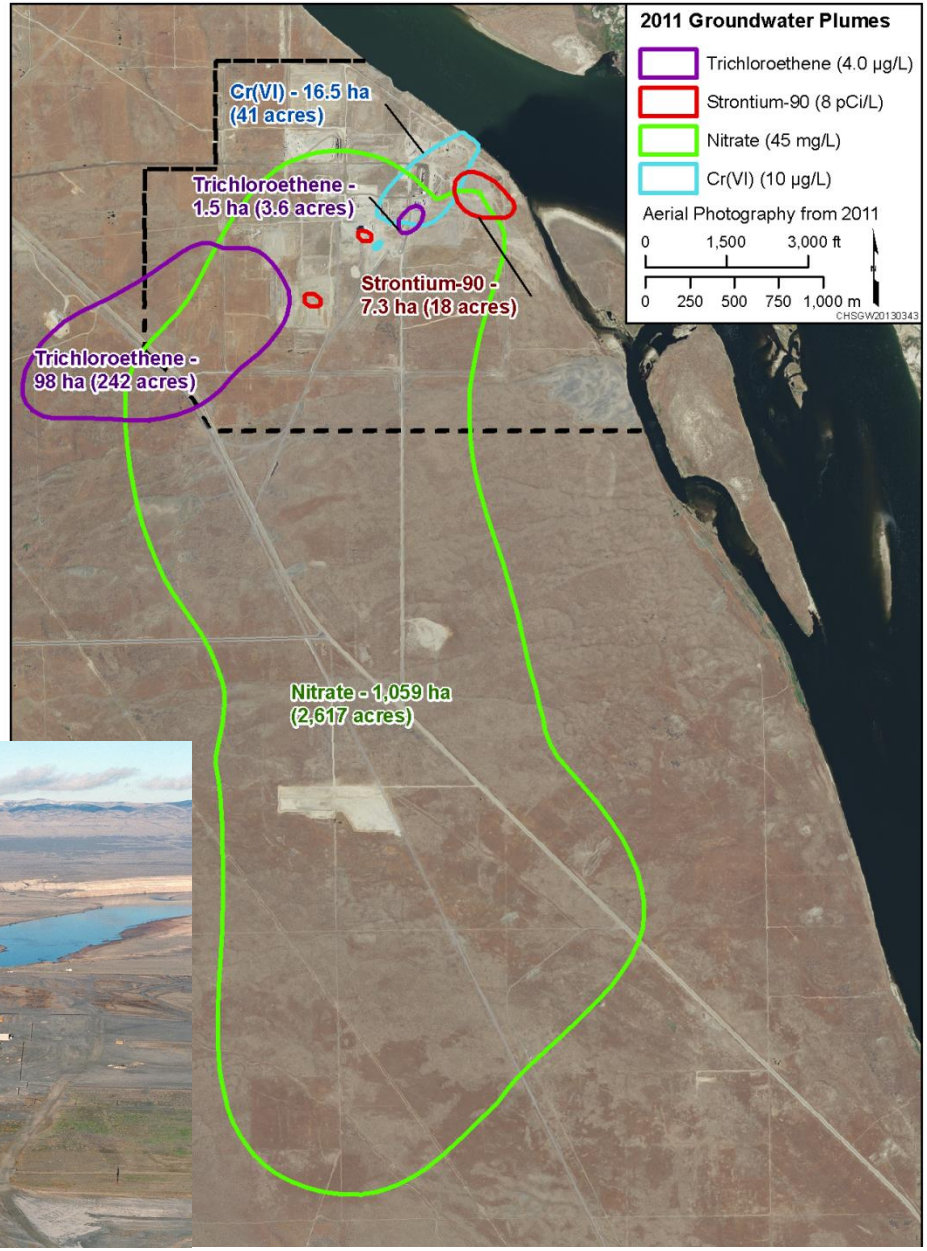
100-N Strontium

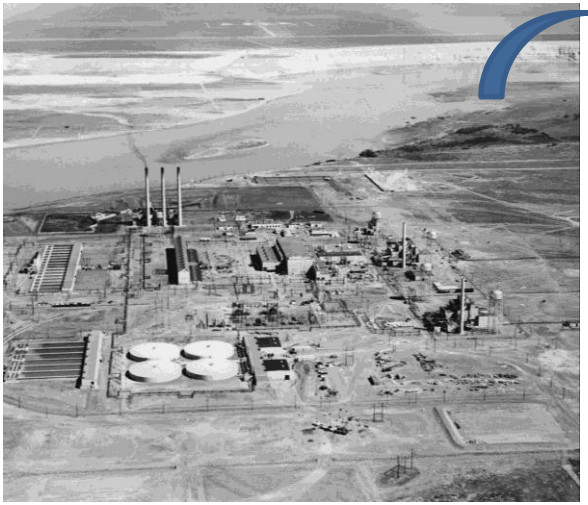
- Only near-river strontium is a risk to the river
- Apatite permeable reactive barrier mitigates this risk
- Over time, strontium-90 in the plume decays and does not pose an exposure risk – a long-term, but protective remedy.



100-F Multiple Plumes

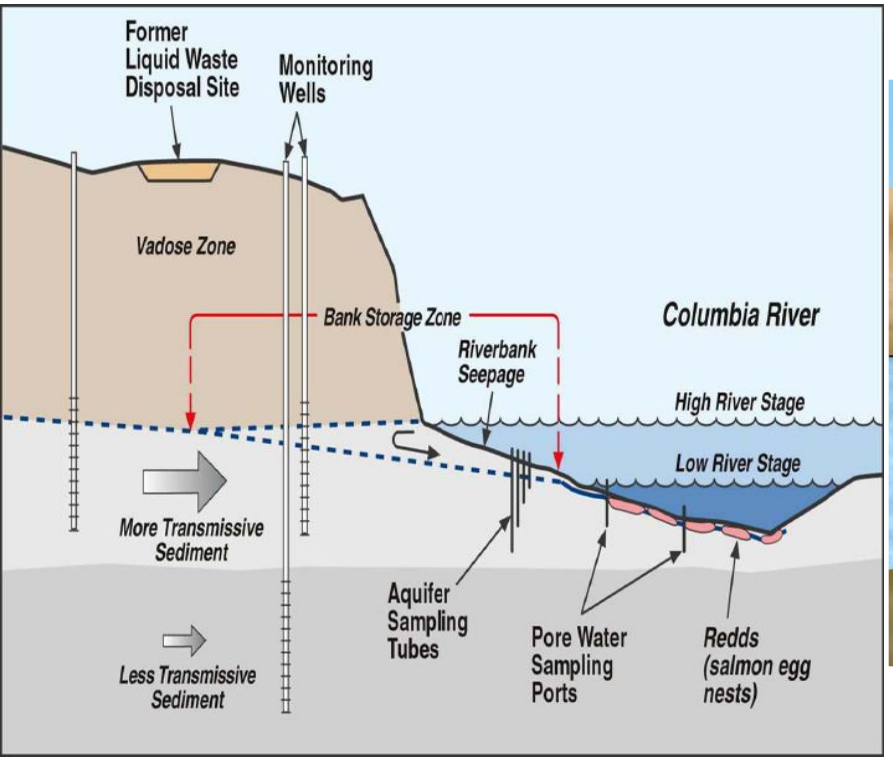
- Multiple sources associated with reactor/facility operations
- D&D and source reduction lead to conditions enabling attenuation of plumes

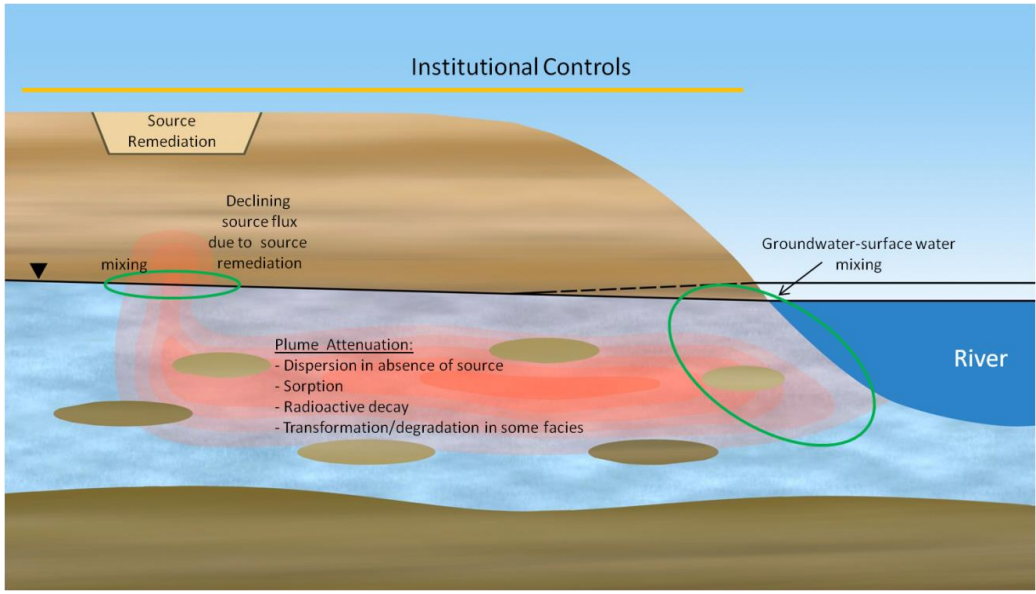




100-F Natural Attenuation

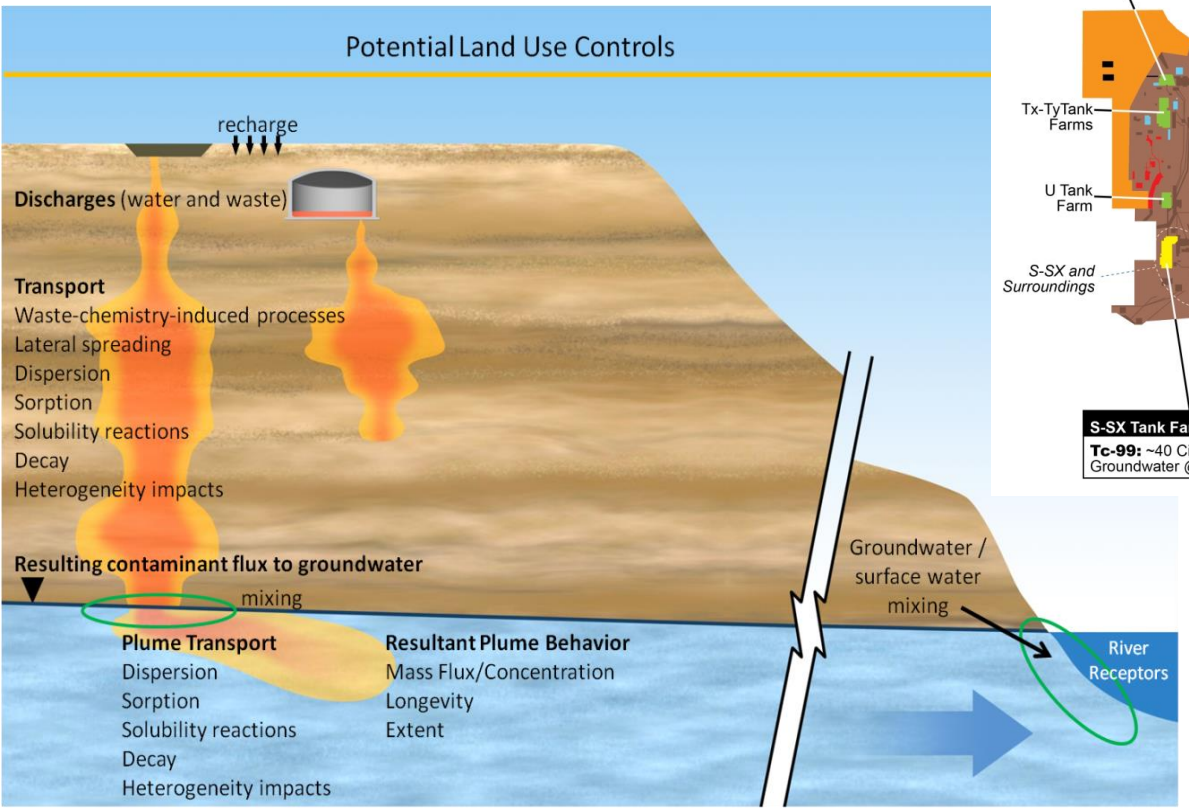
- Understand system and interaction with river
- Transition of plumes to declining condition in absence of source and with attenuation processes
- Predictive assessment of protectiveness, monitoring verification over time – a long-term, but protective remedy

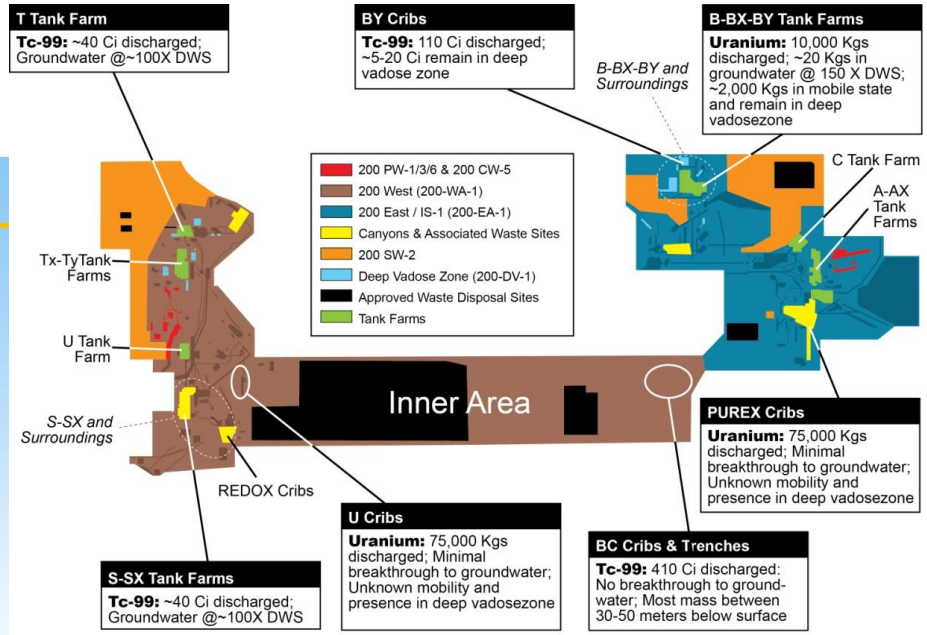




Central Plateau

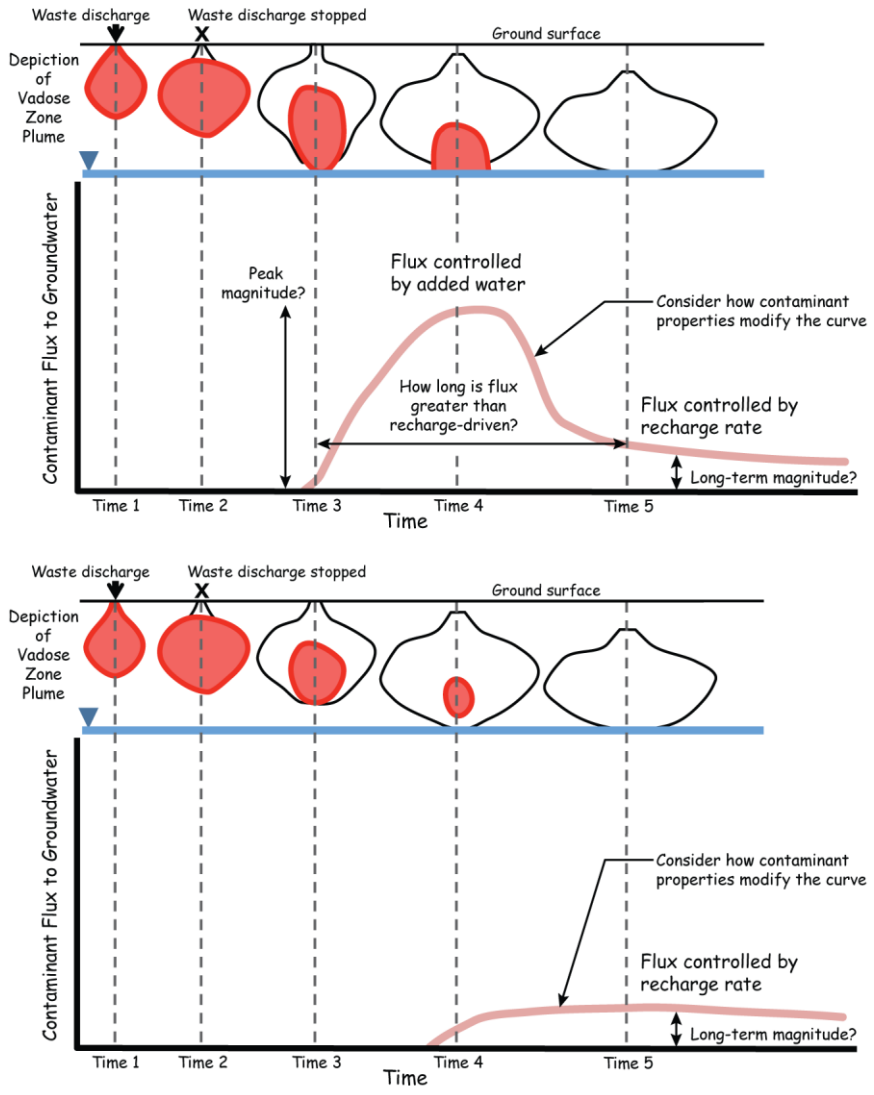
- The vadose zone is thick
- Contaminants would be difficult to extract, pose no direct exposure risk, but are a potential long-term source to groundwater
- Long transport pathway to river
- Need for systems-based approach





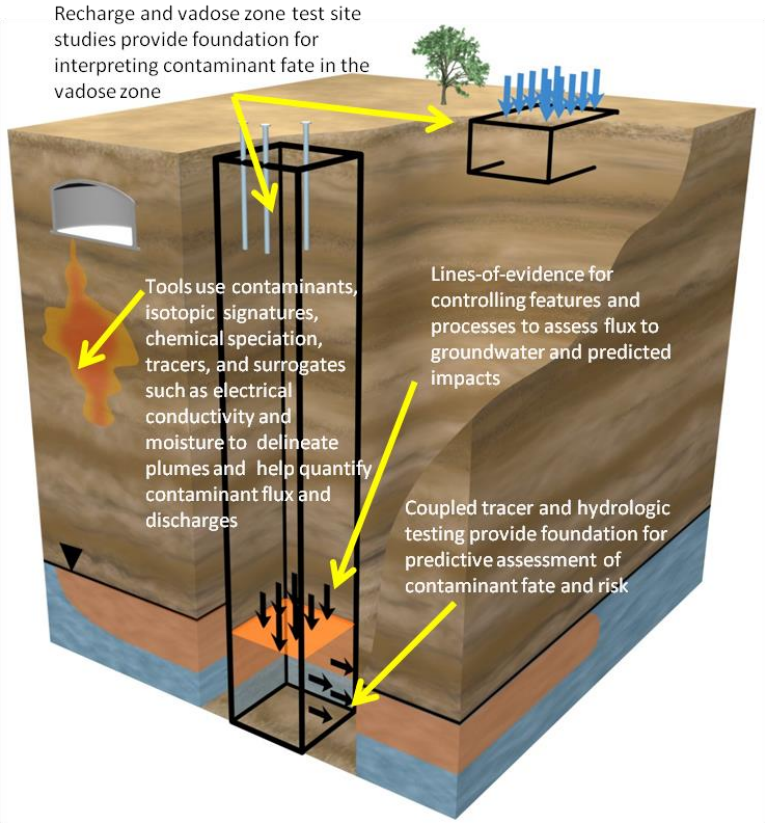
Central Plateau

- The vadose zone has slowed contaminant movement
  - What do we predict for future movement?
  - How can we augment the system to be protective (e.g., reduce vadose zone contaminant flux to groundwater)?
- System responses
  - Difficult to directly measure
  - Slow, long time frames
  - Large scale



Central Plateau

- Holistic Approach/System Assessment
  - Lines of evidence for contaminant behavior
  - Predictive modeling estimates
  - Target actions to be protective and reduce future risk
  - Monitoring to verify behavior and responses
  - Progressive/adaptive remedy strategy
- Factors in favor of a holistic approach
  - Long timeframe – minimal near-term risk
  - Long path to potential exposure
  - Vadose zone has slowed contaminant movement
  - Scientific foundation from current and past investments



Concluding Remarks

- Hanford Successes
  - Source reduction
  - Soil Vapor Extraction, 100-N, and 100-F remediation approach examples
  - Organization for and investments in addressing long-term issues such as the Central Plateau vadose zone
  - Communication (e.g., PHOENIX GIS database tool)
- Remaining Challenges and Issues (Hanford and nationally)
  - On the cusp of challenging long-term issues
  - Scientific basis for reliance on predictive assessments
  - Making decisions for maintaining protectiveness, considering potential uncertainty in reaching cleanup goals, and recognizing the need for time, data, and potential for adaptation at complex sites

Concluding Remarks

- Needs, Opportunities, Current Efforts
  - Applied Field Research Initiatives
  - Scientific Opportunities for Monitoring at Environmental Remediation Sites
  - Advanced Simulation Capability for Environmental Management
  - Systems-Based Framework for Remediation

Acknowledgement: Hanford information from DOE-RL, DOE-ORP, DOE-EM Office of Soil and Groundwater Remediation, Pacific Northwest National Laboratory, and CH2MHill Plateau Remediation Company