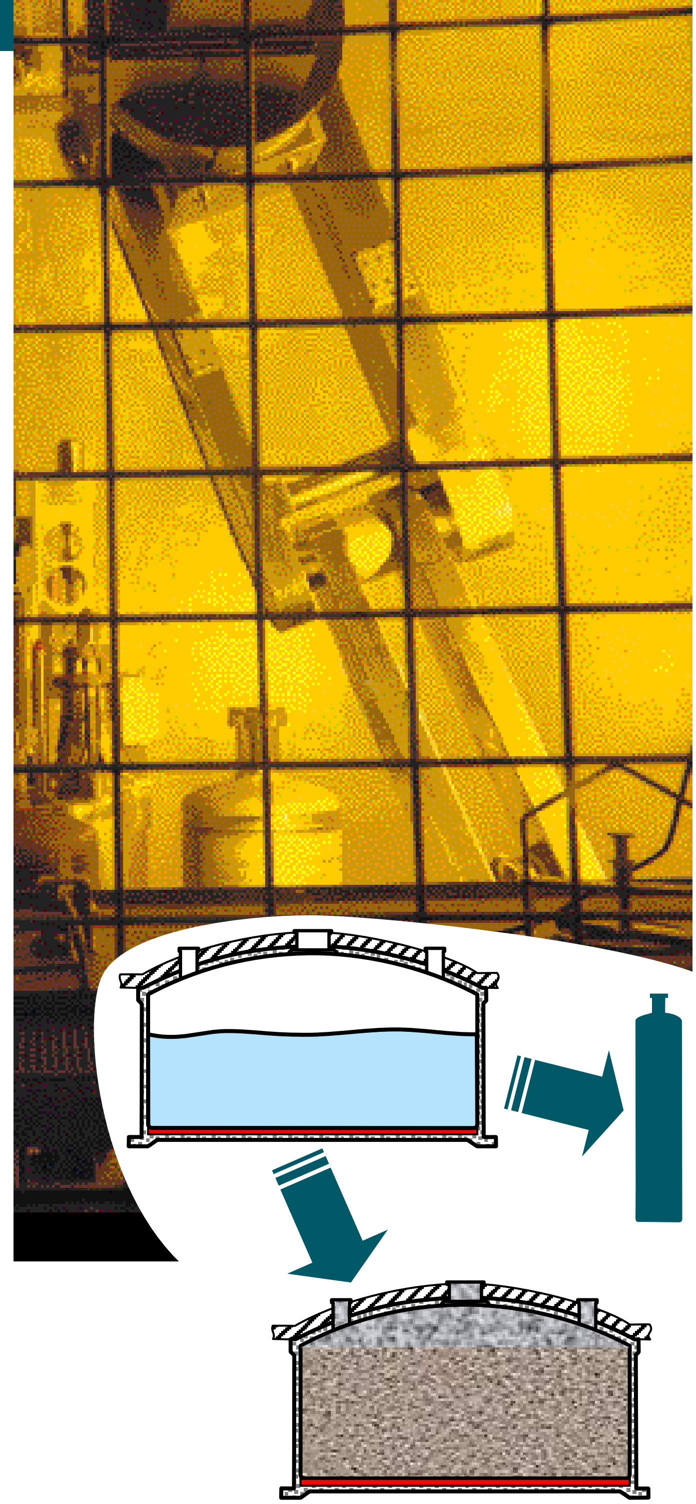
SRR-LWP-2009-00001

SRS

LIQUID Waste System Plan

Savannah River Site Liquid Waste Planning Process

An Integrated System at the Savannah River Site



REVISION 15

January 2010

SRR-LWP-2009-00001
REVISION: 15
January 11, 2010
KEYWORDS: Tank Farm, Salt Program,
DWPF, Liquid Waste,
ETP, Sludge Washing,
Lifecycle, Waste Solidification,
MCU, ARP, CSSX, SWPF

RETENTION: PERMANENT

UNCLASSIFIED
DOES NOT CONTAIN
UNCLASSIFIED CONTROLLED
NUCLEAR INFORMATION
ADC &
Reviewing
Official: (Name and Title)
Date: January 11, 2010

Liquid Waste System Plan

D. P. Chew
B. A. Hamm

Approvals:

L. D. Olson
SRR Operations & Deputy Project Manager

V. A. Franklin
Director, SRR Waste Determinations & General Counsel

T. J. Spears
Assistant Manager for Waste Disposition Project

Savannah River Remediation LLC
Savannah River Site
Aiken, SC 29808

Prepared for U.S. Department of Energy under Contract No. DE-AC09-09SR22505

Authors

January 11, 2010

D. P. Chew, System Integration / Risk Mgmt

B. A. Hamm, System Integration / Risk Mgmt

Reviews

P. J. Hill, Manager, System Integration / Risk Mgmt

E. R. Selden, Manager, Technical Planning & Project Controls

J. C. Robinson for V. G. Dickert

V. G. Dickert, Manager, Closure and Waste Disposal Authority

Table of Contents

Index of Tables

Index of Figures

1. Executive Summary

This plan recognizes the success of the various interim salt processing programs (Deliquification, Dissolution, and Adjustment — DDA, and Actinide Removal Process/Modular CSSX Unit — ARP/MCU) to accelerate salt removal and tank space management initiatives prior to the startup of the new Salt Waste Processing Facility (SWPF). Since the publication of Revision 14 of the *System Plan*, the 2H Evaporator has experienced excellent performance, due in part to the ability to deliquor the evaporator system into space made available by the interim salt programs. These successes have allowed consideration of accelerated closure of non-compliant tanks.

Additionally, since the publication of Revision 14 of the *System Plan*, the Department of Energy, Savannah River Operations Office (DOE-SR) awarded a new Liquid Waste (LW) contract with the objective "…to optimize Liquid Waste system performance, i.e., accelerate tank closures and maximize waste throughput at the Defense Waste Processing Facility (DWPF)[1]." This *Plan* reflects the results of the new contractor's strategy for achieving this objective including deployment of several new technologies such as:

- Enhanced chemical cleaning of tanks after bulk waste removal (BWR) is complete
- Melter bubbler technology to improve the capacity of the DWPF melter
- DWPF feed preparation improvements to reduce processing time within DWPF
- Rotary microfiltration to decrease sludge preparation cycle time
- Low temperature aluminum dissolution of sludge to minimize DWPF canister count
- Optimization of the tank closure process to enable a reduction in the tank closure process cycle time.

These actions result in maximizing sludge and salt processing, doubling DWPF throughput, closing non-compliant tanks ahead of the schedule required by regulatory agreements, and managing and increasing available compliant tank space.

Purpose

The purpose of the *Liquid Waste System Plan* (LW System Plan — hereinafter referred to as "this *Plan*") is to integrate and document the activities required to disposition and close radioactive LW tanks and facilities at the DOE Savannah River Site (SRS). It establishes a planning basis for waste processing in the LW System through the end of the program mission. Its development is a joint effort between DOE-SR and Savannah River Remediation LLC (SRR). Life-cycle program planning for PBS-SR-0014 (Radioactive Liquid Tank Waste Stabilization and Disposition) will use this *Plan* as the scope and schedule basis.

This *Plan* meets the contract deliverable described in Contract № DE-AC09-09SR22505; Part III — List of Documents, Exhibits, and Other Attachments; Section J — List of Attachments; Appendix M — Deliverables; Item № 1 — *Liquid Waste System Plan*.[2]

This *Plan* documents the operating strategy to receive, store, treat, and dispose of approximately 36 million gallons of existing waste and of future generated waste and to close the associated tanks and facilities. This waste is stored in 49 underground tanks. To date, fourteen revisions of the *Plan* have been issued, each giving an updated status of the LW operating strategy at the time of issue.

Additionally, this fifteenth revision (Revision 15) of the *Plan*:

- Provides one of the inputs to development of financial submissions to the complex-wide Integrated Planning, Accountability, & Budgeting System (IPABS)
- Provides a basis for updating the *Savannah River Site Environmental Management Program Project Execution Plan* (PEP)[3]
- Summarizes the scope and schedule baselines with their associated assumptions and plans for the Technical and Programmatic Risk and Opportunity Assessment process
- Forecasts compliance with the currently approved *Federal Facility Agreement* (FFA)[4] and its Waste Removal Plan and Schedule and the *Site Treatment Plan* (STP)[5].

Goals

The goals of this *Plan* are to meet the following programmatic objectives:

- Continue storing liquid radioactive wastes in a safe and environmentally sound manner
- Meet tank closure regulatory milestones in the currently-approved FFA
- Meet the waste treatment goals identified in the STP

- Conduct operations consistent with the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[6], the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[7], and future waste determination (WD) and bases documents for F- and H-Areas
- Comply with applicable permits and consent orders, including the Landfill Permit for the SRS Z Area Saltstone Disposal Facility (SDF) and the Consent Order for Dismissal in Natural Resources Defense Council, et al. v. South Carolina Department of Health and Environmental Control, et al. (South Carolina Administrative Law Court, August 7, 2007)
- Provide tank space to support staging of salt solution adequate to feed the SWPF at system capacity
- Sustain sludge vitrification in the DWPF
- Remove the tetraphenylborate (TPB) laden waste from Tank 48 and recover Tank 50 so these tanks are available to support DWPF feed batch preparation, tank closures, and SWPF feed batch preparation; treat and destroy the TPB in the waste
- Minimize the quantity of radionuclides (as measured in curies) dispositioned in the SDF, keeping the total curies at or below the amount identified in the *Savannah River Site – Liquid Waste Disposition Processing Strategy*[8] (SRS LW Strategy) and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*
- Support continued nuclear material stabilization of legacy materials in H-Canyon through at least 2019.

There is currently a shortage of processing and storage space in the SRS radioactive liquid waste tanks. To enable continuation of risk reduction initiatives encompassed by the goals above, this *Plan* follows a processing strategy providing the tank space required to support meeting, or minimizing impacts to meeting, programmatic objectives. During the period prior to startup of SWPF in 2013, two main tank-space initiatives are required to support programmatic objectives.

First, limited near-term retrieval, treatment, and disposal of salt waste is required. This is performed using the DDA process and operation of the ARP/MCU facilities. Operation of these salt treatment processes frees up working space in the 2F, 2H, and 3H Evaporators' concentrate receipt tanks (Tanks 25, 38, and 37, respectively). This provides support for near-term handling of waste streams generated from early-year tank closures, DWPF sludge batch preparation, DWPF recycle handling, and H-Canyon processing. The amount of material removed from Tank 25 must be maximized during the interim salt processing period to minimize impacts to achieving the programmatic objectives.

Second, it is imperative to return Tank 50 (a 1.3 million gallon [Mgal] Type IIIA tank) to general higher-activity waste service by no later than 2011. Prior to the recovery of Tank 50, modifications are required to provide for decoupling the salt processing facilities' Decontaminated Salt Solution (DSS) feed from the Saltstone Production Facility (SPF). Recovery of Tank 50 is necessary to adequately store and prepare salt solution to feed SWPF at its required capacity. Additionally, the recovery of Tank 50 is critical in utilizing Tank 42 for sludge batch washing activities (by transferring the waste currently stored in Tank 42 to Tank 50 until SWPF begins operations).

These initiatives and the assumed SWPF startup in 2013 provide tank space to minimize impacts to the programmatic objectives.

Revisions

The significant updates from the previous version of this *Plan,* the *Life-cycle Liquid Waste Disposition System Plan, Revision 14* (Rev 14)[9], include:

- **Change in Near-Term Objectives**
  - Since the issuance of Revision 14, DOE has awarded a new Liquid Waste Contract. In the Liquid Waste Request for Proposal[1], DOE stated their objectives "to optimize Liquid Waste system performance, i.e., accelerate tank closures and maximize waste throughput at the DWPF." This *Plan* reflects the results of the new contractor's strategy for achieving this objective including deployment of several new technologies
- **Salt Processing**:
  - **Near-term Salt Waste Processing:** DDA waste processing resumed in October 2007.
  - **ARP/MCU Processing**: ARP/MCU processing began in April 2008.
  - **Salt Storage**: Utilization of Tank 47 as the concentrate receipt tank for the 2F Evaporator has enabled the 2F Evaporator to handle limited campaigns, mainly associated with tank closure and mechanical and chemical cleaning streams. This prolongs the ability of the 2F Evaporator to process salt-laden waste before requiring Tank 25 salt removal and conversion to the 2F Evaporator concentrate receipt

tank. Tank 44 is available for 2F concentrate receipt tank service prior to Tank 25 salt removal, if needed

- **Tank Storage Space**
  - **Tank 48**: Tank 48 return-to-service was delayed to December 2014 from September 2012 due to funding constraints
  - **Tank 50**: Tank 50 will be converted from Low Level Waste (LLW) service to SWPF batch preparation service. This will require modifications to provide for decoupling the salt processing facilities' DSS feed from the SPF. This *Plan* assumes an October 2011 date, accelerating the May 2012 date assumed in Rev 14
- **DWPF Melter Outages:** DWPF operational experience allowed an increase in assumed melter life to 68 months from 44 months
- **Sludge Mass Reduction**: Sludge Batch 6 preparation will include low temperature aluminum dissolution (LTAD) for sludge mass reduction to mitigate in impacts of increased sludge mass and reduce the total number of canisters generated from sludge processing
- **Canister Shipping:** The schedule for shipment of the canisters from SRS is not included in this *Plan*.

Results of the Plan

Table 1-1 — *Results of the Plan* describes the major results as compared to Revision 14 of the System Plan. A description of these results follows.

Table 1-1 — *Results of the* Plan

Parameter	Rev 14	This *Plan*
All yearly tank closure currently-approved FFA commitments met	No	Yes
Final FY2022 currently-approved FFA commitment met	Yes	Yes
Final non-compliant tank closed	2022	2018
FY 2028 STP commitment met	No	No
Date when waste removal complete from all tanks	Sep 2030	Dec 2030
Sludge vitrification at DWPF sustained	Yes	Yes
Sludge processing complete	2030	2023
Salt only canisters	No	Yes
Maximum canister waste loading	50 wt%	40 wt%
Max canister throughput rate	200 canister/yr	400 canister/yr
Total number of canisters produced	~6,300	~7,200
– *Total number of salt only canisters*	*0*	*250*
Cesium concentration of initial SWPF batch	4.8 Ci/gal	<1 Ci/gal
Radionuclides (curies) dispositioned in SDF meet *SRS LW Strategy*	Yes	Yes
Tank space provided to feed SWPF at full capacity	Yes	Yes
Nuclear material stabilization in H-Canyon supported	Yes	Yes

- **Salt Processing**: This *Plan* maintains the tank space required to provide feed for SWPF to maintain full capacity operations. Although the nominal processing rate for SWPF remains 6 Mgal/yr, the average rate, increased to 5.7 Mgal/yr from 5.5 Mgal/yr forecast in Revision 14 of the *Plan* due to a decrease in frequency of DWPF melter outages. This increase, however, is inadequate to meet the 2028 STP waste removal commitment due to delays in the start-up of SWPF
- **Radionuclides Dispositioned in SDF**: This *Plan* is consistent with the *SRS LW Strategy* and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site* concerning the total curies dispositioned at SDF
- **Vitrification of Sludge at DWPF**: This *Plan* provides for the accelerated vitrification of sludge at DWPF (see §5.2.2) that enables all stored and forecast sludge to be processed by 2023. The total projected canister production of ~7,000 canisters over the life of the program includes salt-only canisters (see §5.3.3) and accounts for the use of LTAD versus the use of high temperature aluminum dissolution (HTAD) assumed in Revision 14 of this *Plan*.
- **Supporting Nuclear Material Stabilization**: Sufficient Tank Farm space exists to support the receipt of 230,000 gallons (230 kgal) from April 2008 through the conversion of Tank 25 to 2F Evaporator concentrate receipt tank service in 2010. Space to support the receipt of 300 kgal/yr is planned through the

end of operations in 2019 and for shutdown flows through 2022 (note that this does not include waste sent to Tank 50, SPF, or directly to sludge batches)

- **Tank Closure**: Improvements in waste removal and tank closure enable meeting or exceeding all currently approved FFA commitments
- **Waste Treatment — STP Commitment**: The delays in start-up of SWPF reduce the ability to remove and treat the waste during the STP commitment period. The completion of removal of the backlogged and currently generated waste inventory is projected to be complete in 2030
- **Canister Storage and Shipping**: This *Plan* requires a third Glass Waste Storage Building (GWSB), consistent with previous versions of the *Plan*. The schedule for shipment of the canisters from SRS is not included in this *Plan*.

2. Introduction

The revision of this *Plan* documents the current operating strategy of the LW System at SRS to receive, store, treat, and dispose of radioactive liquid waste and to close waste storage and processing facilities. The LW System is a highly integrated operation that involves safely storing liquid waste in underground storage tanks; removing, treating, and dispositioning the LLW fraction in concrete Disposal Units; vitrifying the higher activity waste; and storing the vitrified waste until permanent disposition. After waste removal and processing, the storage and processing facilities are cleaned and closed. This *Plan* assumes the reader has a familiarity with the systems and processes discussed. Section 9 — *System Description* is an overview of the LW System.

The Tank Farms have received more than 140 million gallons of waste from 1954 to the present. Reducing the volumes of waste through evaporation and vitrification of waste, the Tank Farms currently store approximately 36 million gallons of waste. Containing approximately 400 million curies of radioactivity, dispositioning this waste will take over 20 years. As of June 30, 2009, DWPF had produced 2,739 vitrified waste canisters. All volumes and total curies reported as current inventory in the Tank Farms are as of June 30, 2009 and account for any changes of volume or curies in the Tank Farms since Revision 14 of the *Plan* and the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*.

Additionally, this *Plan*:

- Provides one of the bases for financial submissions to the complex-wide IPABS
- Provides a basis for updating the PEP
- Summarizes the scope and schedule baselines with their associated assumptions and plans for the Technical and Programmatic Risk and Opportunity Assessment process
- Forecasts compliance with the currently approved FFA[4], and the STP[5].

Successful and timely salt waste removal and disposal is integral to efforts by SRS to proceed with all aspects of tank cleanup and closure, extending well beyond permitted disposal of the solidified low-activity salt waste streams themselves. Removal and disposal of salt waste not only enables tanks to be closed; it is necessary for the continued removal and stabilization of the high-activity sludge fraction of the waste. This is because SRS uses the tanks to prepare the high-activity waste so that it may be processed in DWPF. Salt waste is filling up tank space needed to allow this preparation activity to continue. Processing low-activity salt waste through DDA and ARP/MCU relieves this tank space shortage and increases the likelihood that vitrification of the high-activity fraction will be able to continue uninterrupted.

In addition, operating DDA and ARP/MCU as described in this *Plan* will enable continued stabilization of DOE Complex legacy nuclear materials. It will also increase the likelihood that SWPF may be fed at nominal capacity when it begins operation, which would not be possible without these treatment processes. This will allow DOE to complete cleanup and closure of the tanks years earlier than would otherwise be the case. That, in turn, will reduce the time during which the tanks — including many that do not have full secondary containment and have a known history of leak sites — continue to store liquid radioactive waste. Finally, this *Plan* will make more tank space available for routine operations, thereby reducing the number of transfers among tanks and increasing the safety of operations.

2.1 *Alternative Analyses*

Three alternatives are discussed in this *Plan*. These alternatives are analyzed qualitatively as detailed modeling was not required to describe the impacts of the pursuit of these alternatives:

- 2015 SWPF startup — in this alternative the startup of the SWPF is delayed to November 2015 from May 2013
- Additional Pu Disposition — in this alternative disposition 5,000 kg of plutonium via DWPF at the concentration limit of 897 grams of fissile material per cubic meter of glass.
- Eliminate Salt Only Cans — in this alternative additional processes supplement SWPF so that the salt program is completed co-incident with the sludge program.

2.2 *Goals*

The goals of this *Plan*, consistent with the *SRS LW Strategy* are to meet the following programmatic objectives:

- Continue storing liquid radioactive wastes in a safe and environmentally sound manner
- Meet tank closure regulatory milestones in the currently approved FFA

- Meet the waste treatment goals identified in the STP
- Comply with the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, and future WD and bases documents for F- and H-Areas
- Comply with applicable permits and consent orders, including the Modified Permit for the SRS Z-Area SDF (permit No. 025500-1603) and the Consent Order of Dismissal in Natural Resources Defense Council, et al. v. South Carolina Department of Health and Environmental Control, et al. (South Carolina Administrative Law Court, August 7, 2007) and State-approved area-specific General Closure Plans
- Provide tank space to support staging of salt solution adequate to feed the SWPF at system capacity
- Sustain sludge vitrification in the DWPF
- Remove the TPB laden waste from Tank 48 and recover Tank 50 so these tanks are available to support DWPF feed batch preparation, tank closures, and SWPF feed batch preparation; treat and destroy the TPB in the waste
- Minimize the quantity of radionuclides (curies) dispositioned in the SDF, keeping the total curies at or below the amount identified in the *SRS LW Strategy*[8] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*
- Support continued nuclear material stabilization of legacy materials in H-Canyon through at least 2019.

The following generalized priorities are used to establish the sequencing of waste removal and disposition from the Liquid Radioactive Waste tanks:

1. Remove waste from tanks with a leakage history, while safely managing the total waste inventory and
   - Maintaining contingency transfer space per the Tank Farm Authorization Basis (AB)
   - Controlling tank chemistry, including radionuclide and fissile material inventory
   - Ensuring blending of processed waste to meet SWPF, DWPF, and SPF waste acceptance criteria
   - Enabling continued operation of the evaporators as necessary to process waste streams
   - Maintaining sufficient space in the Tank Farms to allow continued DWPF operation, providing for:
     - Recycle receipt space
     - Sludge batch preparation
2. Support closure of non-compliant tanks to meet currently approved FFA commitments
3. Provide tank space to support staging of salt solution adequate to feed salt solution to SWPF at full capacity
4. Support continued nuclear material stabilization in H-Canyon
5. Ensure that the curies dispositioned to the SDF are at or below the amount identified in the *SRS LW Strategy* and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*.

There is currently a shortage of processing and storage space in the SRS radioactive liquid waste tanks. To enable continuation of risk reduction initiatives encompassed by the goals above, this *Plan* follows a processing strategy providing the tank space required to support meeting, or minimize impacts to meeting, programmatic objectives. During the period prior to startup of SWPF in 2013, two main tank-space initiatives are required to support programmatic objectives.

First, limited near-term retrieval, treatment, and disposal of salt waste is required. This is performed using the DDA process and operation of the ARP/MCU facilities. Operation of these salt treatment processes frees up working space in the 2F, 2H, and 3H Evaporators' concentrate receipt tanks (Tanks 25, 38, and 37, respectively). This provides support for near-term handling of waste streams generated from early-year tank closures, DWPF sludge batch preparation, DWPF recycle handling, and H-Canyon processing. The amount of material removed from Tank 25 must be maximized during the interim salt processing period to minimize impacts to achieving the programmatic objectives.

Second, it is imperative to return Tank 50 (a 1.3 Mgal Type IIIA tank) to general higher-activity waste service by no later than 2011. Prior to the recovery of Tank 50, modifications are required to provide for decoupling the salt processing facilities' DSS feed from the SPF. Recovery of Tank 50 is necessary to adequately store and prepare salt solution to feed SWPF at required capacity. Additionally, the recovery of Tank 50 is critical in utilizing Tank 42 for sludge batch washing activities (by transferring the waste currently stored in Tank 42 to Tank 50 until SWPF begins operations).

These initiatives and the assumed SWPF startup in 2013 provide tank space to minimize impacts to the programmatic objectives.

2.3 ***Risk Assessment***

A comprehensive identification and analysis of technical risks and opportunities associated with the execution of this *Plan* are documented within the Risk Assessment Report (RAR), *PBS-SR-0014 Radioactive Liquid Tank Waste Stabilization and Disposition Technical and Programmatic Risk Assessment Report to Support System Plan Revision 15*[10]. It is developed concurrently with the System Plan and documents a correlation between System Plan assumptions and individual technical and programmatic risks and presents the strategies for handling risks and opportunities in the near-term and outyears.

3. Planning Bases

Dates, volumes, and chemical or radiological composition information contained in this *Plan* are planning approximations only. Specific flowsheets guide actual execution of individual processing steps. The activities described are summary-level activities, some of which have not yet been fully defined. The sequence of activities reflects the best judgment of the planners. Full scope, schedule, and funding development are found in individual project execution strategies. Once scope, cost and schedule baselines are approved, a modification of this *Plan* may be required.

3.1 *Reference Date*

The reference date for the mathematical modeling (using SpaceMan Plus™) of this *Plan* is June 30, 2009. Schedules, milestones, and operational plans were current as of that date. Waste Characterization System (WCS) tank inventory data was obtained from *July 2008 Tank Radioactive and Non-radioactive Inventories*[11]. Actual waste transfers and activities between July 2008 and August 2009 were modeled to accurately account for known changes in Tank Farm chemistry.

3.2 *Funding*

Progress toward the ultimate goal of immobilizing all the LW at SRS is highly dependent on available funding. This *Plan* was developed assuming the funding required to achieve the planned project and operations activities at the levels specified in the *SRR Contract Performance Baseline*[12] will be available. It supports justification for requesting necessary funding profiles.

With any reduction from full funding, activities that ensure safe storage of waste claim first priority. Funding above that required for safe storage enables risk reduction activities, i.e., waste removal, treatment — including immobilization — and closure, as described in this Plan.

3.3 *Regulatory Drivers*

Numerous laws, constraints, and commitments influence LW System planning. Described below are requirements that most directly affect LW system planning.

South Carolina Environmental Laws

Under the South Carolina Pollution Control Act, S. C. Code Ann. §§ 48-1-10 *et seq*., the South Carolina Department of Health and Environmental Control (SCDHEC) is the delegated authority for air pollution control, and water pollution control. The State has empowered SCDHEC to adopt standards for protection of water and air quality, and to issue permits for pollutant discharges. Further, SCDHEC is authorized to administer both the federal Clean Water Act and the Clean Air Act. Under South Carolina's Hazardous Waste Management Act, S. C. Code Ann. §§ 44-56-10 *et seq*., SCDHEC is granted the authority to manage hazardous wastes. With minor modifications, SCDHEC has promulgated the federal Resource Conservation and Recovery Act (RCRA) requirements, including essentially the same numbering system. The South Carolina Solid Waste Policy and Management Act, S. C. Code Ann. §§ 44-96-10 *et seq*., provides standards for the management of most solid wastes in the state. For example, SCDHEC issued to DOE-SR permits such as the Industrial Solid Waste Landfill Permit for SDF. This landfill permit contains conditions for the acceptable disposal of non-hazardous waste in the SDF. This permit also contains potential stipulated fines and other penalties in the event defined LW facilities fail to meet other conditions of this permit within prescribed periods subject to certain limited exceptions. Other principal permits required to operate LW facilities pursuant to the state's environmental laws include:

- SCDHEC Bureau of Water:
  - industrial wastewater treatment facility permits (e.g., Tank Farms, DWPF, Effluent Treatment Project [ETP], and the SPF)
  - National Pollutant Discharge Elimination System (NPDES) permit (H-16 Outfall discharges from ETP)
- SCDHEC Bureau of Air Quality:
  - Air Quality Control permit (one Site-wide Air Permit including the LW facilities).

Site Treatment Plan

The STP[5] for SRS describes the development of treatment capacities and technologies for mixed wastes, and provides guidance on establishing treatment technologies for newly identified mixed wastes. The STP allows DOE, regulatory agencies, the States, and other stakeholders to efficiently plan mixed waste treatment and disposal by considering waste volumes and treatment capacities on a national scale. The STP identifies vitrification in DWPF as the preferred treatment option for appropriate SRS liquid high-level radioactive waste streams. SRS has committed that:

> *"Upon the beginning of full operations, DWPF will maintain canister production sufficient to meet the commitment for the removal of the backlogged and currently generated waste inventory by 2028."*

The commitment for the removal of the waste by 2028 encompasses the BWR and heel removal scope of this *Plan*. Final cleaning, deactivation, and closure of storage and processing facilities are subsequent to the satisfaction of this commitment.

Federal Facility Agreement

DOE, the Environmental Protection Agency (EPA), and SCDHEC executed the SRS FFA[4] on January 15, 1993 that became effective August 16, 1993. It provides standards for secondary containment, requirements for responding to leaks, and provisions for the removal from service of leaking or unsuitable LW storage tanks. Tanks that are scheduled to be removed from service may continue to be used, but must adhere to a schedule for removal from service and closure and the applicable requirements contained in the Tank Farms' industrial wastewater treatment facility permit. An agreement between DOE, SCDHEC, and EPA, *Statement of Resolution of Dispute Concerning Extension of Closure Dates for Savannah River Site High-Level Radioactive Waste Tanks 19 and 18*[13]*,* was made in November 2007. This agreement modified the FFA by providing for the submission of Waste Determination documentation for F- and H-Tank Farms and included end dates for BWR and the operational closure of each non-compliant tank. It commits SRS to remove from service and close the last non-compliant tank no later than 2022. Refer to Appendix A — *FFA Waste Removal Plan & Schedule* to see the approved schedule for the currently approved FFA.

National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires federal agencies to assess the potential environmental impacts of proposed actions. Seven existing NEPA documents and their associated records of decision directly affect the LW System and support the operating scenario described in this *Plan*:

- DWPF Supplemental Environmental Impact Statement (SEIS) (DOE/EIS-0082-S)
- Final Waste Management Programmatic Environmental Impact Statement (EIS) (DOE/EIS-0200)
- SRS Waste Management Final EIS (DOE/EIS-0217)
- Interim Management of Nuclear Materials EIS (DOE/EIS-0220)
- SRS High-Level Waste Tank Closure Final EIS (DOE/EIS-0303)
- Environmental Assessment (EA) for the Closure of the High Level Waste Tanks in F- and H Areas at SRS (DOE/EA-1164)
- SRS Salt Processing Alternatives Final SEIS (DOE/EIS-0082-S2).

Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA)

The *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA) Section 3116 (§3116) concerns determinations by the Secretary, in consultation with the Nuclear Regulatory Commission (NR)C, that certain radioactive waste from reprocessing is not high-level waste and may be disposed of in South Carolina pursuant to a State-approved closure plan or State-issued permit. For salt waste, DOE contemplates removing targeted fission products and actinides using a variety of technologies and combining the removed fission products and actinides with the metals being vitrified in DWPF. NDAA §3116 governs solidifying the remaining low-activity salt stream into saltstone for the purpose of disposal in the SDF. For closure activities, NDAA §3116 governs the Waste Determinations for the Tank Farms that demonstrate that the tanks and ancillary equipment (evaporators, diversion boxes, etc.) at the time of closure can be managed as non-high level waste.

3.4 *Revisions*

The significant updates from the *Life-cycle Liquid Waste Disposition System Plan, Revision 14* (Rev 14)[14] include:

- **Contract Near-term Objectives**
  - Since the issuance of Revision 14, DOE has awarded a new Liquid Waste Contract. In the Liquid Waste Request for Proposal[1], DOE stated their objectives "to optimize Liquid Waste system performance, i.e., accelerate tank closures and maximize waste throughput at the DWPF". This *Plan* reflects the results of the new contractor's strategy for achieving these objectives including deployment of several new technologies.
- **Salt Processing**:
  - **Near-term Salt Waste Processing:** DDA waste processing resumed in October 2007
  - **ARP/MCU Processing**: ARP/MCU processing began in April 2008
  - **Salt Storage**: Utilization of Tank 47 as the concentrate receipt tank for the 2F Evaporator has enabled the 2F Evaporator to handle limited campaigns, mainly associated with tank closure and mechanical and chemical cleaning streams. This prolongs the ability of the 2F Evaporator to process salt-laden waste before requiring Tank 25 salt removal and conversion to the 2F Evaporator concentrate receipt tank. Tank 44 is available for 2F concentrate receipt tank service prior to Tank 25 salt removal, if needed
- **Tank Storage Space**
  - **Tank 48**: Tank 48 return-to-service was delayed to December 2014 from September 2012 due to funding constraints
  - **Tank 50**: Tank 50 will be converted from LLW service to SWPF batch preparation service. This will require modifications to provide for decoupling the salt processing facilities' DSS feed from the SPF. This *Plan* assumes an October 2011 date, accelerating the May 2012 date assumed in Rev 14
- **DWPF Melter Outages:** DWPF operational experience allowed an increase in assumed melter life to 68 months from 44 months
- **Sludge Mass Reduction**: Sludge Batch 6 preparation will include low temperature aluminum dissolution for sludge mass reduction to mitigate in impacts of increased sludge mass and reduce the total number of canisters generated from sludge processing
- **Canister Shipping:** The schedule for shipment of the canisters from SRS is not included in this *Plan*.

3.5 *Key Milestones*

Key Milestones are those major dates that are required to remove waste from storage, process it into glass or saltstone, and close the LW facilities. These milestones are compared to Revision 14 of this *Plan*.

Table 3-1 — *Key Milestones*

Key Milestone	Revision 14	this *Plan*
Date when all non-compliant tanks are closed	FY22	FY18
Sludge processing complete	Sep 2030	May 2023
Total number of canisters produced	~6,300	~7,200
– *Salt only canisters produced*	*0*	*250*
Initiate ARP/MCU Processing	Mar 2008	Apr 2008 (actual)
Initiate SWPF Processing	Sep 2012	May 2013
– *Salt Solution Processed via DDA only*	*2.6 Mgal*	*2.8 Mgal*
– *Salt Solution Processed via ARP/MCU*	*4.3 Mgal*	*5.2 Mgal*
– *Salt Solution Processed via SWPF*	*90.3 Mgal*	*89 Mgal*
● *Total Salt Solution Processed*	***97.2 Mgal***	***97 Mgal***
Salt Processing Complete	2030	2030
Tank 41 Available as Salt Blend Tank	Apr 2008	In Service
Tank 42 Available as Sludge Blend Tank	Jun 2012	Oct 2011
Tank 50 Available as Salt Blend Tank	May 2012	Oct 2011
Tank 48 Available as Salt Blend Tank	Sep 2012	Jan 2015
Alternate Recycle Handling Implemented	2018	2025
GWSB #3 Available	Sep 2019	July 2015

4. Key Planning Bases Inputs and Assumptions

The following major assumptions and planning bases are the results of an agreement between SRR[15] and DOE[16]. They address the planning period to the end of the program. Note that these are input assumptions and are not completely achieved by this *Plan*. Specifically, while meeting the 2022 currently approved FFA commitment to close all non-compliant tanks, delays in removing all the waste to meet the STP goal have been unavoidable. Detailed assumptions are described in Section 8 — *Description of Assumptions and Bases*.

Regulatory Drivers – The following regulatory requirements drive the development of the System Plan through the end of the program.

- **Federal Facility Agreement (FFA)** – Commits the Department to remove from service and close the last non-compliant tank (Tanks 1–24) no later than 2022. The specific schedule for the non-compliant tanks is per the *Statement of Resolution of Dispute Concerning Extension of Closure Dates for Savannah River Site High-Level Radioactive Waste Tanks 19 and 18*[13] which is the schedule for the currently approved FFA.
- **Site Treatment Plan (STP)** – "Upon the beginning of full operations, DWPF will maintain canister production sufficient to meet the commitment for the removal of the backlogged and currently generated waste inventory by 2028." This is satisfied by removing waste (including heels) from all Type III tanks by 2028; Types I, II, and IV having had all waste removed in compliance with the FFA above.

Major Assumptions and Input Bases – The following are major assumptions and planning basis inputs for the development of the System Plan through the end of the program.

- **Salt Processing**
  - — The ARP/MCU processing rate is 40 kgal per week from Tank 49, when feed is available
  - — Batch qualification requires 2 months between batches
  - — The ARP and MCU facilities will permanently shutdown no later than six months prior to the startup of SWPF allowing for SWPF tie-ins
    - – This assumes DOE approves extended operation of ARP/MCU due to the delay in SWPF startup
    - – This assumes any ARP/MCU facility upgrades required to maintain the ARP/MCU operating rate for its extended life
    - – The ARP and MCU facilities will operate within the curie limits of the *Savannah River Site — Liquid Waste Disposition Processing Strategy* [17]
  - — The SWPF becomes operational May 2013[18] with SCDHEC approval
    - – SWPF tie-ins will require a four-month outage of DWPF operations beginning February 2013
  - — The SWPF processing rates are:
    - – 3.75 Mgal of salt solution processed in the initial twelve months of operation
    - – 6.0 Mgal/yr (nominal rate) of salt solution processed per year beginning in the second year of operation
      - • 5.7 Mgal per year average, accounting for DWPF outages
    - – ~7.6 Mgal (nominal rate) of DSS will be sent to SPF per year
      - • ~6.9 Mgal per year average, accounting for DWPF outages
    - – ~0.5 Mgal (nominal rate) of Strip Effluent will be sent to DWPF per year
    - – ~0.13 Mgal (nominal rate) of MST solids/sludge will be sent to DWPF per year
  - — The SWPF feed chemistry is per SWPF Feed Specification Radionuclide Limits of the SWPF *Waste Acceptance Criteria*[19] including:
    - – the initial one million gallons of feed to SWPF will be (at 6.44M Na):
      - • $\leq$ 1.0 Ci/gal
    - – All batches will be (at 6.44M Na):
      - • OH > 2 M
      - • Al < 0.25 M
      - • Si < 842 mg/L
  - — Tank 48 waste treatment is complete and the tank is available for general waste service by December 2014[20]. This date is based on the current Tank 48 Treatment Project level of maturity and is subject to change in the future, consistent with following the DOE Order 413.3A process and approval of project Critical Decisions for the Tank 48 Treatment Project. It includes a two-month contingency to ensure the *DNFSB Recommendation 2001-1 Implementation Plan*[21] commitment is met
  - — Tank 50 is available for general waste service with higher levels of radioactivity by October 2011.

- **Sludge Processing**
  - Target waste removed from all Type III tanks by 2028 per the STP[5] or earlier with emphasis on minimizing total canisters produced. This will require implementation of alternative technology initiatives to mitigate life-cycle impact of increased sludge mass including:
  - Sludge mass reduction (i.e., aluminum dissolution)
    - LTAD for Sludge Batch 8 and future batches as required to support flowsheet requirements
  - Rotary Microfilter (RMF) processing of sludge waste begins April 2011
  - DWPF canisters will maintain a fissile material concentration limit of 897 g/m^3 of glass[22]. Sludge batch preparation will supply feed for the DWPF to ensure the canisters remain within this requirement
  - Plutonium discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with the canister fissile material concentration limits.
- **DWPF Operations**
  - DWPF will produce canisters at maximum throughput for the duration of the program (based on achievable melt rate, planned outages, and waste loading for sludge being processed). DWPF near-term canister production is based on revised sludge mass values. Production of salt-only cans is acceptable to DOE
  - DWPF will achieve a Sludge Oxide Loading of 36 weight percent (wt%) beginning with Sludge Batch 6 and 40 wt% by January 2012
    - a 2-week outage of DWPF will be required for installation of melter bubblers in August 2010
      - bubbler technology will yield a 325 canister per year production rate
  - Melter #2 will continue to operate until August 2011
  - A four-month outage beginning September 2011 will include:
    - Melter #3 installation
    - DWPF feed preparation modifications
      - Yields a 400 canister per year production rate after completion of the outage in December 2011
    - Recycle reduction modifications
      - Reduces the recycle amount by ~1.25 Mgal/yr from the forecast of ~3.2 Mgal/yr after SWPF startup (as predicted by the algorithm used in previous versions of the *System Plan*)
      - Includes a two-month contingency to ensure the *DNFSB Recommendation 2001-1 Implementation Plan*[21] commitment is met
  - DWPF recycle is beneficially reused
  - Four-month melter replacement outage every 72 months continues through the life of the program
  - A four-month DWPF outage is required for SWPF tie-ins immediately prior to SWPF becoming operational
  - Modifications will ensure DWPF support of SWPF processing rates as necessary
  - A third GWSB, similar in capacity and design to GWSB #2 will be required with the need date determined by modeling.
  - The schedule for shipment of the canisters from SRS is not included in this *Plan*.
- **SPF and SDF Operations**
  - SPF and SDF will be capable of processing at these rates:
    - During ARP/MCU operations (with or without concurrent DDA processing):
      - ~120 kgal/wk of Decontaminated Salt Solution (DSS) maximum rate
      - ~95 kgal/wk of DSS average, accounting for outages, cold caps, etc.
    - During SWPF operation:
      - ~235 kgal/wk of DSS maximum rate
      - ~150 kgal/wk of DSS annual average
    - SPF and SDF will support SWPF processing rates
  - Modifications will provide sufficient contingency storage capacity to minimize impacts to SWPF, MCU, H-Canyon, or ETP due to SPF or SDF outages.
- **Effluent Treatment Project (ETP)**
  - ETP is assumed (for the purposes of the SpaceMan Plus™ modeling) to receive an average 11 Mgal/yr:
    - LW Evaporators: 5 Mgal/yr
    - Savannah River Nuclear Solutions (SRNS) Facilities: 6 Mgal/yr

      Note: the Agreement between Savannah River Nuclear Solutions, LLC and Savannah River Remediation for Liquid Waste Receipt Services , provides that the total maximum allocation for waste generated from SRNS facilities including H-Canyon, F-Canyon, the Waste Solidification Building, Mixed Oxide Facility, and miscellaneous smaller contributors — is 15 Mgal/yr. This rate is within the capability of ETP and the LW system and, if realized, would not substantially alter the results of this *Plan*.

- **Tank Closures**
  - — Non-compliant Tanks (Types I, II, and IV — Tanks 1–24)
    - – Waste Removal and Tank Closure commitments are per the current FFA
    - – Tank Closure commitments will be consistent with the SRR contract performance baseline
      - Solids removal completed to the heel removal starting point is the condition that satisfies the FFA requirement for bulk waste removal
      - Isolation and grouting of a tank is the condition that satisfies the FFA requirement for tank closure
  - — Compliant Tanks (Type III and IIIA — Tanks 25–51)
    - – Commitment for completion of waste removal (bulk waste and heel) from all Type III/IIIA tanks is per the STP

      Note: Tanks are not required to be isolated and grouted to meet the STP
  - — Prioritize tanks to facilitate closings in groups, as feasible
  - — Overall tank closure priority will support area closure in the following order, as feasible:
    1. F-Tank Farm (FTF)
    2. H-Tank Farm (HTF) West Hill
    3. HTF East Hill
  - — Waste removal and cleaning activities will include mechanical, chemical, and water washing operations
  - — Enhanced Chemical Cleaning (ECC) activities will begin as early as possible, but no later than July 2012
  - — Tank grouting will be completed 24 months after cleaning has been completed
  - — All documentation complete to authorize grouting in FTF after October 2011
  - — All documentation complete to authorize grouting in HTF after June 2012.
- **Tank Farm Operations**
  - — Tank 25 conversion to the 2F Evaporator concentrate receipt tank by March 2010
  - — Sufficient tank space volume is available to support the receipt of an average of 300 kgal per year of HLW into Tank 39 from H-Canyon operations through 2019, with provision for shutdown flows through 2022. This is not inclusive of Unirradiated Uranium Materials (UUM) dispositioned in SPF or direct discards of plutonium or neptunium materials to the DWPF feed system
  - — Tank Farm infrastructure maintained to support SWPF, DWPF, and SPF processing rates and tank closure schedules.
- **Dismantlement and Decommissioning**
  - — LW Areas transferred to dismantlement and decommissioning (D&D) on an Area-by-Area basis upon closure of their included facilities.

5. Planning Summary and Results

This section summarizes the key attributes of this *Plan*. Detailed discussion on risks and associated mitigation strategies are included in other documents such as the RAR and individual implementation project risk assessments.

This *Plan* meets the programmatic objectives with the exception of the following impacts:
- The STP goal of removing all waste from the waste tanks by 2028 is met with the exception of heel removal from the SWPF processing tanks (Tanks 41, 48, 50, and 51), DWPF processing tank (Tanks 42), and three H-Area storage tanks (Tanks 32, 37, and 43) and the final flushing of the SWPF and DWPF feed tanks (Tank 49 and Tank 40, respectively).

In addition, this *Plan* is predicated on receiving adequate funding to achieve the required project and operations activities. Failure to obtain adequate funding will have a commensurate impact on the programmatic objectives.

This section summarizes the *Plan*, based on the key assumptions and bases. Tabular results of the lifecycle, on a year-by-year basis, or graphical results of the lifecycle are included in:
- *Appendix B — Bulk Waste Removal & Tank Closure Schedules*
- *Appendix C — Salt Solution Processing*
- *Appendix D — Sludge Processing*
- *Appendix E — Canister Storage*
- *Appendix F — Tank Farm Volume Balance*
- *Appendix G — Usable Type III Tank Space*
- *Appendix H — Remaining Tank Inventory*
- *Appendix I — Evaporator System Levels (through FY14)*
- *Appendix J — LW System Plan — Rev 15 Summary.*

5.1 *Waste Removal and Tank Closure*

5.1.1 Waste Removal and Tank Cleaning

The first step in the disposition of sludge and salt waste is BWR from the tanks. Accelerated sludge removal rates are required to support higher DWPF production rates than those found in Revision 14 of the *Plan*. Sludge is sent to one of two feed preparation tanks (one more than Rev. 14) ensuring sludge waste is continuously available for treatment. Salt is dissolved, removed, and staged for the SWPF. A modular design for BWR equipment ensures portability without further investment in permanent infrastructure. The Waste on Wheels (WOW) approach to perform BWR activities involves reusable, modular equipment. Mobile power equipment and control stations are easily fed from nearby overhead lines. Extended life mixer pumps are redeployed from tank to tank.

Bulk Waste Removal

This *Plan* assumes utilization of the WOW concept, which requires no new infrastructure. Portable and temporary equipment meets tank infrastructure needs. Additional purchased pumps and WOW equipment perform accelerated BWR operations concurrently in both tank farms. The primary components of the WOW system are:
- Long-lasting submersible mixer pumps with no exterior fittings and fixtures so that the pumps can be quickly decontaminated, removed, and reinstalled in the next tank with minimal radiation exposure to personnel
- A portable field operating station containing pump drives and controls
- A portable substation to provide 480-, 240- and 120-volt power to the WOW equipment
- Disposable carbon steel transfer pumps.

WOW equipment is deployed at the tank as a field operating station, providing temporary power and control for BWR equipment. When BWR is completed on one tank, the WOW equipment is reconfigured to support waste removal on the next tank. Pumps are sized to fit through 24-inch openings allowing a high degree of flexibility to locate the pumps in optimal configurations within the waste tanks. They are supported from the bottom of the tank, which minimizes steel superstructures and tank-top loading. Product lubricated bearings and motor cooling eliminate the need for bearing and seal water supply. These pumps are easily decontaminated, reducing exposure to personnel during relocation to another tank. The waste is transferred to the receipt tank using existing underground transfer lines and diversion boxes. If the transfer system is degraded or non-existent, above-grade hose-in-hose technology is deployed, rather than investing in costly repairs. Temporary shielding is supplied as necessary to reduce exposure to personnel.

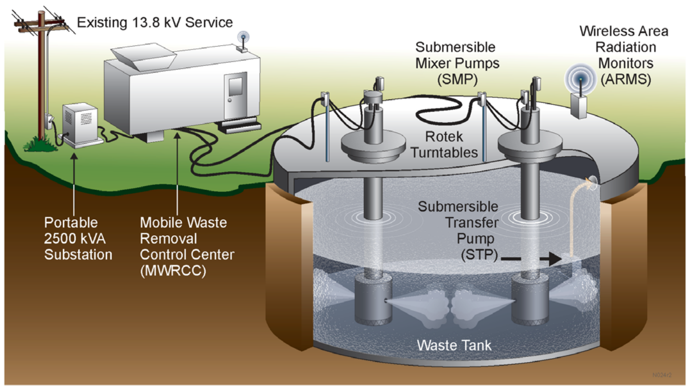


Figure 5–1 — *WOW Deployment for Bulk Waste Removal*

Sludge Removal

Sludge removal operations are conducted with three mixing pumps. Sufficient liquid is added to the tank to suspend sludge solids, with existing supernatant or DWPF recycle material used to minimize introduction of new liquids into the system. Operation of the mixing pumps suspends the solids, which are then transferred as a slurry from the tank. This operation is repeated, periodically lowering the mixer pumps, until the contents of the tank can no longer be effectively removed by this method.

Sludge batches are configured to remove sludge from non-compliant tanks first and to balance the sludge batch composition of PUREX and HM sludges. Tank 13, a non-compliant tank in HTF, will be used as a sludge hub tank as necessary until heel removal is scheduled in early 2015. At that time it will enter the Heel Removal stage to support the closure of Tank 13 in 2017.

Salt Removal

Salt waste removal is accomplished using a modified density gradient process followed by mechanical agitation. A well is mined through the saltcake down to the tank bottom. An off-the-shelf, disposable transfer pump is installed at the bottom of the well, along with instruments to monitor waste density, to pump the interstitial liquid out of the tank until the well is dry. Water is added to dissolve the salt, and as the density increases, the saturated solution migrates to the bottom of the well where it is pumped out. The initial process involves no moving parts in the tank

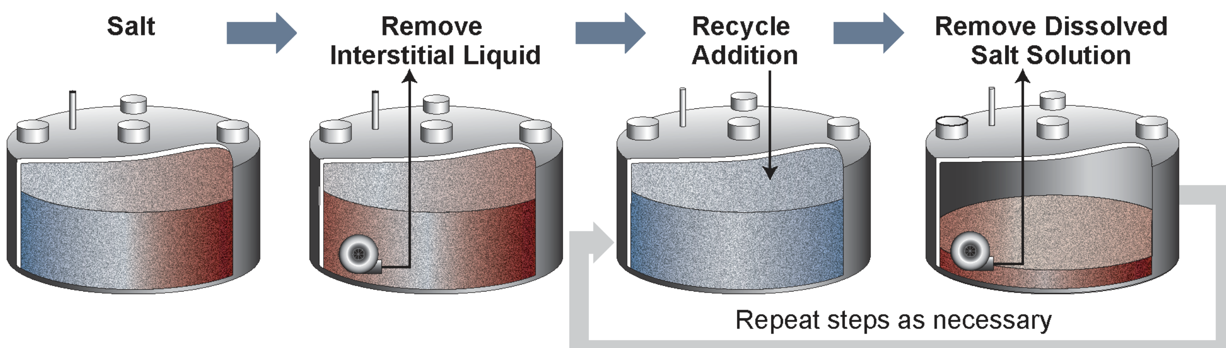


Figure 5–2 — *Modified Density Gradient Salt Removal*

except the transfer pump. DWPF recycle is used to dissolve salt, conserving compliant tank space by minimizing additions of new material and reducing the load on the evaporator system. The dissolved salt solution is prepared as close to saturation as possible prior to pumping out the tank. As salt dissolution progresses and the soluble fraction is pumped from the tank, the insoluble materials dispersed throughout the salt matrix blankets the underlying salt and the dissolution rate decreases significantly. Mixer pumps are installed to within about 60″ of salt left in the tank to displace insolubles and restore rapid dissolution rates all the way to the tank bottom. Mixer pumps, powered and controlled with WOW equipment, suspend and remove insoluble solids at the end of the dissolution step, similar to sludge removal.

Most of the salt removal transfers will utilize existing transfer lines, however, Tanks 1, 2, and 3 currently utilize Tank 7 in the only exit transfer route. As Tank 7 will be closed before salt removal in Tanks 1, 2, and 3, provision of transfer paths will be included in the modifications required for salt removal in those tanks.

Heel Removal

Heel removal is the final stage of waste removal prior to chemical cleaning. Vigorous mixing is continued until less than 5,000 gallons of material remain, using three SMPs for sludge tanks and two SMPs for salt tanks. For difficult heels, more aggressive methods, such as targeted hydro-lancing of sludge mounds, are employed. In Tanks 18 and 19, zeolite deposits have been removed with remote operated equipment (robotic crawlers). The same technology will be used to remove the diatomaceous earth from Tank 23, zeolite from Tank 24, and the sludge heels form Tanks 21 and 22.

Chemical Cleaning

Prior to 2011, tanks will be chemically cleaned via bulk oxalic acid washing after waste removal has left fewer than 5,000 gallons remaining volume. To remaining solids in the tank, oxalic acid is added to a minimum liquid level to enable mixer pump operation. The contents of the tank are agitated for a short period, and then transferred to a receipt tank for neutralization. More acid is added to soak and dissolve solids left behind, which is repeated until all solids that can be dissolved with oxalic acid are dissolved and removed from the tank.

Enhanced Chemical Cleaning

Beginning in 2011 the ECC process will be used to perform tank cleaning. Using a Chemical Oxidation Reduction Decontamination – Ultra Violet (CORD UV) technology, insoluble sludge and salt solids will be dissolved and redeposited in a compliant waste tank using a fraction of the liquid currently used for bulk chemical cleaning. This process employs dilute oxalic acid to dissolve residual waste, removing it along with insoluble material to clean vessels and basins. The ECC process will accelerate cleaning of radioactive waste tanks. This destruction process eliminates oxalates and spent acid reducing liquid volumes needed and evaporator foaming and leading to enhanced melter operation. This process operates in small batch configuration until the visible sludge and corrosion products on the interior surfaces have been removed.

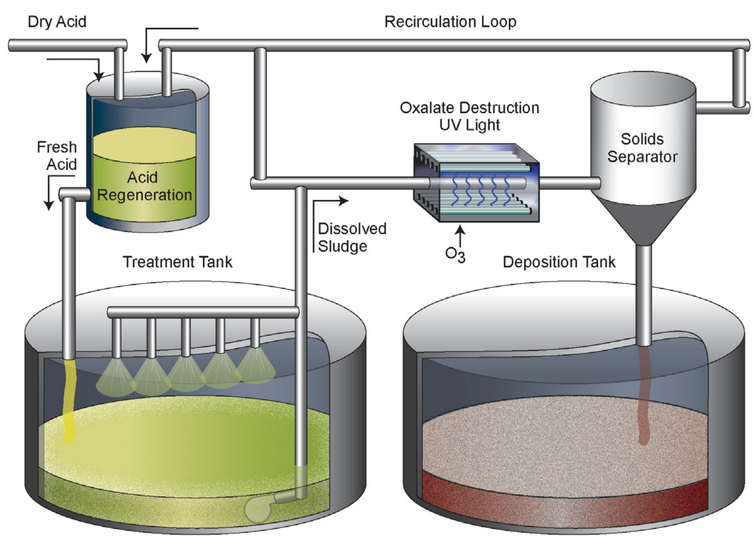


Figure 5–3 — *Enhanced Chemical Cleaning Process*

The standard ECC installation consists of two CORD UV trains and an evaporator. The initial installation on Tank 8, however, will consist of one train and no evaporator. If the initial HTF ECC unit is employed with two trains, but lacking an evaporator (due to, for example, funding constraints) the 2H Evaporator would be required to supplement cleaning activities. As the 2H Evaporator is not heavily used during this period, it is anticipated to have adequate capacity to support the ECC requirements.

Tanks with Documented Leak Sites

Several non-compliant tanks have documented leak sites. Waste removal operations are likely to reactivate old leak sites and potentially create new leak sites in those tanks. Contingency programs and procedures will be utilized to contain leakage, transfer the waste to a compliant tank, and minimize potential release to the environment. Specific plans will avoid liquid levels associated with known leak sites and focused monitoring will be employed where these levels cannot be avoided.

Annulus Cleaning

Some tanks have waste in the annulus space, the majority of which is a soluble form of salt appearing as dried nodules on tank walls at leak sites and at the bottom of the annulus pan. Before declaring the tank ready for closure (for those tanks requiring annulus cleaning), this waste will be removed from the annulus by dissolving the salts with inhibited water and transferring the solution out of the annulus. A remotely operated wall crawler rinses salt nodules from the tank walls to the floor prior to dissolving, for applications where substantial insoluble material remains. Where materials are not readily dissolved or difficult to remove (planned only for Tank 16), remotely operated equipment will be deployed to mechanically remove the waste and transfer it out of the annulus.

Sampling and Characterization

The last step in the waste removal sequence, before declaring a tank ready for closure, is inspection of the tank and annulus and sampling the residual contents. The samples will be analyzed to verify cleanliness requirements have been met. Once the tank inventory, based on the sample characterization, meets or exceeds the closure plan requirements, the tank cleaning equipment is demobilized and redeployed to the next tank. The characterization results will be incorporated into the tank-specific closure modules discussed in the next section.

5.1.2 Tank Closure

The currently approved FFA establishes the regulatory framework for the operation, new construction, and eventual closure of the LW tank systems. The sequence and schedule for planned heel removal and tank closures in this *Plan* support closure of the total number of non-compliant tanks well in advance of the currently approved FFA commitment of 2022. Sludge batch processing and salt waste processing support tank closures within tank farm space constraints and processing facility availability as identified in this *Plan*.

Non-compliant tanks are planned for closure in accordance with a formal agreement among the DOE, Region IV of the EPA, and SCDHEC as expressed in the SRS currently approved FFA.

SRS tanks that do not meet secondary containment standards, as established in the currently approved FFA, must be removed from service per the currently approved FFA schedule shown in Appendix A — *FFA Waste Removal Plan & Schedule*. Twenty-four tanks at SRS do not meet secondary containment standards and are scheduled for closure; two FTF tanks, Tank 17 and Tank 20 were closed in 1997.

Operational closure consists of those actions following waste removal that bring liquid radioactive waste tanks and associated facilities to a state of readiness for final closure of the tank farms complex. The process involves:

- Developing tank-specific regulatory documents referred to as closure modules (initiated in parallel with tank sampling and characterization)
- Isolating the tank from all operating systems in the surrounding tank farm (e.g., electrical, instruments, steam, air, water, waste transfer lines and tank ventilation systems)
- Grouting of the tank primary, annulus, and cooling coils
- Capping all tank risers.

A 24-month closure process is planned for the first tanks to account for sampling and characterization, initial drafting of closure documents, first-time review process, annulus and coil closure, and a 4-month grout period. The experience gained on tanks 5, 6, 18, 19, and 16 will allow compressing the closure process to 18 months for the next four tanks (7, 8, 11, and 12); further refinement of sampling and characterization techniques and review and response cycles will accelerate the tank closure process to 12 months for the remaining tanks.

Closure Module Development

An area-specific Waste Determination approach ensures the DOE 435.1-1 and §3116 tank closure process is implemented as efficiently as possible. Performance assessments and §3116 Basis documents are generated for each of the tank farms—one for FTF and one for HTF. The §3116 Basis documents will include the waste tanks as well as ancillary equipment located within the boundary of the tank farm. An area-specific General Closure Plan is developed for each of the tank farms for approval by SCDHEC in consultation with the EPA. These closure plans will address closure of groups of tanks, not individual tanks.

DOE Manual 435.1-1 mandates a Tier 1 Closure Plans and associated Tier 2 Closure Plans. The Tier 1 plan is area-specific and provides the bases and process for moving forward with tank closures. This document is approved at the DOE-Headquarters level. The Tier 2 documents are tank-specific, follow the approved criteria established in the Tier 1 document, and are locally approved by DOE-SR.

Development of a tank specific closure module, per the State-approved area-specific General Closure Plans, follows completion of tank cleaning activities and proceeds in parallel with sampling and characterization. It describes the waste removal and cleaning activities performed and documents the end state. Sample and characterization are planned to show that remaining waste inventory will meet or exceed cleanliness parameters described in the area-specific General Closure Plan process to determine when adequate waste removal has occurred to permit closure.

Tank Isolation

Isolation is the physical process of disconnecting transfer lines and services from the tank and removing the tank from service. The process begins by preparing the ancillary equipment in advance of waste removal and incorporating tank isolation requirements. This minimizes work packages, process cell entries, and worker exposure, and enables inspecting, flushing, and capping transfer lines no longer needed, during routine process cell entries. The tank penetrations are filled with grout and electrical and signal connections are severed to isolate the tank from the control room. Temporary power skids provide services for grout placement including ventilation, lighting, and cameras, and a portable ventilation system to replaces the permanent system so that each tank is completely isolated from the tank farm during grouting operations.

Grout Selection and Manufacture

A reducing grout provides long-term chemical durability and minimizes leaching of residual waste over time. The reducing grout fills each tank, is self-leveling, and encapsulates the equipment remaining inside the tank. A strong grout cap is applied on top for intruder prevention in tanks that do not have a thick concrete roof.

A mobile grout manufacturing plant will be positioned in each tank farm to minimize the transportation cost of the grout. The plants produce 75 cubic yards per hour continuously, with a peak capacity of 200 cubic yards per hour.

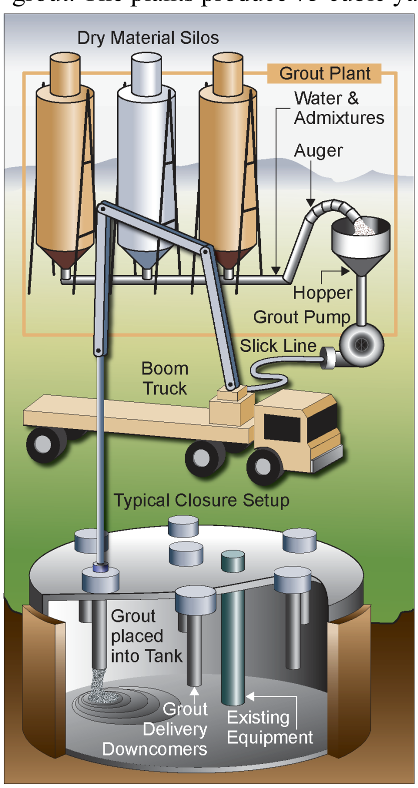


Figure 5–4 — *Tank Closure Setup*

Grout Placement

Grout fill operations, including site preparation, grout plant set up, installation of grout delivery lines, pumper truck placement, and grout equipment placement are established around the tanks. Each grout plant makes two different grout mixes. The reducing grout constitutes the bulk of the tank's fill material, with placement of 4,500 to 8,000 cubic yards of a mix using cement formers from local concrete suppliers. The strong grout, with a compressive strength of 2,000 psi, fills the top two feet of the tank for intruder protection. Fill progress is monitored using an in-tank video to view a level indicator. A temporary ventilation system vents the tank for the reducing grout phase and passive ventilation, through a breather high-efficiency particulate filter, vents the strong grout fill.

The sequence for tanks with an annulus ensures that all voids are filled and the structural integrity of the tank is maintained, overcoming the problems in filling a non-compliant tank with grout. Grouting the annulus and primary tank is in alternating steps providing structural support for the tank wall. A minimum of 24 hours for curing between each five-foot lift allows the grout formations to harden sufficiently for self-support. A two-part strategy purges excess water during grout installation. First, the remaining liquid left over from the ECC evolution for each tank is removed to a level less than one inch with a dewatering pump. Second, because both grout mixes minimize excess water, evaporation promoted by the heat of hydration eliminates any remaining water perched atop the grout layers. Dry Portland cement can be periodically added to absorb bleed water if needed.

Cooling Coil Closure

For tanks with cooling coils, each tank's 25,000 feet of cooling coils are grouted with a technique, initially used during the construction of the Hoover Dam and now an industry standard method, to pressure grout the cooling coils. After filling the tank, hardened grout surrounds the cooling cools. The coils are then pressure filled with grout displacing the previously entrained cooling water. A low-activity waste receipt tanker accepts the displaced cooling water for transfer to a compliant waste tank. The volume and chemical characteristic of this water has a negligible impact on compliant tank space.

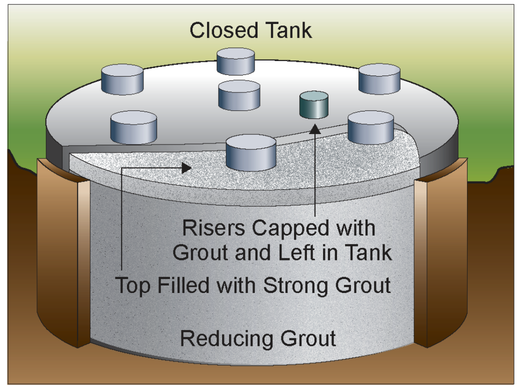


Figure 5–5 — *Closed Tank*

Riser Closure and Capping

The final step in the tank closure operation, after filling the tank, is encapsulating the risers. Using forms constructed of rolled steel plates, strong grout is used to encapsulate the risers thus providing a final barrier to in-leakage and intrusion. The final closed tank configuration is an integral monolith free of voids and ensuring long-lasting protection of human health and the environment.

5.2 Disposition of Sludge Waste

The basic steps for sludge processing are:

1. Sludge removal from tanks
2. Blending and washing of sludge
3. Sludge feeding to the DWPF
4. Vitrification in DWPF.

Sludge processing is constrained by the capabilities of the sludge washing and the DWPF processing facilities and by tank storage space to prepare sludge batches. Sludge batch planning uses the estimated mass and composition of sludge and known processing constraints to optimize processing sequences. Sub-tier plans document the modeling, guide the sequence of waste removal, and support a more detailed level of planning. They are revised as new information becomes available or when significant updates in the overall waste removal strategy are made. The specific input to this *Plan* from sludge batch planning is summarized in *Sludge Batch Plan – 2009 in Support of System Plan R-15* [23].

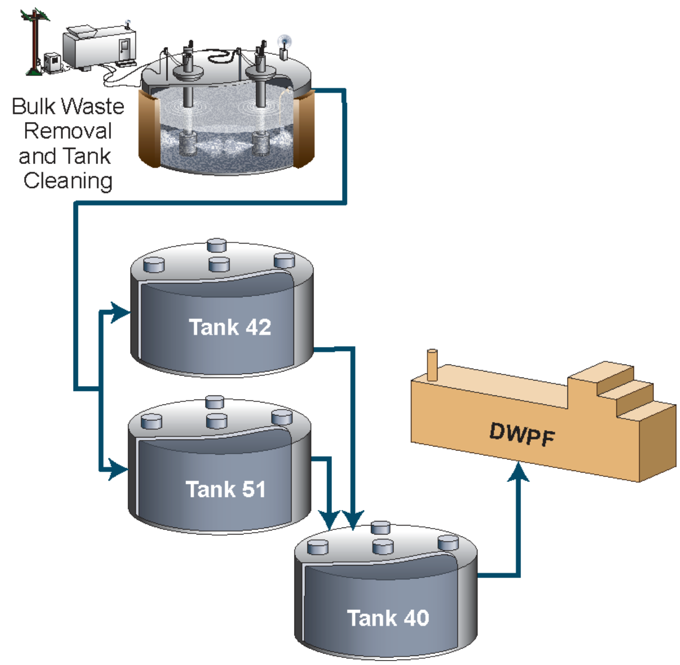


Figure 5–6 — *Sludge Feed Preparation*

5.2.1 Sludge Feed Preparation

This *Plan* adjusts tank farms operation to ensure sufficient feed availability for the retrofitted DWPF melter (described below). Use of a second sludge tank (Tank 42) as a DWPF feed preparation tank doubles the feed availability for the DWPF operation. This *Plan* also ensures that DWPF feed will contain 16 wt% solids, reducing evaporation load on the DWPF processing systems.

An in-tank rotary microfiltration system in Tanks 42 and 51 will eliminate reliance on gravity settling and enables continuous sludge washing. This accelerated batch preparation enables improved glass formulation efforts achieving optimized waste loading in the glass.

Sludge Washing

Sodium and other soluble salts in DWPF feed are reduced through sludge washing. Sludge washing has historically been performed by adding water to the sludge batch, mixing with slurry pumps, securing the pumps to allow gravity settling of washed solids, and decanting the sodium-rich supernate to an evaporator system for concentration. This cycle is repeated until the desired sodium molarity, typically 1 M Na, is reached. Some types of sludge settle slowly, extending wash cycles. Sludge settling typically constitutes 60% of batch preparation time. The total number of washes performed and volume of wash water used is minimized to conserve waste tank space. Sludge batch size and wash volumes are also limited by the hydrogen generation rate associated with radiolysis of water. Tank contents are mixed on a periodic frequency to release hydrogen retained within the sludge layer, resulting in a limited window within operating constraints for gravity settling.

Accelerated Sludge Washing

To overcome washing limitations and enable accelerated DWPF vitrification, two sludge feed preparation cycle time reduction strategies will be implemented to ensure continuous, increased DWPF feed availability:

- A second sludge feed preparation tank (Tank 42) begins service in 2010 to double feed preparation capacity. This includes new slurry pumps using improved bearing design to provide several thousand hours of reliable mixing. Dedicated variable frequency drives enable increased mixing in both sludge batch preparation tanks.
- In-tank rotary microfiltration will be installed in Tanks 42 and 51, eliminating reliance on gravity settling and enabling continuous sludge washing.

The rotary microfilter is a compact filtration system using membrane filters mounted on rotating disks. Its flux advantage (over static membrane filters) results from high shear and centrifugal force acting on membrane boundary layers, greatly reduces fouling, and increases fluid flow. The rotary microfilter's feed flow rate is decoupled from feed pressure, allowing more control over driving force pressure and independent control of shear applied to the filter cake. It uses 11-inch diameter disks operating at 1,170 rpm. Feed fluid enters the filter housing and flows across the membrane surface, while permeate flows through and exits through the hollow shaft. Concentrated slurry is pumped from the filter housing. A filter module with pump is installed in a sludge feed preparation tank riser. Extensive static filter element testing demonstrated rotary microfiltration's advantages including:

- less plugging
- higher utility
- higher throughput.

Advantages of the rotary microfilter include:

- provides more efficient sodium removal,
- uses 40% less wash water,
- reduces batch preparation cycle time,
- enables larger sludge batches that facilitate accelerated waste removal and tank closure
- reduces load on current evaporators
- conserves receipt tank salt storage space.

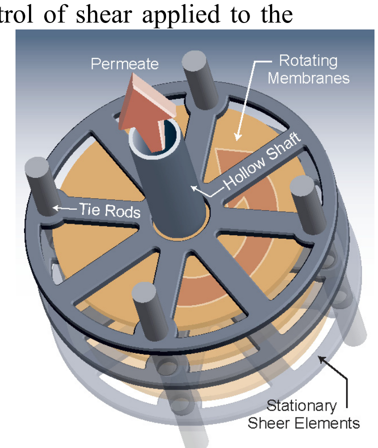


Figure 5–7 — *Rotary Microfilter*

5.2.2 DWPF Operations

Washed sludge is transferred to the DWPF facility where it is combined with the high-level waste streams from salt processing (discussed below) for vitrification into glass canisters and stored in a GWSB pending disposition. The DWPF production rate (over the last ten years) has averaged 215 canisters per year with 4,000 lbs of glass per canister. The canister production, by year is shown in Appendix C — *Salt Solution Processing*.

Two-step Production Improvement Approach

This *Plan* implements a two-step glass production rate improvement program. In the first 14 months, retrofitting the melter with bubblers and upgrading tank farm sludge waste feed preparation capacity increases the DWPF production rate to 325 canisters per year in 2010. Within 30 months, enhancing the feed preparation system and implementing operation improvement initiatives achieves a nominal production rate of 400 canisters per year. This two-step improvement approach provides flexibility and a cost-effective balance between plant production and improvements.

Historically, melter performance has been the limiting factor for DWPF throughput. The DWPF melter (without bubblers) has produced an average of 215 canisters/year for the past ten years. Tank farm sludge waste feed preparation and DWPF feed preparation systems support a canister production capability of 250 and 325 canisters/year respectively. All other DWPF plant systems support designed production capability of more than 400 canisters/year.

In the first step, tank farm sludge waste feed preparation improvements (discussed in §5.2.1) and melter improvements maximize production capability of each. The current DWPF melter will be retrofitted with four or five bubbler systems to double the average production capacity of the melter to 430 canisters/year. The melter off-gas system is also optimized to support higher glass throughput and reduce DWPF recycle water.

The second step of DWPF production capacity improvement program addresses streamlining the DWPF feed preparation system. Four process improvements are planned to streamline the DWPF feed preparation system:

- Implementation of an alternate reductant
- Processing of cesium strip effluent in the slurry mix evaporator (SME)
- Addition of dry process frit to the SME
- Minimization of water from canister decontamination frit stream to SME

This step reduces recycle water generation by 1,250 kgal/yr:

- 250 kgal/yr by using dry process frit
- 400 kgal/yr by replacing steam with air as motive fluid in one SAS
- 600 kgal/yr by routing decon frit water to ETP

This two-step canister production rate improvement initiative establishes a higher maximum DWPF canister production capability of 400 canisters/year.

A summary of yearly canister production rates for the duration of this *Plan* is shown in Table 5-1 — *DWPF Production Rates*. Note that these are nominal canister production rates and do not reflect actual annual canister production numbers per year. The canister rates reflect an assumed two-week outage every year to allow for routine planned maintenance.

Table 5-1 — *DWPF Production Rates*

FY	**Nominal Rate** *(DWPF Discrete Canisters/yr)*	**Outage** *(Months)*	**Total DWPF Discrete Canisters poured** *(DWPF Canisters)*
FY09	186		196
FY10	186		190
FY11	325 [a]	1 [c]	297
FY12	400 [b]	3 [c]	293
FY13	400	4 [d]	243
FY14	400		384
FY15	400		389
FY16	400		380
FY17	400	4 [c]	283
FY18	400		366
FY19	386		370
FY20	386		386
FY21	386		386
FY22	(sludge heels) [e]		152
FY23	(sludge heels & 23 salt only)		89
FY24	(salt only)		42
FY25	(salt only)		42
FY26	(salt only)		41
FY27	(salt only)		41
FY28	(salt only)		41
FY29	(salt only)		10
FY30	(salt only)		10
FY31	(salt only)		5

[a] Installation of bubblers in FY11 — allows increase in the nominal canister production rate

[b] DWPF production capacity improvement program implemented during the melter change out in FY12 — allows an additional increase in the nominal canister production rate.

[c] Four-month melter outage is assumed in 2011 and approximately every six years thereafter during sludge processing. Actual melter change-out is determined by melter performance.
[d] 2013 outage to accommodate transition to SWPF/DWPF coupled operations — assumes no canister production rate impact from coupled SWPF-DWPF operations.
[e] Lower production rate assumed for salt only cans and dilute heel processing.

Failed Equipment Storage Vaults and Melter Storage Boxes

Failed equipment storage vaults (FESVs) and Melter Storage Boxes (MSBs) are repetitive projects required to sustain ongoing DWPF operation by providing interim storage of failed DWPF melters. The original DWPF design has two vaults contained within one construction unit. Each FESV is designed to store one failed melter inside an MSB.

FESV #1 and #2 were built under the DWPF line item project. Melter 1 was placed in FESV #2 in December 2002. Melter 1 (inside MSB #1) had a relatively low radiation field and was placed in the northernmost vault since the next vault pair to be constructed would be adjacent to FESV #2.

FESV #1 remains available for use with Melter 2. Construction of MSB #2 was completed in October 2008. MSB#2 is currently stored in FESV #1 awaiting use during the Melter 2 replacement outage currently forecasted in this *Plan* to occur in September 2011.

Space has been reserved for construction of up to10 FESVs if needed.

Under the current planning basis, the need date for FESV #3 and #4 will be triggered by the failure of Melter 3 and the availability of Melter 4 to replace Melter 3. Melter 3 (if it fails early) does not need to be removed from 221-S until Melter 4 is available. Melter 4 is currently scheduled to be completed in November 2013. Melter 3 is currently scheduled to be in service through June 2017. Based upon this strategy, FESVs #3 and #4 construction should be completed and available for service by January 2014. Likewise, MSB #3 should be constructed and available to receive Melter 3 by January 2014.

The need dates for FESV #3 and #4 and successive pairs of vaults will continue to be evaluated on an ongoing basis.

At the present time, the FESV 200-ton gantry crane is designed to interface only with a MSB which is designed primarily to contain failed melters. The placement of other large failed DWPF equipment (which do not have disposal paths) in FESVs has been considered but the complete engineered system to move large contaminated equipment from the 221-S canyon to the FESV has not been designed or constructed. Alternative methods for disposal of large contaminated equipment from DWPF (not including melters) are being evaluated.

5.3 Disposition of Salt Wastes

As highlighted in the Introduction, this *Plan* includes the use of a series of salt treatment processes over the life of the program, including DDA, ARP/MCU, and SWPF. *Appendix C — Salt Solution Processing* reflects the breakdown of the volumes treated from each of the processes by year. Using the input assumptions for this *Plan*, approximately 97 Mgal of salt solution from the Tank Farms are planned for processing over the life of the program. SWPF processes the vast majority of this salt solution waste. As a result, the salt solution processed after SWPF reaches its nominal capacity is approximately 6 Mgal/yr (actual anticipated throughput varies with respect to DWPF outages, with an average of 5.7 Mgal/yr).

5.3.1 DDA

Tank 41 salt waste is the only waste processed through DDA alone, having been chosen to minimize the curies dispositioned in the SDF while meeting other processing goals. Tank 41 was selected because it was one of the Type III tanks that had the lowest activity supernate waste, did not contain large volumes of sludge, and was not being used for an operational function vital to Tank Farm processes (such as evaporator systems or sludge batch preparation). These criteria are pertinent because:

- Type III tanks meet current EPA requirements for full secondary containment and leak detection and are the only tanks approved for use in further processing
- Low supernate activity minimizes the activity being sent to SDF
- Low sludge content minimizes the potential for sludge carry-over into SDF thus minimizing the activity being sent to SDF

- Tanks performing vital functions are needed for safely disposing of the wastes.

Before this *Plan,* the waste in Tank 41 was deliquified and dissolution was performed on some of the remaining saltcake, with the solution transferred to Tanks 49 and 23.

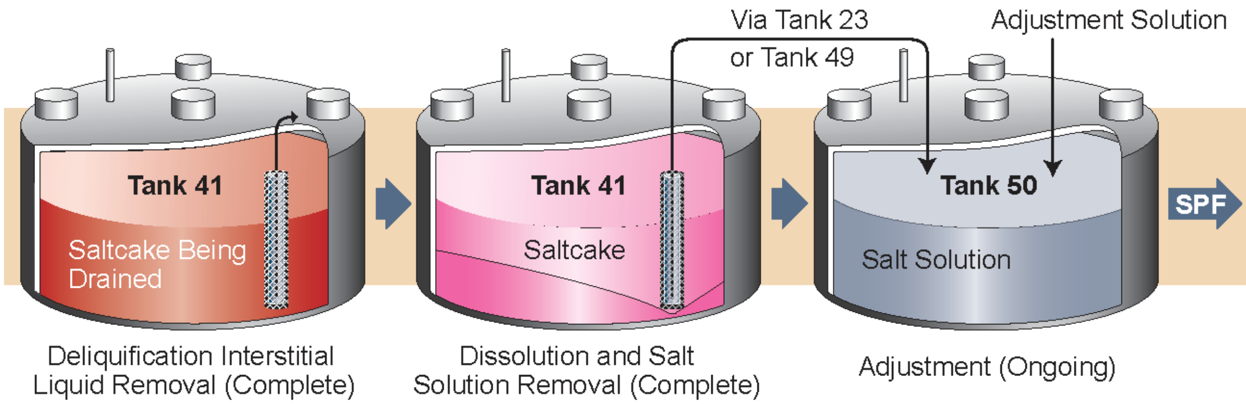


Figure 5–8 — *Deliquification, Dissolution, and Adjustment*

5.3.2 ARP/MCU

The ARP/MCU process reduces the activity of the waste stream going to SDF, albeit at a lower rate than the future SWPF. The DSS stream, the low-level waste stream, is disposed of in the SDF as LLW grout. The higher activity strip effluent (SE) stream is eventually processed by vitrification in DWPF.

ARP/MCU, having begun operation in April 2008, processes salt solutions until permanent shutdown for SWPF transfer line tie-ins. ARP/MCU will not operate during DWPF major outage periods (e.g., melter replacement outages) due to the close coupling of the two facilities.

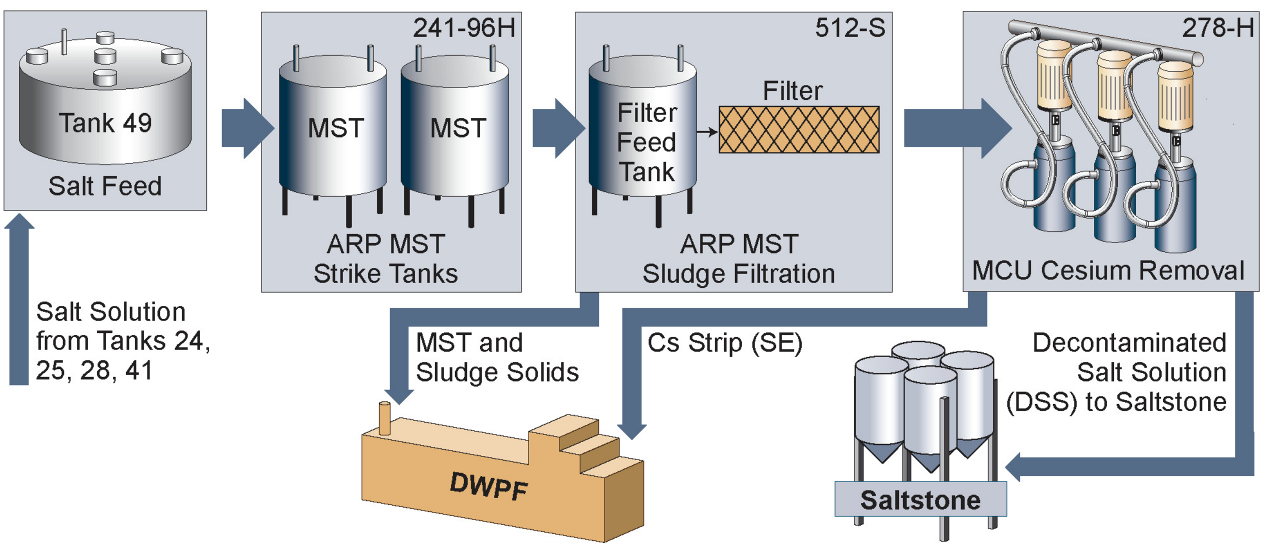


Figure 5–9 — *Actinide Removal Process / Modular Caustic Side Solvent Extraction Unit*

The current MCU permit provides for three-year operations and the need to seek and receive approval for extended operation via a permit change. As hot operations, per the permit requirements, were declared some time on or before September 30, 2007, permission from SCDHEC is anticipated to allow continued operation.

5.3.3 SWPF

SWPF is assumed to begin operation in May 2013. For the first 12 months, the SWPF processing rate is assumed to be 3.75 Mgal/yr of salt solution. After 12 months, the nominal processing rate is increased to 6 Mgal/yr. The 6 Mgal/yr nominal processing rate is based on a 9.4 Mgal/yr. maximum hydraulic rate adjusted for 85% contactor efficiency and 75% availability ([9.4 Mgal/yr.] × [0.85] × [0.75] = 6 Mgal/yr.). However, because of the close coupling between SWPF and DWPF, SWPF must shut down for each DWPF melter replacement outage, with assumed four-month outages approximately every six years. The actual anticipated throughput necessarily varies because of DWPF melter outages with an average of 5.7 Mgal/yr.

The SWPF processing rate is based on an assumed 100% availability for the Tank Farm feed as well as DWPF and Saltstone/DSS Tank receipt of the SWPF discharge streams. Availability of tank space to prepare salt solution batches may impact the ability to achieve full capacity SWPF operations, especially in the first few years of operation.

Table 5-2 below gives the composition of the salt batches for ARP/MCU and SWPF required to removal salt waste from the non-compliant tanks.

Table 5-2 — *Salt Batch Composition*

Process	Source Tanks	Nominal Batch Volume (kgal)
	ARP/MCU Batches 3 through 6	
ARP/MCU B3	Tank 25 Salt Solution; Conc. 2H Supernate (Tank 24)	1,030
ARP/MCU B4	Tank 25 Salt Solution; Conc. 2H Supernate (Tank 24)	1,080
ARP/MCU B5	Tank 25 Salt Solution; Conc. 2H Supernate (Tank 24)	1,050
ARP/MCU B6	Tank 41 Salt Solution; Tank 28 Salt Solution	1,050
	SWPF Batches 1 through 19	
SWPF B1	ARP/MCU B6 Heel; Tank 41 Salt Solution	1,260
SWPF B2	Tank 28 Salt Solution; Tank 42 Supernate; SB5 Al Diss. (Tank 11)	1,250
SWPF B3	Tank 41 Salt Solution; Tank 42 Supernate; SB5 Al Diss. (Tank 11)	1,100
SWPF B4	Tank 13 Supernate; SB6 Al Dissolution	1,260
SWPF B5	Tank 9, 10, 37, & 41 Salt Solution	1,100
SWPF B6	Tank 37 Salt Solution	1,200
SWPF B7	Tank 9, 10, 37, & 41 Salt Solution	1,260
SWPF B8	Tank 9, 10, 28 & 41 Salt Solution	1,100
SWPF B9	Tank 1 & 9 Salt Solution; SB6 Al Dissolution (Tank 8)	1,260
SWPF B10	Tank 1 & 9 Salt Solution; SB6 Al Dissolution (Tank 8)	1,240
SWPF B11	Tank 1 Salt Solution; Tank 33 Supernate	1,100
SWPF B12	Tank 2 & 33 Salt Solution; Tank 33 Supernate	1,240
SWPF B13	Tank 2 & 33 Salt Solution; Tank 1 Heel Removal	1,250
SWPF B14	Tank 3 Salt Solution; Tank 1 Heel Removal	1,100
SWPF B15	Tank 34 Supernate; Tank 2 Heel Removal	1,260
SWPF B16	Tank 34 Salt Solution; Tank 34 & 47 Supernate; Tank 2 HR	1,260
SWPF B17	Tank 47 Salt Solution; Tank 26 & 47 Supernate	1,100
SWPF B18	Tank 47 Salt Solution; Tank 3 Heel Removal	1,250
SWPF B19	Tank 47 Salt Solution; Tank 3 Heel Removal	1,100

Production of Salt-Only Canisters

Consistent with the Key Inputs and Assumptions, this *Plan* allowed production of Salt-Only canisters. Because of the accelerated sludge processing implemented in this *Plan*, the bulk of the sludge waste will be removed from the waste tanks and processed by June 2020. Another two years are required to complete processing the sludge heel in the DWPF feed tank (Tank 40) at a reduced canister rate (~90 canisters per year). Once all sludge has been processed, DWPF will continue to operate to vitrify the Strip Effluent and MST streams received from SWPF using revised frit formulae and trim chemicals as needed. During production of Salt-Only canisters, the canister waste loading will be limited by the canister heat generation limit of the GWSB. As shown in Table 5-1, 250 salt-only canisters are produced in this *Plan*.

5.3.4 SPF / SDF Operations

The current active Disposal Unit (Vault 4) is approximately 200 feet wide, by 600 feet in length, by 26 feet in height. Future Disposal Units will consist of two cells nominally 150 feet diameter by 22 feet high. After accounting for interior obstructions (support columns, drainwater collection systems, etc.) and the requirement for a 2-foot cold cap, the nominal useable volume of a cell is 2,600 kgal. Recent operating experience has resulted in approximately 1.76 gallons of grout being produced for each gallon of DSS feed, thus yielding a nominal cell capacity of approximately 1,500 kgal of DSS.

The maximum allowable grout temperature at SDF during the processing of DDA DSS is 85°C assuming that there is no Isopar® containing waste mixed with these streams. Therefore, the pour strategy for filling the cells must be planned so that the maximum grout temperature in each cell remains below this limit. During the processing of material that has a low Cs-137 concentration (e.g. SWPF DSS or MCU DSS), there is no restriction on the number of cells having exposed grout made from the salt solution feed.

Currently SPF is fed from Tank 50 in the H-Tank Farm. Tank 50, however, is needed for salt batch preparation for SWPF. Lag storage capability in the form of two 60-kgal vessels will be added at SPF to ensure enough capacity in the SPF system to minimize normal production outages' impact to SWPF operations. Other existing tanks may be utilized for this service as they are emptied, specifically, Tank 21 prior to closure (2013–2015) and Tank 50 after it is no longer needed for SWPF feed preparation (after 2015).

Operations using DDA and ARP/MCU waste can be processed at rates as high at 120 kgal/week into an individual cell. This is based on experience in the facility with Isopar® concentrations low enough that ventilation and temperature controls are not required. With higher Isopar® concentrations, two cells are required to process at this rate. Saltstone currently assumes that DSS resulting from the SWPF treatment process will contain Isopar® levels below that required for ventilation or temperature controls. Disposal cells will require ventilation and temperature control additions if Isopar® levels are higher than assumed. However, sufficient cells will be available to process at the required rates even if the Isopar® levels require these controls.

5.4 ***Base Operations***

5.4.1 **Supporting Nuclear Material Stabilization**

A continuing portion of the mission of the Tank Farms, especially H-Tank Farm, is safe receipt, storage, and disposition of waste yet to be received from H-Canyon and HB-Line. This *Plan* supports nuclear material stabilization in H-Canyon through 2019 (with shutdown flows through 2022) per the *H-Area Liquid Waste Forecast Through 2019*[24].

Tank 39 will continue to be dedicated for H-Canyon receipt at least through 2022 to support shutdown flows from H-Canyon. This is one of the reasons that the 2F Evaporator System will continue to operate and that salt must be successfully removed from Tank 37 to allow continued 3H Evaporator operation. Thus, this *Plan* relies on Tank Farm evaporators to operate at reasonable attainment. An unanticipated extended outage of either the 2F or 3H Evaporator Systems could delay the preparation of a DWPF sludge batch, delay tank closures, and impact H-Canyon operation. To mitigate this risk, H-Canyon has implemented the following waste minimization initiatives:

- Sequence H-Canyon Area planned materials to minimize near-term impacts to Tank Farm HLW inventory capacities. This dictates that Special Nuclear Material (unirradiated, low level waste) processing has priority over Spent Nuclear Fuel material (irradiated, high level waste) processing.
- Develop near-term waste minimization alternatives to reduce the volume of waste generated, including the amounts of salts and moles of acid requiring disposition.
- Eliminate High Level Waste transfers to H-Tank Farm by developing alternative disposition paths (i.e. directly to DWPF sludge batch prep and/or feed tanks).
- Eliminate Low Level Waste transfers by developing potential alternative strategies for disposition directly to off-site, out-of-state vendors.

Due to salt accumulation in the evaporator systems, space must be optimized for H-Canyon receipts until after salt has been removed from Tank 25 and the 2F Evaporator System has been restarted in 2010. Therefore, receipt capacity exists to support the receipt of 230 kgal into Tank 39 from H Canyon operations from April 1, 2008 through three months past Tank 25 conversion to the 2F Evaporator concentrate receipt tank, anticipated in 2010. After that, the *Plan* assumes that waste volumes do not exceed 300 kgal per year consistent with the *H-Area Liquid Waste Forecast Through 2019*[24]. Some Pu bearing waste by-passes Tank 39 and is inserted into a DWPF sludge batch "just-in-time" via receipt into the sludge processing tanks (Tank 51 or Tank 42) or the DWPF feed tank (Tank 40) as the alternative disposition path. Plutonium discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with canister fissile material concentration limits.

Receipt of Additional Fissile Material

In accordance with the Key Inputs and Assumptions, this *Plan* produces canisters that comply with a fissile material concentration limit of 897 grams per cubic meter of glass. In addition, this *Plan* allows receipt of additional fissile materials from H-Canyon to the extent allowable without negatively impacting the planned waste loading. Table 5-3 below provides the quantity of additional fissile material that can be added to each batch without impacting the planned waste loading or exceeding the fissile material concentration limit of 897 g/m^3 (including a 4 wt% waste loading margin). Note that Sludge Batches 5, 15 and 17 will be at reduced waste loadings (33.7, 37, and 27 wt% respectively) to comply with the 897 g/m^3 limit (including a 4 wt% waste loading margin).

Table 5-3 — *Additional Fissile Mass*

Sludge Batch	Planned Waste Loading (wt%)	Additional Fissile Mass which could be added to Sludge Batch and maintain the canister fissile material concentration below 897 g/m^3 and 4 wt% waste loading Margin (kg)
Sludge Batch 5	33.7	0
Sludge Batch 6	36	42[25]
Sludge Batch 7	40	59
Sludge Batch 8	40	95
Sludge Batch 9	40	117
Sludge Batch 10	40	119
Sludge Batch 11	40	122
Sludge Batch 12	40	108
Sludge Batch 13	40	71
Sludge Batch 14	40	55
Sludge Batch 15	37	0
Sludge Batch 16	40	2
Sludge Batch 17	27	0

5.4.2 2H Evaporator System

Reliable operation of the 2H Evaporator System is needed prior to SWPF startup to ensure that DWPF recycle, the largest stream received by the Tank Farm, can be managed. The DWPF recycle rate is between 1.5 and 1.9 Mgal/yr during sludge-only operations (the rate depends on canister production rate and Steam Atomized Scrubbers [SAS] operation as well as DWPF Recycle reduction initiatives). The rate could increase to as high as 3.2 Mgal/yr after the startup of SWPF because of extra water in the strip effluent stream and MST slurry and because the higher Cs-137 concentrations will require the operation of two SAS in the DWPF melter offgas system. Currently, only one SAS is operated. Although DWPF recycle can be evaporated only in the 2H Evaporator System due to chemical incompatibility with other waste streams, it may be beneficially reused for salt solution molarity adjustment, salt dissolution, heel removal, etc. This minimizes the utilization of the 2H Evaporator.

Evaporating the DWPF recycle in the 3H Evaporator System has been considered, however, the uranium in the 3H Evaporator system is enriched. Experience has shown that silica in the DWPF recycle combines with aluminum compounds in other wastes to form sodium aluminosilicate deposits that plug lines and concentrate uranium, preventing operation of the evaporator and creating a potential criticality hazard. To eliminate the criticality hazard, uranium enrichment in the 2H Evaporator System is limited to levels that prevent a criticality even if significant sodium aluminosilicate deposits form. In addition, to prevent plugging and extended outages, aluminum-bearing wastes (most other Tank Farm wastes) are excluded from the 2H Evaporator System.

5.4.3 DWPF Recycle Handling

As described in Section 5.4.2 — *2H Evaporator System*, DWPF recycle is the largest influent stream received by the Tank Farm. In this *Plan*, disposition of the recycle stream is handled through evaporation in the 2H Evaporator

System and through the beneficial reuse of the low sodium molarity (less than 1.0 molar sodium) recycle stream for dissolution of salt and adjustment of salt solution feed for salt processing. LW system modeling forecasts that the current life cycle processing outlined in this *Plan* can adequately handle the DWPF recycle stream through 2025.

5.4.4 Transfer Line Infrastructure

Although efforts will continue to be made to keep transfers between tanks to a minimum, executing this *Plan* requires more frequent transfers than have historically occurred in the Tank Farm, especially after the startup of SWPF, when large volumes of salt solution will be delivered to the facility. The Tank Farm transfer line infrastructure is aging and subject to leaks, failures of equipment and instrumentation, pluggage, and other problems. Because of the greatly increased pace of transfers after the startup of SWPF, short downtimes due to unexpected conditions will be more difficult to accommodate without impact because the idle time of transfer lines will be reduced.

In addition, this *Plan* requires transfers that cannot be made with the current infrastructure, e.g., transfers to support SWPF. New infrastructure must be constructed to accomplish these new activities while also continuing activities that have been historically performed, such as waste removal and evaporation. Discoveries of unexpected conditions in existing transfer systems, such as leaks, could impact the installation of new transfer lines and equipment.

The transfers in this *Plan* are generally based on the known current infrastructure and modifications planned in the SWPF transfer line tie-ins and in projects for new facilities. The actions described can be executed as long as the planned modifications are made and significant failures of key transfer equipment do not occur or can be mitigated quickly enough to allow activities to proceed as planned. The American Recovery and Reinvestment Act (ARRA) is anticipated to accelerate several of the needed infrastructure upgrades which, upon completion, will appreciably reduce the risk of failure of the infrastructure required to achieve the goals of this *Plan*. This *Plan*, however, does not attempt to explain all the modifications needed or the failure of specific pieces of transfer equipment.

5.4.5 Tank 48 Return to Service

This *Plan* assumes the waste containing TPB in Tank 48 is dispositioned using a Fluidized Bed Steam Reformer (FBSR) to destroy the organic content and convert the remaining inorganic constituents to a soluble solid form. The solids will then be dissolved in water and the resulting product will be transferred to a Tank Farm receipt tank for eventual treatment by vitrification in DWPF[26]. The treated stream, after decomposition, will still contain Cs-137 and other radionuclides, but the organic concentration will be low enough for mixing with other Tank Farm wastes and disposition at DWPF. This *Plan* assumes the product stream will go to Tanks 42 and 51.

The Tank 48 return-to-service date of December 2014 reflects the realization of a previously identified risk (RAR[10] Risk ID #184) and is consistent with the Tank 48 Alternative Treatment Technology selection process Independent Technical Review (ITR) conclusions. This return-to-service date allows Tank 48 to be used as the blend tank for preparation of Salt Batch 12 beginning in May 2015. Prior to Salt Batch 12, SWPF is fully supported utilizing Tanks 35, 41, and 50 as salt batch blend tanks.

If the Tank 48 return-to-service is delayed, Tank 35 may be used as the blend tank for Salt Batch 12 with the first use of Tank 48 beginning in November 2016 for preparation of Salt Batch 16. This allows the effective use of Tanks 35 and 41 as salt batch blend tanks while minimizing Tank 50 use so that it may be used as the DSS lag storage tank, beginning in November 2016. While contingencies provide for feeding SWPF at the required feed rate, they involve the acceptance of greater risk due to the closely-coupled activities in Tank 35, including the additional salt batch preparation and the Tank 35 sludge removal campaign scheduled just prior to Salt Batch 12 preparation.

5.4.6 Tank 50 Restoration to Service

Tank 50 is currently designated for receipt and storage of low level waste streams that are then fed to Saltstone for disposition. These low-level waste streams are rerouted directly to Saltstone to recover Tank 50 in 2011, alleviating compliant tank space concerns. MCU DSS Hold Tank (DSSHT) discharge piping is tied into the H to Z inter-area line adjacent to Tank 50. ETP concentrate is collected via a new tank installed adjacent to the 241-8H process building at ETP, allowing batch transfers from ETP to SPT via the H to Z inter-area line. Grout formulation will be determined using samples from the HTF blend tanks prior to feed being sent to the SWPF feed tank (Tank 49). The new ETP concentrate storage tank provides eight to ten weeks of ETP concentrate lag storage.

5.4.7 Managing Type III Tank Space

Type III tank space is essential to all the processes described in this *Plan*: evaporation, DWPF sludge batch preparation, salt processing, tank closures, etc. A shortage of waste storage space exists in Type III/IIIA compliant tanks in both F- and H-Tank Farms. There is a risk that a leak in a primary tank or other adverse event could occur that would prevent execution of this *Plan.*

In the 2F and 3H Evaporator Systems, space is needed for evaporator concentrate receipt to support periodic salt dissolutions and storage of high-hydroxide waste that does not precipitate into salt. This "boiled-down" liquid is commonly referred to as liquor and removing the liquor from an evaporator system is referred to as deliquoring. Evaporator effectiveness is diminished when the concentrate receipt tank salt level is 330″ or greater — at this point, the evaporator system is said to be "salt bound." The only long-term viable concentrate receipt tank for the 3H System is Tank 37. In October 2005, about 175 kgal of saltcake (about 50″) was removed from Tank 37. During this salt removal campaign, the average salt level in Tank 37 dropped from about 337″ to about 282″. Subsequent processing since that time has already resulted in a current Tank 37 salt level of 324″.

As the previous 2F concentrate receipt tank, Tank 27, reached ~330″ of saltcake, limiting the 2F Evaporator system operations, Tank 47 was converted to operate as the concentrate receipt tank. Experience gained in operating the 3H Evaporator system under salt bound conditions demonstrated that former 2F concentrate receipt tanks, Tanks 44 and 47, could be utilized similar to Tank 37 to gain Type III tank space. Tank 47 was converted to concentrate receipt tank service and Tank 44 is available, if needed, prior to completion of the Tank 25 salt removal campaign enabling its return to 2F Evaporator concentrate receipt service.

In addition, this *Plan* was structured in such a way as to provide contingency when allowable in order to provide the best opportunity for success. In doing so, risk exists pertaining to availability of Type III tank space, specifically tied to the start-up of the SWPF. If the start-up of SWPF is delayed, the 2F Evaporator System will have to be employed to wash Sludge Batch 8. This would consume the remaining available salt space in the 2F Evaporator concentrate receipt tank (see *Appendix I — Evaporator System Levels (through FY14)*, and space could not be reclaimed until start-up of SWPF. Thus, it would hinder acceleration of tank closures, canister production rate at the DWPF, or H-Canyon support.

This *Plan*, as did Revision 14 of the *Plan*, utilizes non-compliant tanks to store supernate generated by sludge preparation. Tanks 8 and 11, prior to entering heel removal for tank closure, store aluminum-laden supernate from the aluminum dissolution of Sludge Batches 5 and 6, respectively. Tank 4, following completion of BWR and heel removal, is planned for storage of Tank 13 supernate to enable sludge removal from Tank 13.

5.5 *Glass Waste Canister Storage*

The canisters of vitrified HLW glass produced by DWPF are stored on-site in dedicated interim storage buildings called Glass Waste Storage Buildings (GWSB). A Shielded Canister Transporter moves one canister at a time from the Vitrification Building to a GWSB. The schedule for filling the GWSBs is found in *Appendix E — Canister Storage.*

GWSB #1 consists of a below-grade seismically qualified concrete vault containing support frames for vertical storage of 2,262 standard canisters. Eight of these positions have been abandoned due to construction defects and three contain archived non-radioactive glass filled canisters. As of June 30, 2009, 2,241 standard positions are in use storing radioactive canisters, the remaining 10 being contingency positions for placement of canisters if GWSB #2 is temporarily unavailable.

GWSB #2, with a similar design to GWSB #1, has 2,340 standard storage locations. The first radioactive canister was placed in GWSB #2 on July 10, 2006. One archived non-radioactive canister has been placed in GWSB #2. As of June 30, 2009, GWSB #2 stored 498 canisters. The total storage capacity of GWSB #1 and #2 for standard radioactive storage is 4,590.

A third GWSB, similar in design to GWSBs #1 and #2 but with the capacity to store the balance of the cans forecast in this *Plan*, must be ready to store canisters in 2015.

The schedule for shipment of the canisters from SRS is not included in this Plan.

5.6 *Closure Sequence for the Liquid Waste System*

This *Plan* describes a sequence of events to facilitate an orderly and reasonable shutdown and closure of the various facilities used to treat and disposition the waste. A previous section described activities required for closure of tanks and associated equipment in the Tank Farms. The Liquid Waste facilities outside the Tank Farm — DWPF, SWPF, ARP/MCU, ETP, SPF, SDF, and associated ancillary equipment — will also require closure. Projection of shutdown and cleaning of the facilities to the point where they will generate no more liquid effluents is required for modeling the end of this *Plan*. Future plans will project D&D requirements for full closure of processing facilities. As these requirements are sensitive to regulatory changes that may occur between now and the closure of those facilities, a detailed definition of the closure of the processing facilities is premature for this *Plan*.

To the extent practical, closure of tanks and facilities occurs in groups to minimize operating and closure costs for each group. The priority (but not necessarily the sequence) for shutdowns as modeled is:

1. Non-compliant tanks
2. F-Area waste tanks, the 2F Evaporator and ancillary equipment (and including 1F Evaporator and the concentrate transfer system [CTS])
3. H-Area West Hill waste tanks, the 3H Evaporator and ancillary equipment (including 1H Evaporator)
4. H-Area East Hill waste tanks, the 2H Evaporator and ancillary equipment (including any remaining ARP/MCU equipment)
5. Major remaining processing facilities (e.g., DWPF, SWPF, ETP, SDF/SPF, etc.).

Even with the emphasis on closing FTF earlier, space and processing constraints do not support FTF waste removal and tank cleaning completion until FY26 with subsequent closure in FY28. Space is not available within H-Area to store all the waste from F-Area to support final FTF closure earlier than FY28.

It is preferable to close each facility as soon as possible to reduce the cost of operating the system. However, closing facilities will sometimes require operating them in a manner that is outside the current flowsheet. For example, in the FY25–30 period, DWPF processes strip effluent and actinide streams from SWPF. The SWPF, in turn, processes a recycle stream from DWPF. Shut down of both of these facilities will require the development of alternate processing for one or more of these streams.

The key elements of the systematic closure sequence for shutting down and closing the LW System are summarized in Table 5-4.

Table 5-4 — *Closure Activities*

FY16–22	- Waste removal is complete from all non-compliant (Type I, II, and IV) tanks - All non-compliant tanks are closed in compliance with the currently approved FFA closure commitments - H-Canyon influents (shutdown flows) cease
FY23–26	- F-Area waste removal is completed and the FTF (including the 2F Evaporator that had previously shutdown in FY17) begins its shutdown and subsequent closure activities, including final F-Area Tanks - DWPF Feed Tank (Tank 40) processes sludge to DWPF down to a 40″ heel
FY27–FY30	- Grouting is complete on the last FTF tank - H-Area West Hill waste removal is complete and the H-Area West Hill (including the 3H Evaporator) begins its shutdown and subsequent closure activities - H-Area East Hill waste removal is complete and the H-Area East Hill (including the 2H Evaporator) begins its shutdown and subsequent closure activities - ETP and Maintenance Facility (299-H) receipts cease & shutdown and subsequent closure activities begin
FY31–32	- Grouting is complete on the final H-Area West Hill Tank - DWPF, SWPF, and SPF are cleaned by flushing with water and chemicals for one year - Grouting is complete on the final H-Area East Hill tank

The schedule for shipment of the canisters from SRS is not included in this *Plan*.

6. Alternative Analyses

6.1 *2015 SWPF startup*

Summary

In this Alternative Analysis, SWPF operations are delayed to September 2015 from May 2013.

Discussion

A twenty-eight month delay in the start-up of SWPF operations would directly impact those processes that depend on expeditious treatment and disposal of salt waste:

- The immediate results would be a delay in the salt removal campaigns for Tanks 1, 2, and 3 in FTF and Tanks 9 and 10 in HTF. In addition, Tank 21 would continue to be used for lag storage longer than planned. While this results in a day-for-day slip in waste removal and closure of these tanks, the tanks would still be able to meet the FFA commitments for closure. The twenty-eight month delay in the start of SWPF operations would result in a twenty-eight month delay in closure of these tanks. Additionally, because DWPF recycle will not be used for salt dissolution or molarity adjustment, Tanks 22 and 23 closures could be delayed to support receipt of the recycle until the start-up of SWPF.
- An ancillary result would be the delay in salt removal from the 3H Evaporator Concentrate Receipt Tank, Tank 37. Failure to accomplish two salt removal campaigns scheduled between May 2013 through September 2015 results in the shutdown of the 3H Evaporator until the salt can be removed from Tank 37. As this *Plan* utilizes both the 3H and the 2F Evaporators to process Sludge Batch decants at an accelerated canister production rate, the loss of one of the evaporators effectively halves the sludge washing capacity for DWPF feed. The result would be a canister rate reduction to 200 canisters per year from 400 canisters per year for the 28-month delay.
- Delays in salt removal not only impact tanks being prepared for closure under the FFA (Tanks 1, 2, 3, 9, 10, and 21) but also delays waste removal on Type III tanks. This decreases the availability of sludge to make up future sludge batches. The result would be an additional 28 months of decreased canister production for a total impact on DWPF production of four and half years at 200 canisters per year.

The original *Plan* completed operation of ARP/MCU approximately four months before the startup of SWPF in 2013. However, if requested by DOE, ARP/MCU could continue operating after addressing §3116 and related permit issues. At DOE's direction, process improvement modifications to support program risk reduction utilizing ARP/MCU, while achieving an improved Cs-137 DF in MCU, could be implemented. Implementation of the following addresses life extension beyond the three-year design life:

- Evaluate spare parts
- Adjust preventive maintenance
- Increase equipment performance monitoring
- Obtain appropriate regulatory approvals

ARP/MCU could process approximately four million gallons of dissolved salt solution during a 28-month extended interim salt processing option, creating approximately one million gallons of tank space. The total curies disposed at Saltstone during interim salt processing, using the ARP/MCU process, would remain below the 200,000 projected in the *SRS LW Strategy*[8] and the 300,000 curies discussed in the *§3116 Basis*. Mitigation of the impact of the SWPF delay, however, would be limited. The additional million gallons of tank space could allow salt removal from one of the FFA closure tanks or could be used to increase sludge preparation, somewhat mitigating the DWPF production impact. A priority decision on the type of material to be processed through ARP/MCU would dictate which of the impacts would be diminished.

Were the SWPF start-up delayed as described herein, the sequence of salt and sludge removal and tank closures should be reconfigured to minimize the impacts as much as possible. Since the sequence of activities described in this *Plan* are progressing apace, the earlier the notification of a delay in SWPF, the greater the potential for mitigation of the impacts.

6.2 *Additional Pu Disposition*

Summary

In this Alternative Analysis, total H-Canyon plutonium processed is increased to 5,000 kg while maintaining the fissile material concentration limit of 897 g/m^3 of glass in the DWPF canisters.

Discussion

The 5,000 kg of additional fissile material from H-Canyon supplements the ~1,300 kg of fissile material currently in the waste tanks, bringing the total fissile material mass to be vitrified to ~6,300 kg. The volume of a DWPF canister is 0.6745 m^3. At a concentration of 897 g/m^3, this equates to 605 grams of fissile material per canister or over 10,000 canisters remaining to be poured (approximately 6,300 more than the Revision 15 Base Case).

The addition of 6,300 canisters extends the operation of DWPF, and the feed tanks associated with feeding sludge, through the end of 2037 with a total in excess of 13,000 canisters. The storage capacity in the three GWSBs could be exceeded by over 6,000 canisters — the equivalent of three additional GWSBs.

The tables below depict several alternatives for disposing the additional fissile material. Note that each of these alternatives extends DWPF operations, varying only in impacts to Tank Farm and H-Canyon operations. Table 6-1 assumes that discards from H Canyon begin with 50 kg in Sludge Batch 6 and are increased in subsequent batches until a maximum of 500 kg per batch is reached. This alternative impacts the closure dates for all compliant tanks that contain sludge and would likely delay closure of the last non-compliant tank (Tank 13) past 2022. For ease of comparison, in this evaluation it is assumed that melter replacement outages will be required after Sludge Batches 7, 10, 12, and 15.

Table 6-1 — *5,000 kg Pu Addition Option 1*

Canisters per year	Sludge Batch Start	Sludge Batch Finish	Sludge Batch	Fissile Mass per Batch in HLW Tanks (kg)	Additional Fissile Mass from H Canyon (kg)	Total Fissile Mass per Sludge Batch (kg)	Total Canisters @ 897 g/m^3	Waste Loading to meet 897g/m^3
186		Jun-10	5	212	0	212	379	34
325	Jun-10	Mar-11	6	79	50	129	261	36
325	Mar-11	Apr-12	7	63	150	213	352	25
	Apr-12	*Aug-12*			*Melter Replacement*			
400	Aug-12	Dec-13	8	33	300	333	550	17
400	Dec-13	Apr-16	9	62	500	562	929	14
400	Apr-16	Aug-18	10	54	500	554	916	14
	Aug-18	*Dec-18*			*Melter Replacement*			
400	Dec-18	Mar-21	11	49	500	549	908	14
400	Mar-21	Jul-23	12	64	500	564	932	13
	Jul-23	*Nov-23*			*Melter Replacement*			
400	Nov-23	May-26	13	102	500	602	995	13
400	May-26	Nov-28	14	119	500	619	1,024	12
400	Nov-28	Sep-31	15	176	500	676	1,117	11
	Sep-31	*Jan-32*			*Melter Replacement*			
400	Jan-32	Aug-34	16	126	500	626	1,035	9
400	Aug-34	Jul-37	17	201	500	701	1,159	9
Total for Sludge Batches 5 - 17				**1,342**	**5,000**	**6,342**	**10,558**	
Canisters in Sludge Batches 1–4							2,625	
Total Canisters (Lifecycle)							**13,183**	

Table 6-2 displays a scenario where all of the excess fissile material (material that would result in decreased waste loading for the sludge batch) is discarded to Tank 43, which will be in the last sludge batch. Additional fissile material not resulting in decreased waste loading is shown in Table 5-3. One advantage of this scenario is that waste removal from all other tanks will proceed on the same schedule as the Revision 15 Base Case with only the DWPF feed tank remaining in service until the end date. A disadvantage of this alternative is that the last sludge batch, lasting from March 2019 through June 2037, would be poured at a waste loading below 2 wt%.

Table 6-2 — *5,000 kg Pu Addition Option 2*

Canisters per year	SB Start	SB Finish	Sludge Batch	Fissile Mass per Batch in HLW Tanks (kg)	Additional Fissile Mass from H Canyon (kg)	Total Fissile Mass per Sludge Batch (kg)	Total Canisters @ 897 g/m^3	Waste Loading to meet 897g/m^3
186		Jun-10	5	212	0	212	379	34
325	Jun-10	Mar-11	6	79	50	129	261	36
325	Mar-11	Nov-11	7	63	59	122	202	40
	Nov-11	*Feb-12*			*Melter Replacement*			
400	Feb-12	Sep-12	8	33	95	128	211	40
400	Sep-12	Jun-13	9	62	117	179	296	40
400	Jun-13	Feb-14	10	54	119	173	287	40
	Feb-14	*Jun-14*			*Melter Replacement*			
400	Jun-14	Mar-15	11	49	122	171	283	40
400	Mar-15	Nov-15	12	64	108	172	284	40
	Nov-15	*Mar-16*			*Melter Replacement*			
400	Mar-16	Dec-16	13	102	71	173	286	40
400	Dec-16	Aug-17	14	119	55	175	288	40
400	Aug-17	May-18	15	176	0	176	290	40
	May-18	*Sep-18*			*Melter Replacement*			
400	Sep-18	Mar-19	16	126	2	128	212	40
400	Mar-19	Jun-37	17	201	4,202	4,404	7,279	2
	Total for Sludge Batches 5– 17			**1,342**	**5,000**	**6,342**	**10,558**	
						Canisters in Sludge Batches 1–4	2,625	
						Total Canisters (Lifecycle)	**13,183**	

A third alternative is contained in Table 6-3. In this case, the excess fissile material is not added to batches that contain sludge from non-compliant tanks. In this scenario, closure of non-compliant tanks is not impacted.

Table 6-3 — *5,000 kg Pu Addition Option 3*

Canisters per year	SB Start	SB Finish	Sludge Batch	Fissile Mass per Batch in HLW Tanks (kg)	Additional Fissile Mass from H Canyon (kg)	Total Fissile Mass per Sludge Batch, (kg)	Total Canisters @ 897 g/m3	WL to meet 897g/m3
186		Jun-10	5	212	0	212	379	34
325	Jun-10	Mar-11	6	79	50	129	261	36
325	Mar-11	Nov-11	7	63	59	122	202	40
	Nov-11	*Feb-12*			*Melter Replacement*			
400	Feb-12	Sep-12	8	33	95	128	211	40
400	Sep-12	Jun-13	9	62	117	179	296	40
400	Jun-13	Feb-14	10	54	119	173	287	40
	Feb-14	*Jun-14*			*Melter Replacement*			
400	Jun-14	Mar-15	11	49	122	171	283	40
400	Mar-15	Jul-18	12	64	740	804	1,329	9
	Jul-18	*Oct-18*			*Melter Replacement*			
400	Oct-18	Apr-22	13	102	740	842	1,392	8
400	Apr-22	Nov-25	14	119	740	859	1,420	8
400	Nov-25	Aug-29	15	176	740	916	1,513	8
	Aug-29	*Dec-29*			*Melter Replacement*			
400	Dec-29	Jul-33	16	126	740	866	1,432	6
400	Jul-33	Jun-37	17	201	738	939	1,553	7
	Total for Sludge Batches 5–17			**1,342**	**5,000**	**6,342**	**10,558**	
						Canisters in Sludge Batches 1–4	2,625	
						Total Canisters (Lifecycle)	**13,183**	

6.3 *Eliminate Salt-only Canisters*

This *Plan* forecasts the production of approximately 250 salt-only canisters during the period from May 2023 (when all sludge has been depleted) to December 2030. An opportunity exists to reduce or eliminate this "salt-only" campaign by augmenting the total salt processing capacity of the liquid waste system.

Modular Salt Processing (MSP)

A Modular Salt Processing process (MSP — e.g. small column ion exchange [SCIX]) having the capacity to treat approximately 2,500 kgal/yr of salt solution is proposed, which, when combined with SWPF, would bring the total salt processing capacity of the liquid waste system up to 8,500 kgal/yr. MSP could begin operating as soon as October 2013 and, by increasing overall salt processing to 8,500 kgal/yr, would enable completion of salt processing in December 2024, a full 6 years sooner than in the base case of this *Plan*. It is anticipated that incorporation of an MSP output streams into the liquid waste flowsheet would shift the sludge depletion date to approximately December 2024.

Enhanced Low Activity Waste Disposal (ELAWD)

Increasing the salt processing rate by two-and-a-half million gallons per year increases the requirements for SPF processing past its capacity. To accommodate the additional DSS produced via MSP, an Enhanced Low Activity Waste Disposal (ELAWD) is proposed to replace SPF. Presently the SPF is assumed to have a capacity of 235 kgal/wk. The MSP (using SCIX characteristics for estimating purposes), processing 2,500 kgal/yr, adds an average of ~50 kgal/wk, with a maximum instantaneous output of ~65 kgal/wk for a total DSS rate (SWPF and MSP) of approximately 300 kgal/wk (~30 gpm). While SFP could support MSP prior to full SWPF production, after SWPF is operating at its rated capacity in June 2014 SPF capacity would be exceeded. ELAWD treatment of DSS would be required no later than May 2014.

Utilization of ELAWD has potential additional benefits. One technology under consideration is the FBSR process, similar to that used for Tank 48 RTS. In that process, ELAWD would produce 0.8 gal of material for every gallon of DSS processed. This is more favorable than the 1.76 gallons of grout for every gallon of DSS that the SPF produces. With the implementation of ELAWD, the required number of Disposal Units could be halved. The replacement of SPF with ELAWD in May 2014 could reduce the number of DU to 23 from 40.

Table 6-4 shows how salt solution would be processed in FY13–FY25 as a comparison to Appendix C — *Salt Solution Processing* as is modeled in the *Plan*.

Table 6-4 — *Salt Solution Processing with MSP*

FY	Salt Soln via DDA only (kgal)	Salt Soln via ARP/MCU (kgal)	Salt Soln via SWPF (kgal)	Salt Soln via MSP (kgal)	Total Salt Soln from Tank Farms (kgal)	DSS Stream to SPF/ELAWD (kgal)	UUM Stream to SPF/ELAWD (kgal)	ETP Stream to SPF/ELAWD (kgal)	Total Feed Stream to SPF/ELAWD (kgal)	Disposal Unit Numbers
FY08	1,970	140			2,110	2,140	15	99	1,290	4
FY09	830	700			1,530	1,670	45	120	1,570	4
FY10		1,240			1,240	1,490	250	120	2,220	4
FY11		1,340			1,340	1,680	30	120	2,480	4–2
FY12		1,780			1,780	2,210	30	120	2,450	2
FY13			1,250		1,250	1,590	30	120	1,740	2–3
FY14			4,500	2,500	7,000	8,130	30	120	8,280	3–6
FY15			6,000	2,500	8,500	9,860	30	120	10,010	7–10
FY16			6,000	2,500	8,500	10,080	30	120	10,230	10–11
FY17			4,500	1,875	6,375	7,480	30	120	7,630	11–13
FY18			5,500	2,292	7,792	8,923	30	120	9,073	13–14
FY19			6,000	2,500	8,500	9,750	30	120	9,900	14–16
FY20			6,000	2,500	8,500	9,800		120	9,920	16–17
FY21			6,000	2,500	8,500	9,750		120	9,870	17–19
FY22			6,000	2,500	8,500	9,780		120	9,900	19–20
FY23			6,000	2,500	8,500	9,770		120	9,890	20–22
FY24			4,838	2,083	6,921	7,956		120	8,076	22–23
FY25			388		388	463		120	583	23
Total	**2,800**	**5,200**	**62,975**	**26,250**	**97,225**	**112,522**	**580**	**2,139**	**115,112**	

7. Process Simulation Tools

This *Plan* is intended for long-term planning and does not contain sufficient detail to guide operation of individual process steps. It uses simplifying assumptions for each process of the LW System. Any dates, volumes, and chemical or radiological composition information contained in this *Plan* are planning approximations only. To guide actual execution of individual processing steps, flowsheets are made available which contain rates, compositions, and schedules, sometimes including possible ranges of each of these parameters.

The software that performs the process simulation is SpaceMan Plus™, a Visual Basic program that simulates operation of the processes in the LW System. SpaceMan Plus™ integrates facilities tied directly to the tank farms including salt processing facilities, DWPF, and SPF. It is designed to improve planning for SRS LW activities. The program is flexible enough to model a simple case involving just a few transfers to a complete 20-year life-cycle system plan, complete with advanced operations. Modeling LW System activities with SpaceMan Plus™ improves the strategy credibility and increases the confidence level of projected plans, enabling a heightened awareness of the facilities' capabilities and limitations.

SpaceMan Plus™ is an interactive program used to plan the management of liquid radioactive waste. Routine and non-routine tank farm activities are inputted with a simple text file. After running the program, results are graphically displayed. The software provides a crucial element of technical planning. Case results from SpaceMan and SpaceMan II were used as the technical basis for HLW System Plans Revisions 11 through 13, as well as special tank farm inventory studies. SpaceMan Plus™ has been in use since September 2004.

The following are just a few of the tank farm operations supported:

- tank-to-tank transfers
- waste evaporation (including recycle)
- salt interstitial liquid transfer
- sludge slurry washing
- sludge transfer
- salt dissolution
- dilution to target molarity
- waste receipts from all external sources (including pure water)
- transfer to external processing (including a vendor)

SpaceMan Plus™ provides a level of realism not found in other simulation packages. Just a few of the features include feed-dependent evaporator setpoints, preset evaporator endpoints, total tank farm space parameters, and user-defined stream compositions. A combination of simulation commands can be used to perform many off-normal operations such as special transfers from the H-Canyon involving multiple flushes. The program can perform many operations automatically to preset DSA limits such as turning an evaporator off on high silica levels, automatically setting jet heights above sludge levels, or changing the tank fill limits to meet flammable gas requirements. On-screen graphs display forecasted waste inventory volumes.

8. Description of Assumptions and Bases

Details on the key assumptions and bases for this *Plan* are outlined below.

8.1 *Funding*

This *Plan* was developed assuming the funding required to achieve the planned project and operations activities will be available. This *Plan* may be used to provide justification for obtaining the necessary funding profiles.

8.2 *Waste Removal and Tank Closure Program*

The following technical assumptions were input to the modeling of this *Plan*.

Waste Removal

- After the initial BWR campaign in a sludge tank, a ~36″ heel (10–20 kgal) of waste remains.
- After the initial BWR campaign in a salt tank, ~ 2–3 feet (90–130 kgal depending on the type of tank) of insoluble/low solubility material waste (heel) remains
- Two Phases of Waste Heel Removal are planned for all tanks
  - Mechanical Cleaning uses mechanical agitation
    - Assumed to take 12 months of operation unless otherwise stated
      - Heel solids volume reduced to less than 5 kgal
      - Sludge tank is estimated to use 500 kgal of liquid (of which at least 150 kgal is new water[27])
      - Salt tank is estimated to use 800 kgal of liquid (of which at least 300 kgal is new water[27])
  - Chemical Cleaning uses oxalic acid (OA) or advanced/specialized mechanical or chemical technology
    - Assumed to take 6 months of operation unless otherwise stated
  - Tank 8 mechanical cleaning is assumed to take a total of 6 months due to low volume of waste in Tank 8 after previous cleaning campaigns
- For planning purposes, Tank 7 chemical cleaning will be performed per the current Bulk OA flowsheet (results in tank farm waste volume impact of ~200 kgal/tank). If additional chemical cleaning is required in Tanks 5 and 6, it, too, will be performed per the current OA flowsheet
- Following chemical cleaning in Tanks 5, 6, and 7, mechanical cleaning will be performed to remove insoluble solids that will result in a tank farm volume impact of ~150 kgal/tank
- After Tanks 5, 6, and 7, future tanks will use an enhanced chemical cleaning technique that results in tank farm waste volume impact of ~100 kgal/tank with an additional 150 kgal/tank of water to flush the tank.

Annulus Cleaning

- All tanks that have experienced leaks will undergo annulus cleaning. The volume used depends on the extent of waste present.
  - Tanks 5, 6, 10, 11, 12, and 15 are assumed to require 6 kgal. Annulus cleaning is performed in parallel with heel removal
  - Tank 16 annulus cleaning is assumed to require up to 15 kgal for technology demonstration. An additional 100 kgal is assumed for the full cleaning of the annulus and the primary (1,200 gal. solids). Note: The primary of Tank 16 has previously undergone an extensive waste removal and oxalic acid cleaning campaign in the 1970s. Though no requirement for additional cleaning of the primary may is assumed, the volume used makes a waste handling allowance as a conservative assumption
  - Tank 14 annulus contains 12–13″ of waste and is assumed to require 20 kgal.

Tank Closure

- A 24-month closure process is planned for the first five tanks to account for sampling and characterization, initial drafting of documents, first-time review process, annulus and coil closure, and a 4-month grout period. The experience gained on Tanks 5, 6, 18, 19, and 16 will allow compression of the closure schedule to 18 months for the next four tanks (Tanks 7, 8, 11, and 12). Further refinement of sampling and characterization techniques and review and response cycles will accelerate the tank closure schedule to 12 months for the remaining tanks.

Regulatory Approvals

- Two Secretarial Waste Determinations (F-Tank Farm and H-Tank Farm) will be issued pursuant to §3116 of the NDAA to determine whether the provisions of §3116(a) are met such that the tank and ancillary equipment residuals are not high level waste.
- SCDHEC reviews and approves tank closures using a process that will be documented in the respective General Closure Plan.
- DOE will approve any necessary amendments to waste determination documents to support this plan.

8.3 *DWPF Production*

Canister production and sludge batch need dates are projected by the *Sludge Batch Plan*[23]

- In general, assumes 4-month melter replacement outage approximately every 72 months of melter operation (i.e., DWPF operates 68 months out of every 72 months). The next DWPF melter outage planned from September 2011–December 2012 with concurrent feed preparation modifications.
- Discrete Canister Production Rate[i]:
  - Sludge batch planning is performed to recommend the sequencing and timing of future sludge batches. Based on modeling of sludge batches, *Appendix D — Sludge Processing* sums the canister production expectations, assuming the following nominal canister production rates:
    - 186 Discrete canisters/yr. with 34 wt% SOL predicted for Sludge Batch 5 within this *Plan*'s duration.
    - 325 Discrete canisters/yr. with 36 wt% SOL Sludge Batches 6–7 due to improvements in melter technology with the additions of bubblers
    - 400 Discrete canister/yr at 40 wt% SOL upon implementation of feed preparation modifications except where SOL is limited by fissile material concentration.

8.4 *Salt Program*

ARP/MCU

- ARP/MCU processing rates:
  - For modeling purposes, ARP/MCU processes salt feed at a rate of 40 kgal/wk
    - ARP/MCU not operated during DWPF melter replacement outages
    - ARP facility is not anticipated to operate after the startup of SWPF; MCU will not operate after start-up of SWPF.
  - MCU Decontamination Factor (DF) for Cs-137 is 200
- Extended operation of ARP/MCU past its original design life due to the delay in SWPF startup
- Any ARP/MCU facility upgrades required to maintain the ARP/MCU operating rate for its extended life will be provided
- The 96H strike tanks will be utilized by the Tank 48 project beginning in August 2012. Operation of ARP after this date will require addition of MST to be performed at 512-S and will decrease overall ARP/MCU throughput.

SWPF Ready for Hot Ops: 2013

- Annual processing throughput (*Long Term Processing Capacity at SWPF – Inputs to System Plan*[28])
  - Initial year: 3.75 Mgal/yr processing rate
    - Availability of tank space to prepare salt solution batches and the integration with any planned DWPF outages may impact the ability to process the 3.75 Mgal targeted volume during the first 12 months of SWPF operations.
  - Subsequent years: 6.0 Mgal/yr. nominal processing rate (actual anticipated throughput varies with respect to DWPF outages with an average of 5.7 Mgal./yr)
    - Processing rate determined as follows:

$$[9.4\text{Mgal/ yr}]\times[0.85]\times[0.75] = 6\,\text{Mgal/year}$$

9.4 Mgal per year based on maximum hydraulic rate
0.85 – estimated reduction due to hydraulic limits of the V-10 contactor
0.75 – availability

---

[i] *"Discrete canisters" refers to actual canisters (sometimes referred to as cans) that occupy a storage location in the Glass Waste Storage Building.*

   - The 6 Mgal per year is based on 100% availability for the Tank Farm feed as well as DWPF and SPF/DSS Tank receipt of SWPF discharge streams. The yearly throughput varies when adjusted for the assumed 4-month duration melter replacement outage every six years and other planned outages
   - Availability of tank space to prepare salt solution batches may impact the ability to achieve full capacity SWPF operations in the first few years of operation.
   - ~500,000 gallons (nominal rate) of SE will be sent to DWPF per year
   - ~130,000 gallons (nominal rate) of MST solids/sludge will be sent to DWPF per year
   - The SWPF feed chemistry is per SWPF Feed Specification Radionuclide Limits of the SWPF *Waste Acceptance Criteria*[19] including:
     - the initial one million gallons of feed to SWPF will be (at 6.44M Na):
       - ≤ 1.0 Ci/gal
     - All batches will be (at 6.44M Na):
       - OH > 2 M
         - Caustic (50% NaOH) additions are planned during salt dissolution and batch preparation, as needed to meet the minimum 2 M OH requirements
       - Al < 0.25 M
       - Si < 842 mg/L
- Tank Farm feed preparation infrastructure modifications are completed to support SWPF processing rates. Major modifications include:
  - H-Tank Farm Blend tanks readiness for salt solution preparation (Tanks 41, 35, and 50 currently proposed)
  - Mixing capabilities
  - Enhanced transfer capabilities
  - Dedicated transfer routes provided to feed tank
  - Tank 49 readiness as SWPF feed tank.

    NOTE: Timing of Tanks 41, 35, and 50 availability to support SWPF salt solution preparation may be impacted by intermediate needs of these tanks as described elsewhere in this *Plan*.

<u>Tank 48 Return to Service: December 2014</u>

- Material dispositioned by organic destruction using the fluidized bed steam reforming treatment technology. Completion of treatment is December 2014
- The material in Tank 48 will be fully treated by sending 350 kgal to the treatment unit.
- The Tank 48 heel will have an acceptable quantity of potassium tetraphenylborate (KTPB) for mixing with other Tank Farm waste and dispositioning to downstream facilities (i.e., SWPF, and associated transfer facilities)
- Tank 48 waste will be processed at a rate of 184 kgal per year. This is based on seven days per week, 24 hours per day at a utilization factor of 75% (25% downtime allows for 10% duty cycle — defined as the minimum time the FBSR treatment unit is required to be operable — and 15% limitations due to weather, emergent facility issues, etc.).

<u>Tank 50 Return to Service: October 2011</u>

- Requires successful implementation of planned modifications to decouple DSS stream from SPF
- Planned modifications must be coordinated to minimize impact to SPF and salt processing operations during the modification outage duration.

8.5 *<u>SPF Production</u>*

SPF is capable of processing at the following rates:

- During DDA and ARP/MCU processing: ~120 kgal/wk
  - The disposal of DDA batches from Tank 41 must be coordinated with ARP/MCU disposal
  - May require operation of more than one cell and the use of "cold caps" to meet radiological control requirements
- During SWPF operation: Yearly average of ~150 kgal/wk with a maximum rate of ~235 kgal/wk
  - Based on nominal SWPF rate of 6 Mgal/yr x (1.269 gal of DSS/gal of salt solution feed)/ 52 weeks per year at 75% attainment. (Note: due to DWPF outages the average SWPF rate is 5.7 Mgal/yr)
  - Will require additional operational time (i.e., multiple shifts, additional operating days each week, etc.) and adequate Disposal Unit receipt space to match production stream from SWPF

- Since neither ARP/MCU nor SWPF process during melter replacement outages, SPF is not planned to operate other than to run off any backlog material that may be in the feed tanks
- Two Disposal Units (DU), Vault 1 and 4, are in service. Vault 1 will receive no additional saltstone grout; Vault 4 has 5 cells available to receive grout. Future DUs will have two disposal cells with 1.5 Mgal feed capacity. DU fill sequence will be Vault 4, DU 2 (cells 2a, 2b), DU 3 (cells 3a, 3b), DU 5 (cells 5a, 5b), DU 6 (cells 6a, 6b), DU 7 (cells 7a, 7b) … etc.
  - Each gallon of feed, when added to the cement, flyash, and slag, makes 1.76 gallons of grout. Each disposal cell starting with 2 is estimated to contain ~2,600 kgal of grout. Therefore, each cell holds ~1,500 kgal of feed solution; each DU holds ~3,000 kgal of feed solution.

8.6 *Base Operations*

The primary influents into the Tank Farms are DWPF recycle and H-Canyon receipts. In addition, sludge batch preparation produces a large internal stream of spent washwater. In order to continue to maintain space in the Tank Farms to support these missions, these streams must be evaporated. There is one evaporator in F-Area and two in H-Area.

A minor influent is the 299-H Maintenance Facility. The influents from 299-H are received into Tank 39. Beginning in 2024, these receipts are assumed to be redirected to allow for Tank 39 Waste Removal.

DWPF recycle has a high concentration of silica due to the vitrification process. When this stream is mixed with high aluminum streams from Purex and H Modified (HM) canyon processing, there is a potential for forming sodium aluminosilicate. Experience has shown that sodium aluminosilicate can co-precipitate sodium diuranate in the evaporator, causing a potential criticality concern.

In order to prevent the potential for criticality, a feed qualification program is in place to minimize the formation of a sodium aluminosilicate scale in the 2F and 3H Evaporators and to prevent accumulation of enriched uranium in the 2H Evaporator. It is assumed that scale may accumulate in the 2H Evaporator, but uranium enrichments and masses will be well below criticality concerns.

- The 2H Evaporator System is used to evaporate DWPF recycle. The 2F and 3H Evaporators are used to process streams that will not produce scale, i.e., canyon wastes and sludge batch decants. The evaporator system feed and concentrate receipt tanks are defined as
  - 3H: Feed – Tank 32; Receipt – Tank 30 initially, changing to Tank 37
  - 2H: Feed – Tank 43; Receipt – Tank 38
  - 2F: Feed – Tank 26; Receipt – Tank 47 initially, changing to Tanks 44 (if needed), and 25
- Feed Rates – The following evaporator utilities and feed rates were assumed based on operation of the evaporators during the indicated periods. During each of these periods, the indicated evaporator ran continuously and steadily at conditions that were judged favorable for good operation. Thus, the weekly rates shown are the theoretical rates at which the evaporators could operate with continuous good operation.

Table 8-1 — *Evaporator Utilities*

Evaporator	Assumed Utility
2F	50%
2H	50%
3H	50% [a]

[a] 50% utility is assumed when operating. Due to periodic salt dissolutions and feed availability, average percentage of operating time is lower (<30%).

Table 8-2 — *Historical Evaporator Utilities*

Evaporator	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08	Average
2F	50%	65%	51%	46%	51%	40%	28%	36%	46%
2H	0%	59%	67%	58%	54%	44%	49%	44%	54% [b]
3H	30%	30%	43%	27%	12%	18%	10%	22%	24%

[b] 2H Evaporator was shutdown during FY01 for chemical cleaning. The average shown does not include FY01.

Table 8-3 — *Evaporator Feed Rates*

2F Evaporator		
Period Start	Period End	Feed Rate
10/22/2004	10/25/2004	19.9 gal/min
1/5/2005	1/12/2005	22.3 gal/min
11/2/2005	11/6/2005	24.5 gal/min
	Average Feed Rate	22.2 gal/min
	Average Feed Rate (100%)	243,530 gal/week
2H Evaporator		
Period Start	Period End	Feed Rate
12/16/2004	12/19/2004	18.5 gal/min
2/17/2005	2/23/2005	17.5 gal/min
11/5/2005	11/19/2005	22.6 gal/min
	Average Feed Rate	19.6 gal/min
	Average Feed Rate (100%)	214,070 gal/ week
3H Evaporator		
Period Start	Period End	Feed Rate
6/13/2004	6/15/2004	29.8 gal/min
2/9/2005	2/11/2005	29.6 gal/min
10/15/2005	10/22/2005	25.5 gal/min
	Average Feed Rate	28.3 gal/min
	Average Feed Rate (100%)	309,670 gal/ week

- Tank Inventories and Chemistry – Starting inventories and chemistry for all tanks are taken from the WCS as of June 30, 2008. This was used as the starting point for all tank chemistry with the following exceptions:
  - Sludge masses were updated (increased inert material in the sludge) to coincide with those reported in the *Sludge Batch Plan*[23]. This included updates to the sludge masses in Tanks 4–7, 11–15, 21, 22, 26, 32–35, 39, 42, 43, 47, and 51
  - Tank 5 – Sludge level was updated to coincide with information reported in *Tank 5 Sludge Volume Estimation after the Second Phase of Bulk Sludge Removal*[29]
  - Tank 13 – Sludge level was updated to coincide with *June, 2009 Curie and Volume Inventory Report*[30] (*Monthly Report*)
  - Tank 15 – Sludge and salt levels were updated to coincide with the *Monthly Report*. Assumed no supernate in Tank 15 to coincide with the *Monthly Report*
  - Tank 26 – Sludge level was updated to coincide with the *Monthly Report*
  - Tank 27 – Salt level was updated to reflect the salt mound observed during a Tk27–26 recycle on February 10, 2007
  - Tank 41 – Salt level was updated to coincide with the *Monthly Report*
  - Tank 43 – Sludge level was updated to coincide with the *Monthly Report*
  - Tank 50 – Sludge level was adjusted to reflect a sludge sounding completed January 19, 2006 (sludge level of 1.3″; Per SW11.1-WTE-7.2 Rev 43 (IPC-2)[31])
  - Tank 51 – Sludge level was updated to coincide with the *Monthly Report.*
  - Tank Leak Sites – Per *SRS High Level Waste Tank Leaksite Information*[32].
- General supernate assumptions:
  - Sodium concentration is adjusted to preserve charge balance.
  - Solution density is determined by concentration, using empirical relationships. Volume of blends is determined by using the density relationships and solving for volume. Therefore, volumes are not additive
  - Supernate is divided and tracked into two separate parts: free liquid and interstitial liquid. Interstitial liquid is further sub-classified into liquid that is interstitial in salt, drained salt, and sludge. The different fractions are tracked discretely until a process requires them to intermix, such as during salt dissolution or sludge slurrying.
  - Supernate (or dissolved salt solution) is evaporated by removing water. Mass is conserved in the calculations. If the evaporated liquor exceeds saturation for a given component, it is precipitated and treated as saltcake in the evaporator bottoms receipt tank.

- Suspended solids settle at a rate consistent with the settling model in *Particle Size and Settling Velocity of Tank 41H Insoluble Solids*[33]. Settling rates are a function of liquid level and specific gravity.
- Jet dilution for transfers is 4% by volume unless there is a reason to use a higher jet dilution (e.g., inter-area line transfers).
- The transfer jets and pump heights are from SW11.1-WTE-7.2 Rev 43 (IPC-2)[31]

- The 2F Evaporator is assumed to be shut down in 2016.
- The 2H Evaporator is assumed to be placed in standby in 2013.
- The 3H Evaporator is assumed to be shut down in 2027.

Separations Canyon Operations

- Sufficient tank space volume is available to support the receipt of 230 kgal from H-Canyon operations into Tank 39 from April 1, 2008 through three months past Tank 25 conversion (planned in March 2010) to the 2F Evaporator concentrate receipt tank (this is possible using Tanks 44 and 47 as 2F Evaporator concentrate receipt tanks)
- After Tank 25 conversions, the Tank Farms can support an average of 300 kgal per year from H-Canyon operations into Tank 39 through the time period evaluated by this *Plan*
- Source of streams is based on *H-Area Liquid Waste Forecast Through 2019*[24] adjusted to meet the volumes stated above
- Shutdown flows for H-Canyon are assumed from FY20–FY22 and are as outlined in *H-Canyon Liquid Waste Generation Forecast for H-Tank Farm Transfer*[34]. UUM consists of unirradiated uranium material and concentrate from the General Purpose H-Canyon (GP) Evaporator
- Low level streams sent directly to Tank 50 and plutonium streams sent directly to a sludge batch are not included in the volumes stated above
- Additional material sent directly to sludge batches increases total DWPF canister count by as much as 100 canisters
  - Fissile isotope concentration of SRS HLW canisters will be maintained at or below 897 g/m^3
  - Plutonium discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with canister fissile material concentration limits.

9. System Description

9.1 History

The LW System is the integrated series of facilities at SRS that safely manage the existing waste inventory and disposition waste stored in the tanks into a final glass or grout form. This system includes facilities for storage, evaporation, waste removal, pre-treatment, vitrification, and disposal.

Since it became operational in 1951, SRS, a 300-square-mile DOE Complex located in the State of South Carolina, has produced nuclear material for national defense, research, medical, and space programs. The separation of fissionable nuclear material from irradiated targets and fuels resulted in the generation of large quantities of radioactive waste that are currently stored onsite in large underground waste storage tanks. As of June 2009, approximately 36.4 Mgal[30] of radioactive waste are currently stored at SRS. Most of the tank waste inventory is a complex mixture of chemical and radioactive waste generated during the acid-side separation of special nuclear materials and enriched uranium from irradiated targets and spent fuel using the Plutonium–Uranium Extraction (Purex) process in F-Canyon and the modified Purex process in H-Canyon (HM process). Waste generated from the recovery of Pu-238 in H-Canyon for the production of heat sources for space missions is also included. The waste was converted to an alkaline solution; metal oxides settled as sludge; and supernate was evaporated to form saltcake.

The variability in both nuclide and chemical content is because waste streams from the 1st cycle (high heat) and 2nd cycle (low heat) extractions from each Canyon were stored in separate tanks to better manage waste heat generation. When these streams were neutralized with caustic, the resulting precipitate settled into four characteristic sludges presently found in the tanks where they were originally deposited. The soluble portions of the 1st and 2nd cycle waste were similarly partitioned but have and continue to undergo blending in the course of waste transfer and staging of salt waste for evaporative concentration to supernate and saltcake. Historically, fresh waste receipts were segregated into four general categories in the SRS Tank Farms: Purex high activity waste, Purex low activity waste, HM high activity wastes and HM low activity wastes. Because of this segregation, settled sludge solids contained in tanks that received fresh waste are readily identified as one of these four categories. Fission product concentrations are about three orders of magnitude higher in both Purex and HM high-activity waste sludges than the corresponding low-activity waste sludges.

Because of differences in the Purex and HM processes, the chemical compositions of principal sludge components (iron, aluminum, uranium, manganese, nickel, and mercury) also vary over a broad range between these sludges. Combining and blending salt solutions has tended to reduce soluble waste into blended Purex salt and concentrate and HM salt and concentrate, rather than maintaining four distinct salt compositions. Continued blending and evaporation of the salt solution deposits crystallized salts with overlying and interstitial concentrated salt solution in salt tanks located in both Tank Farms. More recently, with transfers of sludge slurries to sludge washing tanks, removal of saltcakes for tank closure, receipts of DWPF recycle, and space limitations restricting full evaporator operations, salt solutions have been transferred between the two Tank Farms. Intermingling of Purex and HM salt waste will continue until processing in the SWPF can begin.

Continued long-term storage of these radioactive wastes poses a potential environmental risk. Therefore, since 1996, DOE and its contractor have been removing waste from tanks, pre-treating it, vitrifying it, and pouring the vitrified waste into canisters for long-term disposal in a permanent canister storage location (see *Figure 9–2 — Process Flowsheet*). As of June 30, 2009, DWPF had produced 2,739 vitrified waste canisters.

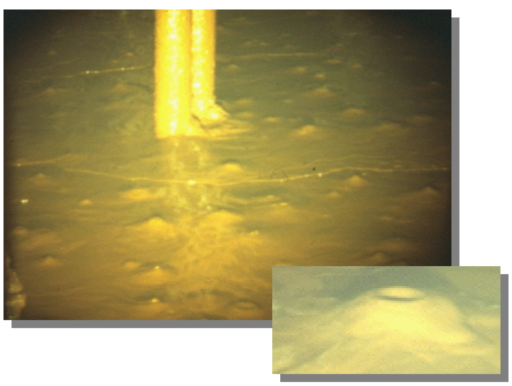
9.2 Tank Storage

SRS has 51 underground waste storage tanks, all of which were placed into operation between 1954 and 1986. There are four types of waste tanks — Types I through IV. Type III tanks are the newest tanks, placed into operation between 1969 and 1986. There are 27 Type III tanks. These tanks meet current EPA requirements for full secondary containment and leak detection. The remaining 24 tanks do not have full secondary containment and do not meet EPA requirements for secondary containment. Type I tanks are the oldest tanks, constructed in 1952 through 1953. Type II waste tanks were constructed in 1955 through 1956. There are eight Type IV tanks, constructed in 1958 through 1962. Two of these Type IV tanks, Tanks 17 and 20 in F-Tank Farm, have been isolated, operationally closed, and grouted. Twelve tanks without full secondary containment have a history of leakage[32]. Sufficient waste has been removed from these tanks such that there are currently no active leak sites. The first tank, Tank 1F, lacking full secondary containment, began receiving waste in 1954. This tank is still in service.

Approximately 36.4 Mgal of radioactive waste, containing 376 million curies (MCi)[30] of radioactivity, are currently stored in 49 active waste storage tanks located in two separate locations, H-Tank Farm (29 tanks) and F-Tank Farm (20 tanks). This waste is a complex mixture of insoluble metal hydroxide solids, commonly referred to as sludge, and soluble salt supernate. The supernate volume is reduced by evaporation, which also concentrates the soluble salts to their solubility limit. The resultant solution crystallizes as salts. The resulting crystalline solids are commonly referred to as saltcake. The saltcake and supernate combined are referred to as salt waste (33.4 Mgal).

Tanks under construction. Note tank size relative to construction workers. Later, dirt is backfilled around the tanks to provide shielding.

The sludge component of the radioactive waste represents approximately 3.0 Mgal (9% of total) of waste but contains approximately 183 MCi (49% of total). The salt waste makes up the remaining 33.4 Mgal (91% of total) of waste and contains approximately 193 MCi (51% of total). Of that salt waste, the supernate accounts for 17.2 Mgal and 181 MCi and saltcake accounts for the remaining 16.2 Mgal and 12 MCi[30]. The sludge contains the majority of the long-lived (half-life > 30 years) radionuclides (e.g., actinides) and strontium. The sludge is currently being stabilized in DWPF through a vitrification process that immobilizes the waste in a borosilicate glass matrix.



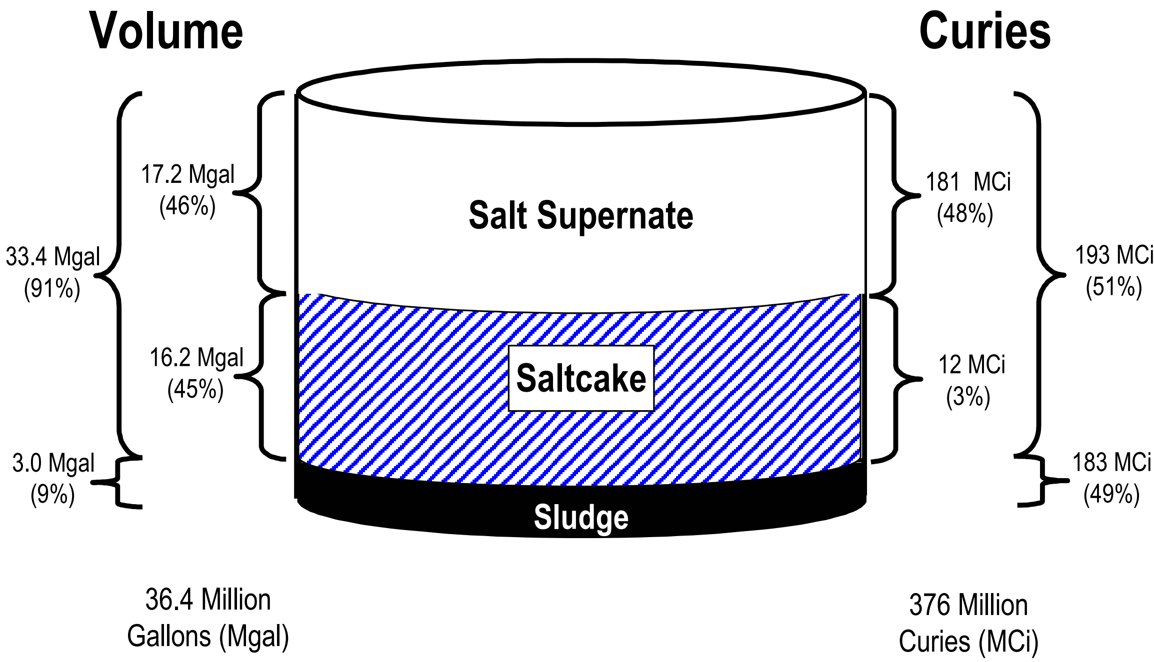
Sludge consists of insoluble solids that settle to the bottom of a tank. Note the offgas bubbles, including hydrogen generated from radiolysis.

Radioactive waste volumes and radioactivity inventories reported herein are based on the WCS database, which includes the chemical and radionuclide inventories on a tank-by-tank basis. WCS is a dynamic database frequently updated with new data from ongoing operations such as decanting and concentrating of free supernate via evaporators, preparation of sludge batches for DWPF feed, waste transfers between tanks, waste sample analyses, and influent receipts such as H-Canyon waste and DWPF recycle. Volumes and curies input in this *Plan* per *July 2008 Tank Radioactive and Non-radioactive Inventories*[11].

Well over 95%[30] of the salt waste radioactivity is short-lived (half-life ≤ 30 years) Cs-137 and its daughter product, Ba-137m, along with lower levels of actinide contamination. Depending on the particular waste stream (e.g., canyon waste, DWPF recycle waste), the cesium concentration may vary. The precipitation of salts following evaporation can also change the cesium concentration. The concentration of cesium is significantly lower than non-radioactive salts in the waste, such as sodium nitrate and nitrite; therefore, the cesium does not reach its solubility limit and only a small fraction precipitates[35]. As a result, the cesium concentration in the saltcake is much lower than that in the liquid supernate and interstitial liquid fraction of the salt waste.

Salt waste is dissolved in the liquid portion of the waste. It can be in normal solution as Supernate (top picture) or, after evaporation, as salt cake (bottom picture) or concentrated supernate. The pipes in all the pictures are cooling coils.

Figure 9–1 — *Waste Tank Composite Inventory (As of June 30, 2009)*



9.3 *Waste Tank Space Management*

To make better use of available tank storage capacity, incoming liquid waste is evaporated to reduce its volume. This is important because most of the SRS Type III waste storage tanks are already at or near full capacity. Since 1951, the Tank Farms have received over 140 Mgal of liquid waste, of which over 100 Mgal have been evaporated, leaving approximately 36.4 Mgal in the storage tanks. Projected available tank space is carefully tracked to ensure that the Tank Farms do not become "water logged," a term meaning that so much of the usable Type III compliant tank space has been filled that normal operations and waste removal and processing operations cannot continue. A portion of tank space must be reserved as contingency space should a new tank leak occur. Waste receipts and transfers are normal Tank Farm activities as the Tank Farms receive new or "fresh" waste from the H-Canyon stabilization program, liquid waste from DWPF processing (typically referred to as "DWPF recycle"), and wash water from sludge washing. The Tank Farms also make routine transfers to and from waste tanks and evaporators. Currently, very little "fresh" waste has not had the water evaporated from it to its maximum extent. The working capacity of the Tank Farms has steadily decreased and this trend will continue until salt processing becomes operational or the system becomes water logged. Three evaporator systems are currently operating at SRS — the 2H, 3H, and 2F systems.

9.4 *Waste Removal from Tanks*

During waste removal, inhibited water (IW–water that has been chemically treated to prevent corrosion of the carbon steel waste tanks) is added to the waste tanks and agitated by mixing pumps. If the tank contains salt, IW and agitation, if required, dilute the concentrated salt or re-dissolve the saltcake. If the tank contains sludge, IW and agitation suspend the insoluble sludge particles. In either case, the resulting liquid slurry, which now contains the dissolved salt or suspended sludge, can be pumped out of the tanks and transferred to waste treatment tanks.

Typical Waste Removal equipment includes two to four 45-foot long mixing pumps and one transfer pump or jet. Note the substantial structural steel required to support the loads in the picture above At right is the typical installation of a transfer pump (Tank 8) requiring difficult, high-risk entries into High Level Waste Tanks.

Waste removal is a multi-year process. First, each waste tank must be retrofitted with mixing and transfer pumps, infrastructure to support the pumps, and various service modifications (power, water, air, and/or steam). These retrofits can take between two and four years to complete. Then, the pumps are operated to slurry the waste. Initially, the pumps operate near the top of the liquid and are lowered sequentially to the proper depths as waste is slurried and transferred out of the tanks. Waste removal activities remove the bulk of the waste to prepare the tank for closure.

9.5 *Safe Disposal of the Waste*

The goal is to convert all of the waste into one of two final waste forms: Glass, which will contain 99% of the radioactivity, and Saltstone grout, which will contain most of the volume. Each of the waste types at SRS needs to be treated to accomplish disposal in these two waste forms. The sludge must be washed to remove non-radioactive salts that would interfere with glass production. The washed sludge can then be sent to DWPF for vitrification. The salt must be treated to separate the bulk of the radionuclides from the non-radioactive salts in the waste. Starting in 2013, this separation will be accomplished in SWPF. However, until the startup of SWPF, DDA, and ARP/MCU will be used to accomplish this separation.

9.6 *Salt Processing*

A final DOE technology selection for salt solution processing was completed and a Record of Decision for the Salt Processing Environmental Impact Statement was issued in October 2001. The Record of Decision designated Caustic Side Solvent Extraction (CSSX) as the preferred alternative for separating cesium from the salt waste. The full-scale CSSX facility, the SWPF, is planned to begin operations in 2013.

This *Plan* uses four different processes to treat salt:

- **Deliquification, Dissolution, and Adjustment** (DDA) – For salt in Tank 41 as of June 9, 2003, that is relatively low in radioactive content, the treatment of deliquification (i.e., extracting the interstitial liquid) is sufficient to produce a salt that meets the SPF WAC. Deliquification is an effective decontamination process because the primary radionuclide in salt is Cs-137, which is highly soluble. To accomplish the process, the salt is first deliquified by draining and pumping. The deliquified salt is dissolved by adding water and pumping out the salt solution. The resulting salt solution is given time to allow additional insoluble solids to settle prior to being sent to the SPF feed tank. If necessary, the salt solution may be aggregated with other Tank Farm waste to adjust batch chemistry for processing at SPF
- **Actinide Removal Process** (ARP) – For salt in selected tanks (e.g., Tank 25), even though extraction of the interstitial liquid reduces Cs-137 and soluble actinide concentrations, the Cs-137 or actinide concentrations of the resulting salt are too high to meet the SPF WAC. Salt from these tanks first will be sent to ARP. In ARP, MST is added to the waste as a finely divided solid. Actinides are sorbed on the MST and then filtered out of the liquid to produce a low-level waste stream that is sent to MCU.
- **Modular CSSX Unit** (MCU) – For tanks with salt that is too high in activity for deliquification to sufficiently reduce Cs-137 concentrations, the salt in these tanks must be further treated to reduce the concentration of Cs-137 using the CSSX process. After approximately 2013, this will be done in a new facility, SWPF. However, so that some of these wastes can be treated before SWPF startup, an MCU was built. Salt to be processed will first be processed through ARP and then through the MCU. The MCU processes salt waste with higher Cs-137 concentrations at a relatively low rate.

- **Salt Waste Processing Facility** (SWPF) – This is the full-scale CSSX process. The facility incorporates both the ARP and CSSX process in a full-scale shielded facility capable of handling salt with high levels of radioactivity. Facility startup of SWPF is assumed to be in 2013.

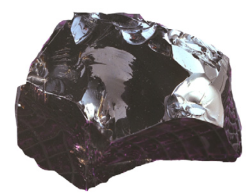
9.7 *Sludge Processing*

Sludge is "washed" to reduce the amount of non-radioactive soluble salts remaining in the sludge slurry. The processed sludge is called "washed sludge." During sludge processing, large volumes of wash water are generated and must be volume-reduced by evaporation. Over the life of the waste removal program, the sludge currently stored in tanks at SRS will be blended into separate sludge "batches" to be processed and fed to DWPF for vitrification.

9.8 *DWPF Vitrification*

Canisters being received (prior to being filled with radioactive glass)

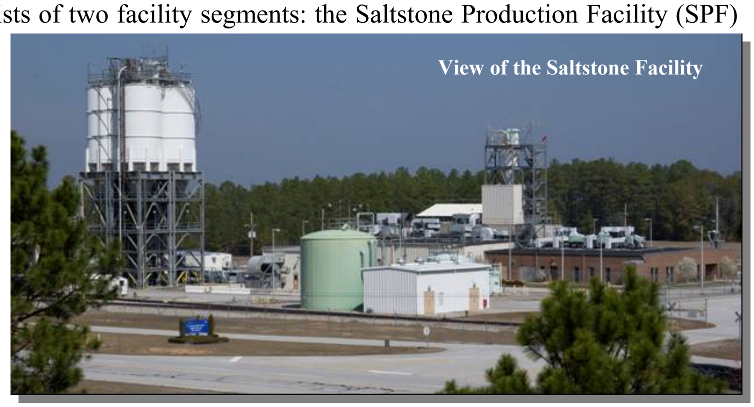
Final processing for the washed sludge and salt waste occurs at DWPF. This waste includes MST/sludge from ARP or SWPF, the cesium strip effluent from MCU or SWPF, and the washed sludge slurry. In a complex sequence of carefully controlled chemical reactions, this waste is blended with glass frit and melted to vitrify it into a borosilicate glass form. The resulting molten glass is poured into stainless steel canisters. As the filled canisters cool, the molten glass solidifies, immobilizing the radioactive waste within the glass structure. After the canisters have cooled, they are first sealed with a temporary plug, the external surfaces are decontaminated to meet United States Department of Transportation requirements, and the canister is then permanently sealed. The canisters are then ready to be stored on an interim basis on-site in the GWSB. A low-level recycle waste stream from DWPF is returned to the Tank Farms. DWPF has been operational since 1996.



Sample of Vitrified Radioactive Glass

9.9 *Saltstone Disposition*

The Saltstone Facility, located in Z-Area, consists of two facility segments: the Saltstone Production Facility (SPF) and the Saltstone Disposal Facility (SDF). SPF is permitted as a wastewater treatment facility per SCDHEC Regulations. SPF receives and treats the salt solution to produce grout by mixing the LLW liquid stream with cementitious materials (cement, flyash, and slag). A slurry of the components is pumped into the Disposal Units, located in SDF, where the Saltstone grout solidifies into a monolithic, non-hazardous, solid LLW form. SDF is permitted as an Industrial Solid Waste Landfill site.



View of the Saltstone Facility

The facility will contain many large concrete Disposal Units. Each of the Disposal Units will be filled with solid Saltstone grout. The grout itself provides primary containment of the waste, and the walls, floor, and roof of the Disposal Units provide secondary containment.

Approximately 15 feet of overburden were removed to prepare and level the site for Disposal Unit construction. All Disposal Units will be built at or slightly below the grade level that exists after the overburden and leveling operations are complete. The bottom of the Saltstone grout monoliths will be at least five feet above the historic high water table beneath the Z-Area site, thus avoiding disposal of waste in a zone of water table fluctuation. Run-on and runoff controls are installed to minimize site erosion during the operational period.

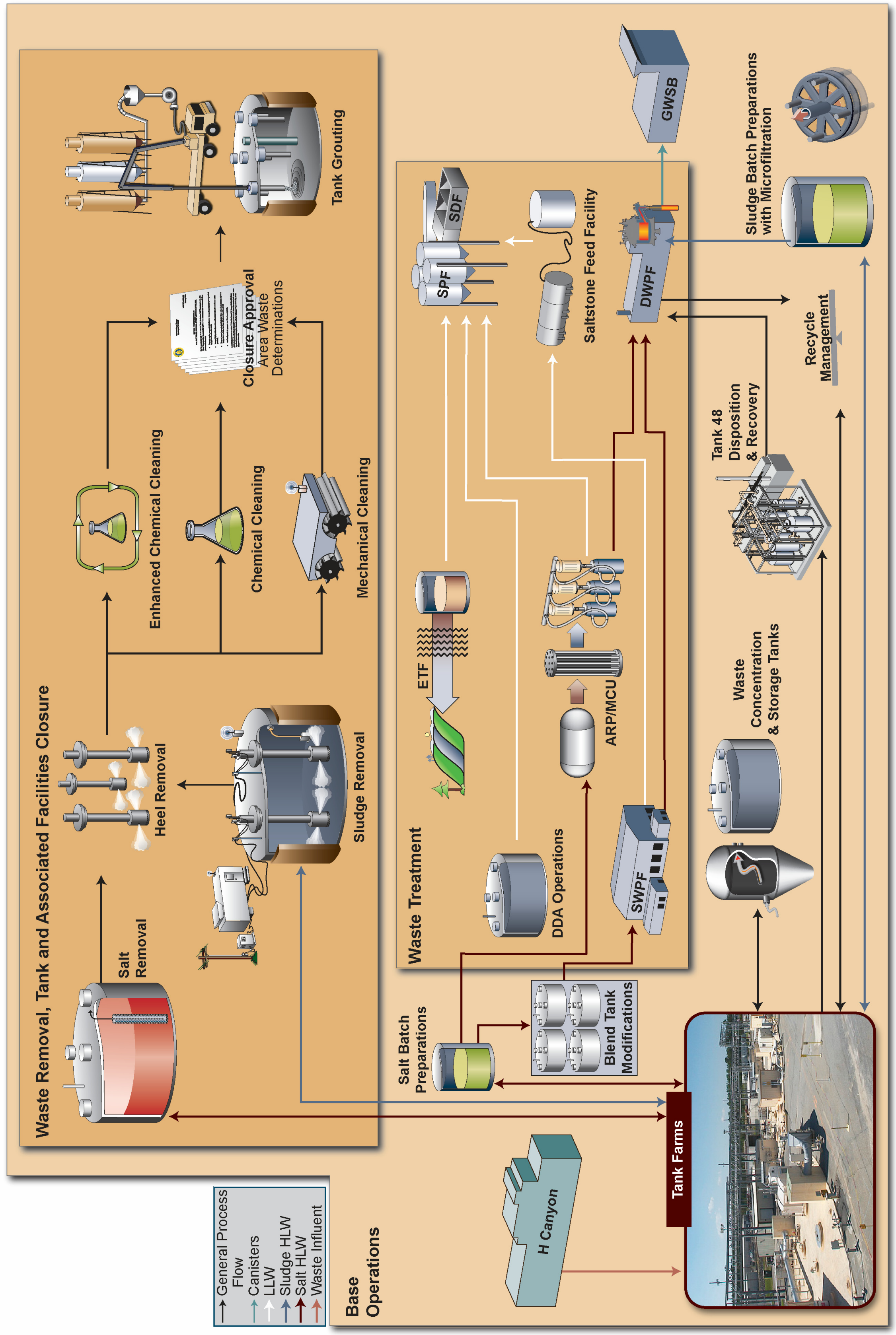
The current active Disposal Unit (Vault 4) is approximately 200 feet wide, by 600 feet in length, by 26 feet in height, divided into twelve cells. The other current Disposal Unit (Vault 1) is approximately 100 feet wide, by 600 feet in length, by 25 feet in height, divided into six cells.

Future Disposal Units are planned to be two cells nominally 150 feet diameter by 22 feet high each and will be designed in compliance with provisions contained in the Consent Order of Dismissal in Natural Resources Defense Council, et al. v. South Carolina Department of Health and Environmental Controls, et al. (South Carolina Administrative Law Court, August 7, 2007). This design is used commercially for storage of water. After accounting for interior obstructions (support columns, drainwater collection systems, etc.) and the requirement for a 2-foot cold cap, the nominal useable volume of a cell is 2,600 kgal. Recent operating experience has resulted in approximately 1.76 gallons of grout being produced for each gallon of DSS feed, yielding a nominal cell capacity of approximately 1,500 kgal of DSS or a nominal capacity of . approximately 3,000 kgal of feed solution per Disposal Unit.

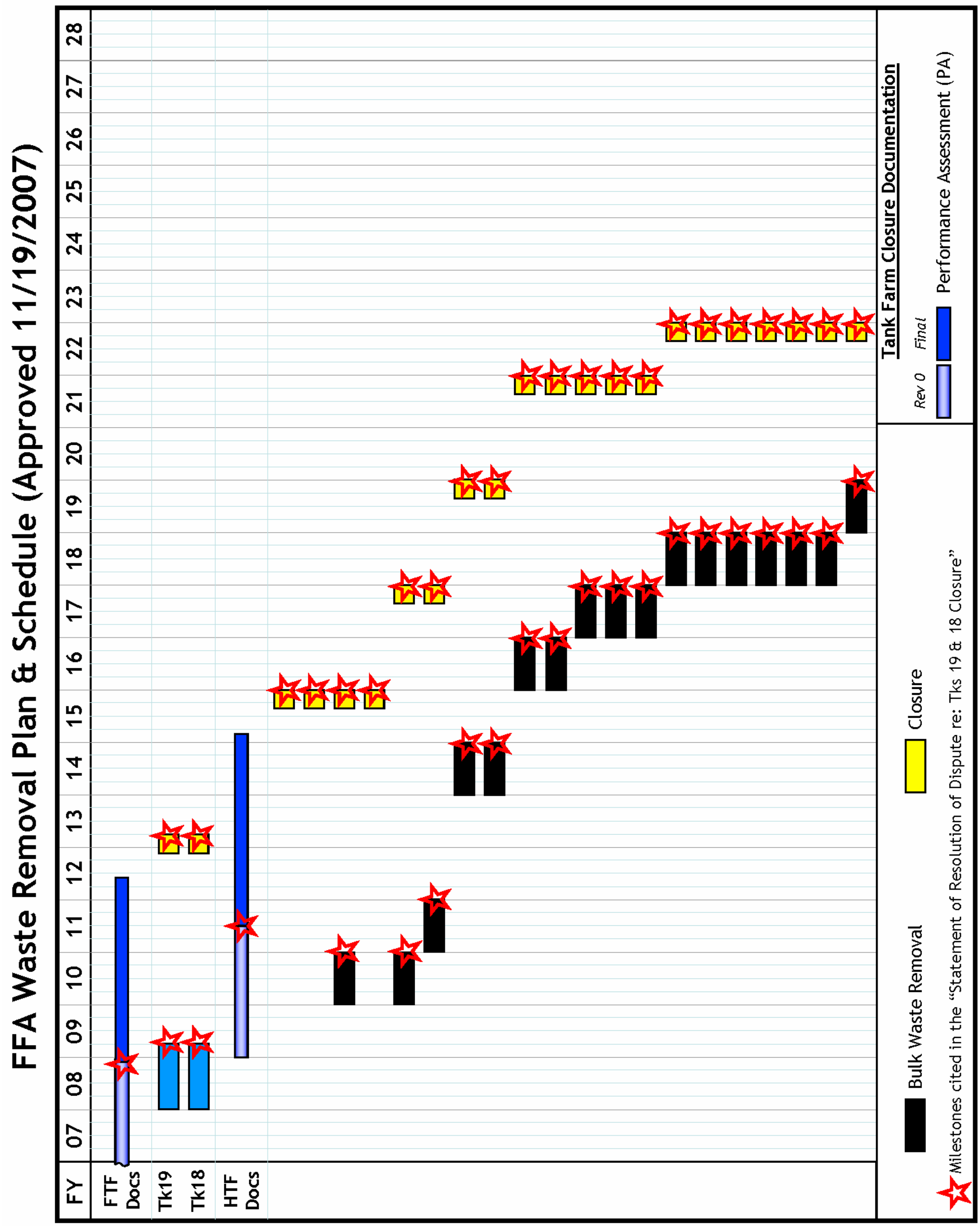
Closure operations will begin near the end of the active disposal period in the SDF, i.e., after most or all of the Disposal Units have been constructed and filled. Backfill of native soil will be placed around the Disposal Units. The present closure concept includes two moisture barriers consisting of clay/gravel drainage systems along with backfill layers and a shallow-rooted bamboo vegetative cover.

Construction of the SDF and the first two Disposal Units was completed between February 1986 and July 1988. The SDF started radioactive operations June 12, 1990. Future Disposal Units will be constructed on a “just-in-time” basis in coordination with salt processing production rates.

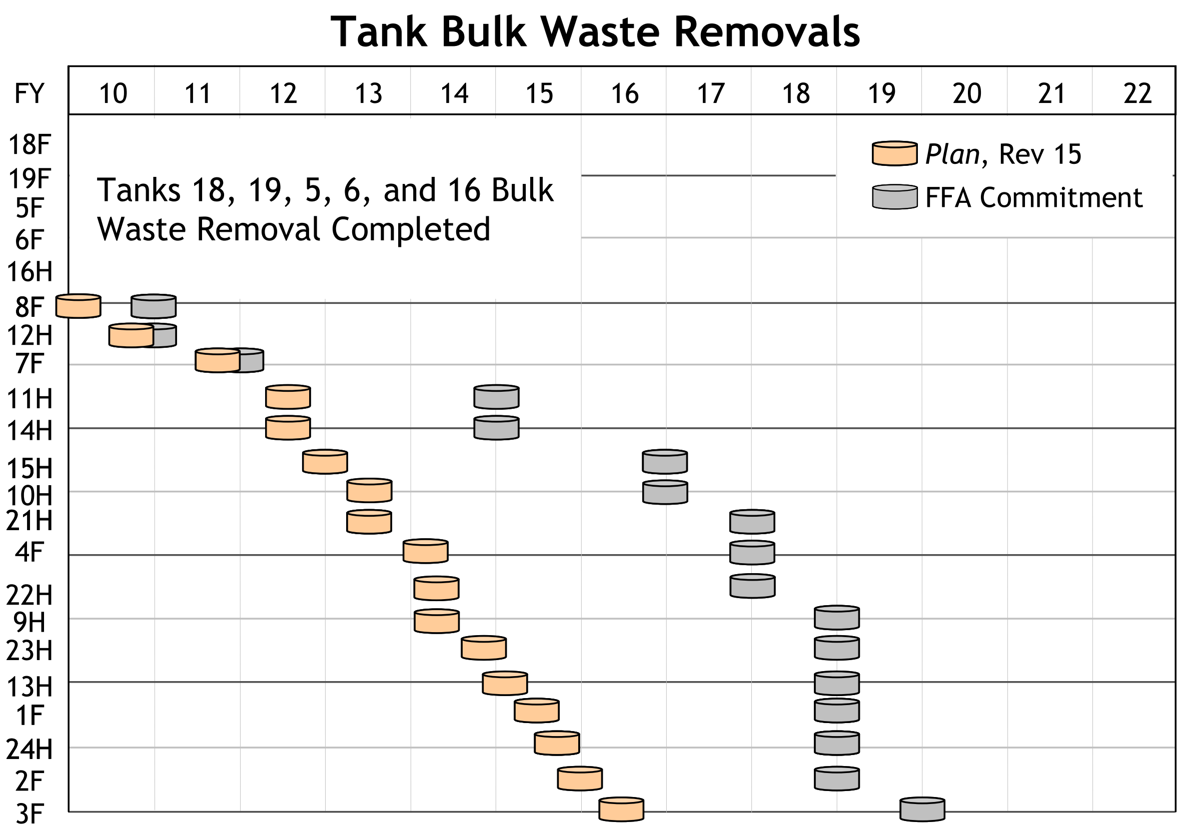
Figure 9–2 — *Process Flowsheet*

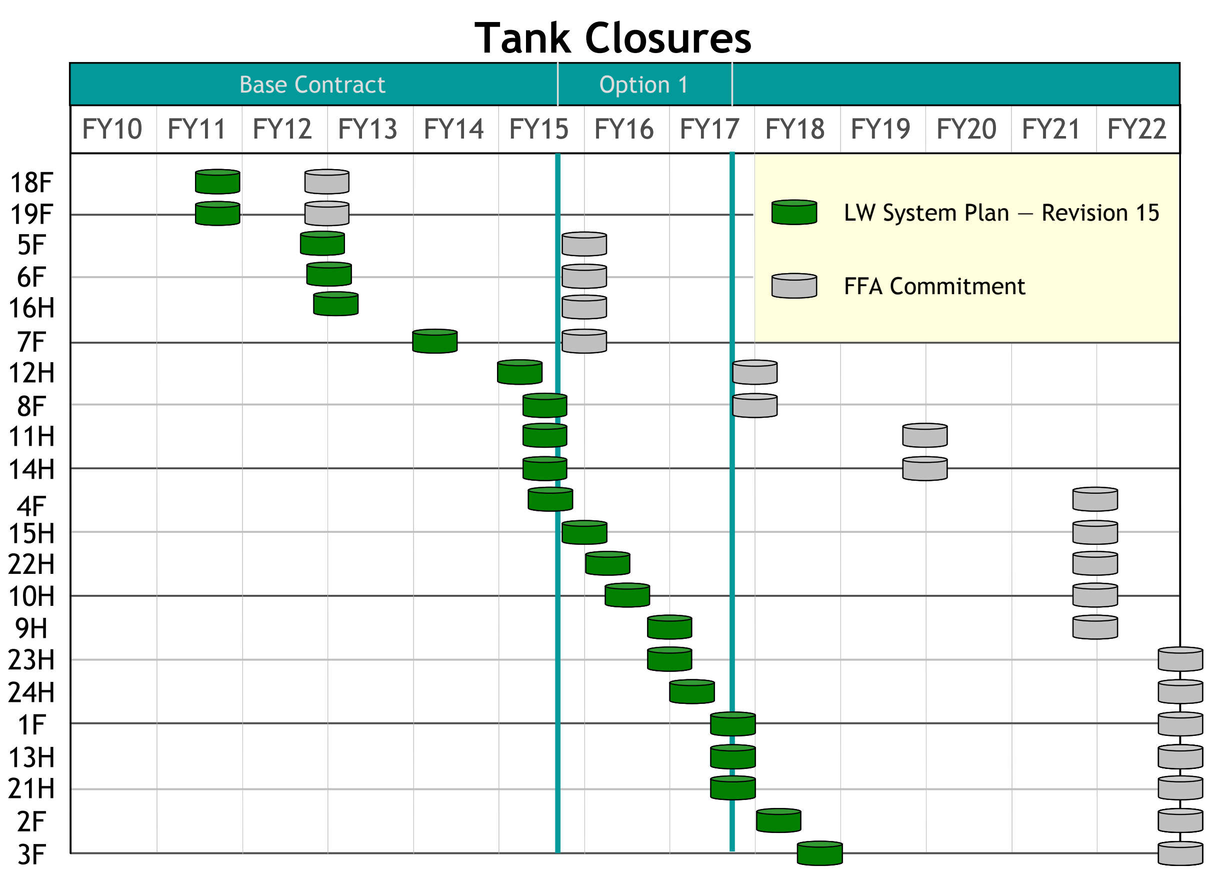


Appendix A — *FFA Waste Removal Plan & Schedule*



Appendix B — *Bulk Waste Removal & Tank Closure Schedules*





Appendix C — *Salt Solution Processing*

End of Fiscal Year	Salt Solution via DDA only (kgal)	Salt Solution via ARP/MCU (kgal)	Salt Solution via SWPF (kgal) [a]	Total Salt Solution from Tank Farms (kgal) [b]	DSS Stream to SPF (kgal)	UUM Stream to SPF (kgal) [c]	ETP Stream to SPF (kgal)	Total Feed Stream to SPF (kgal)	Disposal Unit Numbers [d]
FY08	1,970	140		2,110	2,140	15	99	1,290	4
FY09	830	700		1,530	1,670	45	120	1,570	4
FY10		1,240		1,240	1,490	250	120	2,220	4
FY11		1,340		1,340	1,680	30	120	2,480	4-2
FY12		1,780		1,780	2,210	30	120	2,450	2
FY13			1,250	1,250	1,590	30	120	1,740	2-3
FY14			4,500	4,500	5,530	30	120	5,680	3-6
FY15			6,000	6,000	7,260	30	120	7,410	6-8
FY16			6,000	6,000	7,480	30	120	7,630	8-11
FY17			4,500	4,500	5,530	30	120	5,680	11-13
FY18			5,500	5,500	6,540	30	120	6,690	13-15
FY19			6,000	6,000	7,150	30	120	7,300	15-17
FY20			6,000	6,000	7,200		120	7,320	17-20
FY21			6,000	6,000	7,150		120	7,270	20-22
FY22			6,000	6,000	7,180		120	7,300	22-25
FY23			6,000	6,000	7,170		120	7,290	25-27
FY24			6,000	6,000	7,250		120	7,370	27-29
FY25			6,000	6,000	7,260		120	7,380	29-32
FY26			6,000	6,000	7,230		120	7,350	32-34
FY27			6,000	6,000	7,150		120	7,270	34-37
FY28			6,000	6,000	7,120		120	7,240	37-39
FY29			1,350	1,350	1,670		120	1,790	39-40
FY30			125	125	150		120	270	40
FY31					700			700	40
FY32					[e]				40
Total	**2,800**	**5,200**	**89,225**	**97,225**	**117,500**	**580**	**2,739**	**120,690**	

a
- SWPF throughput in several years is impacted by assumed DWPF outages in those years
- Due to the shutdown of all evaporator systems by the end of FY26 and the need to continue flushing waste tanks to successfully complete heel removal, salt solution sent to SWPF from FY27 - FY30 may be less than 5.6 M Na. It is assumed that this material can be accommodated at SWPF.

b *Total Salt Solution from Tank Farms* is a total of all LLW sent directly from the Tank Farm and all salt solution treated via the DDA, ARP/MCU, and SWPF processes.

c Low Level Waste receipts to Tank 50 are assumed as outlined in *H-Area Liquid Waste Forecast Through 2019*[24].

d
- Vault 1 and 4 are in service. Vault 1 will receive no additional grout; Vault 4 has 5 cells available to receive grout. Future Disposal Units will have (2) cells with 1.5 Mgal feed capacity. Disposal Unit # fill sequence to be 4, 2 (cells 2a, 2b), 3 (cells 3a, 3b), 5 (cells 5a, 5b), 6 (cells 6a, 6b), 7 (cells 7a, 7b) … etc.
- Each gallon of feed, when added to the cement, flyash, and slag, makes 1.76 gallons of grout. Each cell is estimated to contain ~2,600 kgal of grout. Therefore, each cell holds ~1,500 kgal of feed solution (each Disposal Unit holds ~3,000 kgal of feed solution).

e FY31 DSS stream derives from flushing facilities prior to removal from service.

Note Dates, volumes, and chemical or radiological composition information are planning approximations only.

Appendix D — *Sludge Processing*

Sludge Batch	Prep Tank	Source Tanks [a]	Projected SOL (weight %)	Canister Production Rates (Cans/Year)	Actual Cans @ Projected SOL	Date Batch Finished @ Projected SOL[b]
		Current through June 30, 2009:			2,739	
SB5 (LTAD #1)	51	7,11	34	186	221	Aug 2010
Melter Improvement Outage						Aug 2010
SB6 (LTAD #2)	51	4, 7, 12	36	325	323	Aug 2011
Melter Replacement Outage						Dec 2011
SB7	51	4, 12, 5, 6,	40	400	293	Sep 2012
SB8	51	7, 13	40	400	126	Jan 2013
SWPF Tie-in Outage						May 2013
SB8	51	7, 13	40	400	194	Dec 2013
SB9 (LTAD #3)	42	11, 13, 14, 15	40	400	346	Nov 2014
SB10 (LTAD #4)	51	12, 13, 15	40	400	350	Sep 2015
SB11 (LTAD #5)	42	13, 21, 22, 23, 32	40	400	330	Jul 2016
SB12	51	13, 26, 32	40	400	333	Jun 2017
Melter Replacement Outage						Oct 2017
SB13 (LTAD #6)	42	26, 33, 34, 35, 47	40	400	314	Jul 2018
SB14	51	33, 34, 35, 47	40	400	354	Jul 2019
SB15 (LTAD #7)	42	33, 34, 35, 39, 47	37	400	426	Sep 2020
SB16	51	33, 34, 47, 43	40	400	171	Feb 2021
SB17	51	33, 34, 35, 47	27	400	285	Nov 2021
Sludge Heels	42		27		180	May 2023
Sludge Canister Total					**6,985**	
Salt Only Canisters					250	Dec 2030
Total Canisters					**7,235**	

[a] The indicated tanks are the sources of the major components of each sludge batch, not necessarily the sludge location just prior to receipt for sludge washing. Tanks 7, 13, and 42, for example, are also used to stage sludge that is removed from other tanks.

[b] Dates are approximate and represent when Tank 40 gets to a 40″ heel. Actual dates depend on canister production rates.

[c] Lower production rate assumed for dilute heel processing

Note: Dates, volumes, and chemical or radiological composition information are planning approximations only.

Appendix E — *Canister Storage*

End of Fiscal Year	SRS Cans Produced		SRS Cans in GWSB #1 (2,251 capacity)[a]		SRS Cans in GWSB #2 (2,339 capacity)[b]		SRS Cans in GWSB #3 (capacity TBD)[c]	
	Yearly	Cum.	Added	Cum.	Added	Cum.	Added	Cum.
FY96	*64*	*64*	*64*	*64*				
FY97	*169*	*233*	*169*	*233*				
FY98	*250*	*483*	*250*	*483*				
FY99	*236*	*719*	*236*	*719*				
FY00	*231*	*950*	*231*	*950*				
FY01	*227*	*1,177*	*227*	*1,177*				
FY02	*160*	*1,337*	*160*	*1,337*				
FY03	*115*	*1,452*	*115*	*1,452*				
FY04	*260*	*1,712*	*260*	*1,712*				
FY05	*257*	*1,969*	*257*	*1,969*				
FY06	*245*	*2,214*	*244*	*2,213*	*1*	*1*		
FY07	*160*	*2,374*	*28*	*2,241*	*132*	*133*		
FY08	*225*	*2,599*		*2,241*	*225*	*358*		
FY09	*196*	*2,795*		*2,241*	*196*	*554*		
FY10	190	2,985		2,241	190	744		
FY11	297	3,282		2,241	297	1,041		
FY12	293	3,575		2,241	293	1,334		
FY13	243	3,818		2,241	243	1,577		
FY14	384	4,202		2,241	384	1,961		
FY15	389	4,591		2,241	378	2,339	11	11
FY16	380	4,971		2,241		2,339	380	391
FY17	283	5,254		2,241		2,339	283	674
FY18	366	5,620		2,241		2,339	366	1,040
FY19	370	5,990		2,241		2,339	370	1,410
FY20	386	6,376		2,241		2,339	386	1,796
FY21	386	6,762		2,241		2,339	386	2,182
FY22	151	6,913		2,241		2,339	151	2,333
FY23	89	7,002		2,241		2,339	89	2,422
FY24	42	7,044		2,241		2,339	42	2,464
FY25	42	7,086		2,241		2,339	42	2,506
FY26	41	7,127		2,241		2,339	41	2,547
FY27	41	7,168		2,241		2,339	41	2,588
FY28	41	7,209		2,241		2,339	41	2,629
FY29	10	7,219		2,241		2,339	10	2,639
FY30	10	7,229		2,241		2,339	10	2,649
FY31	6	7,235		2,241		2,339	6	2,655

Numbers in italics are actuals — through FY09. FY10 and on are forecast based on modeling assumptions

[a] GWSB #1 filling began in May 1996. Of 2,262 standard canister storage locations, 8 are unusable and 3 store non-radioactive archive canisters yielding a usable storage capacity of 2,251 standard canisters; 10 are contingency positions for placement of canisters if GWSB #2 is temporarily unavailable. It reached its maximum capacity in FY07.

[b] GWSB #2 was built with 2,340 standard storage locations. One archived non-radioactive canister is stored in GWSB #2 yielding a usable storage capacity of 2,339 standard canisters. GWSB #2 received its first radioactive canister in June 2006. It is expected to reach maximum capacity in FY16.

[c] This Plan assumes the construction of a third GWSB to be available in FY16. GWSB #3 is assumed to be designed and built to similar specification as GWSB #2 with the necessary capacity to store the remaining canisters forecast in this *Plan*.

Note: Dates, volumes, and chemical or radiological composition information are planning approximations only.

Appendix F — *Tank Farm Volume Balance*

End of Fiscal Year	Influents (kgal)								Effluents (kgal)						Total Inventory[k]
	H-Canyon[a]			DWPF			IW/Chem	Total	Space Recovery			Salt	Sludge	Total	
	HLW	UUM	Pu[b]	Recycle[c]	299-H	ETP	Add[f]	In	2F Evap[g]	2H Evap[h]	3H Evap[i]	Solution[j]	to DWPF	Out	
FY08															**37,121**
FY09	50	194	23	1,880	2	120	1,124	**3,392**	676	2,200	82	1,530	126	**4,614**	**32,821**
FY10	54	250	22	1,790	4	120	831	**3,071**	1,970	1,280	291	1,240	120	**4,901**	**30,252**
FY11	258	30		2,160		120	576	**3,144**	878	881	-	1,340	130	**3,229**	**30,396**
FY12	258	30		1,280		90	950	**2,608**	908	305	-	1,780	194	**3,187**	**29,809**
FY13	274	30	8	1,330	1	e	797	**2,440**	770	126	55	1,250	255	**2,456**	**29,592**
FY14	258	30		2,130	11		1,841	**4,270**	75	-	954	4,500	147	**5,676**	**27,697**
FY15	274	30	8	2,260	3		3,067	**5,642**	833		97	6,000	224	**7,154**	**25,503**
FY16	258	30		2,270			3,353	**5,911**	633		275	6,000	159	**7,067**	**23,902**
FY17	274	30		2,210	12		2,952	**5,478**			1,130	4,500	110	**5,740**	**22,753**
FY18	258	30		1,940	12		2,417	**4,657**			1,025	5,500	162	**6,687**	**20,804**
FY19	274	30		2,270	12		4,295	**6,881**			794	6,000	273	**7,067**	**20,419**
FY20	399			2,270	21		3,877	**6,567**			726	6,000	257	**6,983**	**18,506**
FY21	321			1,440	10		3,694	**5,465**			342	6,000	171	**6,513**	**16,979**
FY22	165			1,190	14		4,865	**6,234**			910	6,000	86	**6,996**	**15,819**
FY23	-			1,080	16		6,472	**7,568**			913	6,000	20	**6,933**	**15,938**
FY24				994	18		4,957	**5,969**			904	6,000	-	**6,904**	**13,576**
FY25				1,010	16		3,739	**4,765**			656	6,000	-	**6,656**	**11,022**
FY26				1,010	24		5,373	**6,407**	-		1,910	6,000	-	**7,910**	**8,062**
FY27				1,010	14		5,972	**6,996**			524	6,000	-	**6,524**	**5,875**
FY28				1,010	d		4,101	**5,111**			-	6,000	-	**6,000**	**2,212**
FY29				1,010			1,713	**2,723**			-	1,350	-	**1,350**	**1,056**
FY30				936			647	**1,583**			-	125	-	**125**	**607**
FY31				-			459	**459**			-	1,066	-	**1,066**	**-**
FY32				-							-	-	-	**-**	

[a] H-Canyon receipts are based on *H-Area Liquid Waste Forecast Through 2019*[25], adjusted for actual receipts in FY98. Shutdown flows for H-Canyon are assumed from FY20–FY22 and are as outlined in *H-Canyon Liquid Waste Generation Forecast For H-Tank Farm Transfer*[36]. HLW is the main component of H-Canyon waste and is received into Tank 39. UUM consists of unirradiated uranium material and concentrate from the General Purpose H-Canyon (GP) Evaporator that is received in Tank 50. Pu consist of Pu-bearing waste that is received in directly into a sludge batch (either in the sludge preparation tanks (Tanks 51 and 42) or the DWPF feed tank (Tank 40)

[b] Plutonium discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with the canister fissile material concentration limits.

[c] DWPF Recycle receipts reflect modifications made in the DWPF to reduce recycle. Additionally, DWPF recycle is used to minimize inhibited water addition required for salt dissolution and molarity adjustments within the tank farms.

[d] Maintenance Facility (299-H) receipts are assumed to be redirected to SWPF beginning in FY28 in order to complete Tank 39 heel removal (current receipt tank for Maintenance Facility, 299-H, receipts).

[e] ETP receipts are assumed to be redirected to SPF (bypassing the Tank Farm) beginning in July 2012 when Tank 50 is returned to service.

[f] The "IW / Chemical Addition" column includes all additions, including IW used during sludge batch washing activities, salt dissolution activities, and during tank cleaning activities (mechanical and chemical heel removal).

[g] 2F Evaporator is assumed to be shut down permanently in FY25.

[h] Since DWPF recycle will be used for molarity adjustment and salt dissolution, the 2H Evaporator is assumed to be shut down permanently in FY13.

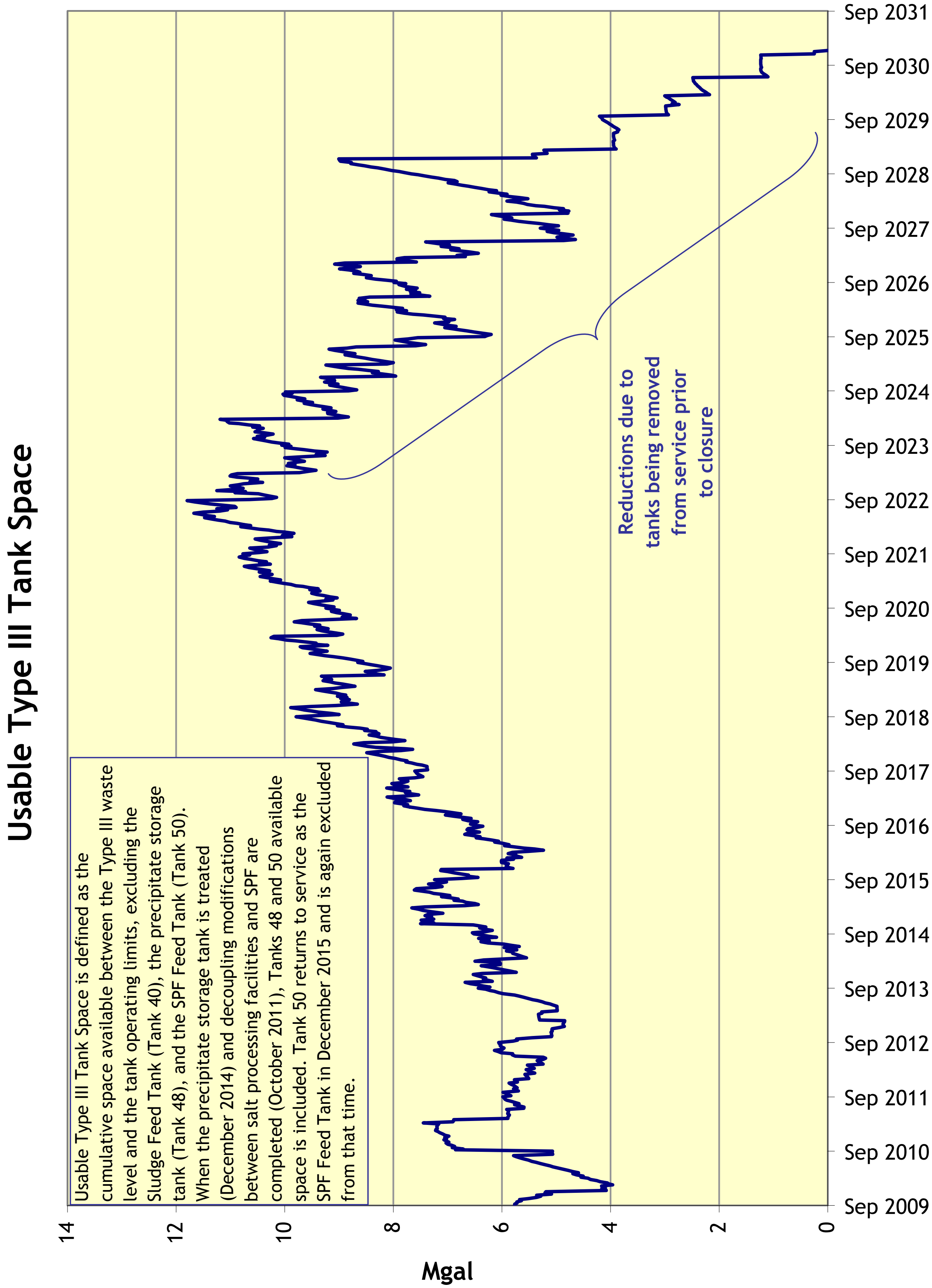
[i] The 3H Evaporator is assumed to be shut down for periods during FY11 and FY16 for periodic salt removal campaigns. The 3H Evaporator is assumed to shut down permanently in FY27.

[j] Due to the shutdown of all evaporator systems by the end of FY26 and the need to continue flushing waste tanks to successfully complete heel removal, salt solution sent to SWPF from FY27 - FY31 may be less than 6.44 M Na. It is assumed that this material will be sent from the Tank Farm to be concentrated prior to being sent to SWPF.

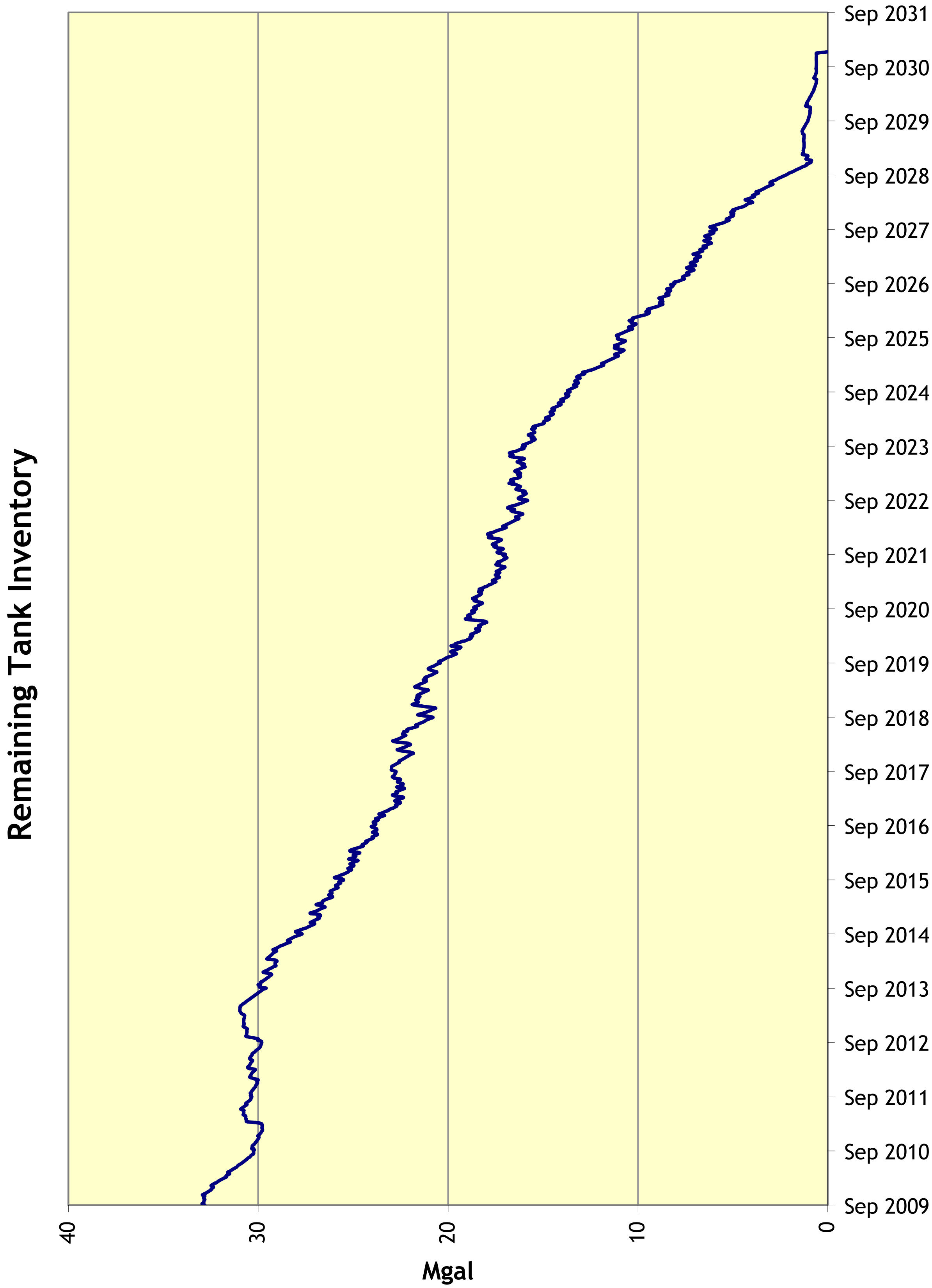
[k]
- FY08 total inventory was obtained from the ending inventory as cited in *Evaporator Performance, Tanks Space Management, and Liquid Waste Transfers: Fiscal year 2008 Summary*[37]. All other total inventory values were obtained from modeling completed to support this *Plan*.
- Volumes are not additive after accounting for jet dilution, expansion of sludge during sludge slurrying operations (sludge becomes less dense), and other volume changes during the processing of waste. During a transfer, steam eductor jets are used to transfer liquid waste from tank to tank. Volume from the transfer steam accounts for 4% of the mass being transferred for intra-area transfers and 6% for inter-area lines. Mixing waste forms of different compositions are not mathematically additive. For example, noticeable space recovery can be achieved when a light solution (such as DWPF recycle water) is mixed with concentrated supernate. Also, the dissolution of "dry salt" (i.e. salt with interstitial liquid removed) tends to recover space. Years with large amounts of salt dissolution reflect this anomaly.

Note: Dates, volumes, and chemical or radiological composition information are planning approximations only.

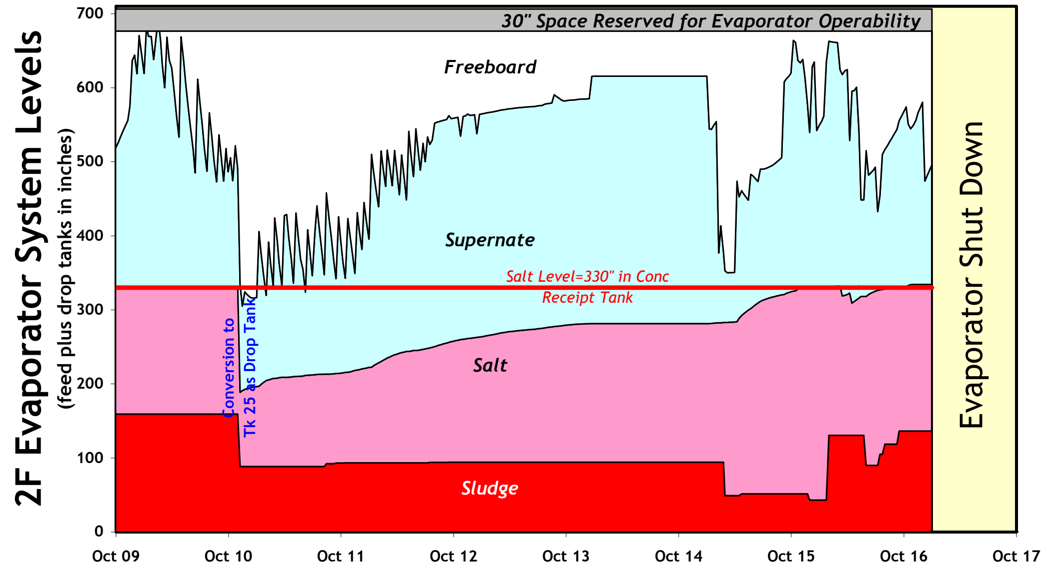
Appendix G — *Usable Type III Tank Space*

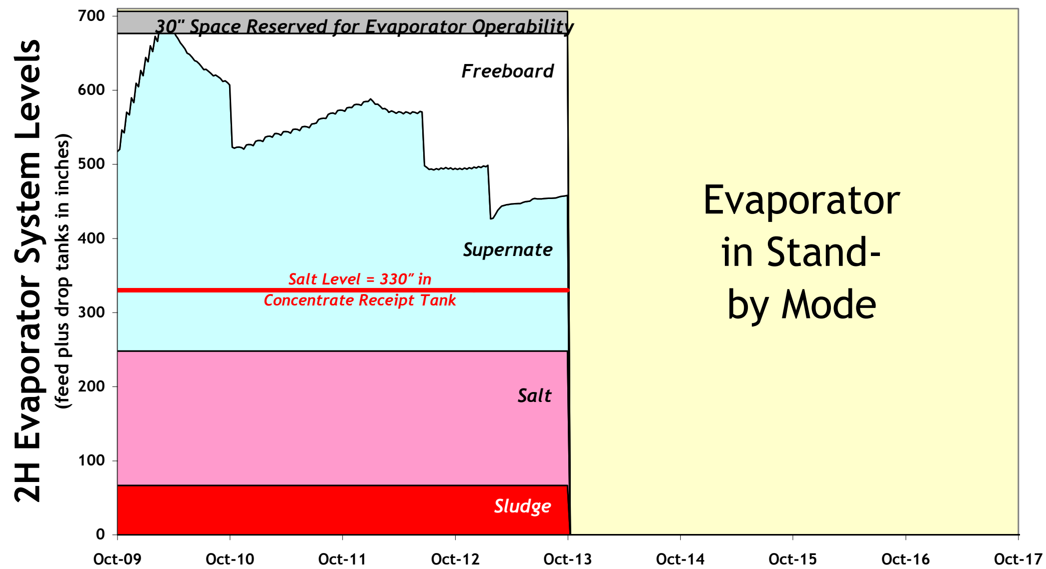


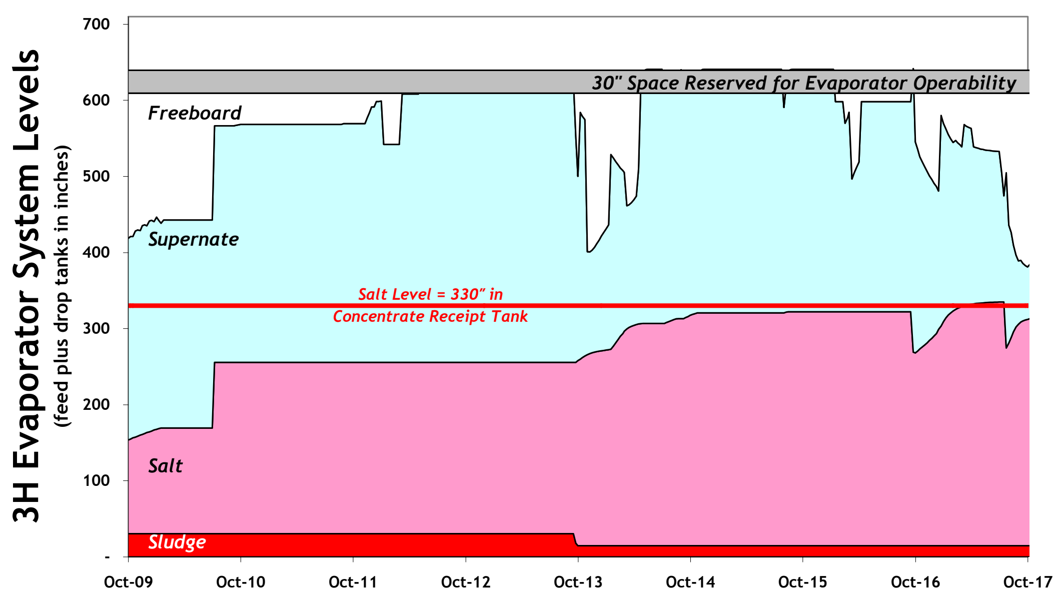
Appendix H — *Remaining Tank Inventory*



Appendix I — *Evaporator System Levels (through FY14)*







Appendix J — *LW System Plan — Rev 15 Summary*

(see attached foldout chart)

Appendix K — *Acronyms*

AB	Tank Farm **Authorization Basis**
ARP	**Actinide Removal Process** – planned process that will remove actinides and Strontium-90 (Sr-90), both soluble and insoluble, from Tank Farm salt solution using MST and filtration
BWR	**Bulk Waste Removal**
Ci/gal	Curies per gallon
CSSX	**Caustic Side Solvent Extraction** – process for removing cesium from a caustic (alkaline) solution. The process is a liquid-liquid extraction process using a crown ether. SRS plans to use this process to remove Cesium-137 (Cs-137) from salt wastes.
CTS	**Concentrate Transfer System**
D&D	**Dismantlement and Decommissioning**
DDA	**Deliquification, Dissolution, and Adjustment** – process for treating salt that is low in activity by removing the interstitial liquid (deliquification), dissolving the salt that remains, and adjusting the salt concentration to acceptable SPF feed concentrations
DOE	**Department of Energy**
DOE-SR	The **DOE Savannah River** Operations Office
DNFSB	**Defense Nuclear Facility Safety Board**
DSS	**Decontaminated Salt Solution** – the decontaminated stream from any of the salt processes – DDA, ARP/MCU, or SWPF
DSSHT	**Decontaminated Salt Solution Hold Tank**
DU	**Disposal Units**
DWPF	**Defense Waste Processing Facility** – SRS facility in which LW is vitrified (turned into glass)
EA	**Environmental Assessment**
ECC	**Enhanced Chemical Cleaning**
EIS	**Environmental Impact Statement**
ELAWD	**Enhanced Low Activity Waste Disposal**
EPA	**Environmental Protection Agency**
ETP	**Effluent Treatment Project –** SRS facility for treating contaminated wastewaters from F & H Areas
FFA	**Federal Facility Agreement** – tri-party agreement between DOE, SCDHEC, and EPA concerning closure of waste sites. The currently-approved FFA contains commitment dates for closing specific LW tanks
FBSR	**Fluidized Bed Steam Reformer**
FESV	**Failed Equipment Storage Vault**
FTF	**F-Tank Farm**
gal/yr	**gallons per year**
GP	**General Purpose** Evaporator – an H-Canyon process that transfers waste to HTF
GWSB	**Glass Waste Storage Building** – SRS facilities with a below-ground concrete vault for storing glass-filled HLW canisters
HLW	**High Level Waste**
HM	**H Modified** – the modified Purex process in H-Canyon for separation of special nuclear materials and enriched uranium from irradiated targets
HTAD	**High-Temperature Aluminum Dissolution**
HTF	**H-Tank Farm**
IPABS	**Integrated Planning, Accountability, & Budgeting System**
ITR	**Independent Technical Review**
IW	**Inhibited Water** – well water to which small quantities of sodium hydroxide and sodium nitrite have been added to prevent corrosion of carbon steel waste tanks
kgal	**thousand gallons**
KTPB	potassium **t**etra**p**henyl**b**orate
LTAD	**Low Temperature Aluminum Dissolution**
LLW	**Low Level Waste**
LW	**Liquid** (Radioactive) **Waste** – broad term that includes the liquid wastes from the canyons, HLW for vitrification in DWPF, LLW for disposition at SDF, and LLW wastes for treatment at ETP
MCi	**Million Curies**

MCU	**Modular CSSX Unit** – small-scale modular unit that removes cesium from supernate using a CSSX process similar to SWPF
Mgal	**million gallons**
MSB	**Melter Storage Box**
MSP	**Modular Salt Processing**
MST	**monosodium titanate**
NDAA	Ronald W. Reagan **National Defense Authorization Act** for Fiscal Year 2005, Public Law 108-375
NEPA	**National Environmental Policy Act**
NPDES	**National Pollution Discharge Elimination Systems**
NRC	**Nuclear Regulatory Commission**
OA	**Oxalic Acid**
PEP	**Project Execution Plan**
PMP	**Performance Management Plan**
RCRA	**Resource Conservation and Recovery Act**
RMF	**Rotary Microfilter**
RAR	**Risk Assessment Report**
SAS	**Steam Atomized Scrubbers**
SBP	**Sludge Batch Plan**
SCDHEC	**South Carolina Department of Health and Environmental Control** – state agency that regulates hazardous wastes at SRS
SCIX	**Small Column Ion Exchange**
SDF	**Saltstone Disposal Facility** – Disposal Units that receive wet grout from SPF, where it cures into a solid, non-hazardous Saltstone
SE	**Strip Effluent**
§3116	**Section 3116** – Defense Site Acceleration Completion — of the NDAA
SEIS	**Supplemental Environmental Impact Statement**
SIMP	**Systems Integrated Management Plan**
SOL	**Sludge Oxide Loading**
SPF	**Saltstone Production Facility** – SRS facility that mixes decontaminated salt solution and other low-level wastes with dry materials to form a grout that is pumped to SDF
SRNS	**Savannah River Nuclear Solutions**
SRR	**Savannah River Remediation** LLC
SRS	**Savannah River Site**
STP	**Site Treatment Plan**
SWPF	**Salt Waste Processing Facility** – planned facility that will remove Cs-137 from Tank Farm salt solutions by the CSSX process and Sr-90 and actinides by treatment with MST and filtration
TBD	**to be determined**
TPB	**t**etra**p**henyl**b**orate
UUM	**Unirradiated Uranium Material**
WCS	**Waste Characterization System** – system for estimating the inventories of radionuclides and chemicals in SRS Tank Farm tanks using a combination of process knowledge and samples
WD	**Waste Determination**
WOW	**Waste on Wheels**

References

[1] Final Request for Proposals (RFP) No. DE-RP09-07SR22505 for the Savannah River Liquid Waste (LW) Program, September 2007

[2] Contract No. DE-AC09-09SR22505 for the Liquid Waste (LW) Program at the Savannah River Site (SRS), December 2008

[3] Sellers, M.C., OCPM-06-037, *2006 Savannah River Site Environmental Management Program Project Execution Plan (PEP)*, July 2006

[4] WSRC-OS-94-42, *Federal Facility Agreement for the Savannah River Site*, August 1993

[5] SRNS-TR-2008-00101, *Savannah River Site Approved Site Treatment Plan, 2008 Annual Update*, Revision 0, November 2008

[6] Bodman, S.W., DOE-WD-2005-001, *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, Revision 0, January 2006

[7] DOE-WD-2005-001, *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, Revision 0, January 2006

[8] Thomas, S.A., LWO-PIT-2006-00017, *Savannah River Site – Liquid Waste Disposition Processing Strategy*, Revision 0, September 2006

[9] Chew, D.P., *et al.*, LWO-PIT-2007-00062, *Life-cycle Liquid Waste Disposition System Plan*, Revision 14, October 2007

[10] Winship, G.C., Y-RAR-G-00022, *PBS-SR-0014 Radioactive Liquid Tank Waste Stabilization and Disposition, Technical and Programmatic Risk Assessment Report to Support System Plan Revision 15*, Revision 5, January 2010

[11] Tran, H.Q., LWO-LWE-2008-00224 , *July 2008 Tank Radioactive and Non-radioactive Inventories*, Revision 0, August 2008

[12] Mayson, W.P., III, *et al.*, SRR-LWP-2009-00012, *SRR Contract Performance Baseline*, Revision 0, September 2009

[13] Agreement between DOE, SCDHEC, EPA, *Statement of Resolution of Dispute Concerning Extension of Closure Dates for Savannah River Site High-Level Radioactive Waste Tanks 19 and 18*, November 2007

[14] Chew, D.P., *et al.*, LWO-PIT-2007-00062, *Life-cycle Liquid Waste Disposition System Plan*, Revision 14, October 2007

[15] French, J.W., SRR-2009-00013, *Agreement on Key Input Bases and Assumptions for Revision 15 of the Liquid Waste System Plan and Revision 5 of the Risk Management Plan*, Revision 0, July 2009

[16] Folk, J.L., Jr., WDPD-09-051, *Agreement on Key Input Bases and Assumptions for Revision 15 of the Liquid Waste System Plan and Revision 5 of the Risk Management Plan (You letter, 7/23/09)*, Revision 0, August 2009

[17] LWO-PIT-2006-00017, *Savannah River Site Liquid Waste Disposition Processing Strateg*y, Revision 0, September 2006

[18] SWPF-09-097, *Reply to LWO-SDIP- 2008-0004*, December 2008

[19] Norton, M.R., X-ESR-J-00001, *Waste Acceptance Criteria*, Revision 1, September 2009

[20] *DOE Plan of Action to Re-Assess Savannah River Site's High Level Waste Management Strategy, DNFSB Recommendation 2001-1 Implementation Plan,* Revision 5, Draft

[21] *DOE Plan of Action to Re-Assess Savannah River Site's High Level Waste Management Strategy, DNFSB Recommendation 2001-1 Implementation Plan*, Revision 5, September 2009

[22] WDPD-09-07, *Fissile Isotope Concentration in Defense Waste Processing Facility (DWPF) Canisters and Agreement of Key Input Assumptions for Revision 15 of the Lifecycle Liquid Waste Disposition () System Plan*, November 2008

[23] Shah, H.B., SRR-LWP-20009-00009, *Sludge Batch Plan – 2009 in Support of System Plan R-15*, Revision 0, September 2009

[24] Price, M.R., SRNS-N2000-2009-00052, *H-Area Liquid Waste Forecast Through 2019*, Revision 1, September 2009

[25] Shah, H.B., SRR-LWP-2009-00006, *Sludge Batch 6 Re-Projected Batch and Blend Compositions, Post-Aluminum Dissolution and Varying Tank 4 Solids to 51*, Revision 1, Draft

[26] Cederdahl, B.A., LCW-SPT-00100, *Tank 48 Treatment Process Project G-2 Critical Decision 1 (CD-1) Package*, Revision 1, December 2006

[27] B. A. Martin and R. D. Deshpande, CBU-PIT-2006-00047, *Tank Closure inputs and Assumptions in Support of the Liquid Waste Disposition Processing Plan*, Revision 2, August 2007

[28] Suggs, P.C. to Mahoney, M.J., PIT-MISC-0195, email *Long Term Processing Capacity of SWPF-Inputs to System Plan*, July 2006

[29] Daily, D.E., M-ESR-F-00109, *Tank 5 Sludge Volume Estimation after the Second Phase of Bulk Sludge Removal*, Revision 0, December 2005

[30] Le, T.A., SRR-LWP-2009-00003, *6/30/2009 - June, 2009 Curie and Volume Inventory Report*, Revision 0, July 2009

[31] Barnes, S.G.., SW11.1-WTE-7.2, *Transfer Jet/Pump/Waste Downcomer Levels and Adjustments Data Sheet*, Revision 43, Immediate Procedure Change (IPC) 2, June 2008

[32] Waltz, R.S.,Jr., C-ESR-G-00003, *SRS High Level Waste Tank Leaksite Information*, Revision 2, March 2006

[33] Hobbs, D.T., WSRC-TR-95-0249, *Particle Size and Settling Velocity of Tank 41H Insoluble Solids*, May 1995

[34] Jilani, I.A., CBU-HCP-2005-00105, *H-Canyon Liquid Waste Generation Forecast For H-Tank Farm Transfer*, Revision 0, May 2005

[35] Brooke, J. N., Peters, J. F., and K. Stahell, WSRC-TR-99-00358, *Hydrological Methods Can Separate Cesium from Nuclear Waste Saltcake*, 1999.

[36] Jilani, I.A., CBU-HCP-2005-00105, *H-Canyon Liquid Waste Generation Forecast For H-Tank Farm Transfer*, Revision 0, May 2005

[37] Chew, D.P., LWO-LWP-2009-00007, *Evaporator Performance, Tank Space Management, and Liquid Waste Transfers: Fiscal Year 2008 Summary*, Revision 0, February 2009

DOE-SR
T. J. Spears, 704-S (50)

SRR-Sr. Staff
J. W. French, 730-4B
L. D. Olson, 766-H

SRR-Staff
C. J. Winkler, 766-H (50)
S. P. Fairchild, 766-H (30)
P. D. Campbell, 766-H (5)
M. D. Hasty, 704-26F (30)
S. W. Wilkerson, 704-S (30)
W. C. Clark, Jr., 704-56H (30)
P. M. Allen, 766-H (10)
J. E. Dickenson, 760-4B
V. A. Franklin, 705-1C (20)
K. S. Cassara, 766-H (20)

SRNS
R. W. Oprea, 704-2H (5)

File
ECATS (DOE), 730-1B
D. P. Chew (200 copies), 766-H
Records Administration, 773-52A

Appendix J — LW System Plan — Rev 15 Summary