EM Nuclear Waste for Repository Disposal

National Spent Nuclear Fuel Program Strategy Meeting

Idaho Falls, Idaho

March 24, 2010

DOE Managed High Level Waste

- High-Level Waste (HLW) Inventory and Location
- EM Strategy
- Path Forward
- Improved Tank Waste Treatment
- State agreements
- Stakeholder Issues
- Related Waste Issues
- Summary

Inventory and Location

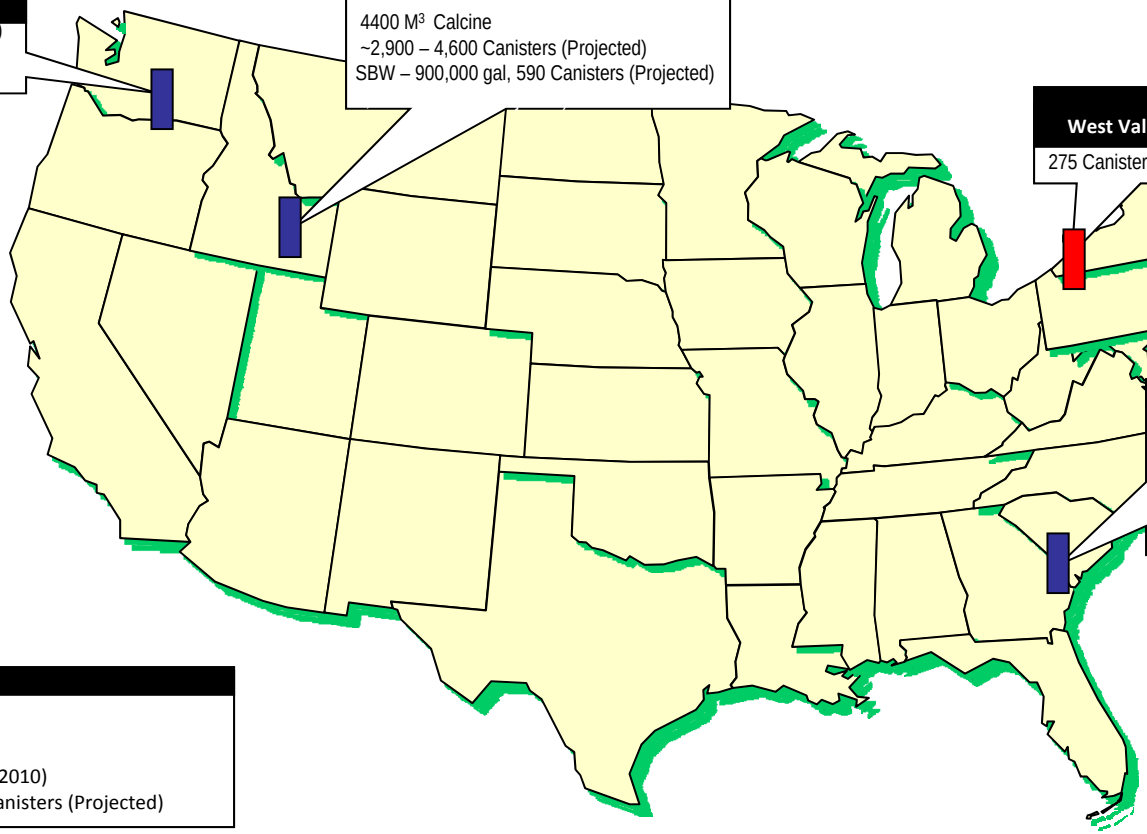
- Savannah River Site
  - About 2,900 canisters produced (of 6,300 planned)
  - Storage in 2 near surface modular structures (a 3rd is planned)
  - About 200 canisters produced per year (expect to accelerate with new technology)
  - 31 million of the 37 million gallons of tank waste remain to be treated (51 tanks; 2 closed)
- Idaho National Laboratory
  - 4,400 m^3 of calcine (a granular solid) stored in 7 bin sets (43 bins)
  - Bin set design life of several hundred years
  - Convert to monolithic solid by hot isostatic pressing (HIP)
  - 2,900 to 4,600 canisters, depending on HIP process
  - Sodium Bearing Waste (SBW) – treat 900,000 gallons by steam reforming to produce ~590 ten-foot canisters of granular powder (7 of 11 tanks closed)

Inventory and Location (Continued)

- Hanford
  - 53 million gallons of radioactive and hazardous mixed waste (177 tanks, 6 emptied) awaiting treatment in Waste Treatment Plant (WTP)
  - 9,700 canisters projected; about 400+ per year planned
  - Cs/Sr Capsules – 120 canisters projected

- West Valley - Non-DOE HLW
  - 275 canisters of EM managed commercial-origin HLW stored in hot cell (dry cask storage planned)

EM Nuclear Waste for Repository Disposal



HANFORD
~9,700 Canisters (Projected)
-Cs/Sr capsules - 120 canisters

IDAHO
4400 M^3 Calcine
~2,900 – 4,600 Canisters (Projected)
SBW – 900,000 gal, 590 Canisters (Projected)

West Valley
275 Canisters (2010)

* HLW at West Valley is owned by New York State.

SAVANNAH RIVER
37 Mgal
~2,900 Canisters (2010)
~6,300 Canisters (Total Projected)

Total
~90 Mgal (liquid)
4400 M^3 (Dry)
~3,200 Canisters (2010)
~20,000-21,000 Canisters (Projected)

Mgal – Million gallons
Canisters – HLW Canisters for Disposal

EM Strategy

- Storage/Eventual Disposal
  - Remove waste from aging underground tanks*
    - Separate high activity and low activity fractions
    - Vitrify/immobilize high activity fraction for storage
    - Solidify low activity fraction for on-site disposal
    - Solidify HLW calcine by hot isostatic pressing
  - Store canisters in near surface storage facilities (about 3,200 canisters now in storage)

- Develop Improved Methods for Treating Tank Waste to Reduce Life-Cycle Costs and Schedules

*An interim step is to transfer waste from single shell tanks to high integrity double shell tanks

Path Forward

- Savannah River Site and Hanford – Vitrify/Immobilize Tank Waste
  - Store canisters of treated waste on-site
- Idaho National Laboratory – Treat HLW Calcine by Hot Isostatic Pressing to Form a Monolithic Solid; Treat SBW by Steam Reforming
  - Store canisters of treated HLW calcine and SBW on-site
- Continue Developing Improved Treatment Methods to Reduce Costs and Schedules
- Continue Safe Canister Storage (20,000-21,000) On-Site
  - Re-evaluate canister integrity if >100 year storage expected

State Agreements

- Settlement Agreement between the State of Idaho, DOE, and the Department of the Navy
  - Calcine must be ready for transport out of Idaho by December 31, 2035.
  - Penalty – suspension of SNF receipt into Idaho, subject to appropriations. Federal parties must pay the State of Idaho $60,000 per day for each day in violation.

Stakeholder Issues

- Uphold State Agreements – Concerns that Waste May be Stored On-Site Indefinitely
  - Hanford TPA
  - Idaho Settlement Agreement
  - South Carolina Federal Facility Agreement

- Maintain Institutional Controls
- Develop Technical Basis for Extended Storage
- Assess Environmental Impacts

Related Waste Issue

Greater Than Class C (GTCC) Waste

- **Commercial LLW** containing high concentrations of short-lived or long-lived radionuclides and similar DOE waste ("GTCC-like waste") **that lacks a disposition path**
  - Primarily activated metals from decommissioning nuclear power plants, certain radioactive sealed sources, and potential DOE non-defense TRU
- Scope: 12,000 m^3 (75% commercial and 25% DOE waste)
- **NRC regulations require GTCC LLW be disposed in a geologic repository unless alternative methods are proposed to and approved by NRC**

Summary

- Continue Safe Management/Storage of Treated Waste and SNF
- No Significant Near-Term Technical or Safety Impacts for 50+ Years
- Continue to Develop Improved Techniques to Reduce Treatment Costs and Schedules
- Address Potential Compliance Issues with Affected States

BACKUP SLIDES

Proposed Repository Baseline

- **DOE Allocation is 7,000 MTHM Identified in 2008 License Application Proposed for Withdrawal**
- **2,333 MTHM of DOE SNF**
  - All SNF would be packaged in standardized canisters (except intact DOE-owned SNF of commercial origin)
  - DOE SNF would be co-disposed with HLW in repository waste packages to increase disposal efficiency
- **4,667 MTHM of Vitrified HLW Glass (each canister of defense HLW is considered equivalent to 0.5 MTHM)**

Improved Tank Waste Treatment *

- **Near Tank Processing** – Provide capability near waste tanks to remove solids/radionuclides for processing as LAW and reduce overall treatment time
- **Advanced Melters** – Investigate cold crucible melters, melter bubblers and revised glass chemistry to achieve higher waste loading
- **Higher Waste Loading** – Investigate glass formulations, new glasses (e.g., iron phosphate), grout, steam reforming, etc.
- **Alternative Treatment/Disposal Processes** – Use steam reforming and evaporation followed by sodium silicate solidification to reduce waste volume
- **Aluminum and Caustic Separation** – Processes could reduce HLW fraction
- **HLW Mixing and Blending** – Will minimize treated waste volume by mixing of compatible tank wastes
- **Other** – Waste staging, accelerated area closure, system analysis

*Implementation may reduce life-cycle costs by $20-35 billion or about 1/3 of the total treatment cost

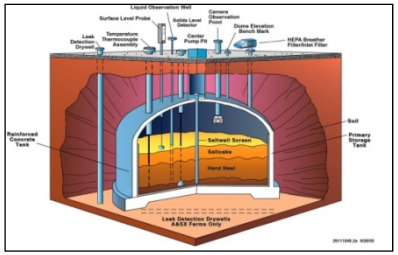
Highlights from Waste Management 2010 – Dr. Triay

- **Utilize Science and Technology to optimize the efficiency of:**
  - Tank waste
  - Excess nuclear materials
  - Spent nuclear fuel
  - Groundwater treatment and disposition
  - Evaluate programmatic alternatives to reduce the life cycle cost and period of execution
- **Tank Waste Management**
  - Completed 9 tank closures (2 tanks at Savannah River; 7 tanks at Idaho)
  - Completed 16 tank retrievals
  - Defense Waste Processing Facility operational in 1996
  - West Valley Demonstration Plant – operational 1996, complete 2002
    - 275 canisters of vitrified high level waste
- **Construction initiated on three additional tank waste processing facilities**
  - Hanford Waste Treatment and Immobilization Plant (2003)
  - Savannah River Salt Waste Processing Facility (2005)
  - Idaho Sodium Bearing Waste Treatment Facility (2007)
- **Transferred all spent nuclear fuel from wet to dry storage at Hanford (just over 2,100 metric tons)**
  - Hanford K-East Basin closed and D&D complete

Highlights from Waste Management 2010 – Dr. Triay FY 2011 Budget

- **Funds Tank Waste Management and Treatment Activities Across the Complex**
  - Hanford Waste Treatment and Immobilization Plant ($740M) to accelerate completion of design
  - Savannah River Salt Waste Processing Facility ($288M) for construction and pre-operations
  - Idaho Sodium Bearing Waste Treatment ($6.5M) to complete construction activities
  - Tank waste retrieval at Hanford and Savannah River ($95M) to meet regulatory commitments
- **Funds Increased Technology Investments**
  - Tank Waste Technologies ($60M)

Waste Retrieval and Closure Technologies



Challenge

- Increase Capability to Remove Tank Waste Material
- Reduce Waste Volumes
- Increase Storage Capacity in Existing Tanks
- Ability to Assess Environmental Safety of Grouted Waste Residuals in Tanks

Possible Solutions

- Develop Alternative Chemical Cleaning Methods to Control Tank Heel Chemistry
- Develop Improved Methods for Tank Waste Handling and Tank Space Usage
- Develop in-tank settling technologies to separate radionuclides
- Evaluate cementitious materials for in tank closure

Benefits

- Reduces Retrieval Time and Improves Efficiencies
- Reduces Further Environmental Impact When Retrieving from Unsound Tanks
- Reduces Waste Volume to Maximize Available Tank Space
- Provides Backup Evaporative Capability to Single Large Evaporator
- Provides Predictive Modeling and Materials for Tank Closure Decisions

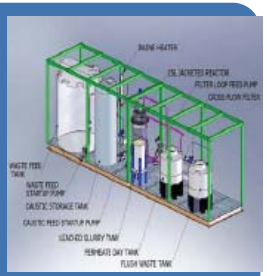
Alternative Waste Pretreatment

Challenges

- Accelerate Tank Waste Treatment by Using Small, At-Tank Systems
- Increase Incorporation of Long-Lived Radionuclides in Immobilized Waste Forms
- Remove Glass-Limiting, Non-Hazardous Chemicals from Waste to Increase WTP's Efficiency
- Obtain Reliable Data Without Physical Sampling

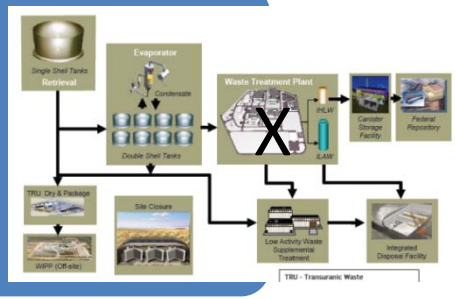
Possible Solutions

- Develop At-Tank/Near-Tank Processing to Provide Supplemental Waste Treatment Capability
- Develop Approaches for Managing Technetium During Processing
- Develop In-Situ Tank Characterization Technologies
- Develop Advanced Separation Technologies to Address Key Waste Constituents (Aluminum, Sodium and Sulfate Removal; Lithium Hydrotalcite Process for Sodium Removal, Beginning with Bench-Scale Testing)



Benefits

- Decrease WTP mission duration
- Reduce or eliminate second LAW facility
- Increase WTP efficiency
- Reduce amount of glass produced, thus reducing disposal costs
- Minimize releases to Hanford soils and groundwater
- Reduces worker exposure and gives real-time data for process control



Advanced Unit Operations and Scaling

Challenges

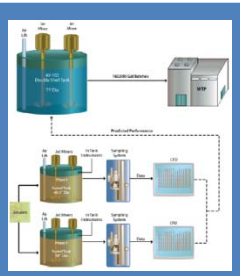
- To Predict Waste Transport and Mixing Properties
- Validated Waste Simulants that Mimic the Actual Waste for Large-Scale Testing

Possible Solutions

- Develop Advanced Multi-Phase Mixing Methods
- Develop Simulants to Enable Design Verification

Benefits

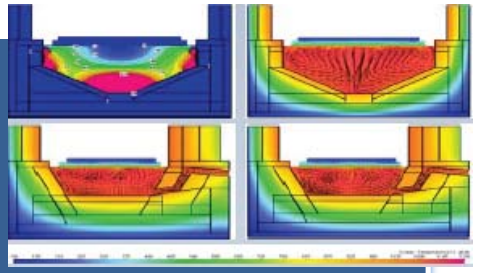
- Optimizes WTP Flowsheet by Reducing Over-Conservatism
- Increases WTP Flowsheet Flexibility
- Allows for Validated Testing on Large-Scale Equipment

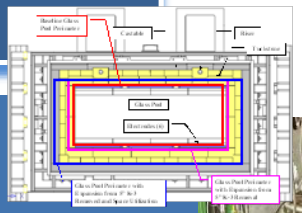


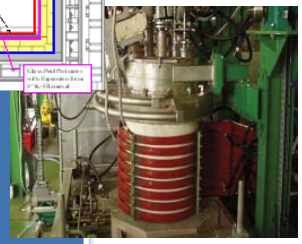
Improved Vitrification Capacity

Challenges

- Next Generation Melters are Needed to Increase WTP Throughput
- Develop Understanding a Process Tools for Maintaining Cold Cap on Melt Surface







Possible Solutions

- Develop Next-Generation Melters Such as Advanced Joule-Heated Melter and Cold Crucible Induction Melter
- Develop Advance Process Understanding of Cold-Cap Chemistry

Benefits

- Increase WTP Efficiency by Increasing Melter Throughput and Increasing Waste Loading
- Increase Flexibility in Alternative Waste Forms
- Increase Steady State Operations by Reducing Process Upsets

Agreements/Permits

- **EM/RW Memorandum of Agreement of January 2007** - Complies with section 302(b) (4) of the Nuclear Waste Policy Act (NWPA) by defining terms and conditions, equivalent to those for nuclear utilities, for EM use of the repository (violating requirements. could result in producing non-conforming waste forms).

- **Settlement Agreement between the State of Idaho, DOE and the Department of the Navy** – Required a NEPA ROD for calcine treatment by 12/31/09, Calcine must be ready for transport out of Idaho by December 31, 2035. (SNF to be moved to dry storage and removed from Idaho by 1/1/2035.) Penalty – suspension of SNF receipt into Idaho, subject to appropriations. Federal parties must pay State of Idaho $60,000 per day for each day in violation.

- **Settlement Agreement on Fort Saint Vrain SNF between the State of Colorado and DOE** – Remove SNF from Colorado by January 1, 2035. Subject to availability of funds, DOE would pay Colorado $15,000 per day for each violation after January 1, 2035. DOE obtained a license for this facility from NRC in 1991.

- **Idaho RCRA Part B Permit for Calcine Storage** - INL calcine bin sets are permitted under RCRA through 2016. Permit revocation could result in a RCRA closure permit with an enforceable schedule. Penalty for non-compliance could be $10,000 per day per violation or $430,000 per day for 43 tanks (bins) while out of compliance.

Agreements/Permits (continued)

- **Idaho Federal Facility Agreement and Consent Order/Site Treatment Plan Milestones** - Approve CD-1 for Calcine Disposition Project by December 31, 2010, and submit enforceable schedule for Project design, construction, and operation by June 30, 2010. Missed milestone dates would result in notice of violation and possible fines up to $10,000/day for each of 43 tanks ($430,000 per day total).

- **Hanford Federal Facility Agreement and Consent Order or TPA** - Includes milestone TPA M-92-05 requiring plans for disposition of the Cs/Sr capsules by June 30, 2017. Other milestones are for tank waste retrieval, WTP construction, and waste treatment; stipulated penalties of $10,000 per week levied per missed milestone.

- **Hanford RCRA Permit, Dangerous Waste Section** - The WTP operation has been incorporated into the permit administered by the State of Washington. Notice of violation and fines could be levied if TPA milestones are not met.

- **South Carolina Federal Facility Agreement** - With South Carolina and the Environmental Protection Agency requires DOE to remove waste from aging tanks by specific dates at the Savannah River Site. The HLW tanks are not RCRA permitted units.

Applicable Laws

- **Atomic Energy Act of 1954 and Energy Reorganization Act of 1974, as amended** - Along with their implementing regulations (primarily Title 10 CFR), these laws specify the safety requirements and framework for licensing nuclear activities and facilities for both domestic and foreign applicants. NRC functions are identified in the Energy Reorganization Act.

- **Nuclear Waste Policy Act of 1982 (and 1987 amendments and the Energy Policy Act of 1992)** - This law and its implementing regulations in 10 CFR 63 and 40 CFR 191 are still in effect and specify requirements for characterization and licensing of a Federal nuclear waste repository.

- **1980 West Valley Demonstration Project Act (WVDPA)** – The WVDPA, which has never been amended, designates the State of New York as the owner of WVDP HLW. This infers the State will pay for repository disposal. Transfer of the 275 canisters of HLW to off-site storage would require an amendment.

- **Low-Level Radioactive Waste Policy Amendments Act of 1985** – Assigns responsibility for disposal of GTCC LLW to the Federal Government (DOE).

- **National Environmental Policy Act of 1969, as amended** - specifies requirements for soliciting public participation in all Federal actions that impact the environment. The implementing regulations are 40 CFR 1500-1508 (on a government-wide basis) and 10 CFR 1021 (for DOE activities).

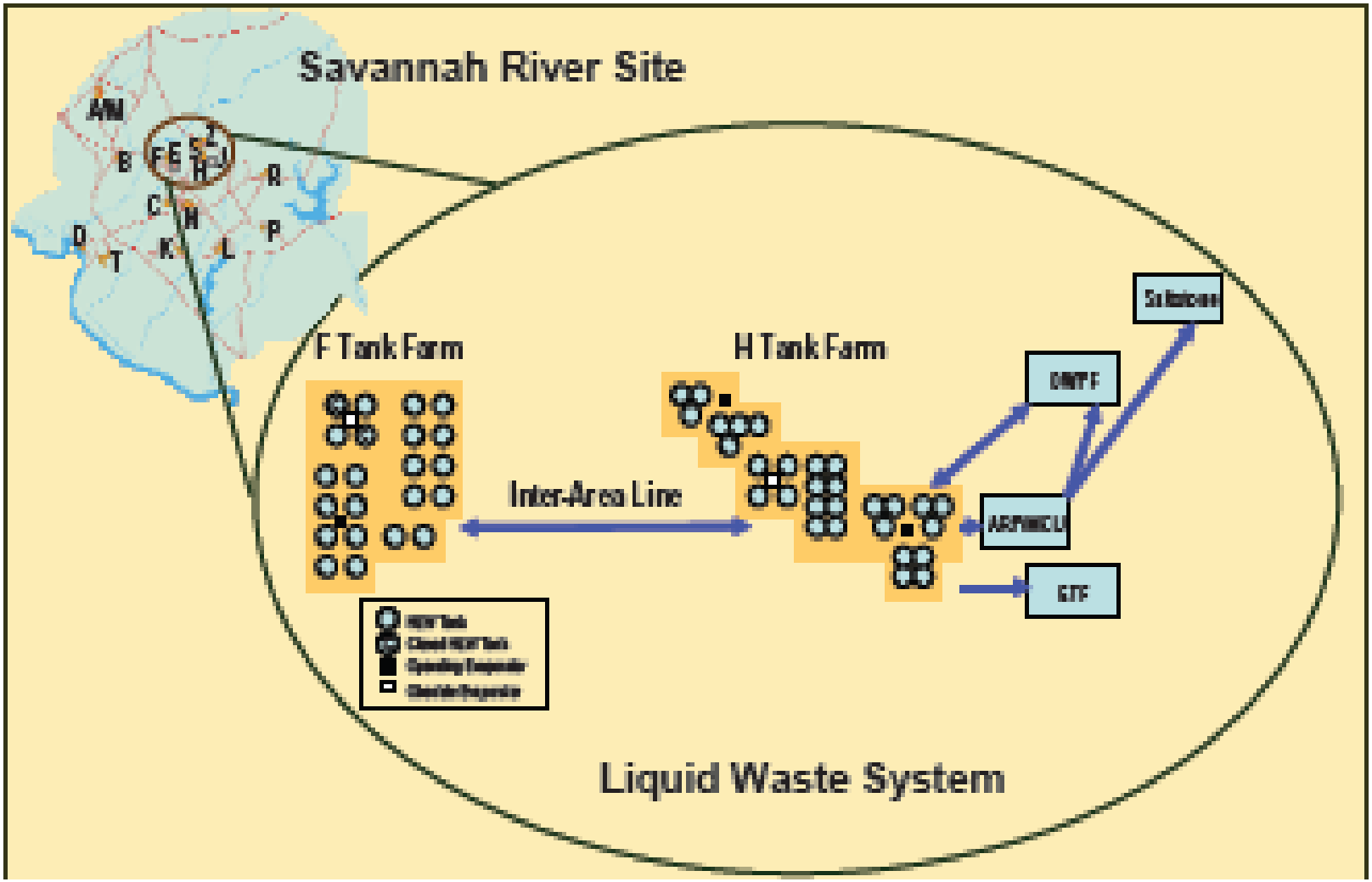
Savannah River Site Waste Treatment Overview

- Continue Treating Tank Waste
  - Separate tank waste into HLW and LAW fraction using saltstone process
  - Vitrify HLW fraction in Defense Waste Processing Facility (DWPF) and store on site
  - Solidify LAW in Salt Waste Processing Facility for on site disposal
- Complete Operations in H-Canyon by 2019 (other alternatives being considered)
- Complete DWPF Operations by About 2023-2026

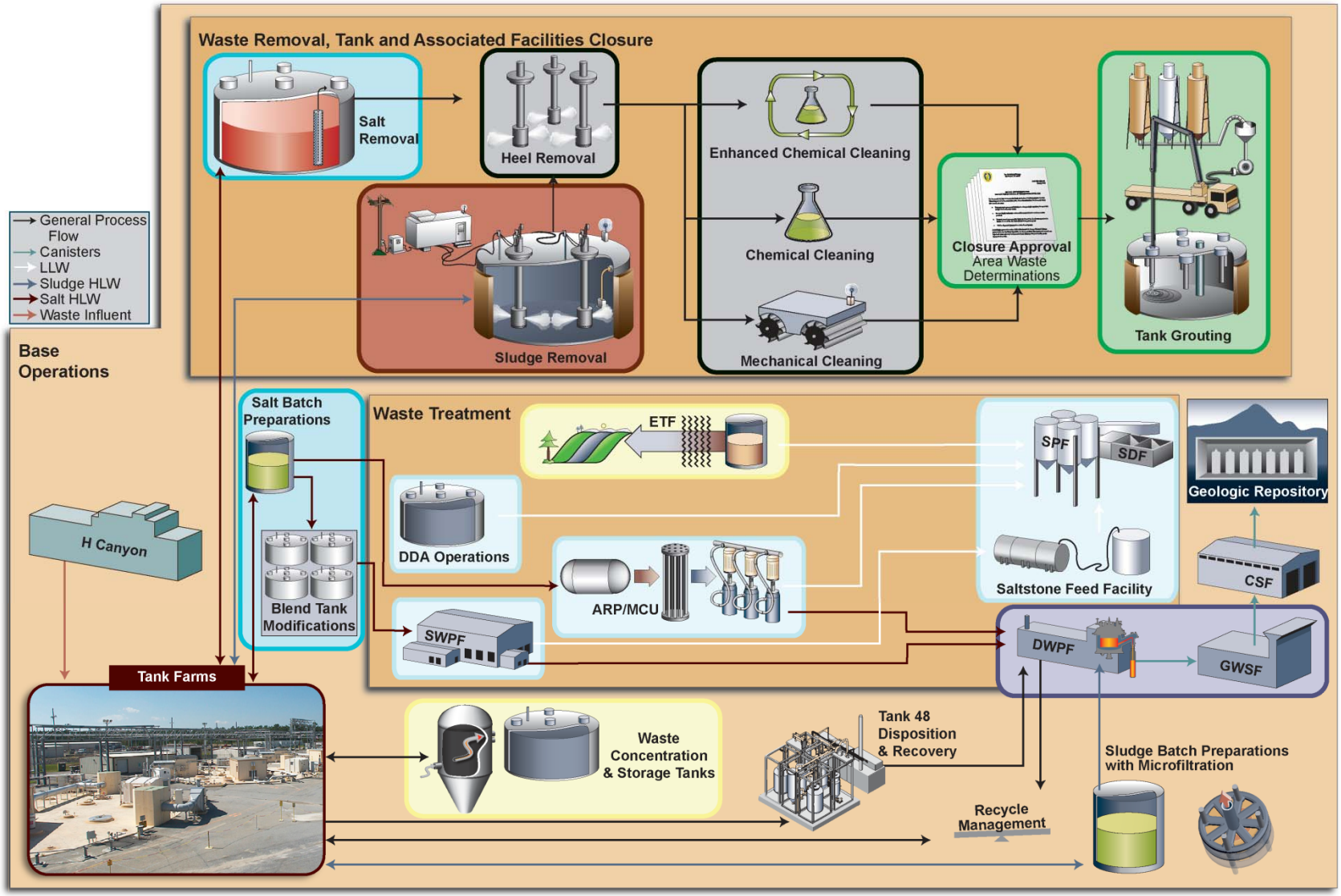
HLW Glass Canister

- Pictured is an SRS Canister - 10 feet tall
- Hanford Canisters will be 15 Feet Tall
- Both Canisters are Constructed of 3/8 inch Stainless Steel and 24 inch Diameter
- Canisters are Believed to be Capable of 100 Year Extended Storage Followed by Safe Retrieval

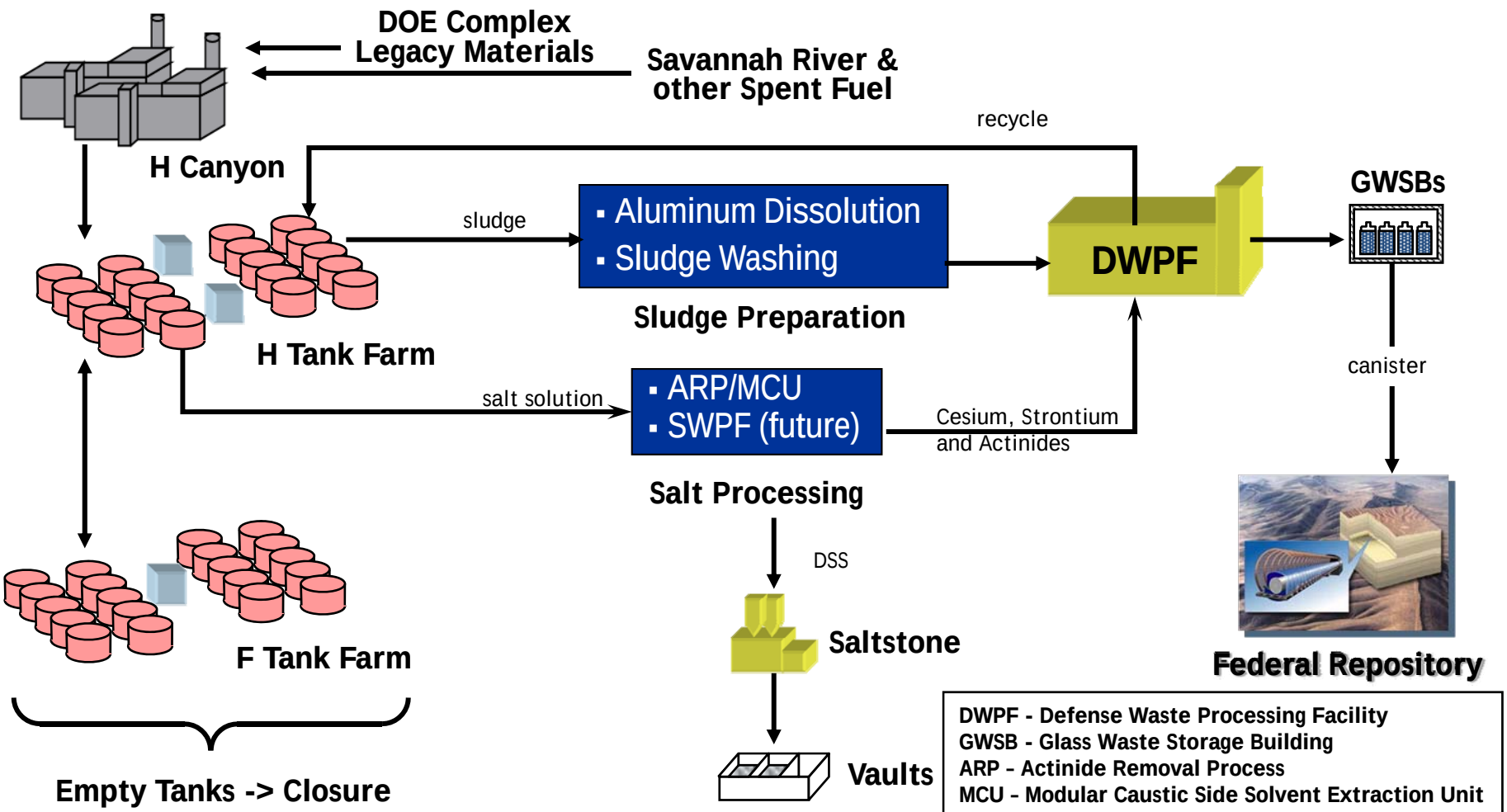
Savannah River Site Tank Waste System



Savannah River Site Liquid Waste Overview

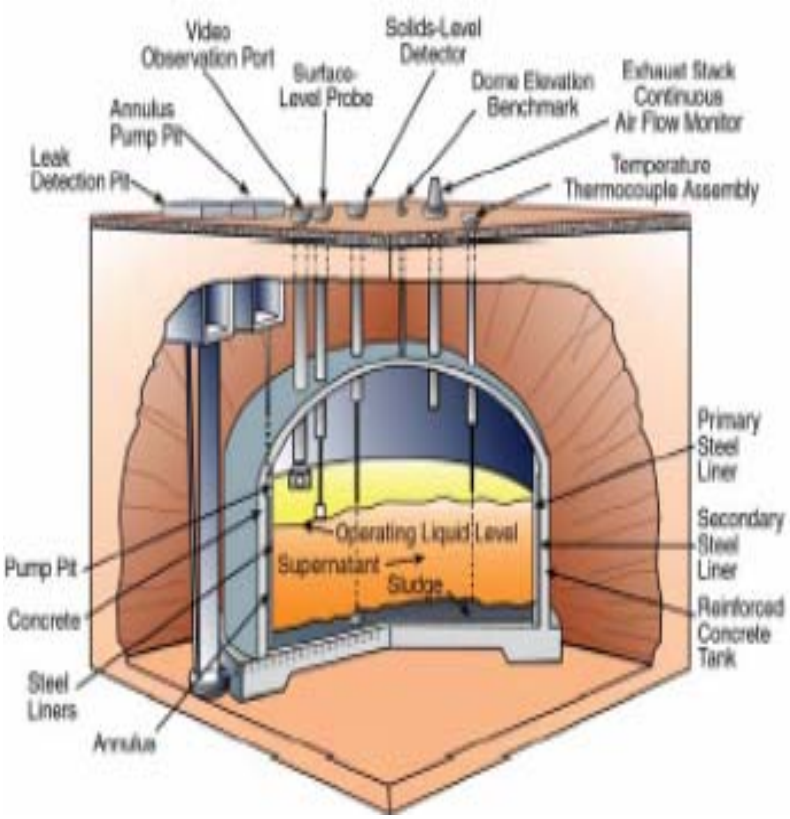


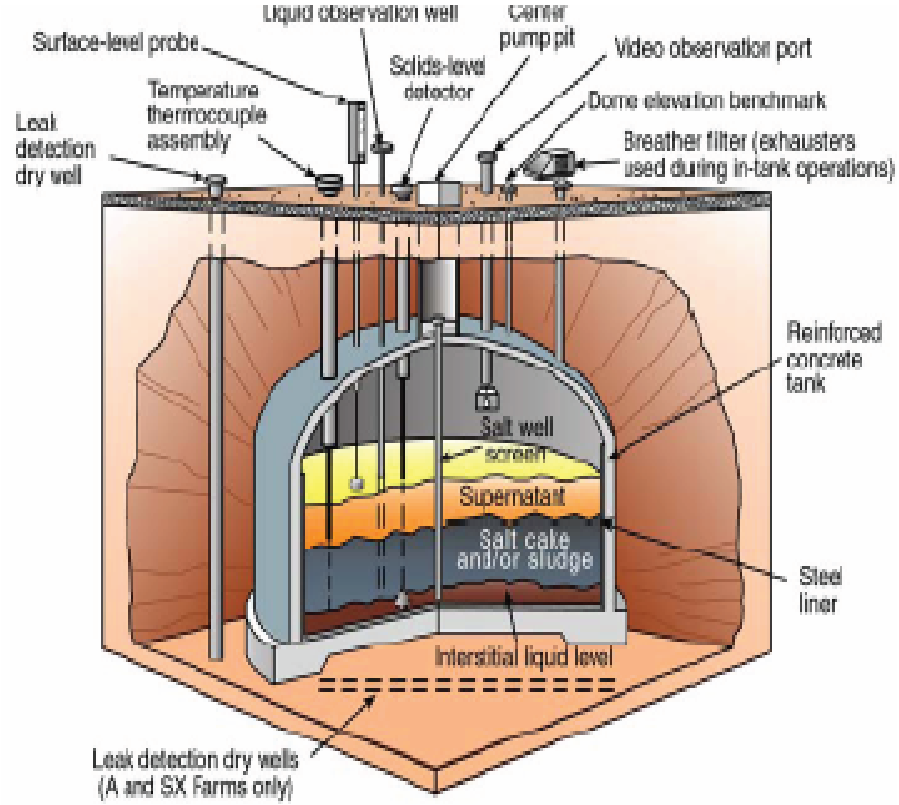
Savannah River Waste Flow



DWPF - Defense Waste Processing Facility
GWSB - Glass Waste Storage Building
ARP – Actinide Removal Process
MCU – Modular Caustic Side Solvent Extraction Unit
SWPF – Salt Waste Processing Facility
DSS – Decontaminated Salt Solution

Hanford Waste Tank Schematics: Double Shell and Single Shell





Hanford Waste Treatment Plant – February 2010

Completion Status

Total Project 53% Complete (78% Eng., 52% Proc., 49% Const.)
TRC Rate 0.41, DAFW Rate 0.00 (CY 2010 through Feb.)

Construction Scope of Work

Concrete

263,000 cubic yards

Structural steel

36,500 tons

Piping

901,000 feet

Ductwork

2,090 tons

Electrical raceway

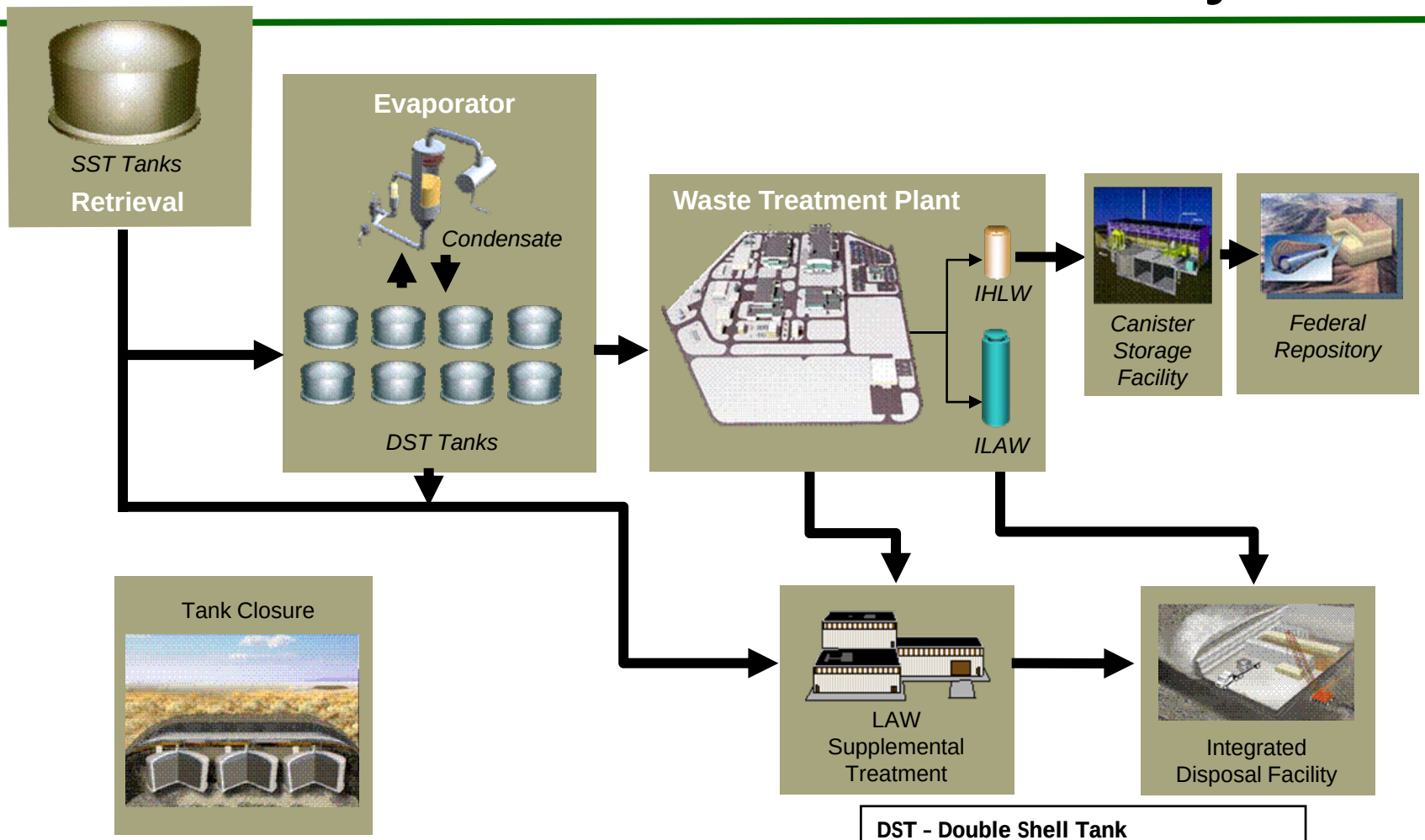
1,100,000 feet

Electrical cable

4,667,000 feet

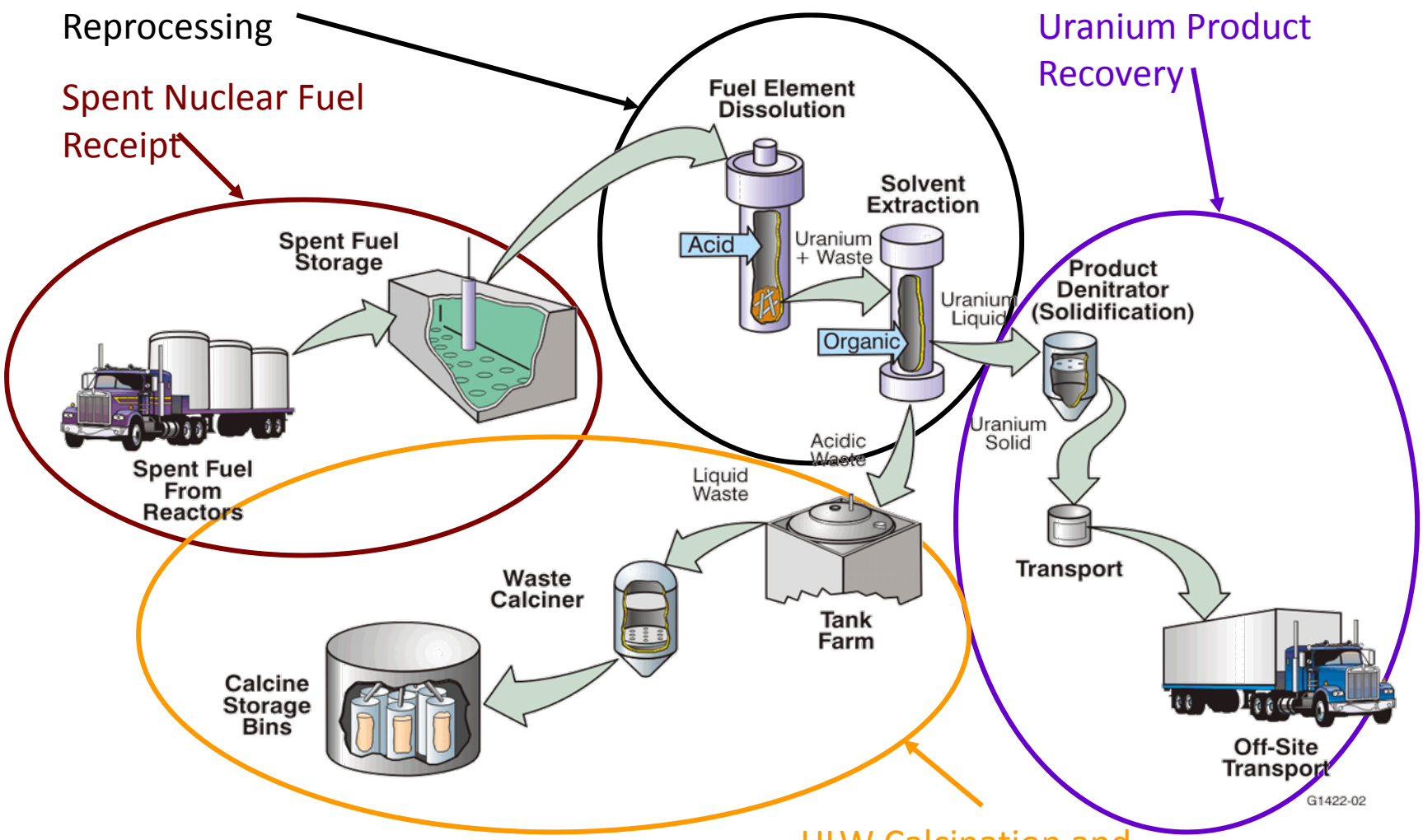
Craft hours to build: 24,000,000 hours

Hanford River Protection Project

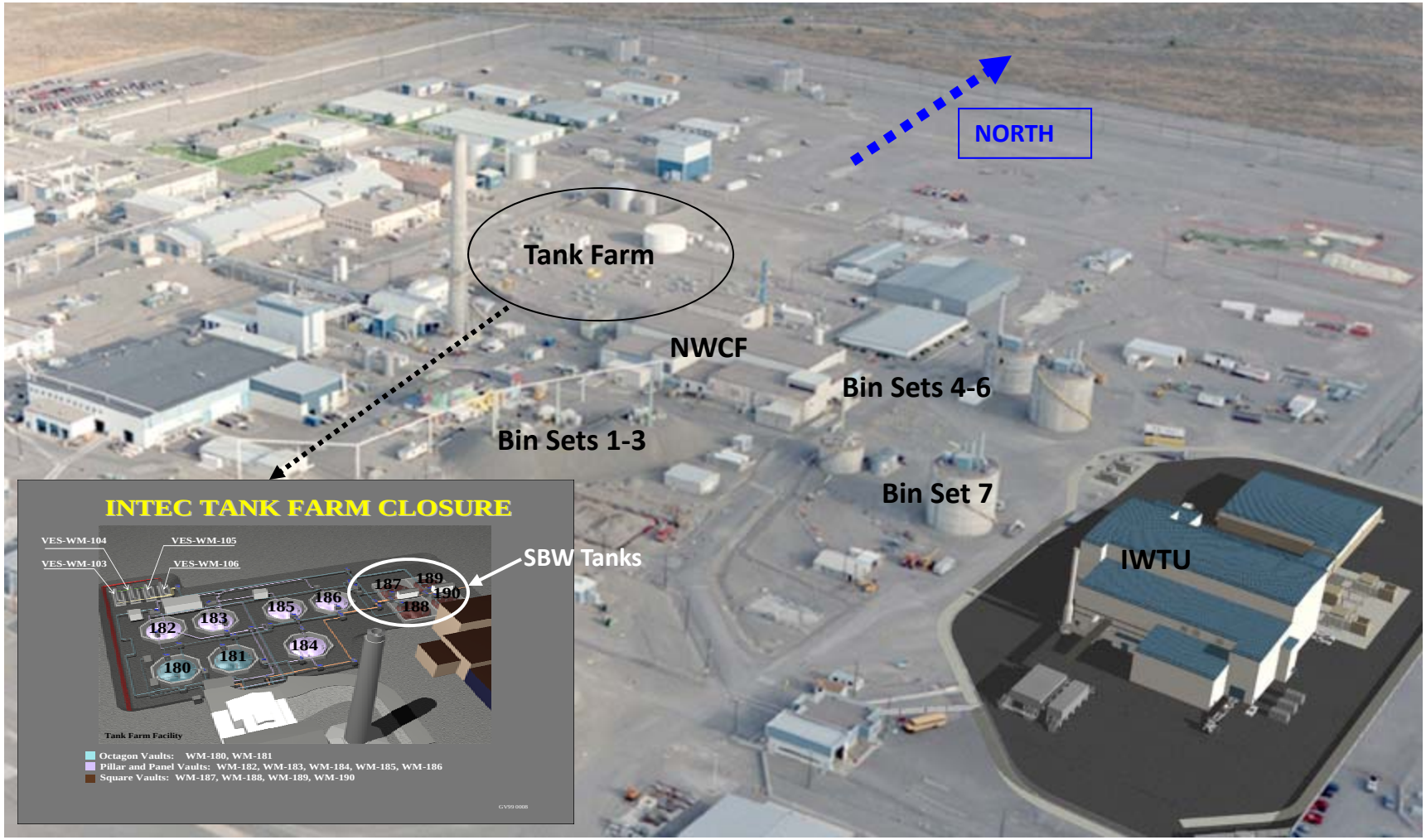


DST – Double Shell Tank
SST – Single Shell Tank
WIPP – Waste Isolation Pilot Plant
IHLW – Immobilized High Level Waste
ILAW – Immobilized Low Activity Waste

Calcine is First Cycle Raffinate from Reprocessing of SNF



SBW Treatment & HLW Calcine Facility Locations at INTEC



Related Waste Issue (in scope of GTCC EIS)

Low-Level Waste (LLW) Without a Disposal Path

- Geological disposal provides a possible disposal option for low-level radioactive waste without a path to disposal
  - A very small fraction of DOE low-level radioactive waste does not meet the waste acceptance criteria for DOE or commercial near-surface disposal.
  - Waste may exceed waste acceptance criteria due to size, radioactivity, or other characteristics.
    - Activated metal and shielding components in research reactors at Oak Ridge National Laboratory and Idaho National Laboratory.
    - Waste with large quantities of beryllium.
    - Waste exceeding radionuclide concentrations approved for the disposal facility performance assessment.
  - **Add volume here** <20 cubic meters