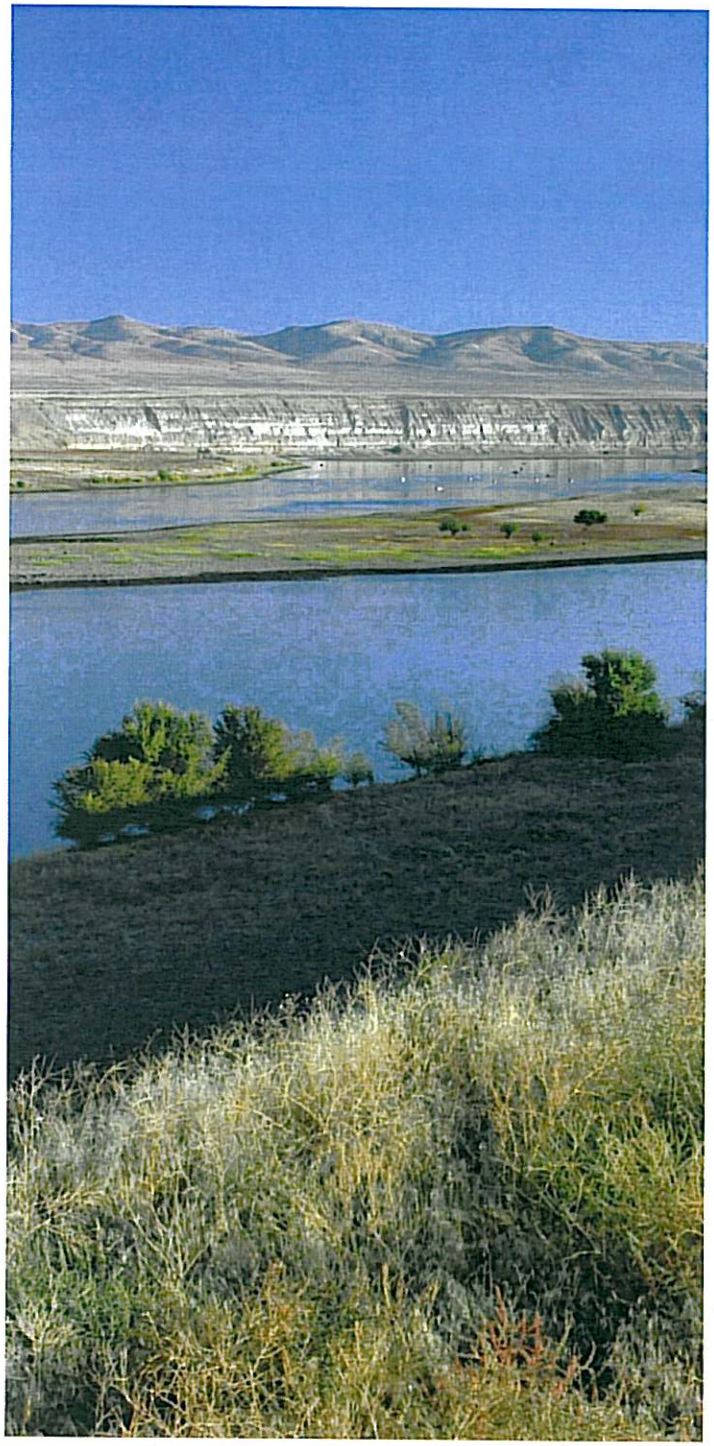


Office of River Protection

High Level Waste
Corporate Board
March 31, 2008

Delmar Noyes
Acting Assistant Manager
Tank Farm Project

U.S. Department of Energy

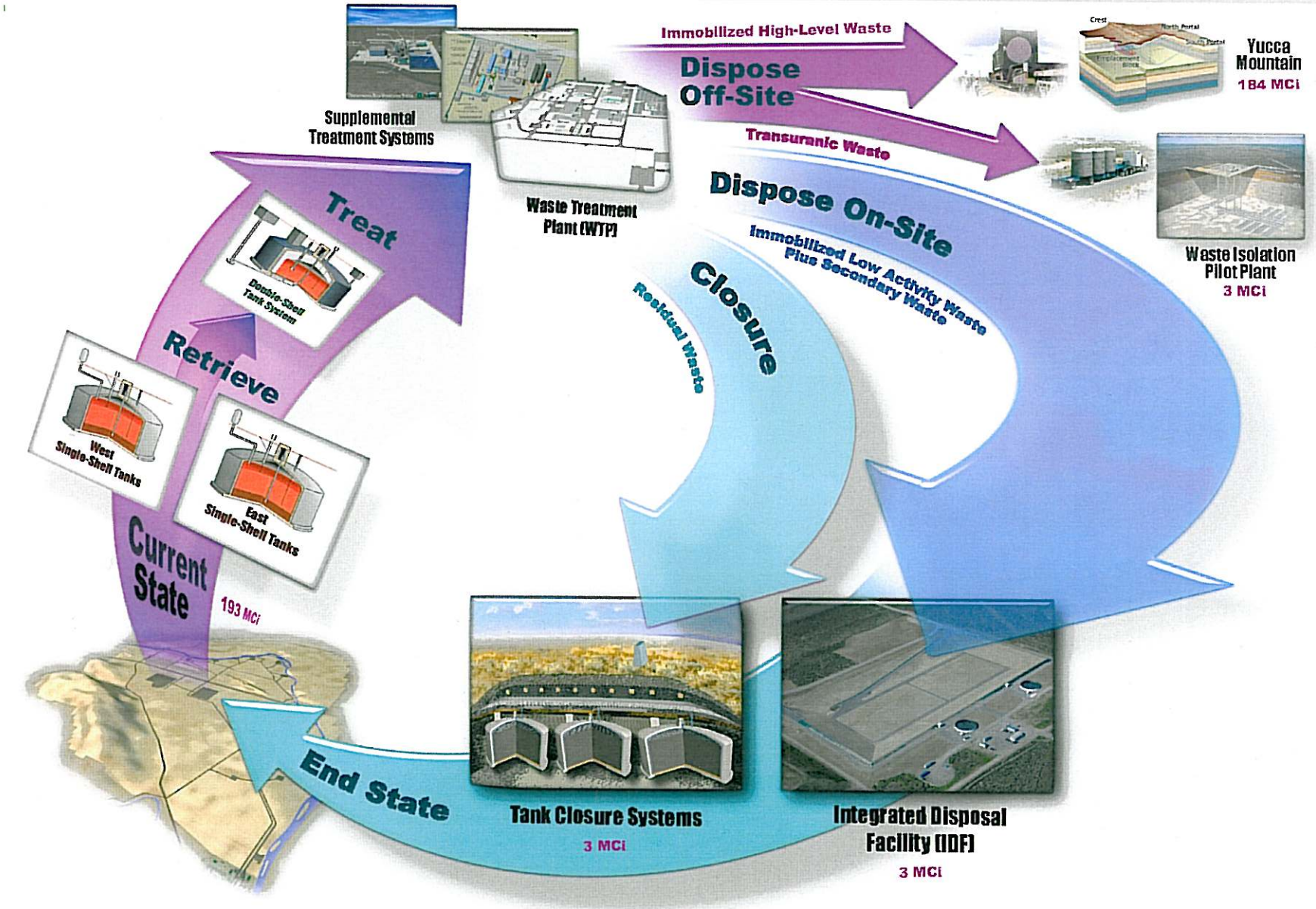
Office of River Protection

Project Scope

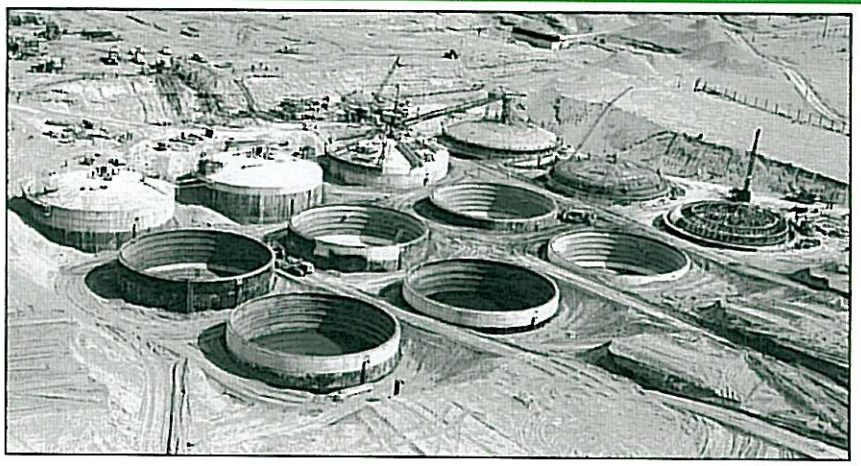
- Storing, retrieving, treating and disposing of tank waste and closing the Tank Farms
- Maintaining Tank Farm infrastructure consisting of 177 underground storage tanks that contain ~53 million gallons of radioactive waste from past processing operations
- Constructing and Operating the Waste Treatment Plant (WTP)
- Decontaminating and Decommissioning the WTP

RPP Mission Life-Cycle

CH2MHILL Office of River Protection



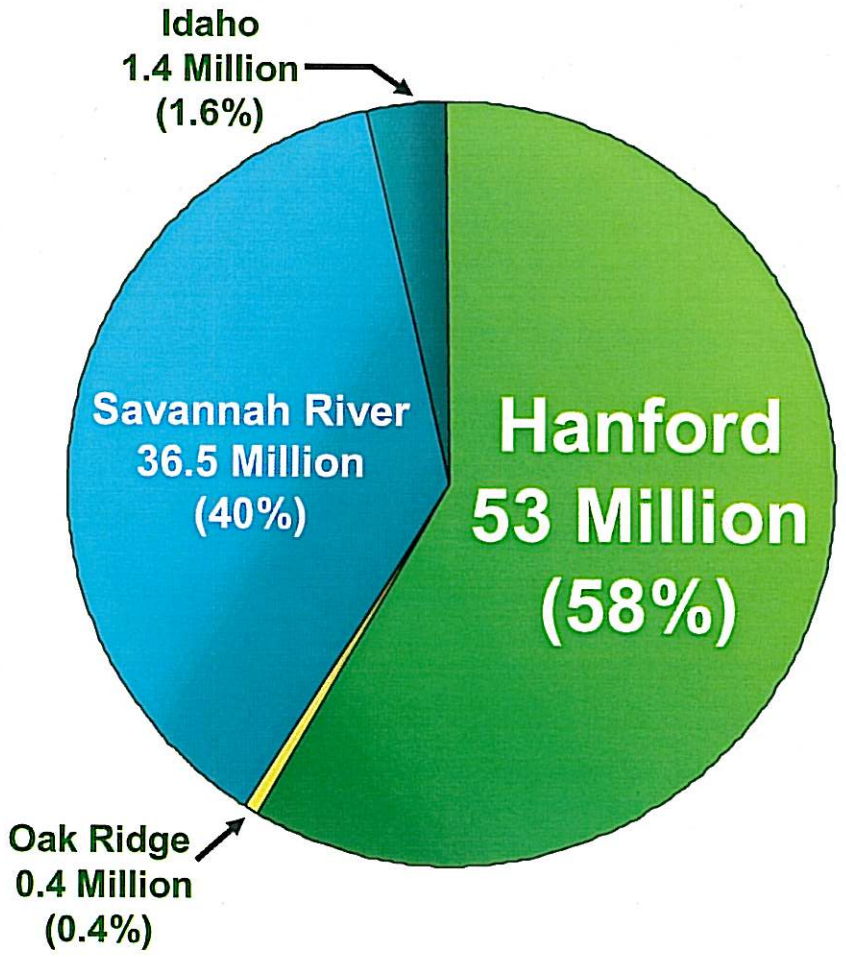
Hanford Tank Waste Cleanup Challenge



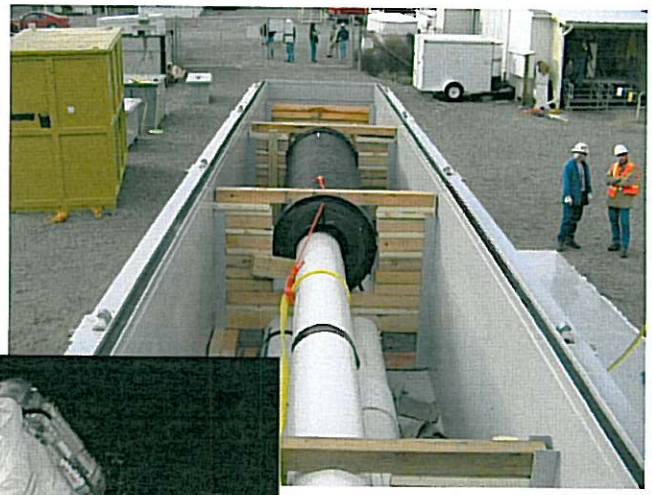
Hanford Site:

- 177 underground storage tanks
  - 149 Single-Shell Tanks
  - 28 Double-Shell Tanks
- ~194 million curies of radioactivity in tanks
- ~190,000 tons of chemicals

Total Number of Gallons in Waste Tanks at DOE Sites:



Hanford Tank Farms



Hanford Tank Farm Overview

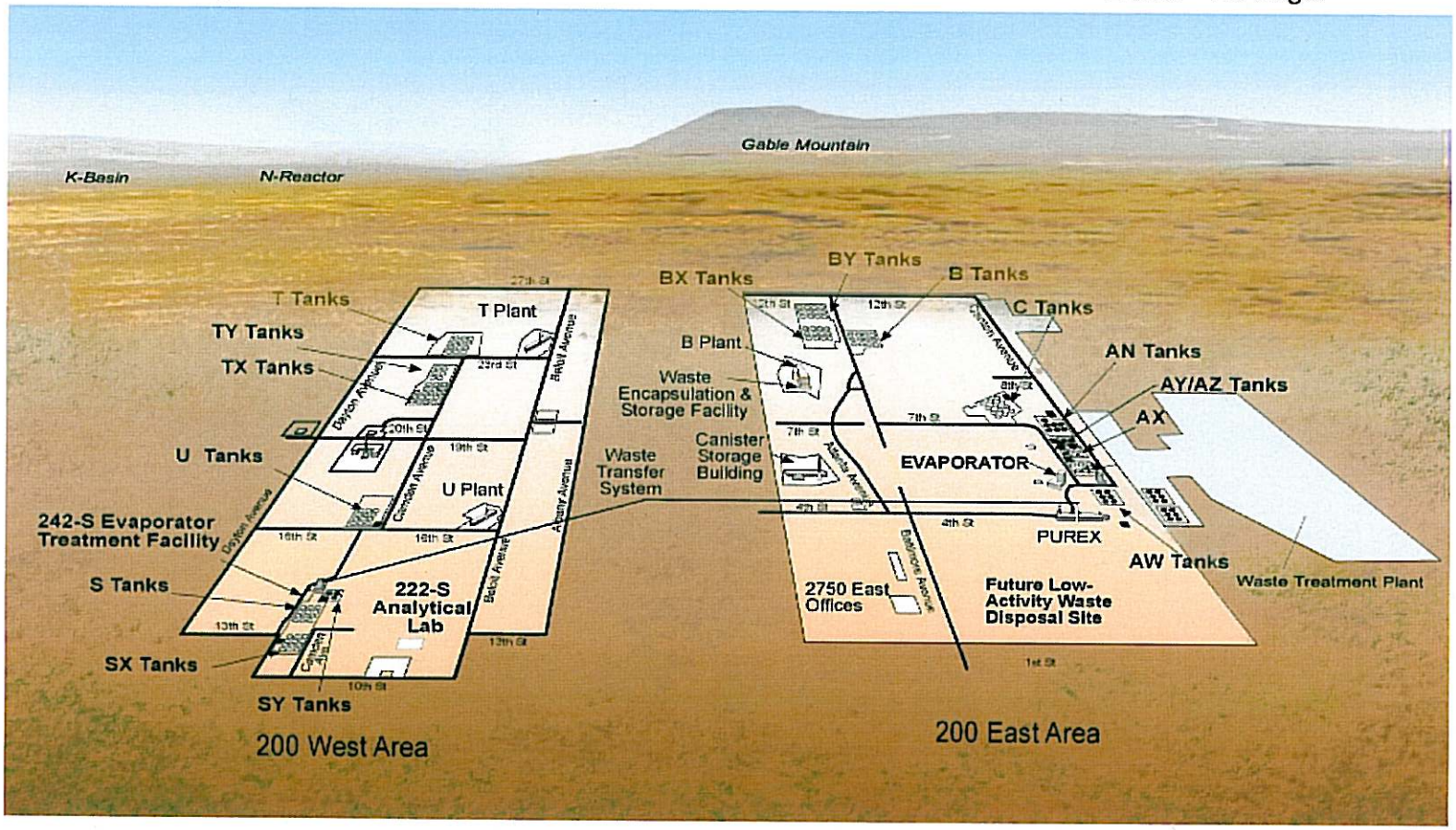
- ~53 million gallons of tank waste
- **177 underground tanks**
  - 149 Single-Shell Tanks (SSTs)
  - 28 Double-Shell Tanks (DSTs)
- **7 SSTs Retrieved to date**

200 West Area

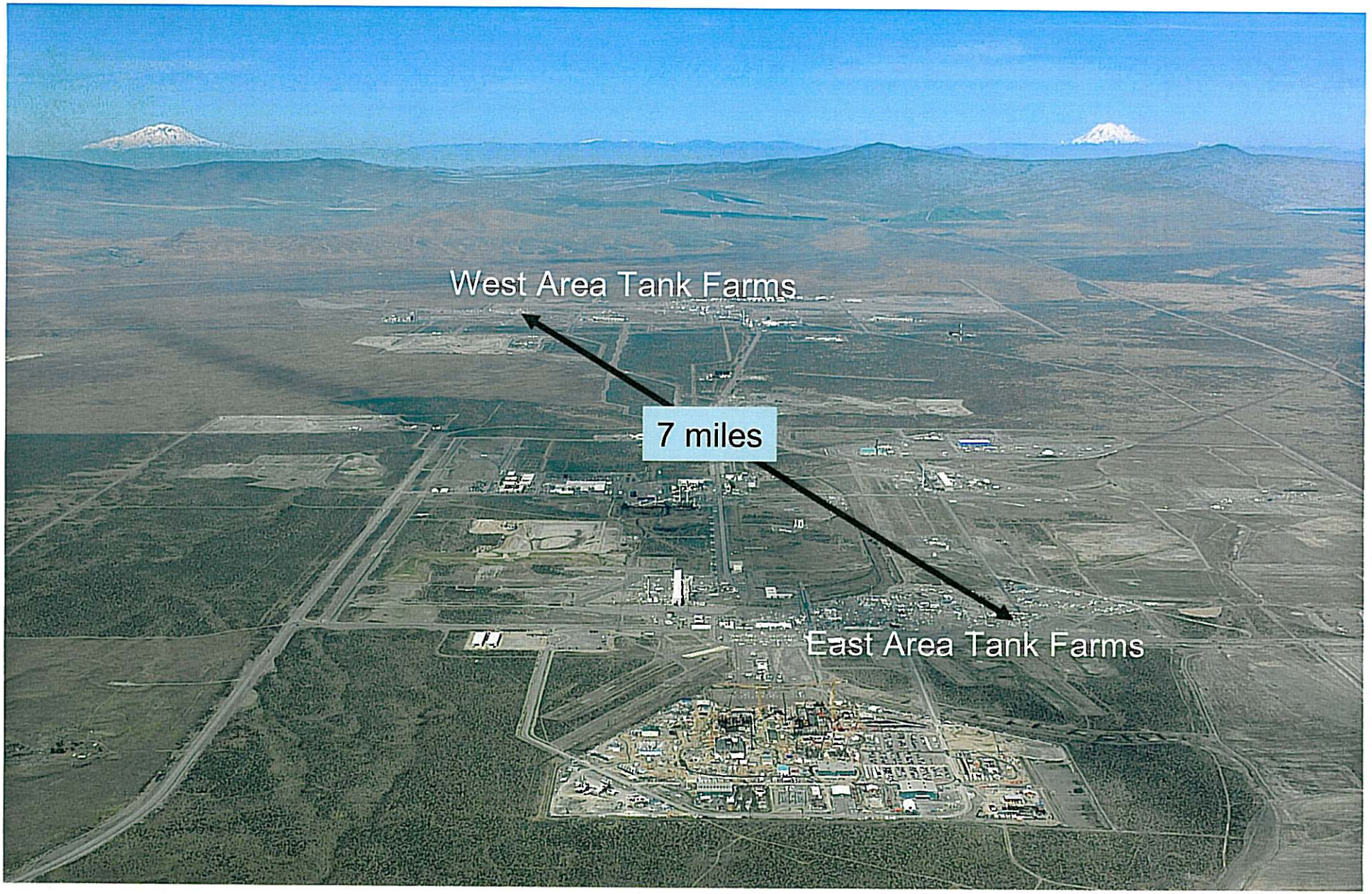
- SSTs = 19 M gal
- DSTs = 2 M gal

200 East Area

- SSTs = 11 M gal
- DSTs = 21 M gal



Hanford 200 Area Plateau



Mission – Our focus remains the same

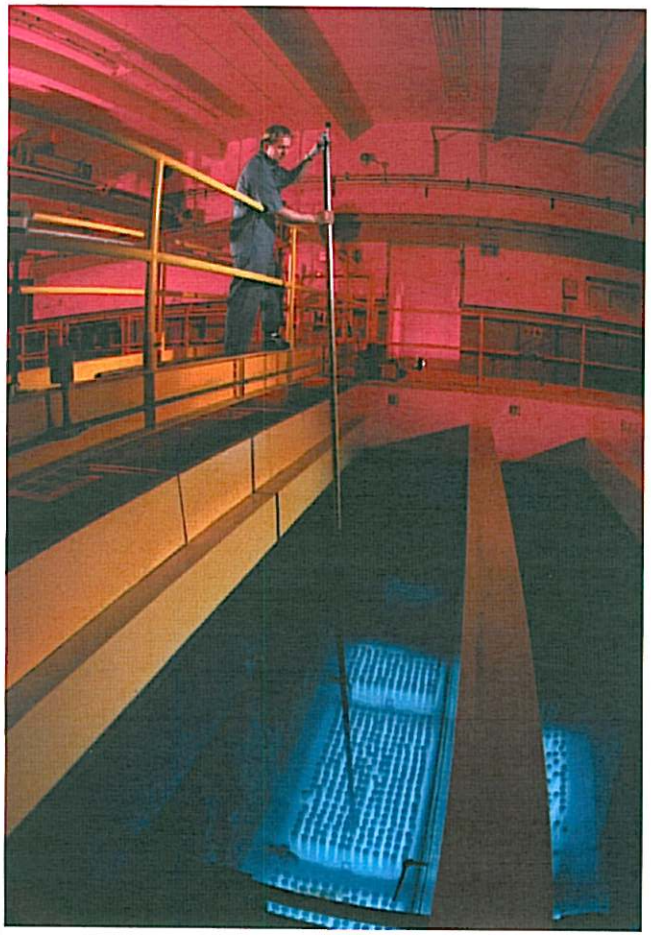
- Cleanup and closure of Tank Farms
  - safe operations
  - maximizing tank retrievals
  - develop and deploy retrieval technologies (10 to date) without compromising double-shell tank space needed for efficient treatment operations
- Construction of the Waste Treatment Plant by 2019; and Low-Activity Waste Vitrification Facility by 2012
- Ensuring adequate infrastructure is in place to feed WTP when it comes online
- Evaluating a viable waste treatment configuration to begin making glass as soon as possible with early LAW or supplemental treatment technologies

Tank Farm Project Status

Transferred over 294,000 gallons of radioactive and hazardous waste from single-shell tanks to safer double-shell tanks

- Seven tanks have been emptied to date
- Processed more than 2 million gallons of waste
  - reducing the waste volume in the double-shell tanks by more than 1.2 million gallons

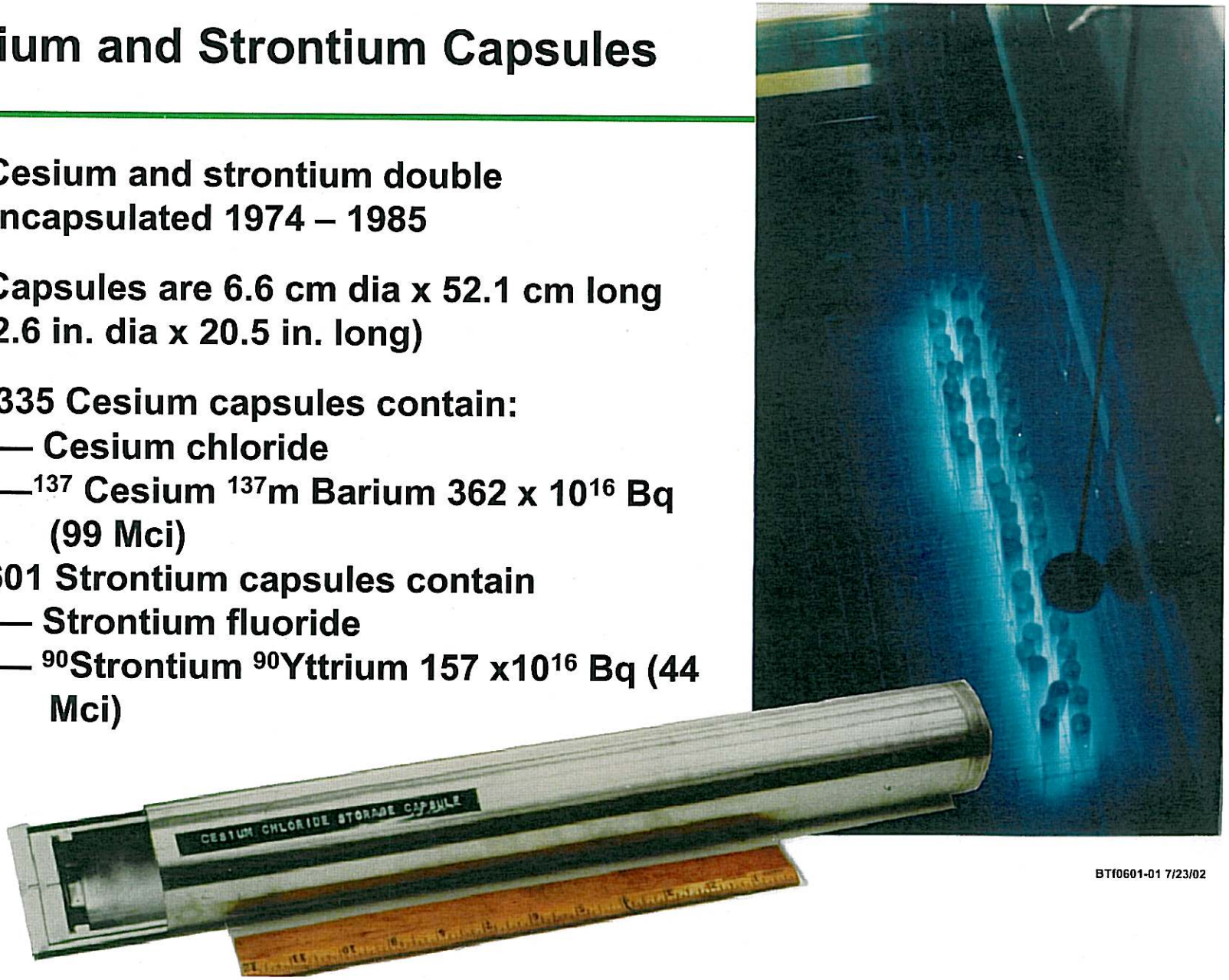
Richland Operations Office
Cesium and Strontium Capsules



- RL is storing the 601 strontium and 1,335 cesium capsules at the Waste Encapsulation and Storage Facility (WESF)
- Capsules are considered HLW
- Baseline planning is to ship directly to the high-level waste repository in DOE Standard Canisters without further processing.
- RL strategy is to seek regulatory relief from RCRA waste designation as preliminary performance assessment modeling indicate that the regulated materials do not present a risk to human health and environment.

Cesium and Strontium Capsules

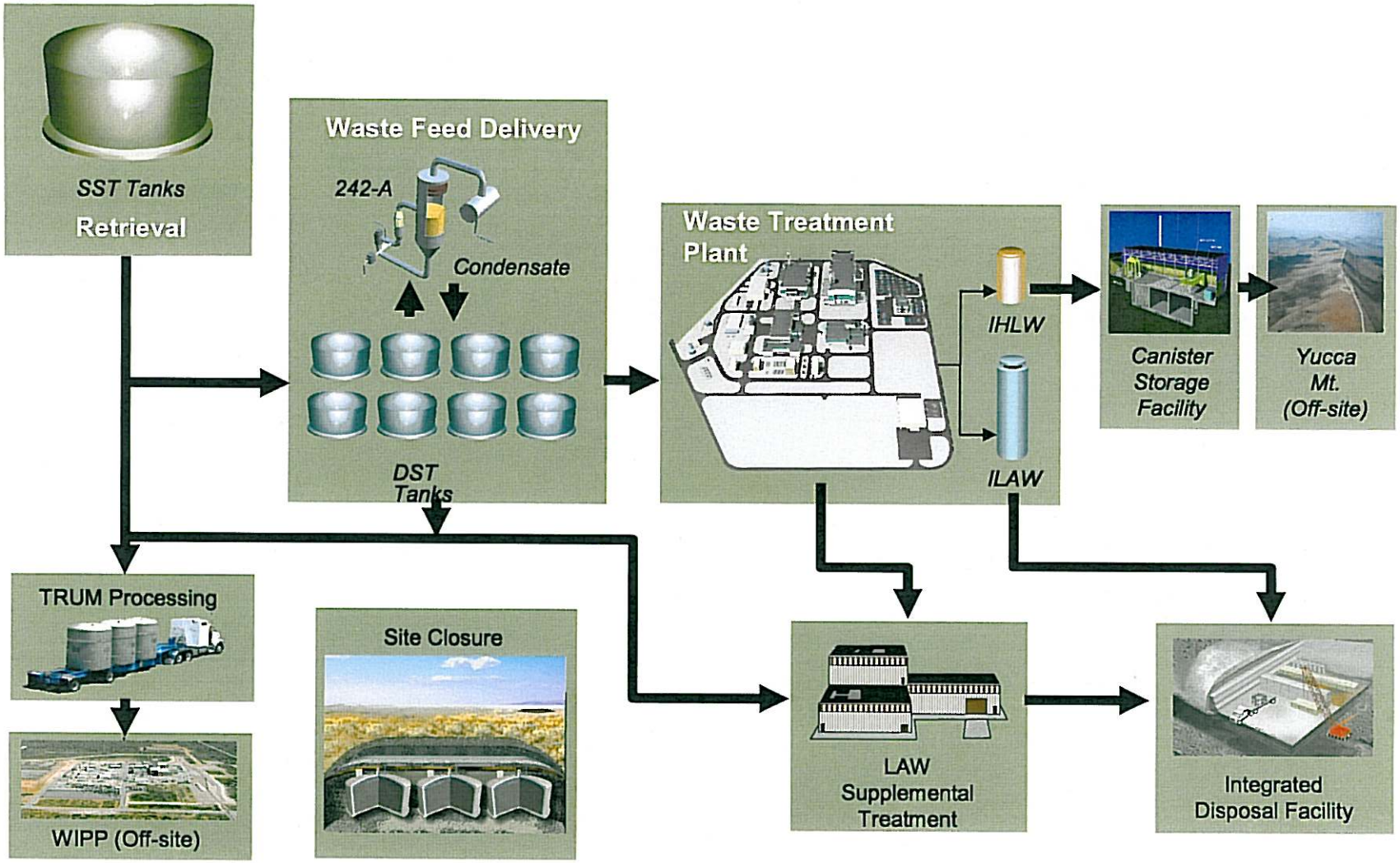
- Cesium and strontium double encapsulated 1974 – 1985
- Capsules are 6.6 cm dia x 52.1 cm long (2.6 in. dia x 20.5 in. long)
- 1335 Cesium capsules contain:
  - — Cesium chloride
  - — ^{137} Cesium ^{137}m Barium 362 x 10^{16} Bq (99 Mci)
- 601 Strontium capsules contain
  - — Strontium fluoride
  - — ^{90}Strontium ^{90}Yttrium 157 x10^{16} Bq (44 Mci)



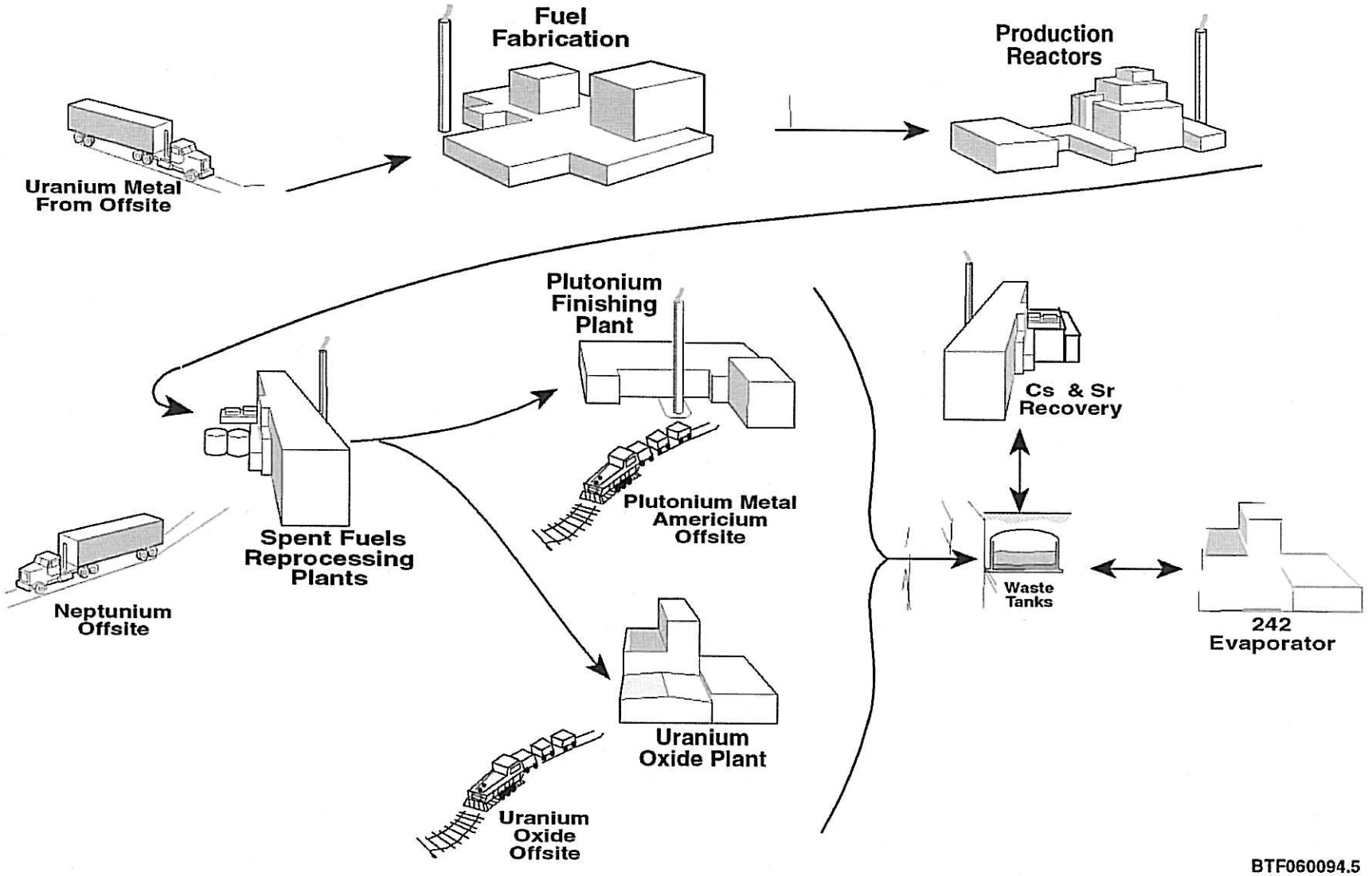
BTf0601-01 7/23/02

Data Source: DOE/RW-006, Rev. 13 1996 Integrated Database
Radionuclides decayed to 12/31/96

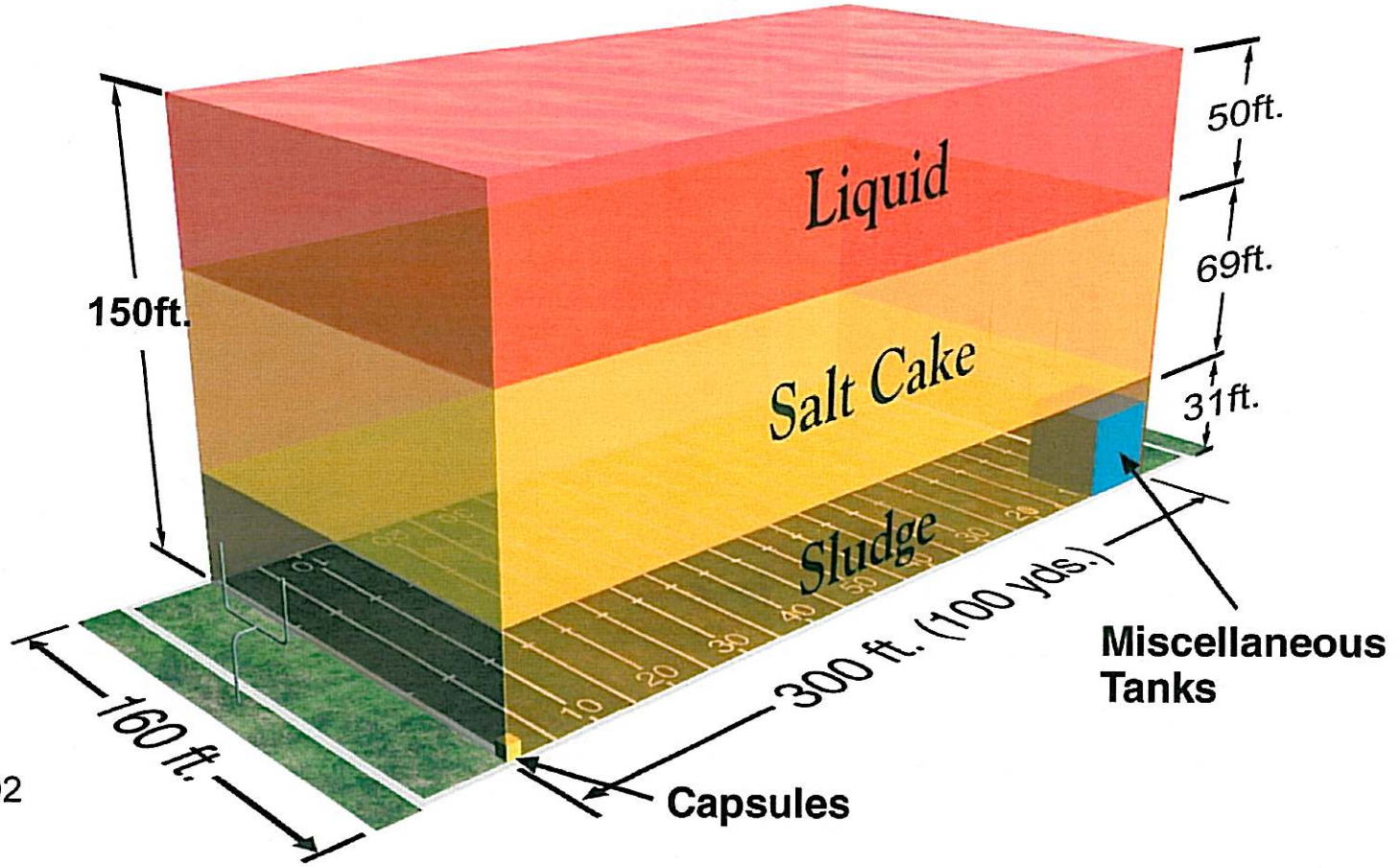
River Protection Project



Hanford Defense Production Facilities (1944 - 1990)

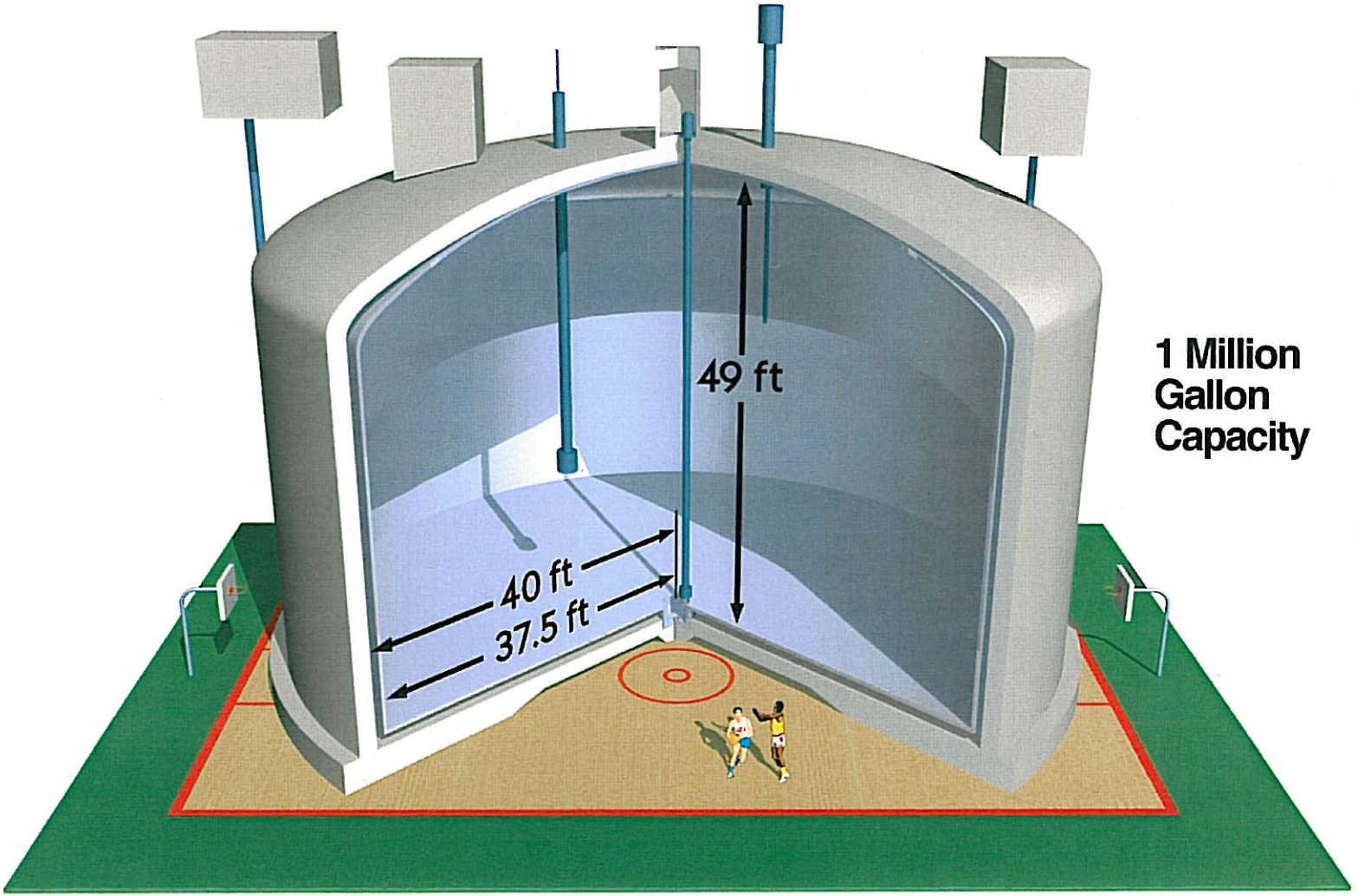


Hanford Tank Waste Would Cover a Football Field 150 Feet Deep

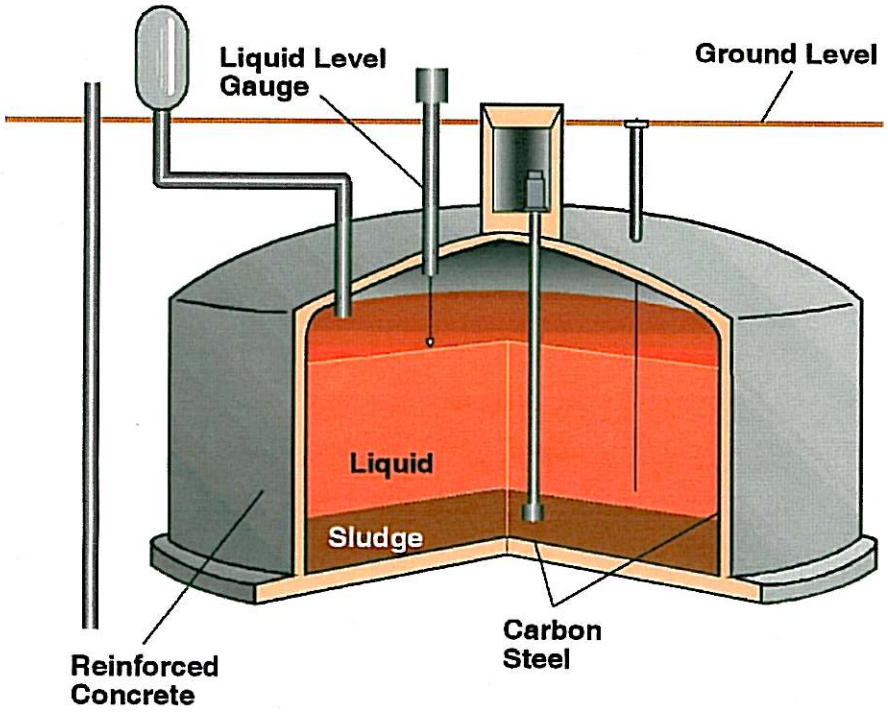


*As of April 2002
7/23/02

Hanford High-level Waste Radioactive Underground Storage Tanks are Large



Single-Shell Tanks



- 149 Tanks Constructed 1943-64
- ~210 m^3 to 3,800 m^3 Capacity (55 kgal to 1 Mgal)
- Bottom of Tanks at Least 50 m (150 Feet) Above Groundwater
- No Waste Added to Tanks Since 1980
- Tanks Currently Contain:

  ~121,000 m^3 (32 Mgal) of Salt Cake, Sludge, and Liquid

  ~370 x 10^{16} Bq (100 MCi)
- 67 Are Assumed to Have Leaked ~ 3,800 m^3 (~1 Mgal)

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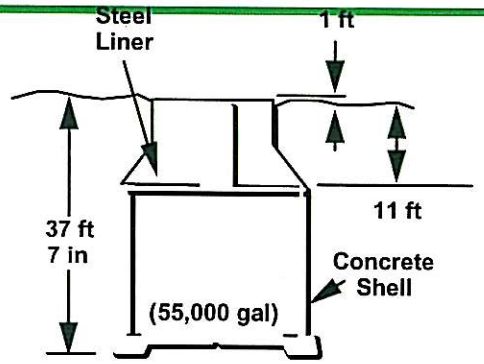
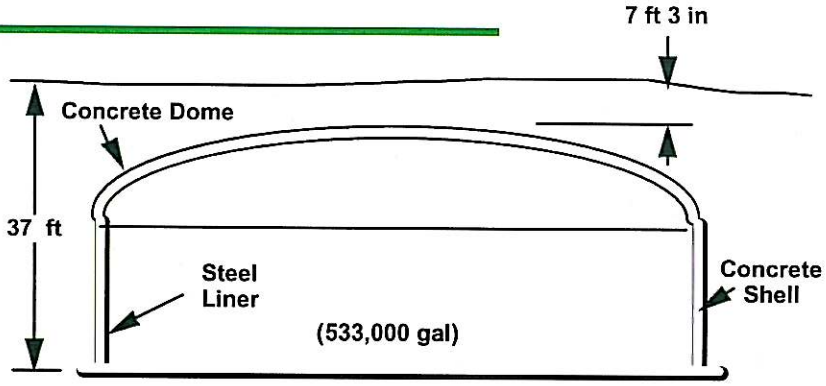
Rev. Date 7/23/02

P 6885

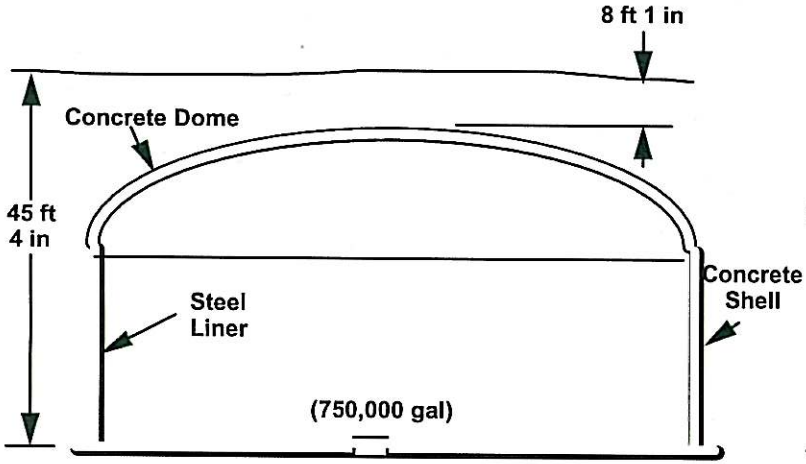
Cross-Sectional Views of Hanford Single-Shell Tanks



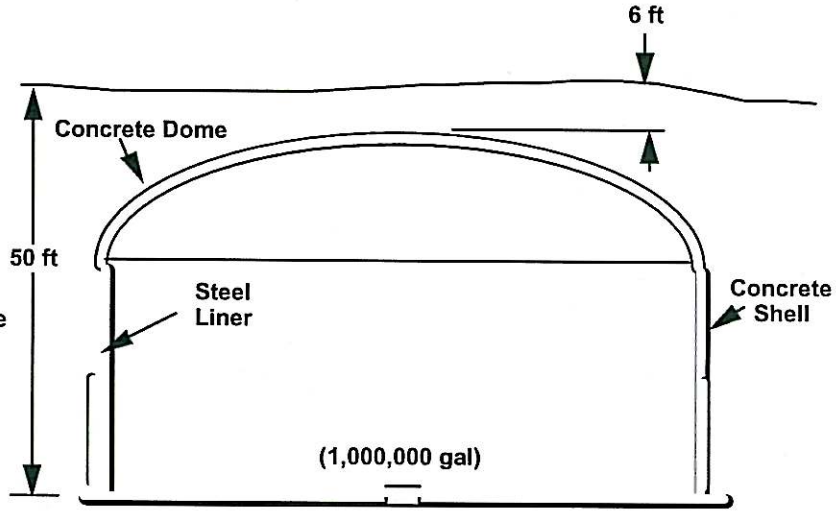
20 ft Diameter Single-Shell Tank



75 ft Diameter Single-Shell Tank



75 ft Diameter Single-Shell Tank



75 ft Diameter Single-Shell Tank

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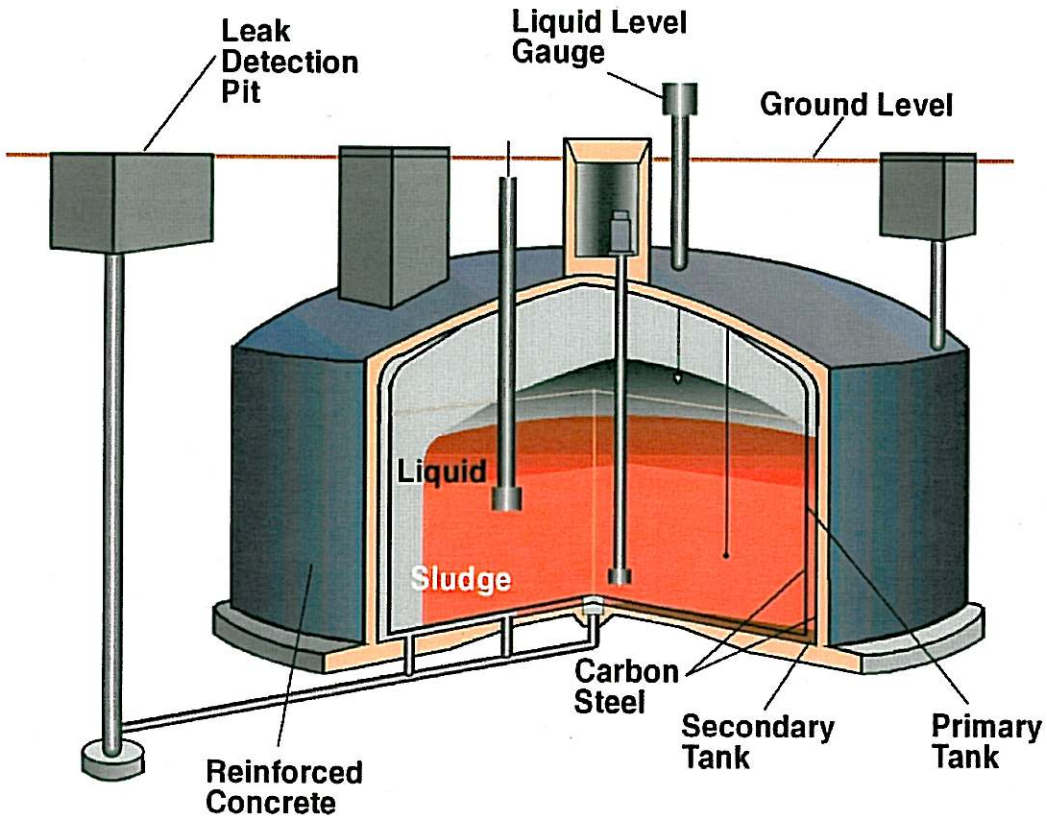
Double-Shell Tanks



- 28 Tanks Constructed Between 1968-86
- ~3,800 m^3 to 4,300 m^3 (1 to 1.14 Mgal) Capacity
- Tanks Currently Contain
  - ~ 83,000 m^3 (22 Mgal) of Mostly Liquids (Also Sludges and Salts)
  - ~ 333 x 10^{16} Bq (90 MCi)
- None Have Leaked

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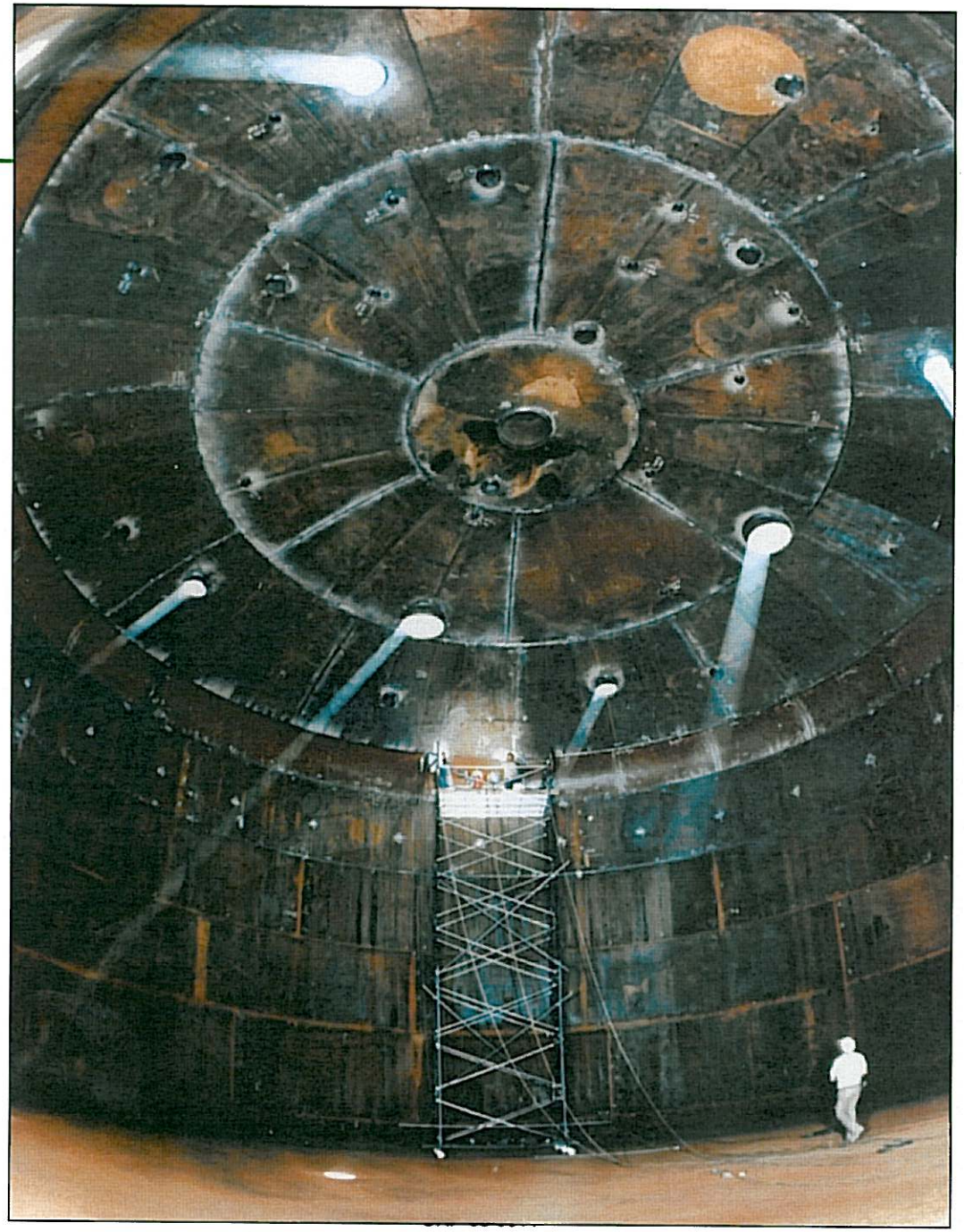
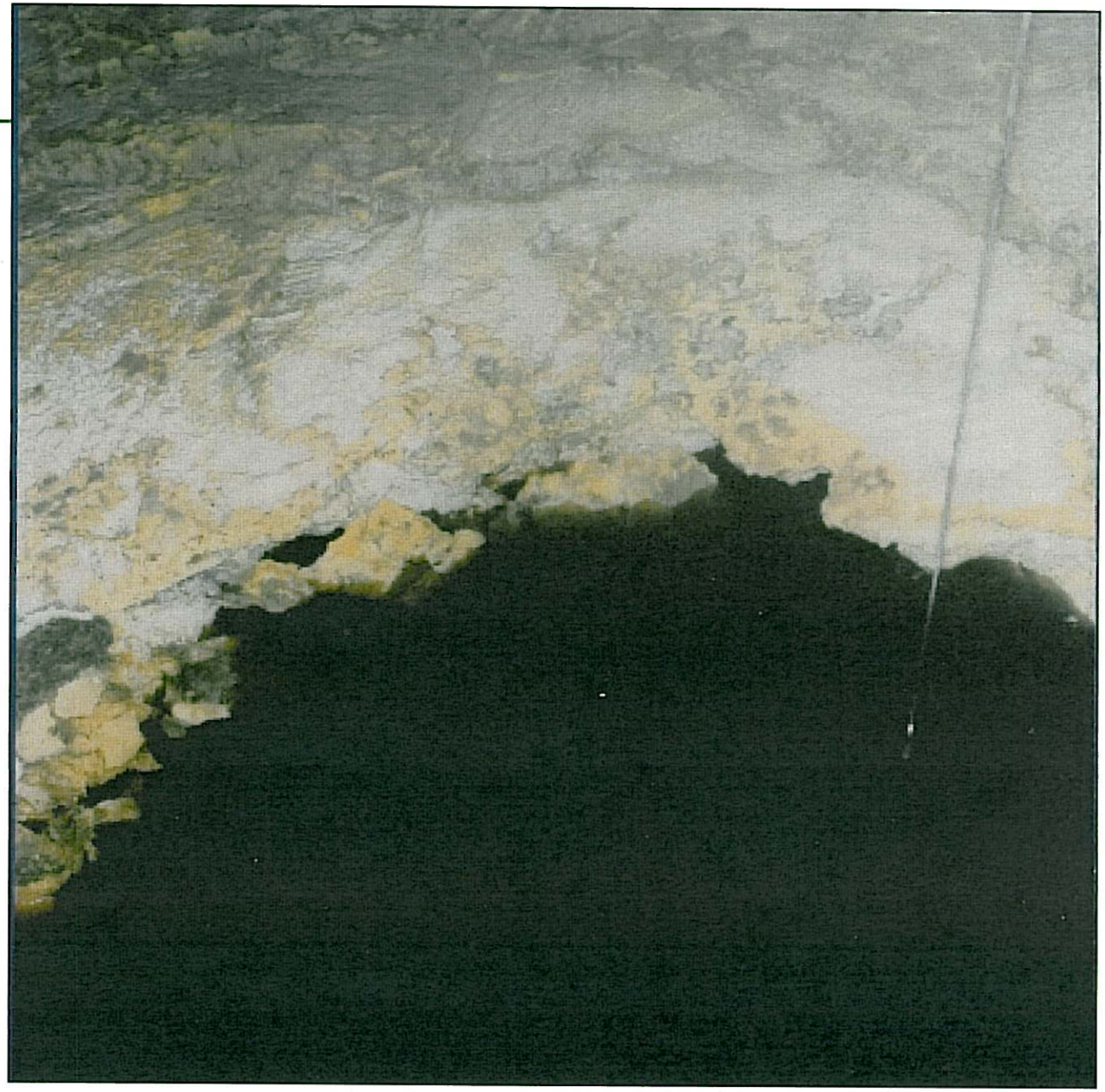
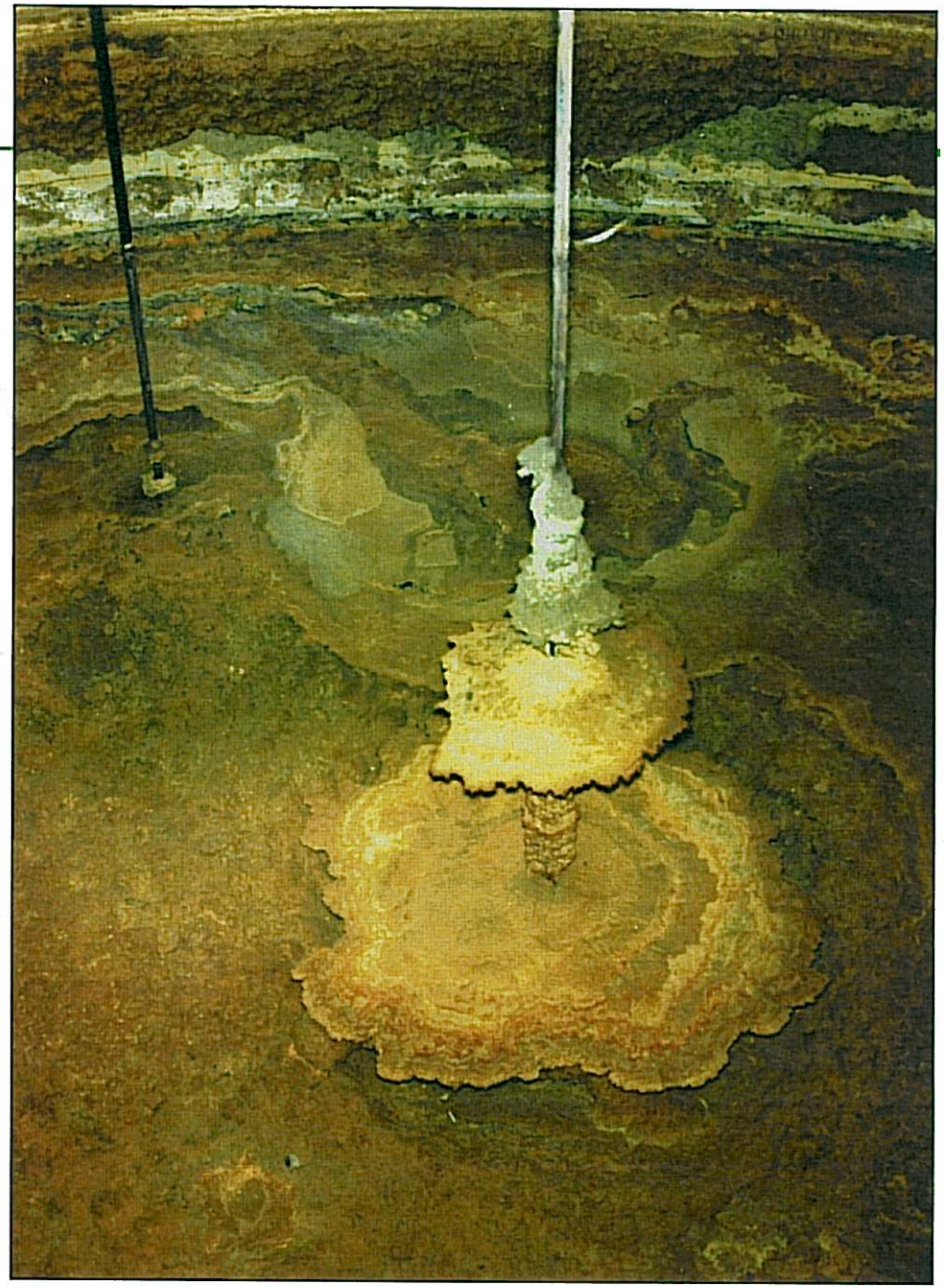
Rev. Date 7/23/02

Double-Shell Tanks under construction







Program History

- 1956: First tank leak discovered
- 1958: First waste treatment plan, calcine 1/3, solidify 2/3 in tanks -- not implemented
- 1960s-1970s: Concern over more tank leaks and lack of tank space, growing interest in radioisotopes
  - Removed primary heat producers (Sr-90 and Cs-137)
  - Operated in-tank solidification systems
  - Encapsulated Sr-90 and Cs-137
  - Constructed double-shell tanks
- 1975: First waste management EIS issued

Program History (cont.)

- 1980: Stopped adding waste to single-shell tanks
- 1983: DOE issues plan. Savannah River HLW first, Hanford second, Idaho third. For Hanford:
  - Retrieve DST waste, divide in two fractions, vitrify HLW for repository disposal, grout LAW and dispose onsite
  - Solidify SST waste and dispose in place
  - EIS preparation started
- 1986: Last eight double-shell tanks constructed

Program History (cont.)

- 1987/1988: EIS/ROD issued. Followed plan except for:
  - Disposal of SST waste in place not acceptable to public
  - SST decision deferred until additional development and evaluation
- 1989: Grout facility immobilized 1 million gallons of waste, Hanford Waste Vitrification Plant designed
- 1989: Tri-Party Agreement signed
- 1990: Tank safety issues identified, 54 tanks placed on "watch list"

Program History (cont.)

- 1991: Secretary Watkins directed formation of the Tank Waste Remediation System as a single project
- 1993: Hanford Waste Vitrification Project terminated because:
  - Tank waste safety issues would take active intervention
  - Modification of existing facility for waste treatment could not achieve full environmental compliance
  - Policy decision to retrieve all tank waste, increased volume of waste to be treated four-fold
- 1994: New strategy developed and Tri-Party Agreement amended

- 1995: Decision to privatize waste treatment
- 1996-97: EIS/ROD issued
  - All waste retrieved and vitrified
  - Project to be done in two phases
  - Decision on capsules deferred
- 1997: Cross-site transfer line constructed
- 1998: Office of River Protection formed
- 1999: Retrieved waste from single-shell tank C-106

- 2000: Privatization terminated and contract awarded
  to Bechtel National Inc.
- 2001: Last tanks removed from the Watch List
- 2002:
  - 133 Single-shell tanks interim stabilized
  - Waste retrieval Cold Test Facility constructed
  - Waste Treatment Plant construction started

CH2MHILL Hanford Group, Inc.

Hanford Tank Cleanup Status

Office of River Protection

Retrieval Summary Updated through July 1, 2007

RETRIEVED

S-112
- Capacity of tank: 758 Kgals
- Completion date: March 29, 2007

C-202
- Capacity of tank: 55 Kgals
- Completion date: August 11, 2005

C-204
- Capacity of tank: 55 Kgals
- Completion date: December 11, 2006

C-203
- Capacity of tank: 55 Kgals
- Completion date: March 24, 2005

C-103
- Capacity of tank: 530 Kgals
- Completion date: November 1, 2006

C-106
- Capacity of tank: 530 Kgals
- Completion date December 31, 2003

C-201
- Capacity of tank: 55 Kgals
- Completion date: March 23, 2006

IN PROGRESS

C-109
- Capacity of tank: 530 Kgals
- Retrieval started: June 19, 2007
- Volume of waste to be removed: 63 Kgals

C-108
- Capacity of tank: 530 Kgals
- Retrieval started: December 20,2006
- Volume of waste to be removed: 66 Kgals

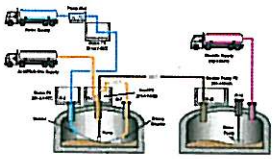
S-102
- Capacity of tank: 758 Kgals
- Retrieval started: December 17, 2004
- Volume of waste to be removed: 464 Kgals

NEXT IN LINE

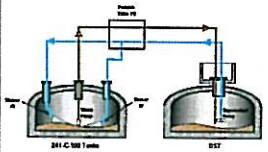
C-104
- Capacity of tank: 530 Kgals
- Volume of waste to be removed: 259 Kgals
- Retrieval to begin: FY 2008

C-110
- Capacity of tank: 530 Kgals
- Volume of waste to be removed: 178 Kgals
- Retrieval to begin: FY 2008

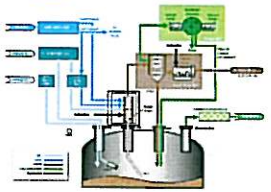
Acid Dissolution



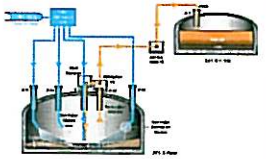
Modified Sluicing



Vacuum Retrieval



Saltcake Dissolution

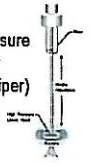


Remote Water Lance (Salt Mantis)

Mobile Retrieval Tool (Sand Mantis)

Mobile Retrieval Tool (Foldtrack)

High Pressure Mixer (Rotary Viper)



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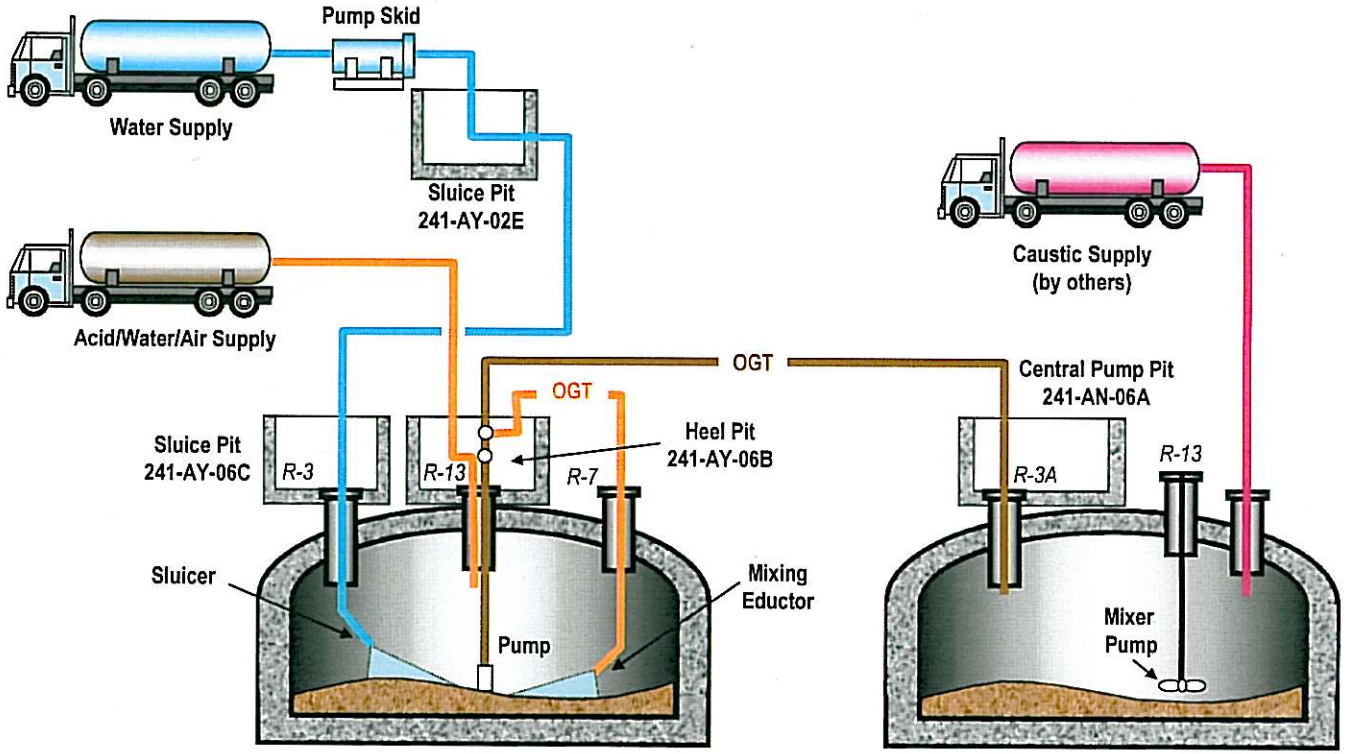
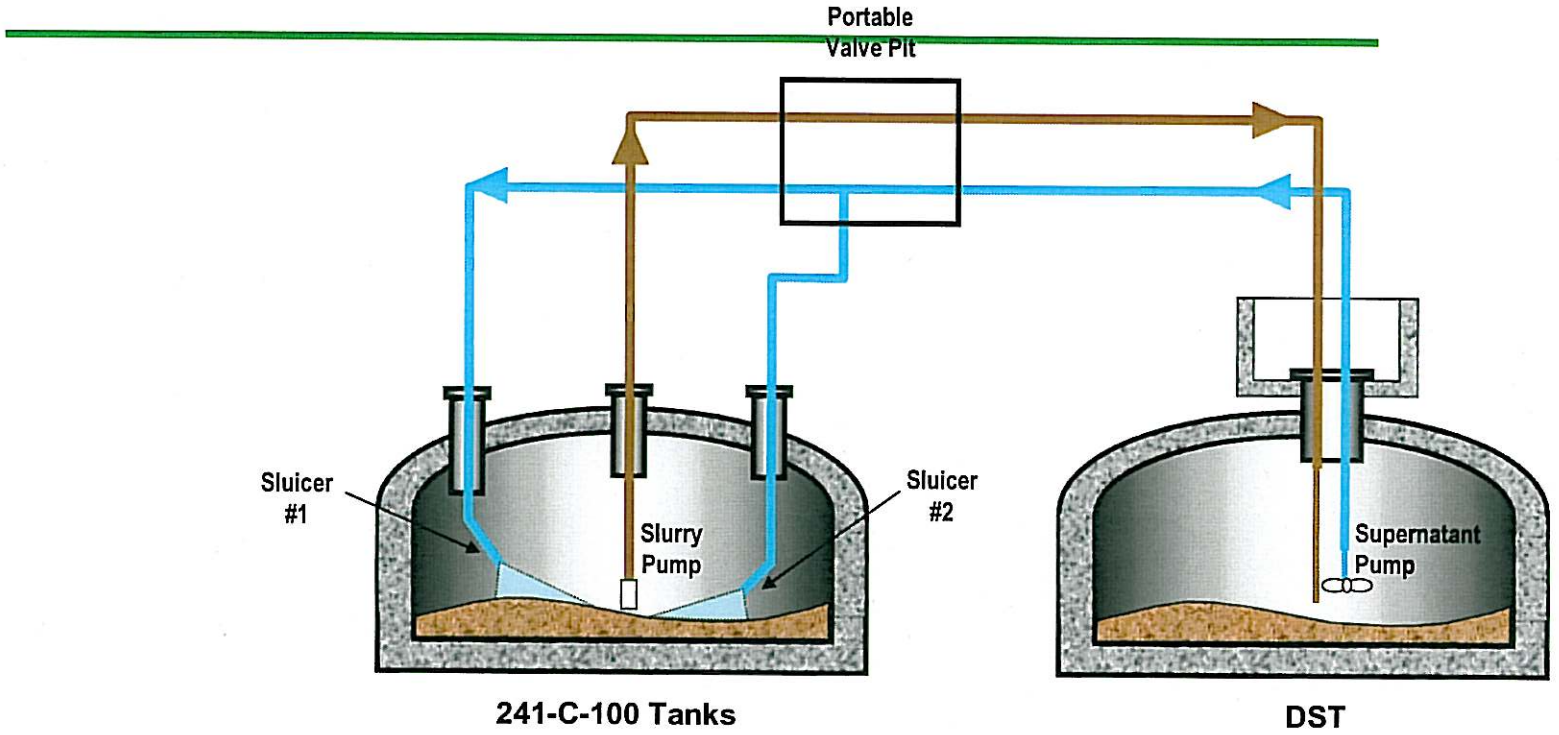
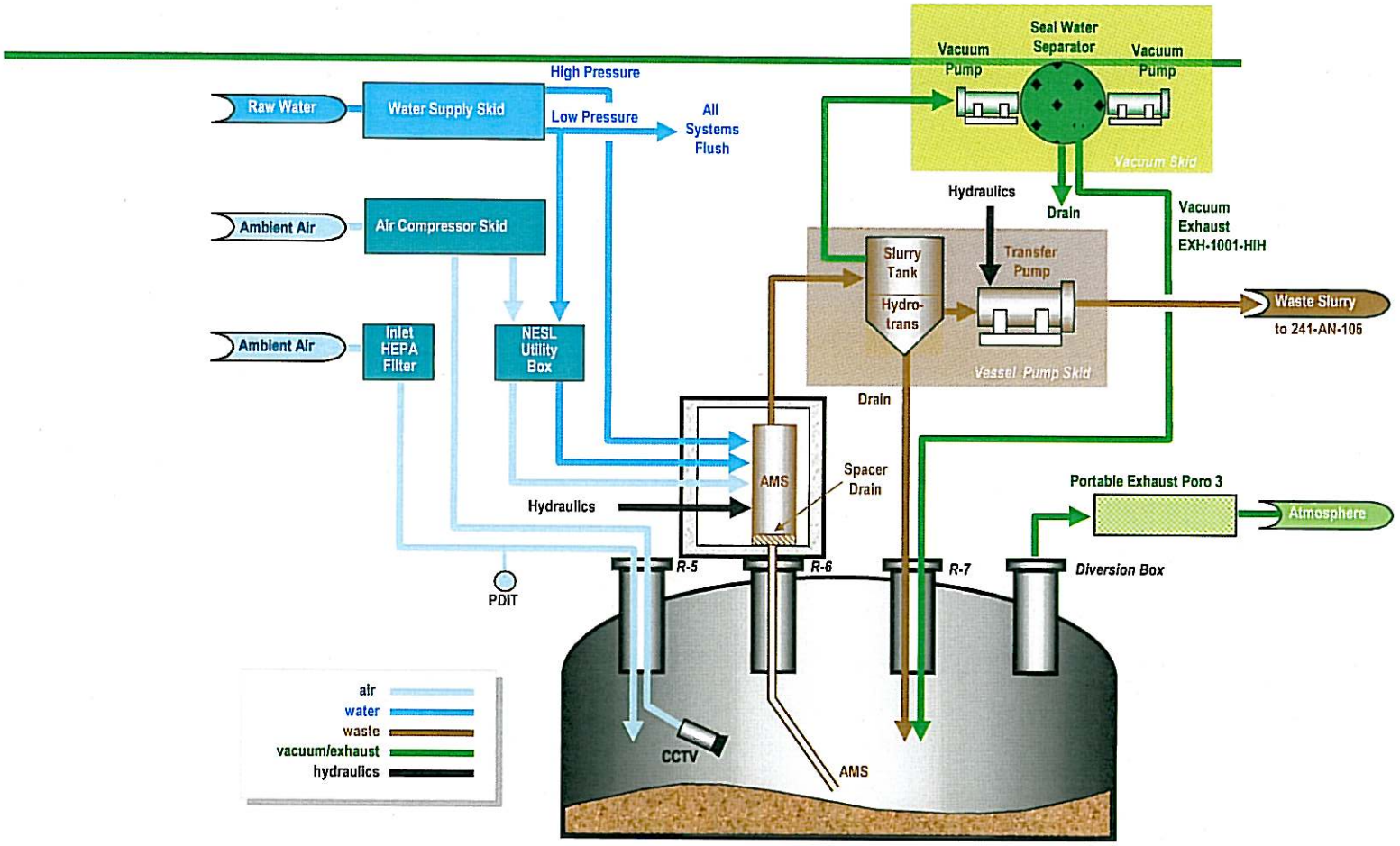


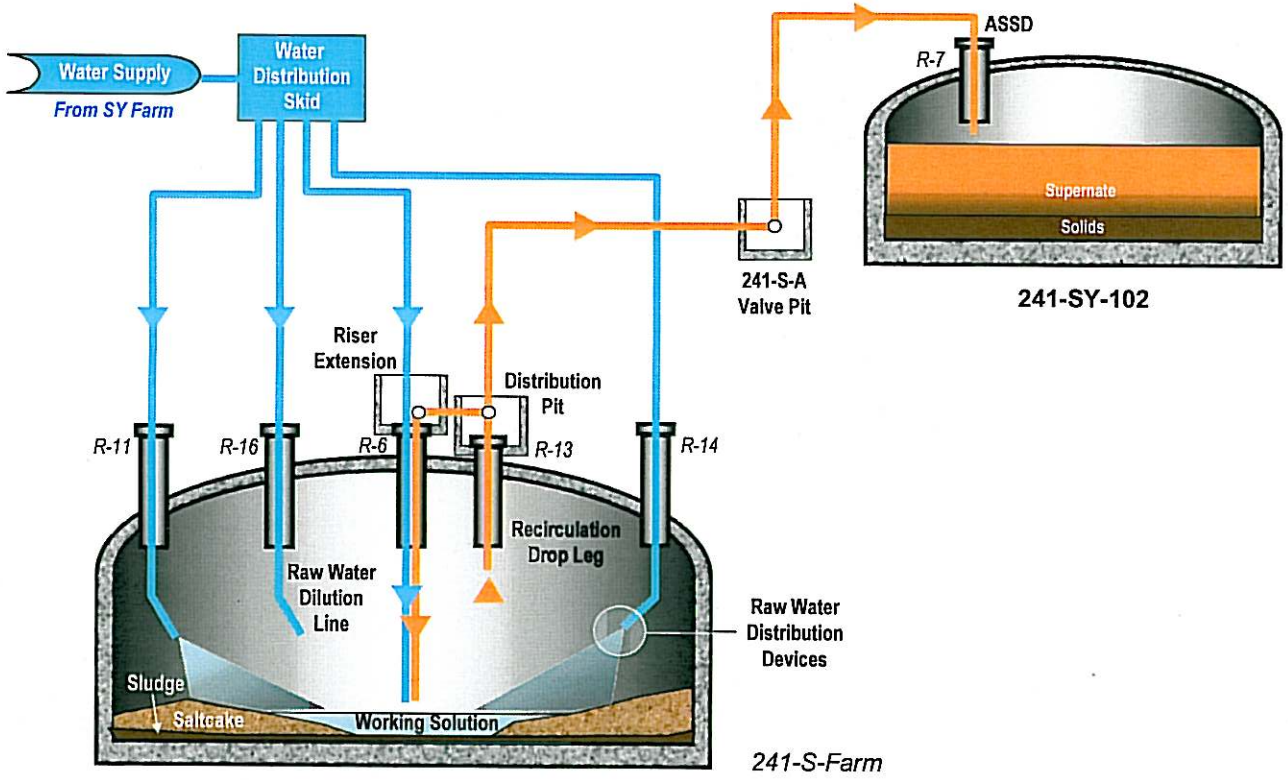
Acid Dissolution



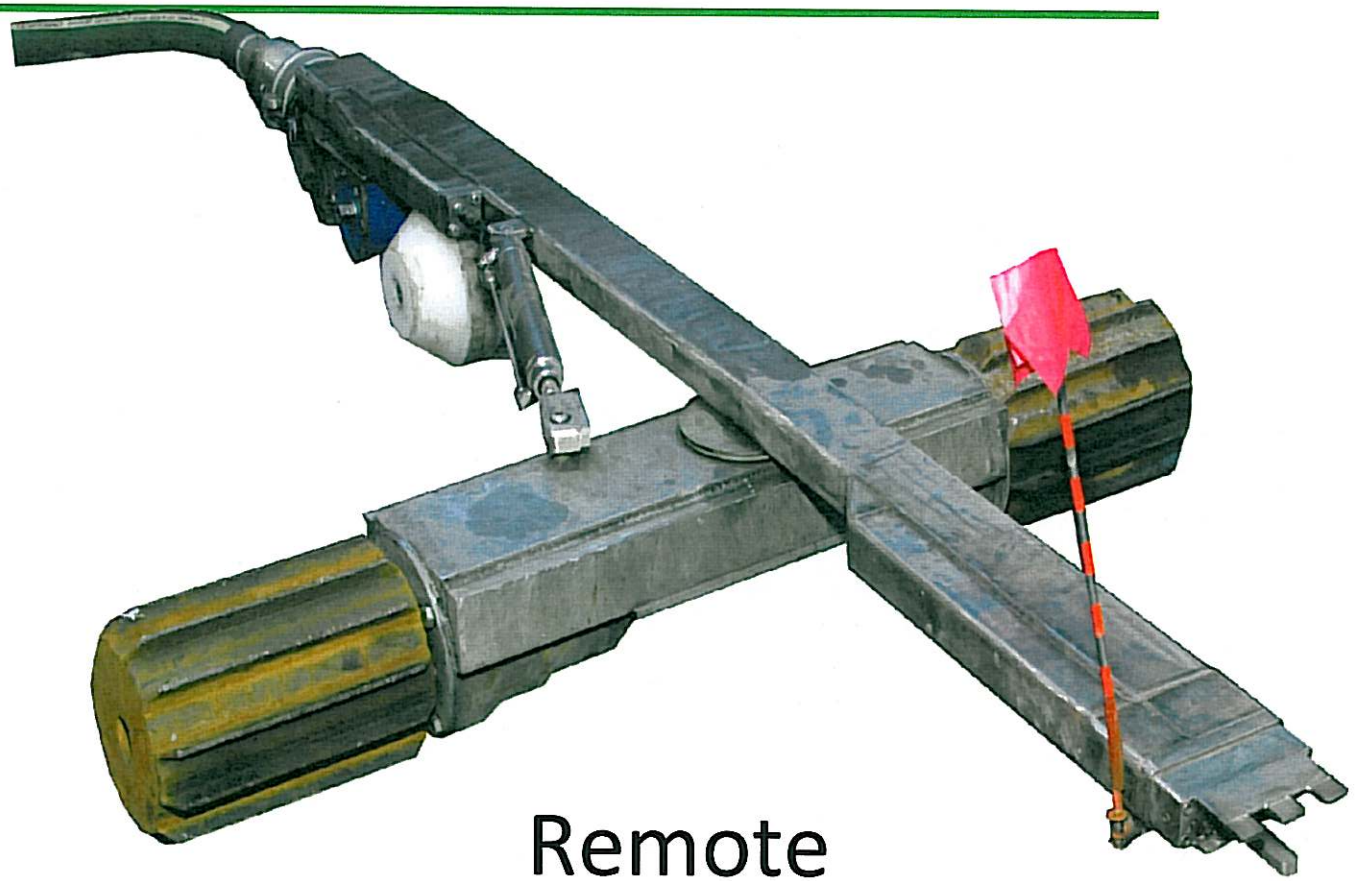
Modified Sluicing



Vacuum Retrieval



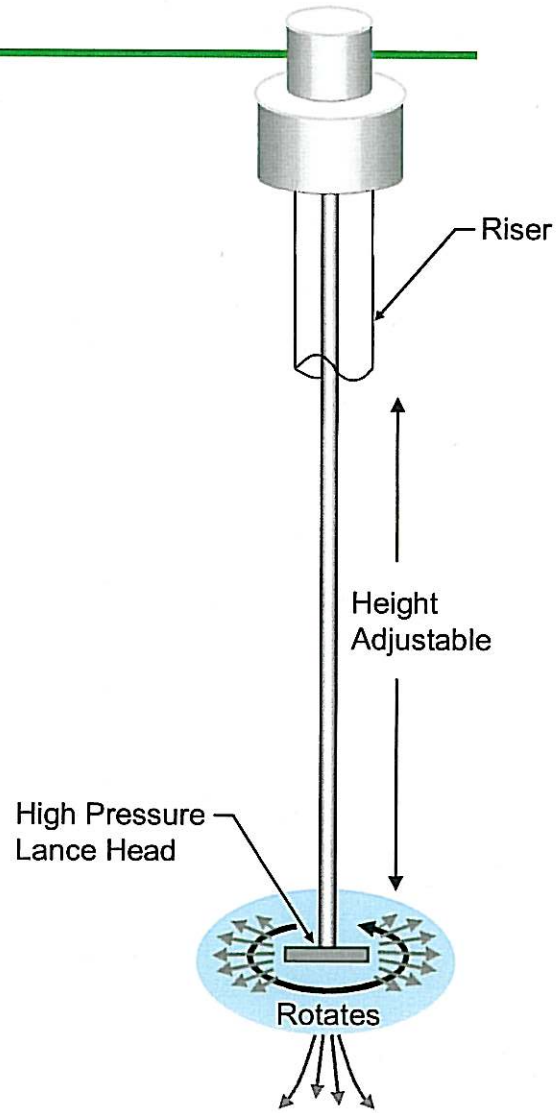
Saltcake Dissolution



Remote Water Lance (Salt Mantis)

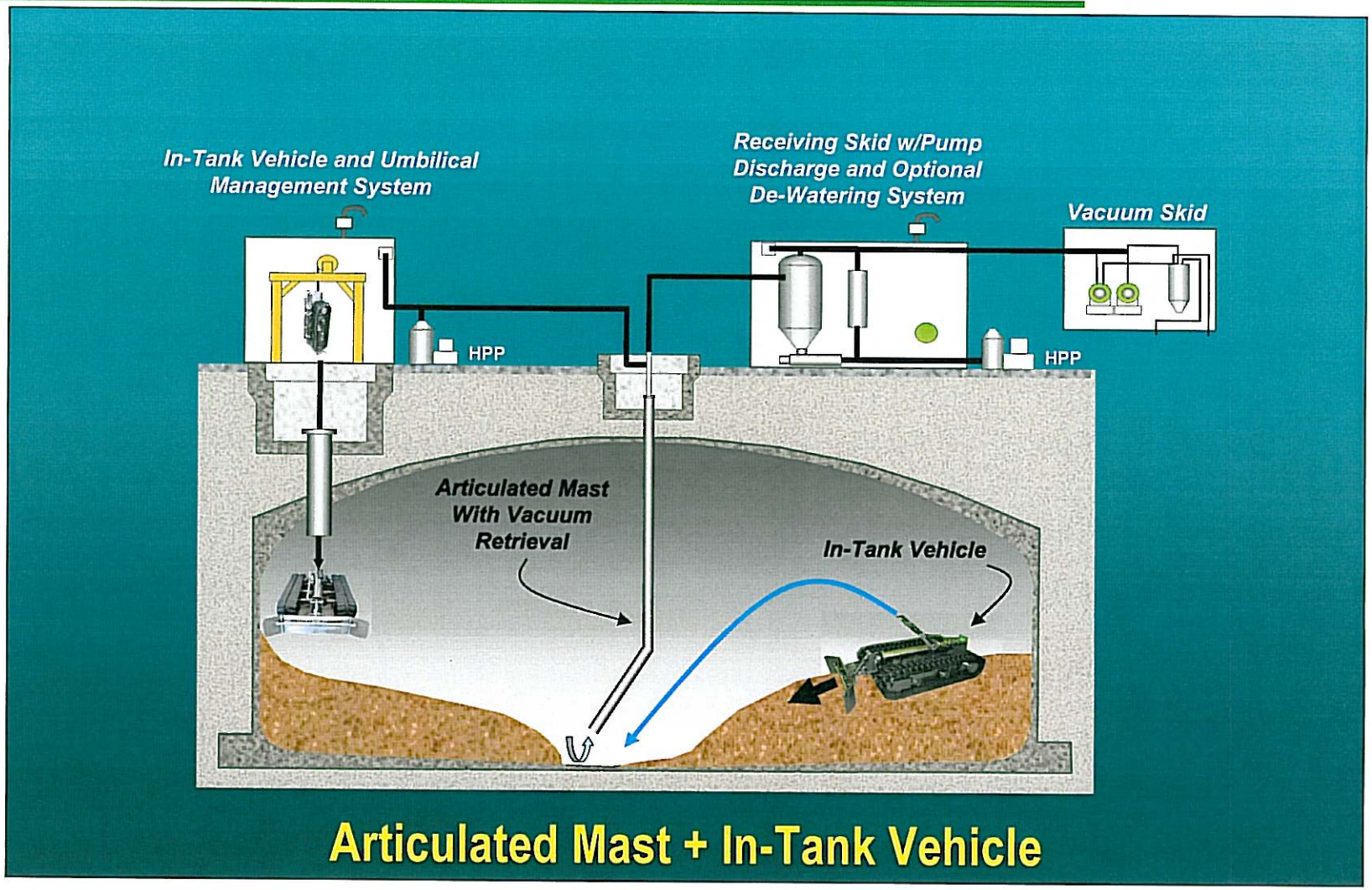
Mobile Retrieval Tool (Sand Mantis)

High Pressure Mixer (Rotary Viper)



Mobile Retrieval Tool (FoldTrack)

Mobile Retrieval System - Future

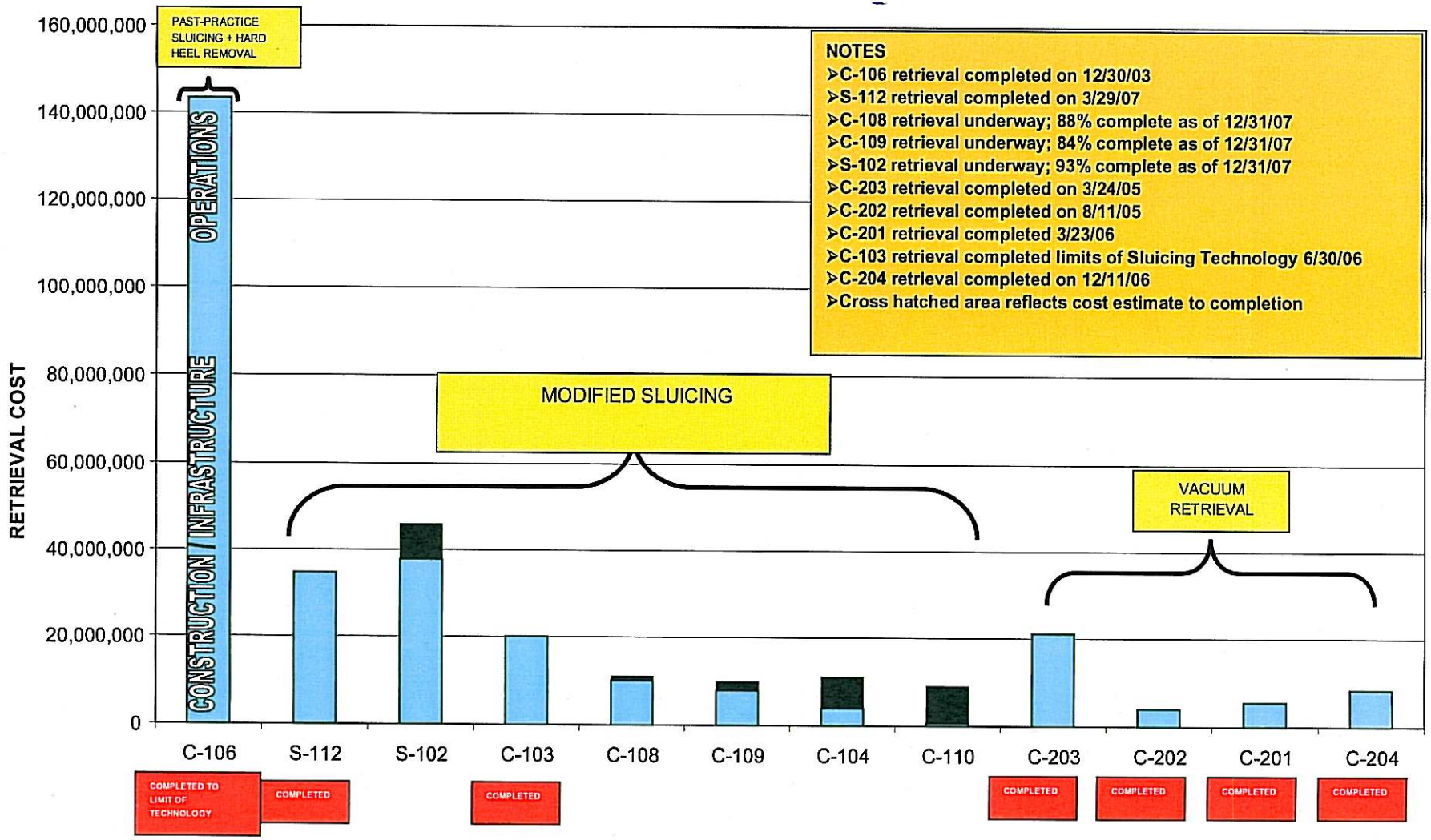


- Tank Space
  - Waste will remain in most SSTs longer consistent with extended treatment mission duration
  - SST Integrity Program to provide improved information
  - DST space to retrieve SST wastes limited until WTP startup
- Retrievals
  - Limited to ~ one SST retrieval per year until WTP startup
  - Early LAW potentially enables 5 – 10 additional SST retrievals before full WTP startup
  - Improved technologies desirable;
    - hard heel removal
    - known and suspected leaker tanks
- Tank Closure
  - No closures envisioned prior to TC&WM EIS ROD
  - TPA Appendix I identifies RCRA closure process
  - DOE must determine tank residuals are not HLW prior to closure

How is the Vitrified Waste Stored?

- High Level Waste Canisters
  - 2' x 14.5'
  - 6,600 pounds of glass
  - Temporarily stored in Hanford's Canister Storage Building until national repository built
  - Plan to generate 12,000 – 15,000 canisters
- Low Activity Waste Containers
  - 4' x 7.5'
  - 13,000 pounds of glass
  - Stored at Hanford's Central Plateau
  - Plan to generate 30,000 – 40,000 Containers

Better, Faster, Cheaper



- Multiple waste forms create multiple sampling challenges
  - Supernatant liquid
  - Interstitial liquid
  - Sludge
  - Saltcake
  - Slurry

Chemical Sampling

- Grab Sampling
- Finger Trap
- Core Sampling

Residual Waste Sampling

- Off-Riser Sampling
- Alligator

Off-Riser Sampler

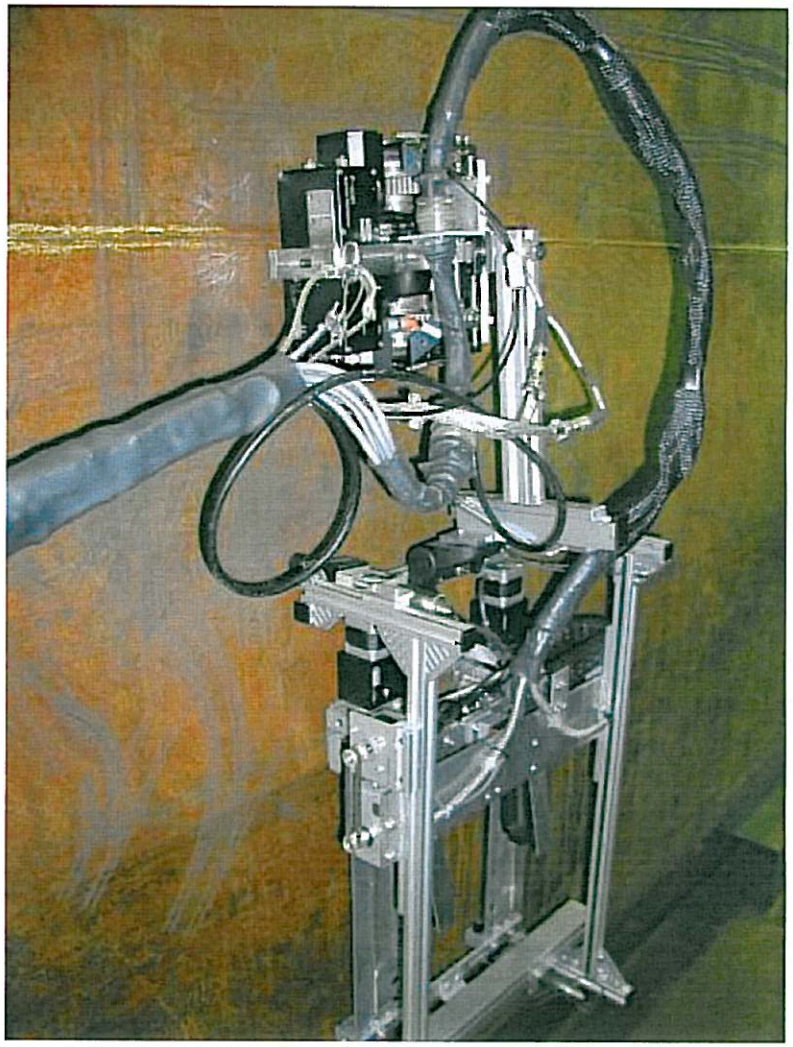
Alligator

Sampling Outside the Tanks

- Direct Push
- Boreholes

Continued Waste Management

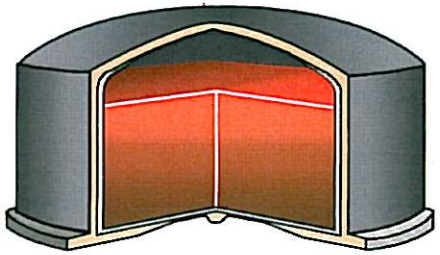
- Ultrasonic testing of double-shell tanks
- Cold Test Facility



Where do we go From Here?

- New technologies will be vital to maintain retrieval progress
- Complete retrieval of C-109
- Initiate retrievals in C-104 and C-110
- Major upgrades to 242-A Evaporator
- Organizational realignment to meet the challenges of the future
  - Waste retrieval
  - Waste management
  - Infrastructure maintenance

The Plan: Send ~97% of Radioactivity and ~5% of Waste Volume to Yucca Mountain



Initial Waste Volume:

8 M gal HLW

42 M gal LAW

Previously Removed - Cs/Sr Capsules and German Logs [Repository Disposal]

Vitrification and SF/HLW Repository Disposal (Yucca Mountain)

330 M Ci

14 M gal → ***WTP LAW Vitrification***

28 M gal → ***Any One or Combination of:***

- ***Bulk Vitrification***
- ***WTP LAW Vitrification***

~5-10 M Ci

3 M gal TRU → ***Package for WIPP Disposal***

Eliminates 1500 HLW Canisters

Waste Remaining in All Tanks:

~0.5 M gal residuals @ 99% retrieval

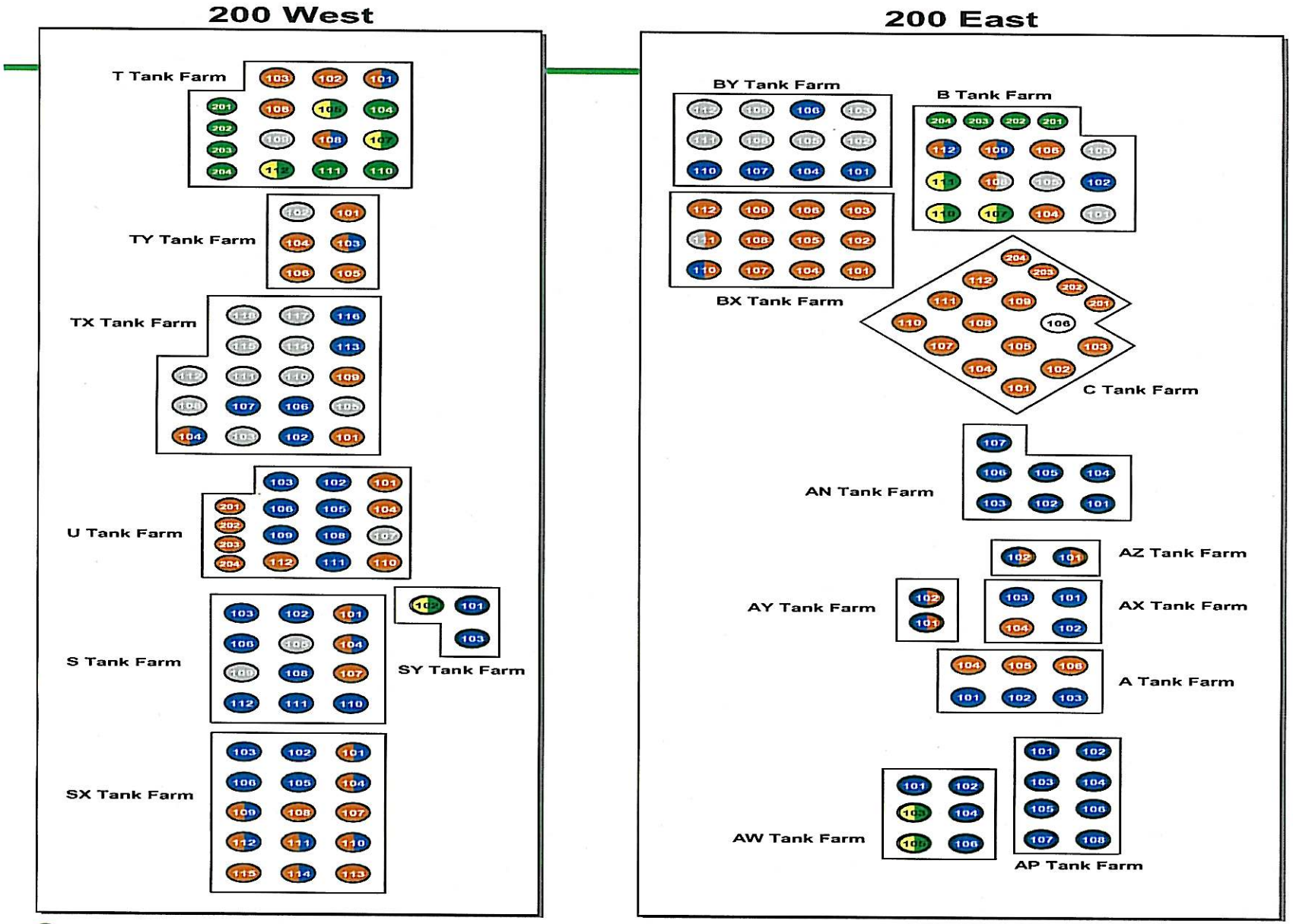
~1-2 MCi

Extensive Tank Characterization Completed

- **Over 600 tank samples taken since 1994**
- **Hanford Historical Process Model allows projection of sample data to all tank contents**
- **Extensive library of tank data**
- **Over 1M analytical records**
- **Over 40M cells of data; 634 chemical constituents and physical properties included**
  - **Best Basis Inventory estimates for all tanks (sampled and projected)**
  - **Analytical results from tank samples**
  - **Tank vapor sample data, temperatures and waste levels**
  - **Ongoing sampling to support operation**

We know what's in the tanks

TANK TREATMENT & DISPOSAL PATHWAYS



- Primarily Saltcake or Supernatant– ILAW Feed
- Primarily Sludge – HLW Feed
- RH -TRU
- Contact Handled – TRU Tanks
- Low Curie Feed – Supplemental Treatment
- Retrieval Complete

CHG0404-03
1-13-05

Background

- Tank waste to be disposed through several pathways
  - WTP-HLW - Supplemental treatment
  - WTP-LAW - TRU
- Two types of WTP waste feed
  - LAW (Soluble saltcake and supernatant)
  - HLW (Insoluble sludges and cesium removed from supernatants)
- Retrievals planned based on keeping LAW and HLW process rates balanced
  - Evaluated using Hanford Tank Waste Operations Simulator (HTWOS) model
- Feed conditions and constraints described in Interface Control Documents (ICD-19)

Hanford Tank Waste Operations Simulator

General Input (Independent Pedigree)

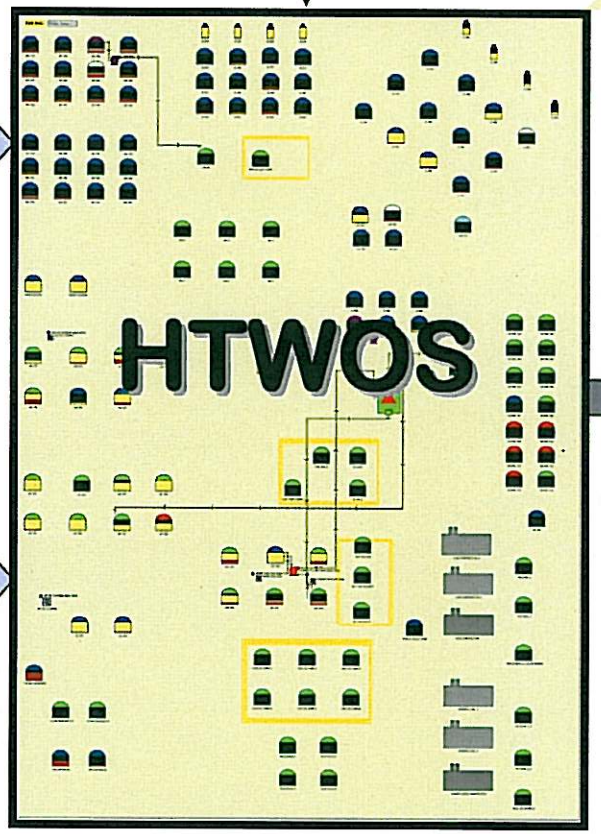
- Best Basis Inventory
- Historic Waste Transfers
- Radioactive Decay Data
- Waste Wash Factors
- Caustic Leach Factors
- Tank Specific Flowsheets
- HLW Glass Properties Model
- LAW Glass Formulation Model

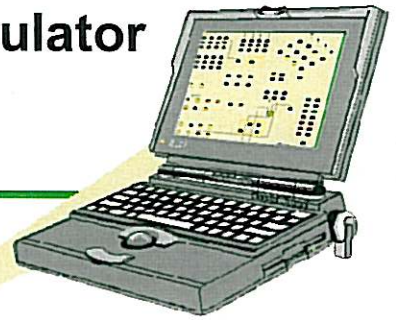
Case-Specific Input

- Customer's Key Planning Assumptions
- Equipment and Systems Constraints
- DST Tank Usage Allocations
- Non-waste Sodium Additions
- Capacities and Rates
- Near-term Waste Transfers
- Treatment Processes
- Conditioned Cs/Sr Capsule Inventory

WTP Detailed Model

Optional Iterations





Results (some require post-processing)

- Feed Vector (Comp., Quantity, And Dates)
- Total Glass Production And Glass v. Time
- DST Space Usage and Volume v. Time
- Projected Waste Transfers
- SST Retrieval Sequence and Timing
- Feed Envelope Assessment
- Progress Towards 2018 Milestone
- SST Risk Reduction v. Time
- SST Retrieval End Date
- Waste Treatment End Date
- Equipment Need Dates
- Input For Funding Profiles

Simulates Waste Treatment Mission

- Mix Streams
- Partition Streams (Evaporator, IX, S/L Separation, Wash & Leach)
- Rule Based
- Dynamic (time-varying flows and compositions, discrete events)

Subject to Constraints

- Tank Space
- Production Rates
- Transfer Rates
- Equipment Availability
- Simultaneous Transfers
- Other Relevant Constraints

Not Addressed

- Reaction Kinetics
- Thermodynamics
- Heat Transfer
- WTP Details (internal stream compositions, cycle time, non-waste sodium additions, tank sizing and utilization, actual pretreatment throughput impact on melter)

Background

- Tank waste to be disposed through several pathways
  - WTP-HLW - Supplemental treatment
  - WTP-LAW - TRU
- Two types of WTP waste feed
  - LAW (Soluble saltcake and supernatant)
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- Retrievals planned based on keeping LAW and HLW process rates balanced
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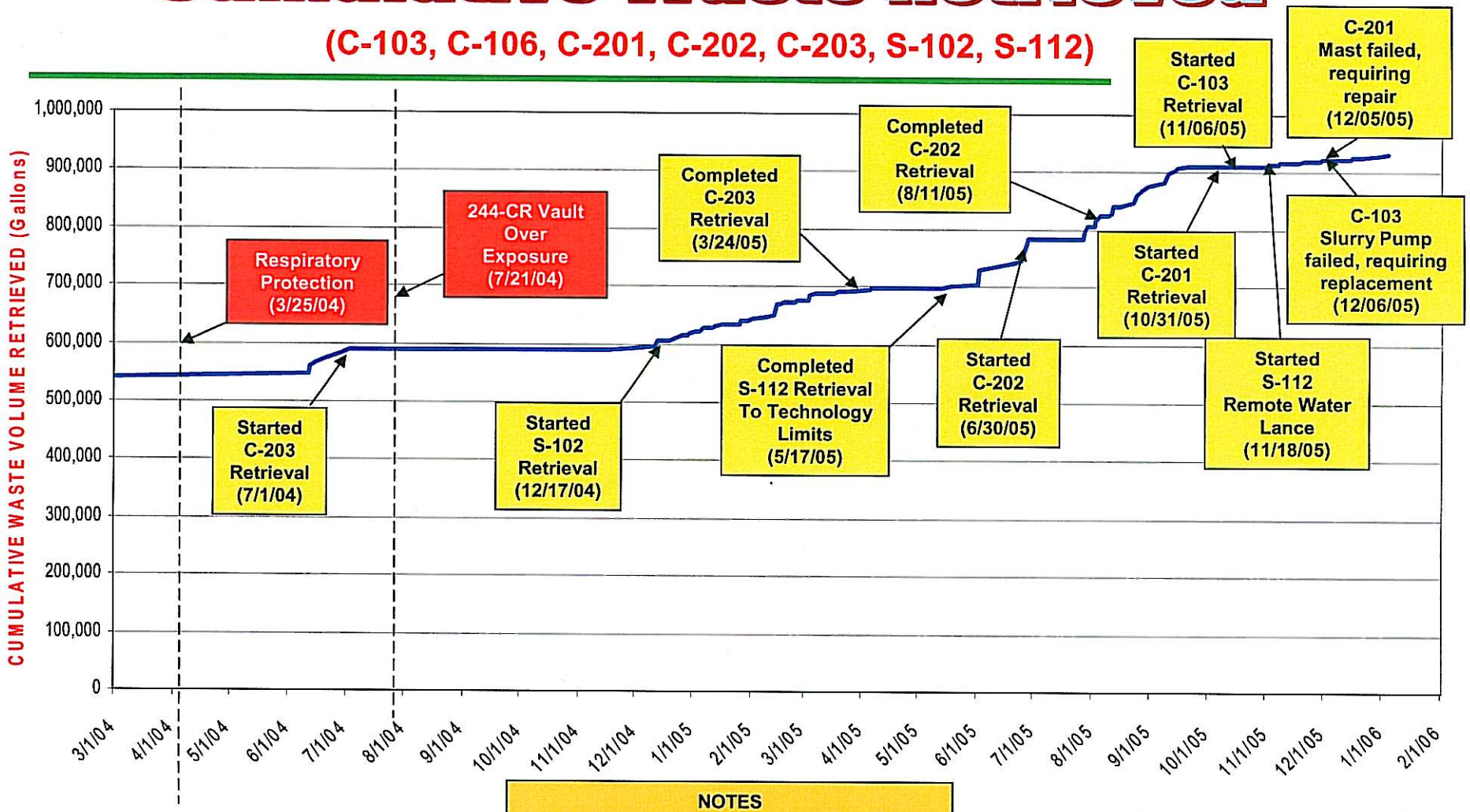
Cumulative Waste Retrieved

(C-103, C-106, C-201, C-202, C-203, S-102, S-112)

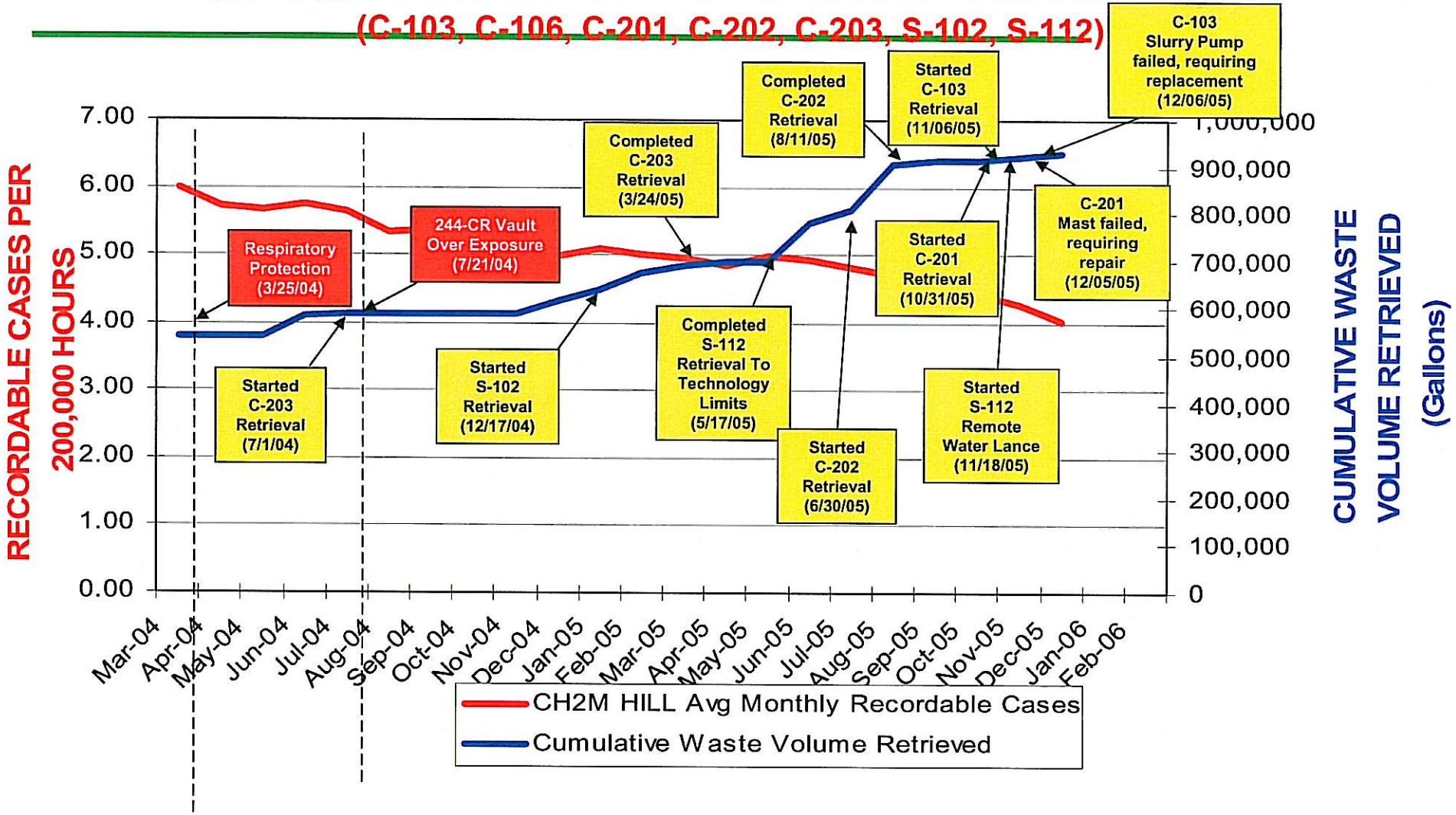


NOTES

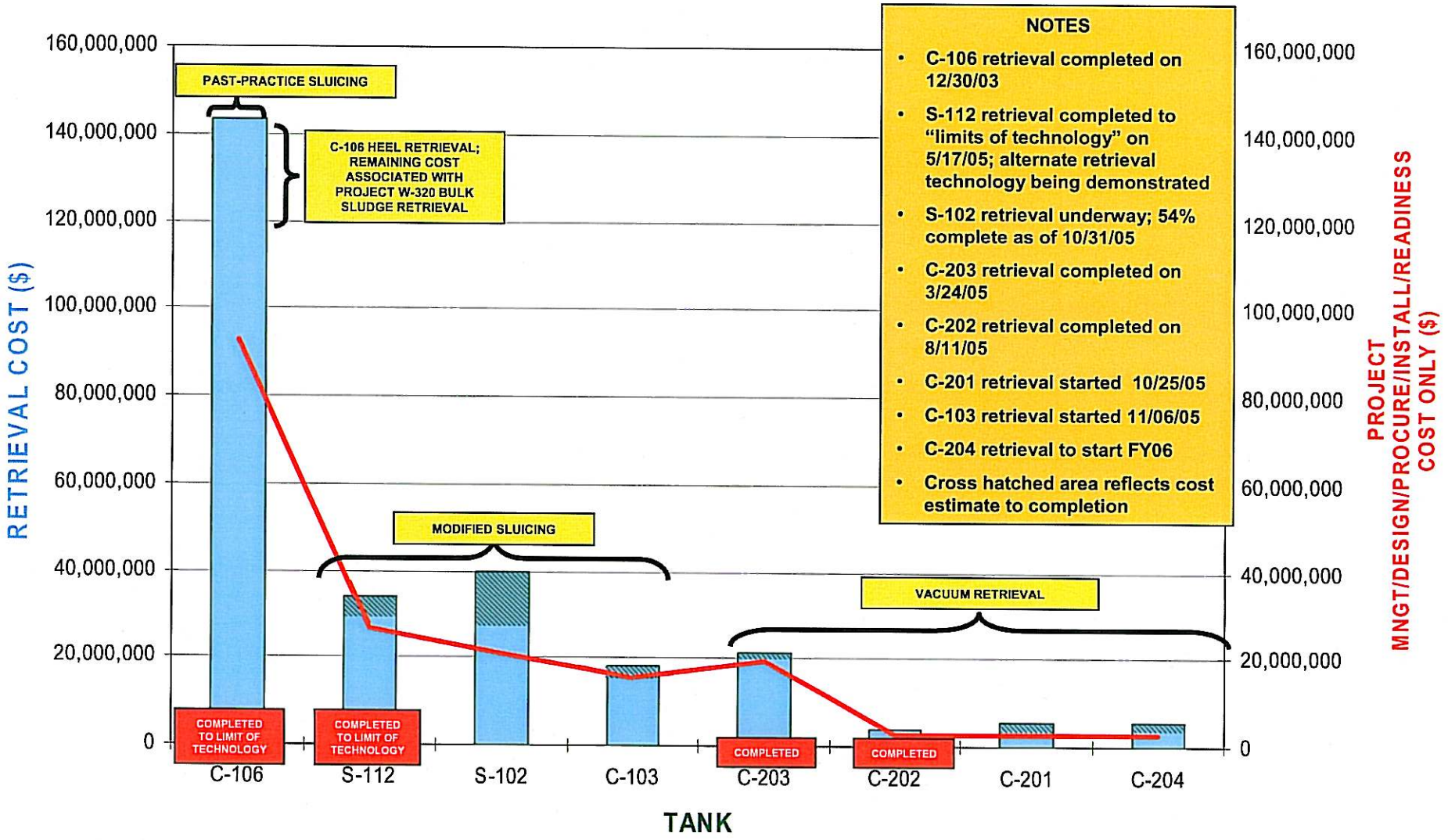
- Total waste volume retrieved as of 12/30/05 is 930,173 gallons
- S-102 approximately 54% complete as of 10/31/05
- S-112 completed to limits of technology; alternate retrieval technology being demonstrated
- C-106 retrieval completed 12/30/03

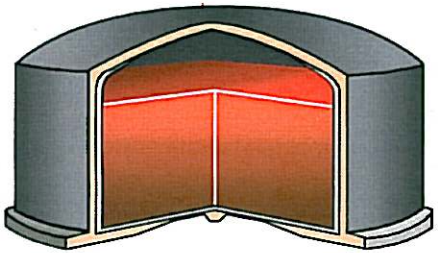
Injury Cases vs. Volume Retrieved

(C-103, C-106, C-201, C-202, C-203, S-102, S-112)



Retrieval Cost By Tank





Initial Waste Volume:

8 M gal HLW

42 M gal LAW

Previously Removed - Cs/Sr Capsules and German Logs [Repository Disposal]

Vitrification and SF/HLW Repository Disposal

~ 50% → ***WTP LAW Vitrification***

~ 50% → ***Any One or Combination of:***

- ***Bulk Vitrification***
- ***2nd LAW Vitrification***

~97% Curies and 5% of volume

~2% curies and 90% volume

3 M gal candidate TRU → ***Package for WIPP Disposal***

Eliminates 1500 HLW Canisters

~1% curies and 5% volume

Tank Farm Facility Definitions

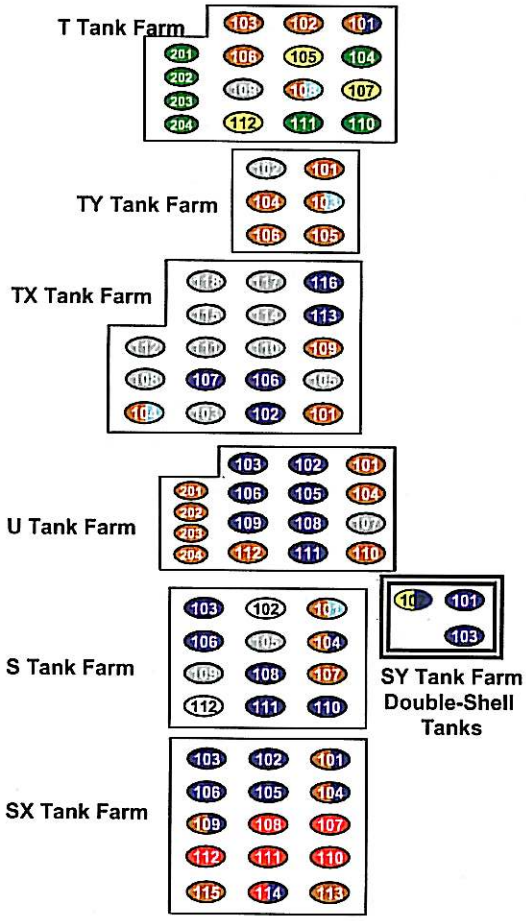
- Supplemental Pre-treatment
  - Major facility within the **tank farms** to remove the high level fraction of waste. Supplemental Pretreatment supports:
    - » Supplemental LAW facility in the 200 West (e.g. Bulk Vitrification)
    - » and/or supports LAW First

- Demonstration Bulk Vitrification System (DBVS)
  - Purpose is to demonstrate the viability of this down-selected technology as a supplemental LAW facility
  - Research and Development facility that will produce up to 50 boxes of glass using Tank S-109 waste

- Bulk Vitrification
  - **Production scale DBVS:** One option for LAW Supplemental Treatment. Major facility within the **Tank Farms** to supplement the Waste Treatment Plant LAW capacity
  - Processes up to 50% of the Low Activity Waste
  - Baseline has a 4-line plant in the 200 West and 4-Line Plant in the 200 East Area

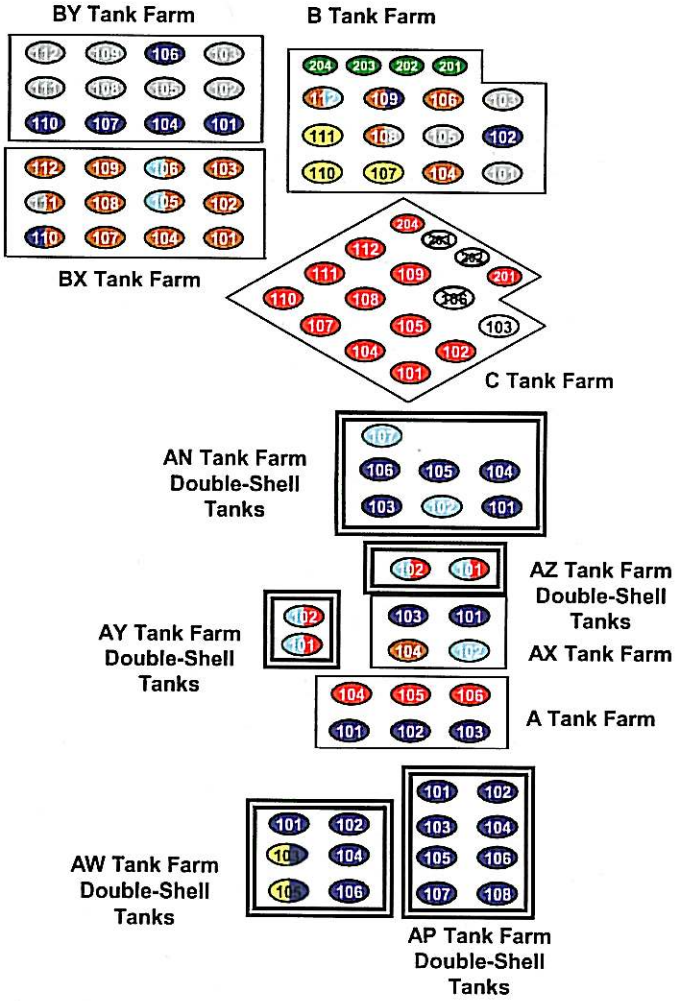
Tank Treatment & Disposal Pathways

200 West



- Primarily Saltcake or Supernatant– ILAW Feed
- Primarily Sludge – HLW Feed
- Remote Handled -TRU
- Contact Handled – TRU Tanks
- Candidate Low Curie Feed – Supplemental Treatment
- Retrieval In Progress

200 East



- Candidate Sludge for Supplemental HLW Pretreatment (Note: A and SX Farm tanks have Moderate Access for sludge retrieval)
- Candidate Medium Curie Feed to Supplemental LAW Pretreatment (Primarily Saltcake or Supernate)
- Retrieval Completed

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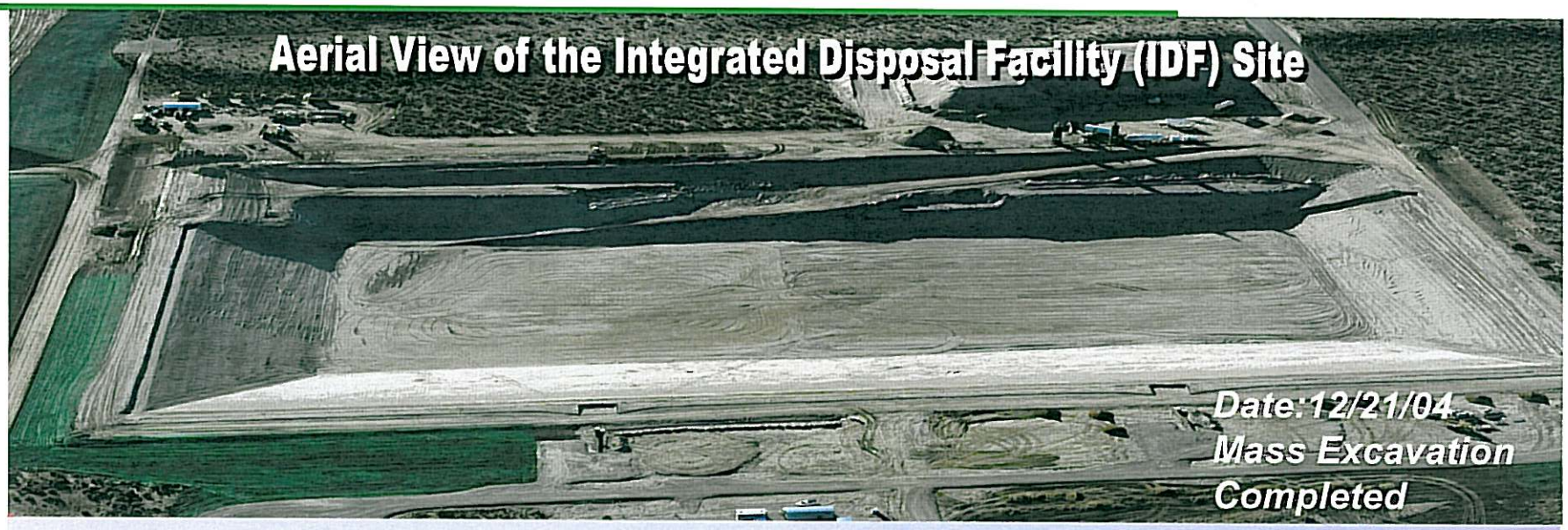
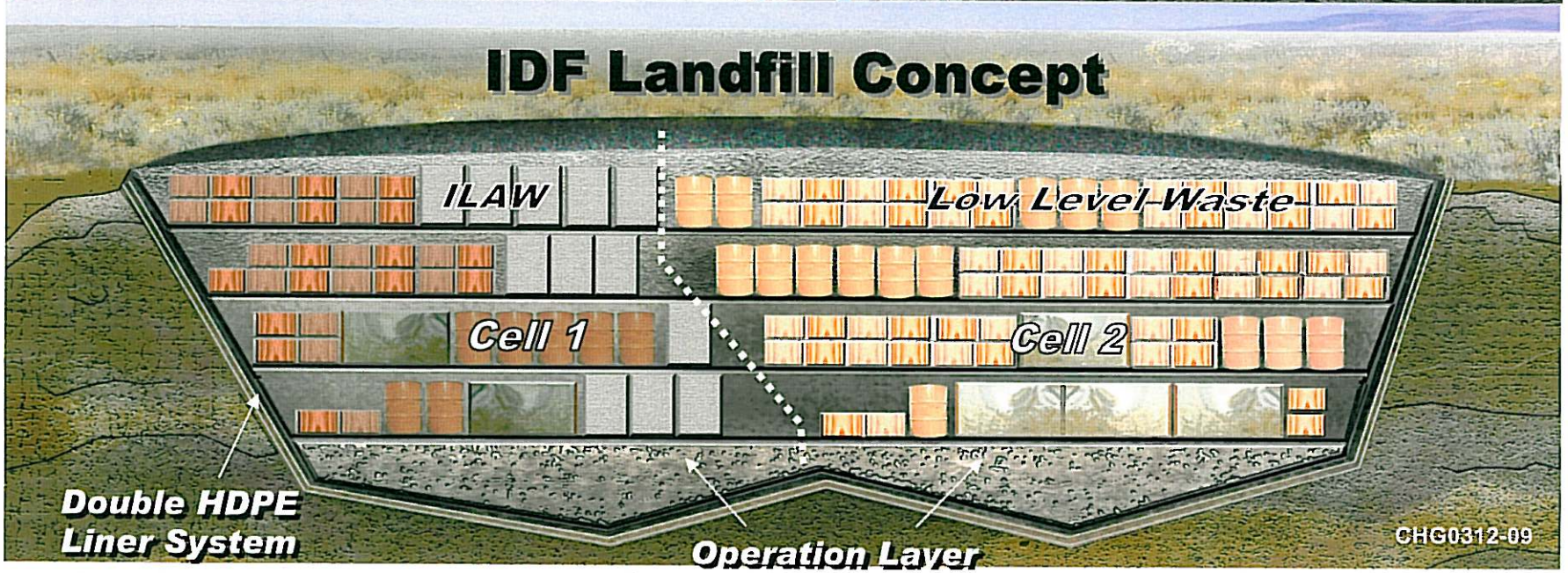
2/08/2006

Tank Waste Retrieval

- Retrieval of waste from older single-shell tanks continues
- Technologies based on waste characteristics and tank physical condition
- Demonstrating achievability of 99% waste retrieval
- Working with State of Washington and Nuclear Regulatory Commission on retrieval effectiveness
- Managing available Double-Shell tank space

Integrated Disposal Facility