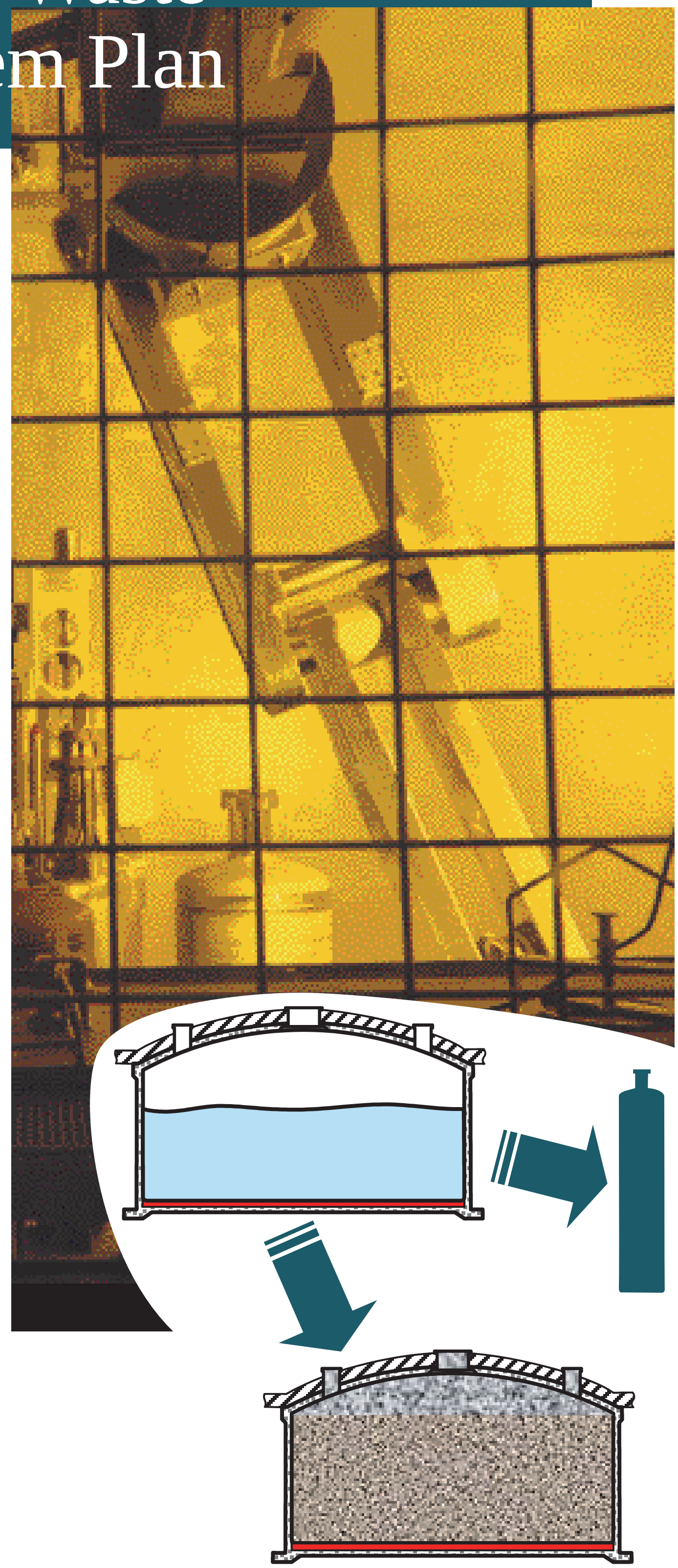
SRR-LWP-2009-00001

LIQUID Waste System Plan

Savannah River Site Liquid Waste Planning Process

An Integrated System at the Savannah River Site



REVISION 20

March 2016

SRR-LWP-2009-00001
REVISION: 20
March 21, 2016
KEYWORDS: Tank Farm, Salt Program
Saltstone, DWPF, Liquid Waste
SPF, ETP, Sludge Washing
Lifecycle, Waste Solidification
MCU, ARP, CSSX, SWPF

RETENTION: PERMANENT

Liquid Waste System Plan Revision 20

D. P. Chew
B. A. Hamm

Approvals:

Mark Schmitz
Acting SRR President & Project Manager

James L. Folk, Jr.
Assistant Manager for Waste Disposition

Savannah River Remediation LLC
Savannah River Site
Aiken, SC 29808

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

Authors

D. P. Chew, System Planning

B. A. Hamm, System Planning

Reviews

P. J. Hill, Manager, System Planning

Table of Contents

Index of Tables

Index of Figures

1. Executive Summary

Treatment and disposition of salt waste is the critical path to completion of the Savannah River Site (SRS) Liquid Waste (LW) Disposition Program. During the period prior to startup of the Salt Waste Processing Facility (SWPF), salt waste disposition will continue through the Actinide Removal Process (ARP) and Modular Caustic Side Solvent Extraction (CSSX) Unit (MCU) facilities.

The May 2014 Revision 19[1] of the *LW System Plan* included updated inputs and assumptions. Revision 19 recognized challenges from the further delay of SWPF and its concomitant effect on regulatory milestones. This twentieth revision of the *Liquid Waste System Plan* (hereinafter referred to as the *Plan*) is predicated on the funding guidance provided in September 2015[2]. This *Plan* continues to resequence the SRS LW Program in a way that integrates facility operating schedules and supporting infrastructure upgrades. The overarching objective of this *Plan* is to ensure safe storage of the waste and minimize extension of the remaining time at risk associated with legacy high level waste storage in aging tanks. Any statement or assumption that there may be a non-compliance does not constitute intentional violation of a required environmental objective. Instead, such discussions relating to noncompliance should be viewed as responsible consideration of planning cases and their results.

This *Plan* includes three cases with different assumptions:

- The base case, Case 1, assumes the funding guidance provided and a December 2018 SWPF start-up date
- Case 2 also assumes the funding guidance but assumes a January 2021 SWPF start-up date
- Case 3 explores technology changes required to accelerate the closure schedule with a goal of isolating F-Tank Farm (FTF) by Fiscal Year (FY) 2030, assuming funding restrictions are relaxed.

This *Plan* requires timely approval of major scope items (e.g., Saltstone Disposal Unit 7 (SDU-7) and subsequent SDUs, etc.). Availability of facilities that require multi-year construction projects and approvals well before the need date is a necessary component of achieving the results forecast in this Plan. Delay in approving these major scope items increases the risk associated with accomplishment of the goals of this Plan.

Safe storage, risk reduction, and provision of necessary facilities are essential precursors to successful closure of waste tanks.

Purpose

The purpose of this *Plan* is to integrate and document the activities required to disposition the existing and future High Level Waste (HLW) and remove from service radioactive LW tanks and facilities at DOE at SRS. It records a planning basis for waste processing in the LW System through the end of the program mission. Development of this *Plan* is a joint effort between DOE-Savannah River (DOE-SR) and SRR per C.N. Smith to J.J. Bair, September 2015[2].

This *Plan* satisfies the contract deliverable described in Contract Nº DE-AC09-09SR22505; Part III — List of Documents, Exhibits, and Other Attachments; Section J — List of Attachments; Appendix M — Deliverables; Item Nº 1 — *Liquid Waste System Plan*.[3]

This twentieth revision (Revision 20) 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 technical basis for LW Contract and Contract Performance Baseline changes.

Common Goals & Values

The overarching principles which govern strategic planning and execution of the SRS Liquid Waste Disposition Program are summarized in the seven “Common Goals and Values” that were agreed upon by key stakeholders over a decade ago[4]. These remain the guiding goals and values for program execution and planning:

1. Reduce operational risk and the risk of leaks to the environment by removing waste from tanks and closing the tanks.
2. Remove actinides from waste expeditiously since their impact on the environment is the most significant if a leak occurs.
3. Maximize amount of waste ready for disposal in deep geologic repository. Make significant effort to ensure maximum amount of long lived radionuclides are disposed in a deep geologic repository.
4. Remove as much cesium as practical from salt waste and dispose in parallel with vitrified sludge.
5. Dispose of cesium as soon as practical to avoid having cesium only waste when sludge vitrification is complete.

6. Limit disposal of radioactive waste onsite at SRS so that residual radioactivity is as low as reasonably achievable.
7. Ensure DOE's strategy and plans are subject to public involvement and acceptance.

<u>Goals</u>

The goals of previous revisions of this *Plan*, through Revision 17, have always been to meet *Federal Facility Agreement* (FFA)[5] and *Site Treatment Plan* (STP)[6] regulatory commitments. However, with the delays of SWPF beyond October 2014, as demonstrated in Revision 17, the following regulatory commitments have been adversely affected:

- Meet tank bulk waste removal efforts (BWRE) regulatory milestones in the currently-approved FFA
- Meet tank removal-from-service regulatory milestones in the currently-approved FFA
- Meet the waste treatment goals identified in the STP.

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

- Continue storing liquid radioactive wastes in a safe and environmentally sound manner
- Optimize program life cycle cost and schedule to minimize extension of the remaining time-at-risk associated with legacy HLW storage in aging tanks
- Conduct operations consistent with the Waste Determinations (WD): *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[7], the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8], the *Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*[9], the *Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*[10], the *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*[11], and the *Basis for Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*[12]
- Comply with applicable permits and consent orders, including the Modified Class 3 Landfill Permit for the SRS Z-Area Saltstone Disposal Facility (SDF) (permit ID 025500-1603) and State-approved area-specific General Closure Plans
- Provide tank space to support staging of salt solution adequate to feed ARP/MCU and SWPF per the inputs and assumptions
- Sustain sludge vitrification in the Defense Waste Processing Facility (DWPF)
- Minimize delays in meeting milestones and goals identified in the FFA and the STP
- Minimize the quantity of radionuclides (as measured in curies) dispositioned in the SDF, keeping the total curies at or below the amount identified in *Savannah River Site – Liquid Waste Disposition Processing Strategy*[13] (SRS LW Strategy), as amended by letter from the South Carolina Department of Health and Environmental Control (SCDHEC) to DOE-SR[14] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8]
- Support continued nuclear material stabilization of legacy materials in H-Canyon.

To enable continuation of risk reduction initiatives encompassed by the goals above, this *Plan* follows a processing strategy to provide the tank space required to support meeting, or minimizing impacts to meeting, programmatic objectives. During the period prior to startup of SWPF in 2018, near-term retrieval, treatment, and disposal of salt waste are required. The ARP/MCU facilities provide this treatment. Operation of these salt treatment processes frees up working space in the 2H and 3H Evaporators' concentrate receipt tanks (Tanks 38, 30, and 37). This provides support for near-term handling of waste streams generated from early-year tank removals from service, DWPF sludge batch (SB) preparation, DWPF recycle handling, and H-Canyon processing.

During the approval process of this *Plan*, a leak was detected in the 3H Evaporator pot. The impact of the leak could not be fully assessed as of the publication of this *Plan*, however, early projections indicate a manageable impact on the goals of this *Plan*. A full treatment of compensatory measures will be modeled and included in the next revision of this *Plan*.

<u>Revisions</u>

The significant updates from the previous version of this *Plan*, the *Liquid Waste System Plan, Revision 19*[1], include:

- **Funding**: Increase funding by $186M over the next five years (FY16–FY20)
- **Salt Processing**:
  - Tank Closure Cesium Removal (TCCR) technology is introduced
- **Sludge Processing**
  - The canister rate was coupled to the salt processing rate as opposed to operating at a constant nominal rate with the objective of pouring the minimum number of canisters needed to support planned salt processing rates

Results of the Plan

Table 1-1 — *Results of Modeled Cases* describes the major results as compared to Revision 19 of the *Plan*:

Table 1-1 — *Results of Modeled Cases*

Parameter	Revision 19	Rev 20, Case 1	Rev 20, Case 3
Date SWPF begins hot operations	Sep 2018	Dec 2018	Dec 2018
Date last LW facility turned over to D&D	2042	2041	2038
Final Type I, II, and IV tanks complete operational closure	2032	2036	2032
Complete bulk sludge treatment	2030	2031	2030
Complete bulk salt treatment	2033	2032	2030
Complete heel treatment	2039	2036	2036
TCCR for supplemental salt waste treatment	No	1 unit	2 units
Next generation extractant for increased SWPF throughput	FY22	FY22	FY21
Maximum canister weight percent (wt%) waste loading	40 wt%	40 wt%	40 wt%
Total number of canisters produced	8,582	8,170	8,210
Year supplemental canister storage required to be ready	2019	2029	2029
Radionuclides (curies) dispositioned in SDF within the amended *SRS LW Strategy*	Yes	Yes	Yes
Total number of SDUs	13	14	13

- **Operational Closure:** In Case 1, operational closure of the Type I, II, and IV tanks is delayed with respect to Rev. 19 in order to prioritize closure of the F-Tank Farm (FTF) and the Inter-Area Line (IAL).
- **SWPF Processing**: Processing at a 9 Mgal/yr rate is forecast to begin after conversion to a Next Generation Solvent (NGS) in FY22 (Case 1).
- **Radionuclides Dispositioned in SDF**: All three cases of this *Plan* are consistent with *SRS LW Strategy* as amended by letter from the SCDHEC to DOE-SR[14] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8] concerning the total curies dispositioned at SDF.
- **Vitrification of Sludge at DWPF**: In Revision 19, completion of sludge processing three years ahead of salt processing required cans using sludge simulant to supplement the reduced amounts of sludge available to maintain glass quality. Case 1 and Case 2, however, project a reduction in the total canisters with respect to Rev. 19 due to the completion of salt processing concurrent with sludge processing, eliminating sludge simulant and the commensurate additional canisters. Case 3 accelerates F-Area sludge removal with respect to Case 1, decreasing available blending and reducing aluminum dissolution, both of which slightly increase sludge simulant with negligible additional canisters.
- **Supporting Nuclear Material Stabilization**: Tank Farm space exists to support limited receipt of projected H-Canyon waste during FY16 and FY17. Beginning in FY18, Tank Farms will fully support H-Canyon receipts, assumed to be 300 thousand gallons (kgal) per year through the end of H-Canyon operations in 2025 and shutdown flows in 2026. Additionally, this *Plan* accommodates receipt of H-Canyon waste in Tank 50 or directly to sludge batches.
- **Canister Storage**: This *Plan* assumes modification of GWSB #1 to allow storage of an additional 2,270 canisters. This allows the need for supplemental canister storage to be delayed for approximately ten years with respect to Rev. 19. Shipment of canisters from SRS is not included in this Plan since a repository has not been identified to date.
- **Saltstone Disposal Units (SDU)**: SDU-2, SDU-3, and SDU-5 (the current operating units) are dual cylindrical cell units with ~2.3 Mgal grout capacity (~1.3 Mgal Decontaminated Salt Solution or DSS) per cell. SDU-6 is a single cylindrical cell unit with ~32 Mgal grout capacity (~17 Mgal DSS). For planning purposes this *Plan* assumed future SDUs will be similar to SDU-6. Note that these plans employ four different salt processes (H-TCCR, F-TCCR, MCU, and SWPF). Each process has particular requirements that control the amount of DSS produced and, due to these differing requirements, Case 1 and Case 3 vary by approximately 6 million gallons in total DSS produced. This relatively small difference, however, results in exceeding the capacity of SDU-13 resulting in the need for SDU-14. Additionally, the modeled volumes are idealized in terms of batch efficiency (due to regularly emerging issues in the tank farm, e.g. the 3H Evaporator pot leak) and the actual amount of DSS produced may likely be somewhat larger than the modeled cases.

2. Introduction

This revision of the *Plan* documents the current operating strategy of the LW System at SRS to receive, store, treat, and dispose of radioactive LW and to close waste storage and processing facilities. The LW System is a highly integrated operation involving safely storing LW in underground storage tanks; removing, treating, and dispositioning the low-level waste (LLW) fraction in concrete SDUs; vitrifying the higher activity waste at DWPF; and storing the vitrified waste in stainless steel canisters pending 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 7 — *System Description* of this *Plan* provides an overview of the LW System.

The Tank Farms have received over 160 million gallons of waste from 1954 to the present. Having reduced the volume of waste via evaporation and dispositioned waste via vitrification and saltstone, the Tank Farms currently store approximately 36 million gallons of waste containing approximately 250 million curies (MCi) of radioactivity. As of January 1, 2016, DWPF had produced 4,000 vitrified waste canisters. All volumes and curies reported as current inventory in the Tank Farms are as of December 31, 2015 and account for any changes of volume or curies in the Tank Farms since Revision 19 of the *Plan* and the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*.

Successful and timely salt waste removal and disposal is integral to efforts by SRS to proceed with all aspects of tank cleanup and removal from service, extending well beyond permitted disposal of the solidified low-activity salt waste streams themselves. Removal and disposal of salt waste not only enables removal of tanks from service, 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 for processing in DWPF. Salt waste is filling up tank space needed to allow this preparation activity to continue. Processing low-activity salt waste through ARP/MCU reduces, but does not eliminate, this tank space shortage and increases the likelihood that vitrification of the high-activity fraction will be able to continue uninterrupted.

Operating ARP/MCU as described in this *Plan* enables continued stabilization of DOE Complex legacy nuclear materials. It also increases the likelihood of feeding SWPF per the inputs and assumptions, which would not be possible without these treatment processes. Use of ARP/MCU allows DOE to complete cleanup and removal from service of the tanks years earlier than would otherwise be the case, which, in turn, will reduce the time during which the tanks — including several that do not have full secondary containment and some of which that have known history of leak sites — continue to store liquid radioactive waste.

The use of ARP/MCU and operation of DWPF has allowed BWRE to be completed for Tanks 4, 5, 6, 7, 8, 11, and 12. Additionally, salt dissolution from Tank 37, enabling continued evaporation operations, would not have been feasible without the use of ARP/MCU. Elimination of most of the high-risk, mobile waste from the Type I and II tanks would not have been possible without the aggressive pursuit of salt processing, pending SWPF startup.

2.1 *Common Goals & Values*

The overarching principles which govern strategic planning and execution of the SRS Liquid Waste Disposition Program are summarized well in the seven "Common Goals and Values" that were agreed upon by key stakeholders over a decade ago[4]. These remain the guiding goals and values for program execution and planning:

1. **Reduce operational risk and the risk of leaks to the environment by removing waste from tanks, and closing the tanks**
    - Curie Workoff from ~550 MCi in 1995 to 250 MCi at the end of 2015 (~58 MCi in glass, 0.4 MCi in grout, and the remainder due to radioactive decay).
    - Of the 14 SRS tanks with leakage history (all old-style tanks):
        - 5 are operationally closed and grouted (Tanks 5, 6, 16, 19, and 20)
        - 1 is being grouted (Tank 12)
        - 1 is currently being prepared for BWRE (Tank 15)
        - 4 contain essentially dry waste, with little or no free liquid supernate (Tanks 1, 9, 10, and 14)
        - 3 contain liquid supernate at a level below known leak sites (Tanks 4, 11, and 13)
    - Of the 24 SRS old-style tanks:
        - 7 are grouted and operationally closed (Tanks 5, 6, 16, 17, 18, 19, and 20)
        - 1 is being grouted (12)
        - 4 have had BWRE completed (Tanks 4, 7, 8, and 11)

- Approximately 64% of old-style tank space is currently empty or grouted and approximately 21% of new-style tank space is empty.

2. **Remove actinides (sludge) from waste expeditiously since they impact on the environment most significantly if a leak occurs.**
   - Actinides and other high activity components are being immobilized in glass as a top priority
   - To date, 4,000 canisters of waste (~49 % of the projected lifecycle total) have been vitrified
   - Canister waste loading has been raised from the originally planned ~28% to the current waste loading of ~36% and is planned to be maximized further to ~40%
   - In August 2013, DWPF set a production record of 40 canisters produced in a single month.

3. **Maximize amount of waste ready for disposal in deep geologic repository. Make significant effort to ensure maximum amount of long lived radionuclides are disposed in a deep geologic repository.**
   - To date, over 99% of the curies immobilized have been placed in glass in preparation for disposal in a deep geologic repository
   - Less than 1% of treated curies have been immobilized in grout
   - At mission completion, over 99% of treated curies are projected to have been immobilized in glass.

4. **Remove as much cesium as practical from salt waste and dispose in parallel with vitrified sludge.**
   - Only 15% of the volume of salt waste originally projected to be treated only via Deliquification, Dissolution, and Adjustment (DDA) was actually treated with that process; the remainder will have been treated through processes with higher cesium removal efficiency
   - Extraction of cesium from salt waste through ARP/MCU began in 2008 and, through 2013, was ~10 times more efficient than the original projection
   - Deployment of NGS at MCU in 2014 improved cesium removal efficiency by more than 200 times, exceeding the original SWPF design
   - The cesium-laden MCU Strip Effluent (SE) stream is vitrified with sludge and disposed in canisters.

5. **Dispose of cesium as soon as practical to avoid having cesium only waste when sludge vitrification is complete.**
   - To date, 8.3 million gallons (Mgal) of salt waste (approximately 6.8% of the projected lifecycle total) have been treated and dispositioned
   - Allocation of available resources is focused on maintaining the pace of risk reduction through waste treatment and immobilization
   - The contribution of ARP/MCU was enhanced and maximized by deploying NGS to increase cesium removal efficiency
   - With the disposition of monosodium titanate (MST) sludge from salt processing and sludge heel processing, no cesium only canisters will be produced.

6. **Limit disposal of radioactive waste onsite at SRS so that residual radioactivity is as low as reasonably achievable.**
   - Formal Performance Assessments (PA) of low level waste (LLW) disposal and operational closure of tanks, coupled with cost to benefit evaluations prior to cessation of tank waste removal activities, support that any residual future impacts from onsite waste disposal are within the requirements of applicable federal and state laws and regulations and are as low as reasonably practical
   - Based on operational experience, over 95% of the radioactive inventory in a tank has been removed after bulk waste removal and heel dilution; over 99% of the radioactive inventory has been removed after final cleaning
   - At mission completion, over 99% of treated curies are projected to have been immobilized in glass and packaged for offsite disposal in a deep geologic repository
   - The originally agreed upon projection for onsite emplacement in engineered disposal units from LW treatment and disposition was 3 MCi (2.5 MCi from DDA-only; 0.3 MCi from ARP/MCU; and 0.2 MCi from SWPF). That agreement was reduced to 0.8 MCi in August 2011[14] based on progress as of 2011.

7. **Ensure DOE's strategy and plans are subject to public involvement and acceptance.**
   - The formal processes for evaluation, determination, and execution of all tank waste removal, disposal, and operational closure fully involves SCDHEC, the Environmental Protection Agency (EPA), and the Nuclear Regulatory Commission (NRC)
   - Various formal hold points exist in these processes for public involvement and comment
   - All SRS LW Disposition activities fall within the purview of the Defense Nuclear Facilities Safety Board (DNFSB) oversight, and DNFSB periodically issues publically accessible reports of their evaluations and conducts periodic meetings to receive public input regarding their activities

- The SRS Citizen's Advisory Board receives routine updates in a public venue regarding all SRS LW Disposition activities
- Annual updates to this *Plan* are provided to all regulatory and oversight entities and made available for public review
- Quarterly updates of radiological inventory additions to SDUs are posted to a publically accessible website
- SRR monthly and annual reports of progress towards disposition of SRS LW are available to the public.

2.2 ***Goals***

The overarching priorities for development of this *Plan* are:

1. Continued Safe Storage of LW in tanks and vitrified canisters in storage
2. Maximize Risk Reduction through Waste Disposition
3. Tank Cleaning and Grouting.

This prioritizes activities that maintain optimal sludge and salt processing over cleaning and grouting activities. It also minimizes the duration of unstabilized curies remaining in the waste tanks.

Goals for this Plan

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

- Continue storing liquid radioactive wastes in a safe and environmentally sound manner until processed and dispositioned
- Optimize program life cycle cost and schedule to minimize extension of the remaining time at risk associated with legacy HLW storage in aging tanks
- Conduct operations consistent with the *Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[7], the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8], the *Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*[9], the *Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*[10], the *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*[11], and the *Basis for Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*[12]
- Satisfy applicable permits and consent orders, including the Modified Class 3 Landfill Permit for the SRS Z-Area SDF (permit ID 025500-1603) and State-approved area-specific General Closure Plans, except where this plan assumes noncompliance as a planning notion.
- Provide tank space to support staging of salt solution adequate to feed ARP/MCU and SWPF per the inputs and assumptions
- Sustain sludge vitrification in the DWPF
- Minimize delays in meeting milestones and goals identified in the FFA and the STP
- 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 *SRS LW* Strategy[13] as amended by letter from the SCDHEC to DOE-SR[14] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8]
- Support continued nuclear material stabilization of legacy materials in H-Canyon through 2025 and the shutdown flows in 2026.

The following generalized priorities guide 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
2. Ensure the curies dispositioned to the SDF are at or below the amount identified in the *SRS LW Strategy*[13] as amended by letter from the SCDHEC to DOE-SR[14] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8]
3. Provide tank space to support staging of salt solution adequate to feed salt solution to ARP/MCU and SWPF per the inputs and assumptions
4. Provide tank space to support staging of sludge adequate to feed DWPF
5. Support removal from service of Type I, II, and IV tanks to meet currently approved FFA commitments
6. Support continued nuclear material stabilization in H-Canyon through 2025 and shut down in 2026.

There is currently a premium on processing and storage space in the SRS radioactive LW 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 meet, or minimizing impacts to meeting, programmatic objectives. During the period prior to startup of SWPF in 2018, near-term retrieval, treatment, and disposal of salt waste are required. The ARP/MCU facilities perform this treatment. Operation of these salt treatment processes frees up working space in the 2H and 3H Evaporators' concentrate receipt tanks (Tank 38 for 2H, and Tank 30 and Tank 37 for 3H). This provides limited support for near-term handling of waste streams generated from early-year tank removals from service, DWPF sludge batch preparation, DWPF recycle handling, and H-Canyon processing.

These initiatives and the assumed SWPF startup in 2018 provide tank space to minimize impacts to the programmatic objectives. Currently, there are approximately 36 million gallons of LW stored on an interim basis in 43 underground waste storage tanks. Since 1996, the LW Program at SRS has been removing waste from tanks, pre-treating it, vitrifying it, and pouring the vitrified waste into canisters for long-term storage and disposal. Through January 1, 2016, 4,000 canisters of waste (containing over 58 MCi) have been vitrified. Canister waste loading has been raised from the originally planned ~28% to the current waste loading of ~36% and is planned to be maximized further to ~40%. The canisters vitrified to date have contained sludge waste and, since April 2008, processed salt waste. These canisters represent ~44% of sludge waste immobilization lifecycle and over 6% of salt waste disposition lifecycle.

Approximately 64% of the old-style tank nominal space is currently empty or grouted and 21% of the new-style tank nominal space is empty. Of the 24 old-style tanks in the SRS LW System, seven are grouted and operationally closed, one is in the process of being grouted, and four others have had bulk waste removed. Based on operational experience, over 95% of the radioactive inventory in a tank has been removed after bulk waste removal and heel dilution; over 99% of the radioactive inventory has been removed after cleaning.

Space in new-style tanks is used for various operations for waste processing and disposal. Tank space is recovered through evaporator operations, DWPF vitrification, ARP/MCU treatment, and saltstone disposal. This valuable space has been used to: (1) prepare, qualify, and treat sludge waste for disposal; (2) prepare, qualify, treat, and dispose salt waste; (3) retrieve waste from and clean old-style tanks; and (4) support nuclear materials stabilization and disposal in H-Canyon through 2025 along with shut down flows in 2026. The Tank Farm space management strategy is based on a set of key assumptions involving projections of DWPF canister production rates, influent stream volumes, Tank Farm evaporator performance, and space gain initiative implementation. The processing of salt and sludge utilizes new-style tank space to retrieve and prepare waste from old-style tanks, and therefore nominal empty space in new-style tanks will increase only after all waste in old-style tanks is processed. Sludge processing through the DWPF removes the highest risk material from the tank farms. However, for every 1.0 gallon of sludge processed, 1.3 gallons of salt waste is formed due to sludge washing and DWPF processing operations to return the resulting low hazard salt waste to the Tank Farm. Similarly, salt waste retrieval, preparation, and batching typically require the use of about three gallons of tank space per gallon of salt waste treated. Given these parameters, the "key to reducing the overall risk is processing high-level waste as expeditiously as possible and managing the total tank space efficiently," as recognized by the DNFSB in their letter dated January 7, 2010[15].

New-style tank space is a currency used to prepare for permanent immobilization and disposition of HLW in a vitrified waste form and low-level waste in a grouted waste form. The tank space management program maintains sufficient space in the new-style tanks to allow continued DWPF operations. The tank space management program also provides the necessary tank space to support staging of salt solutions to sustain salt waste disposition currently through ARP/MCU and subsequently through SWPF. Of the 27 new-style tanks (with a total capacity of 35 million gallons) in the SRS LW System:

- 5 (Tanks 38, 41, 43, 49, and 50) are dedicated to salt batching, qualification, and disposition (including DWPF recycle beneficial reuse, feeding the Saltstone Production Facility (SPF), and the 2H Evaporator)
- 6 (Tanks 29, 30, 32, 37, 40, and 51) are dedicated to sludge batching, qualification, and disposition (including the 3H Evaporator)
- 1 (Tank 39) is dedicated to uninterrupted H-Canyon waste receipts
- 15 (Tanks 25, 26, 27, 28, 31, 33, 34, 35, 36, 42, 44, 45, 46, 47, and 48) are dedicated to safe storage of legacy LW pending retrieval and disposition.

There are currently ~7.5 Mgal of empty space (~21%) in these new-style tanks:

- 3.2 Mgal is margin as defense-in-depth operational control coupled with Safety Class or Safety Significant (SC/SS) structures, systems, or components (SSC) to facilitate reasonably conservative assurance of more than adequate dilution and ventilation of potentially flammable vapors
- 1.3 Mgal is procedurally-required minimum contingency space for recovery from the unlikely event of a bulk waste leak elsewhere in the system
- 3.0 Mgal is operational "working" space variously used to provide:
  - Additional contingency transfer space as operational excess margin above the procedurally-required minimum
  - Excess margin to preserve salt batch quality and maintain uninterrupted treatment and disposition through ARP/MCU and Saltstone
  - Excess margin to preserve sludge batch quality and maintain uninterrupted immobilization through DWPF

— Excess margin to preserve uninterrupted support for H-Canyon.

2.3 <u>*Risk Assessment*</u>

The *PBS-SR-0014, Radioactive Liquid Tank Waste Stabilization and Disposition, Risk and Opportunity Management Plan*[16] (ROMP) documents the comprehensive identification and analysis of technical risks and opportunities associated with the LW program. It identifies individual technical and programmatic risks and presents the strategies for handling risks and opportunities in the near-term and outyears.

The ROMP identifies over 100 risks associated with this *Plan* with a total outyear Technical and Programmatic Risk Assessment (T&PRA) of several billion dollars. After mitigation, several high risks remain:

- Being able to adequately fund PBS-SR-0014 throughout its life cycle to permit full execution of the System Plan is uncertain. This risk is a crosscutting risk for both major contractors at SRS and will be handled at the site level.
- The System Plan end date places significant stress on what will be an increasingly aging infrastructure. Recent infrastructure failures provide an insight into the problems that may be encountered with operating the HLW System for an additional 24 years.
- The capacity of the existing Tank Farm infrastructure will be stretched close to its limits in supporting salt batch preparation. Choke points could easily be encountered if multiple use conflicts develop and planned availability of transfer routes and equipment are impacted.

3. Planning Bases

This *Plan* is based on inputs and assumptions provided by DOE[2]. 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 yet to be fully defined. The sequence of activities reflects the best judgment of the planners. The individual activity execution strategies contain full scope, schedule, and funding development. Upon approval of scope, cost, and schedule baselines; modifications of this *Plan* may be required.

3.1 *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 availability of the funding required as specified in the inputs and assumptions referenced above. 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 removal from service, as described in this *Plan*.

3.2 *Regulatory Drivers*

Numerous laws, constraints, and commitments influence LW System planning. Described below are requirements most directly affecting LW system planning. This *Plan* assumes the timely acquisition of regulatory approvals.

South Carolina Environmental Laws

Under the South Carolina Pollution Control Act, S.C. Code Ann. §§ 48-1-10 *et seq*., 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 Class 3 Landfill Permit for SDF. This landfill permit contains conditions for the acceptable disposal of non-hazardous waste in the SDF. This permit also contains provisions for fines and penalties. 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, ARP/MCU, 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:
  - Part 70 Air Quality Permit (one Site-wide Air Permit including the LW facilities).

Site Treatment Plan (STP)

The STP[6] 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 and solidification in Saltstone for low-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 BWRE and heel removal scope of this *Plan*. Final cleaning, deactivation, and removal from service of storage and processing facilities are subsequent to the satisfaction of this commitment.

Federal Facility Agreement (FFA)

The EPA, DOE, and SCDHEC executed the SRS FFA[5] on January 15, 1993, which 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 scheduled for operational closure may continue to be used, but must adhere to the FFA schedule for operational 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*[17] effective in November 2007) modified the FFA by providing for the submission of Waste Determination documentation for FTF and H-Tank Farm (HTF) and including end dates for BWRE and the operational closure of each old style tank. The FFA requires SRS to operationally close the last Type I, II, and IV tank no later than 2022. An agreement between DOE, SCDHEC, and EPA (*Statement of Resolution of Dispute Concerning Extension of Federal Facility Agreement (FFA) Closure Date*[18] effective in April 2015) modified the FFA by extending the operational closure date of Tank 12 to May 2016.

National Environmental Policy Act

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 (PEIS) (DOE/EIS-0200-F)
- SRS Waste Management Final Environmental Impact Statement (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 HLW 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

The *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005* (NDAA) Section 3116 (NDAA §3116) allows determinations by the Secretary of Energy, in consultation with the NRC, 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 Type I, II, and IV tank removal from service 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 removal from service and stabilization can be managed as non-high level waste.

3.3 *Revisions*

The significant updates from the previous version of this *Plan,* the *Liquid Waste System Plan, Revision 19*[1], include:

- **Funding**: Increase funding by $186 over the next five years (FY16–FY20)
- **Salt Processing**:
  - Tank Closure Cesium Removal (TCCR) technology is introduced
- **Sludge Processing**
  - The canister rate was coupled to the salt processing rate as opposed to operating at a constant nominal rate with the objective of pouring the minimum number of canisters needed to support planned salt processing rates

3.4 *Key Milestones*

Key Milestones are those major dates deemed necessary under this *Plan* to remove waste from storage, process it into glass or saltstone, and close the LW facilities. The *LW System Plan, Revision 19* milestones are provided for comparison.

Table 3-1 — *Key Milestones*

Key Milestone	Revision 19	Case 1	Case 3
Date SWPF begins hot operations	Sep 2018	Dec 2018	Dec 2018
Date last LW facility turned over to D&D	2042	2041	2038
BWRE complete for Type I, II, and IV tanks	2028	2030	2029
Final Type I, II, and IV tanks complete operational closure	2032	2036	2032
Complete bulk sludge treatment	2030	2031	2030
Complete bulk salt treatment	2033	2032	2030
Complete heel treatment	2039	2036	2036
Total number of canisters produced	8,582	8,170	8,210
Year supplemental canister storage required to be ready	2019	2029	2029
Initiate ARP/MCU Processing *(actual)*	*Apr 2008*	*Apr 2008*	*Apr 2008*
Initiate TCCR Processing	n/a	2018	2018
Initiate SWPF Processing	Sep 2018	Dec 2018	Dec 2018
– *Salt Solution Processed via DDA-solely*	*2.8 Mgal*	*2.8 Mgal*	*2.8 Mgal*
– *Salt Solution Processed via ARP/MCU*	*11 Mgal*	*10 Mgal*	*10 Mgal*
– *Salt Solution Processed via TCCR*	*n/a*	*0.8 Mgal*	*5.3 Mgal*
– *Salt Solution Processed via SWPF*	*102 Mgal*	*110 Mgal*	*92 Mgal*
Number of SDU	13	14	13

- **Operational Closure:** In Case 1, operational closure of the Type I, II, and IV tanks is delayed with respect to Rev. 19 in order to prioritize closure of the F-Tank Farm (FTF) and the Inter-Area Line (IAL).
- **SWPF Processing**: Processing at a 9 Mgal/yr rate is forecast to begin after conversion to a Next Generation Solvent (NGS) in FY22 (Case 1).
- **Vitrification of Sludge at DWPF**: In Revision 19, completion of sludge processing three years ahead of salt processing required cans using sludge simulant to supplement the reduced amounts of sludge available to maintain glass quality. Case 1 and Case 2, however, project a reduction in the total canisters with respect to Rev. 19 due to the completion of salt processing concurrent with sludge processing, eliminating sludge simulant and the commensurate additional canisters. Case 3 accelerates F-Area sludge removal with respect to Case 1, decreasing available blending and reducing aluminum dissolution, both of which slightly increase sludge simulant with negligible additional canisters.
- **Canister Storage**: This *Plan* assumes modification of GWSB #1 to allow storage of an additional 2,270 canisters. This allows the need for supplemental canister storage to be delayed for approximately ten years with respect to Rev. 19. Shipment of canisters from SRS is not included in this Plan since a repository has not been identified to date.
- **Saltstone Disposal Units (SDU)**: SDU-2, SDU-3, and SDU-5 (the current operating units) are dual cylindrical cell units with ~2.3 Mgal grout capacity (~1.3 Mgal Decontaminated Salt Solution or DSS) per cell. SDU-6 is a single cylindrical cell unit with ~32 Mgal grout capacity (~17 Mgal DSS). For planning purposes this *Plan* assumed future SDUs will be similar to SDU-6. Note that these plans employ four different salt processes (H-TCCR, F-TCCR, MCU, and SWPF). Each process has particular requirements that control the amount of DSS produced and, due to these differing requirements, Case 1 and Case 3 vary by approximately 6 million gallons in total DSS produced. This relatively small difference, however, results in exceeding the capacity of SDU-13 resulting in the need for SDU-14. Additionally, the modeled volumes are idealized in terms of batch efficiency (due to regularly emerging issues in the tank farm, e.g. the 3H Evaporator pot leak) and the actual amount of DSS produced may likely be somewhat larger than the modeled cases.

4. 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 ROMP and individual implementation activity risk assessments.

In addition, this *Plan* assumes 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. For Case 1 and Case 3, tabular results of the lifecycle, on a year-by-year basis, or graphical results of the lifecycle are included in:

- Appendix A — Canister Storage
- Appendix B — Salt Solution Processing
- Appendix C — Tank Farm Influents and Effluents
- Appendix D — BWRE (Base Case only) & Removal from Service
- Appendix E — LW System Plan — Revision 20 Summary
- Appendix F — Sludge Processing (Base Case only)
- Appendix G — Remaining Tank Inventory (Base Case only)

4.1 *Disposition of Sludge Waste*

The basic steps for sludge processing (Figure 4-1) are:

1. Sludge removal from tanks
2. Optional Low-Temperature Aluminum Dissolution (LTAD) (in Tank 51)
3. Blending and washing of sludge (in Tank 51)
4. Sludge feeding to the DWPF (from Tank 40)
5. Vitrification in DWPF.

Sludge processing

Sludge processing is paced by available canister storage, ability to fund sludge BWRE, and by tank storage space to prepare sludge batches. Sludge batch planning uses the estimated mass and composition of sludge and known processing capabilities to optimize processing sequences. Sub-tier plans document the modeling, guide the sequence of waste removal, and support a more detailed level of planning. These sub-tier plans are revised as new information becomes available or when significant updates in the overall waste removal strategy are made. A more detailed analysis related to sludge batch planning is summarized in *Sludge Batch Plan 2015 in Support of System Plan Rev. 20* [19].

Differences in sludge batch sequencing, total number canisters produced, and batch end dates between this *Plan* and the previous Rev 19 are mainly driven by the following:

- This *Plan* balances the end of salt processing more closely with the end of sludge processing, reducing the necessity for supplemental chemical additions
- This *Plan* assumes 21 total sludge batches as compared to 23 in Rev 19.
  — Batches 19 through 21 are primarily sludge heels, insoluble salt, and oxalates
- The projected canister pour rate is balanced to be appropriate for salt processing support.

Sludge Feed Preparation

This *Plan* uses a single tank (Tank 51) as the sole DWPF feed preparation tank (see Figure 4-1).

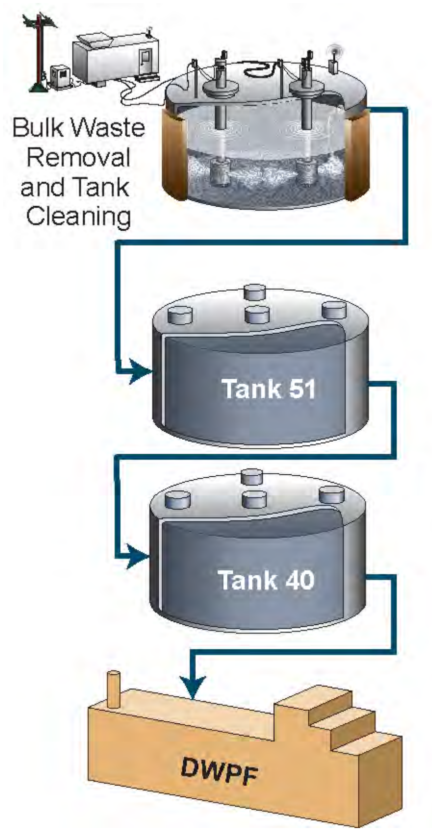


Figure 4-1 — *Sludge Feed Preparation*

Low Temperature Aluminum Dissolution

High-heat sludge generated from the Canyon H-Modified (HM) process has high amounts of aluminum solids as gibbsite or boehmite. Much of this aluminum can be removed from the sludge by dissolution of the aluminum and subsequent removal by decanting of the liquid phase. This reduces the number of canisters needed to disposition the sludge, due to the lowered sludge solids mass and improved waste loading in the glass. Dissolution is achieved by application of added caustic, elevated temperature, mixing, and sufficient reaction time. “Low Temperature” refers to the use of a maximum temperature of around 75ºC to achieve the dissolution, as demonstrated for SB5 and SB6.

Sludge Washing

Sodium and other soluble salts (e.g., sulfates, nitrates, nitrites) in DWPF feed are reduced through sludge washing. Sludge washing is 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 molarity (typically 1.25 M Na) is reached. Some types of sludge settle slowly, extending wash cycles. Sludge settling and washing typically constitutes ~75% of batch preparation time. The total number of washes performed and volume of wash water used are 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.

4.2 ***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 on-site pending disposition.

Historically, melter performance has been the limiting factor for DWPF throughput. The DWPF melter (without bubblers) had produced an average of 215 canisters/yr before melter bubblers were installed. When bubblers were installed in September 2010, however, the melter capacity improved such that, in FY12 a record 277 canisters were poured and a monthly record of 40 canisters were poured in August 2013. The feed preparation systems internal to DWPF have demonstrated a capacity of greater than 325 canisters/yr, e.g., the 337 canisters poured from July 2011 thru June 2012. DWPF thus has a demonstrated capability of producing the maximum annual rate forecast in this *Plan* of 288 canisters/yr.

Total Canister Count

The total canister production varies with the different cases in this *Plan*, based on multiple requirements. In the early years it is primarily based on the mass of sludge in a tank that has to be emptied, the ability to perform aluminum dissolution, and the need to add sludge modifiers to meet physical and chemical requirements for DWPF processing. Providing tank space for SWPF and ongoing waste removal may require transfer of sludge to a temporary storage location (sludge hub tank). Limits on the mass of sludge that can be physically managed in a sludge batch may dictate an increase or decrease in both solids loading and canister generation rate. There is also a minimum practical operating rate (approximately five canisters per month) for keeping the DWPF processes functioning. Additionally, a minimum canister production rate is required to support salt processing, based on the amount of SE and MST generated. SWPF processing at 7.2 Mgal/yr is anticipated to require 264 canisters. The conversion to NGS allows a reduction in the SE produced by SWPF such that increasing to 9 Mgal/yr does not increase the number of cans needed to support SWPF. The 288 canister pre year rate in Case 1 is required to balance the end of bulk sludge processing and salt processing.

Beginning as early as Sludge Batch 12, trim chemicals (e.g., iron or depleted uranium) may need to be added to some sludge batches. The glass canisters generated in the later years of salt waste disposition will contain sludge from heel removal and chemical cleaning of tanks in support of the tank closure program. These cans may require the addition of sludge simulant to make acceptable quality glass.

Disposition of salt waste in canisters requires a sludge component because DWPF is designed to disposition sludge waste supplemented with salt waste, when available. Facility infrastructure; such as pumps, transfer lines, and tank mixers; were designed for a sludge type waste. If there is a sludge deficit, some quantity of synthetic sludge is added. The synthetic sludge is a mixture of oxides of iron, manganese, nickel, aluminum and other metals. This type of material has been made in the past to support the cold start-up of the DWPF and is also made to support sludge batch qualification studies conducted by SRNL. For this *Plan*, the synthetic sludge is made up as if it was Plutonium Uranium Reduction Extraction (PUREX) waste. PUREX waste is high in iron and is needed to offset the high aluminum found in the HM waste. The amount of synthetic sludge needed per can, the composition of the synthetic sludge, and the best addition point for the synthetic sludge will be determined before these canisters are produced.

It should be noted that advanced frit formulations and development of a salt-focused flowsheet for DWPF could reduce or eliminate the need for synthetic sludge or sludge modifiers.

Two-step Production Improvement Approach

To support higher glass throughput, the DWPF melter was retrofitted with four bubbler systems and the melter off-gas system was optimized in September 2010. The second step of DWPF production capacity improvement program addresses streamlining the DWPF feed preparation system. Several process improvements are planned to streamline the DWPF feed preparation system which are required to support SWPF operations at a feed rate greater than 6 Mgal per year:

- Implementation of an alternate reductant
- Processing of cesium SE in the slurry mix evaporator (SME)
- Addition of dry process frit to the SME (may be optional).

The feed preparation modifications reduce recycle water generation by using dry process frit:

Reduction of liquid addition in DWPF supports receipt of SE from SWPF. Beneficial reuse of DWPF recycle for waste removal and tank cleaning, in lieu of water additions, supplements recycle reduction and supports maintenance of Tank Farm capacity (see §4.6 below).

The DWPF production rate (prior to the bubbler installation) averaged 215 canisters per year with ~4,000 pounds of glass per canister. The production rate improvement initiatives enable a higher nominal DWPF canister production capability of 275 canisters/yr.

Future estimated canister production, by year is shown in Table 4-1 — *Planned DWPF Production*. The canister rates include two one-week outages every year to allow for routine planned maintenance and another two weeks for the site-wide steam outage each year.

Table 4-1 — *Planned DWPF Production*

FY	Case 1 Canisters poured		Case 3 Canisters poured	
2016	150		156	
2017	90	(3 mo outage) [a]	143	
2018	117	(3 mo outage) [a]	78	(6 mo outage) [a]
2019	166		166	
2020	248		248	
2021	264		198	
2022	198		264	
2023	264		264	
2024	264		264	
2025	180	(4 mo outage) [b]	176	(4 mo outage) [b]
2026	288		264	
2027	288		264	
2028	288		264	
2029	288		264	
2030	282		258	
2031	264		264	
2032	264	(sludge heels)	216	(sludge heels)
2033	60	(4 mo outage) [b] (sludge heels)	132	(4 mo outage) [b]
2034	120	(sludge heels)	180	(sludge heels)
2035	60	(sludge heels)	120	(sludge heels)
2036	57	(sludge heels)	57	(sludge heels)

[a] A six month outage is planned beginning July 2017 in Case 1 (October 2017 in Case 3) to perform MCU contactor bearing replacement. The normal four-month outage for this task is expanded to perform SWPF tie-ins in anticipation of SWPF start-up. The regular melter replacement (as described in note "b" below) will also occur in this outage, pending authorization by DOE.

[b] A four-month melter outage is assumed every eight years of processing. Actual melter change-out is determined by melter performance. The last melter change was completed in March 2003.

Failed Equipment Storage Vaults and Melter Storage Boxes

Failed equipment storage vaults (FESVs) and Melter Storage Boxes (MSBs) are repetitive activities 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.

Melter 1 was placed in FESV #2 in December 2002. Melter 1 (inside MSB #1) had a relatively low radiation field. It 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 forecast in this *Plan* to occur in 2018. Space has been reserved for construction of up to ten FESVs, if needed.

Under the current planning basis, the need date for FESV #3 and #4 will be triggered by the installation of Melter 3. Melter 3 is currently scheduled to be placed into service in December 2017. Based upon this strategy, FESVs #3 and #4 construction should be completed and available for service by June 2017 (approximately six months prior to the planned installation of Melter 3). Likewise, MSB #3 should be constructed and available to receive Melter 3 by June 2017. The need dates for FESV #3 and #4 and successive pairs of vaults will be evaluated on an ongoing basis.

Currently, the FESV 200-ton gantry crane is designed to interface only with an MSB 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.

Glass Waste Canister Storage

The canisters of vitrified HLW glass produced by DWPF are currently stored on-site in dedicated interim 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 *Case 1: Appendix A — Canister Storage* or *Case 3: Appendix A — 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 were abandoned due to construction defects and three contain archived non-radioactive glass filled canisters. As of January 1, 2016, 2,051 standard positions are in use storing radioactive canisters.

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 is in GWSB #2. As of January 1, 2016, GWSB #2 stored 1,939 radioactive canisters. An additional eight poured canisters were in temporary storage in the Vitrification Building pending final processing required to move them to the GWSB.

In FY15 193 canisters were moved, and in FY16 approximately 150 additional canisters are planned to be moved, to GWSB #2 from GWSB #1 to enable conversion of GWSB #1 for stacking two canisters in each storage location. Additionally, the eight abandoned positions are planned for recovery and conversion. The capacity of GWSB #1 will be 4,524 standard canisters, including the three archived canisters. The GWSB #2 design is not conducive to double stacking using the design developed for GWSB #1. Additional glass waste storage capacity will be required, with availability beginning in FY29, when the 6,864 radioactive canister capacity of GWSB #1 & GWSB #2 is filled.

The schedule for shipment of the canisters from SRS is not included in this *Plan*. It will be developed upon availability of a permanent federal repository.

4.3 *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 ARP/MCU, TCCR, and SWPF. *Case 1: Appendix B — Salt Solution Processing* reflects the breakdown of the volumes treated from each of the processes by year. Using the input assumptions for this Plan, over 100 Mgal of salt solution from the Tank Farms are planned for processing over the life of the program; over 8.3 Mgal were processed by December 2015. SWPF is planned to process the majority of this salt solution waste.

Salt preparation capability is limited by the number of blend tanks available to prepare salt batches. A single tank is capable of preparing 4 Mgal/yr. Initially, only two blend tanks will be available. Beginning the third year, a third tank will be available, enabling the Tank Farms to feed SWPF at 9 Mgal/yr.

Other factors could limit salt processing capacity:

- SE & MST processing in DWPF at the planned rates. Achieving greater than 7 Mgal/yr of SWPF processing will require reducing the SE volume through implementation of NGS in addition to other facility enhancements
- DSS processing in SPF at the planned rates. Enhanced Low Activity Waste Disposal (ELAWD) phase II, along with 24/7 operations are required to ensure SPF's ability to process the DSS stream from SWPF when SWPF operates at rates greater than 6 Mgal/yr.

A more detailed analysis related to salt batch planning is summarized in *Salt Batch Plan in Support of System Plan R-20* [20].

4.3.1 Actinide Removal Process / Modular CSSX Unit (ARP/MCU)

Salt waste is currently processed through ARP/MCU. A summary of the process is shown in Figure 4-2 — *Schematic of the ARP/MCU Process*.

The ARP decontaminates salt solution via adsorption of strontium-90 (Sr-90), actinide radionuclides, and entrained sludge solids in the salt solution onto MST followed by filtration or settling. The actinides, Sr-90, and MST laden sludge waste stream are transferred to DWPF for vitrification and the remaining clarified salt solution is transferred to the MCU process. In 2016, a demonstration of ARP was initiated to demonstrate that, with the correct salt batch makeup, MST addition is not necessary to meet the SPF Waste Acceptance Criteria (WAC).

The MCU process extracts Cs from the clarified salt solution using CSSX chemistry. The low Cs-137/low actinide decontaminated salt solution (DSS) is subsequently transferred to Tank 50 for feed to the SPF, and the SE solution of cesium nitrate from the CSSX process is transferred to the DWPF for vitrification.

The ARP/MCU process was constructed and initially permitted for a three-year service period, bridging the crucial period before the startup of the SWPF. With the delay of SWPF, however, ARP/MCU has been enhanced and improved to provide a longer term option for salt disposition. The original goals of the ARP/MCU process were *first* treat salt solution prior to the start of SWPF; and *second* provide operational experience and lessons learned for the SWPF project.

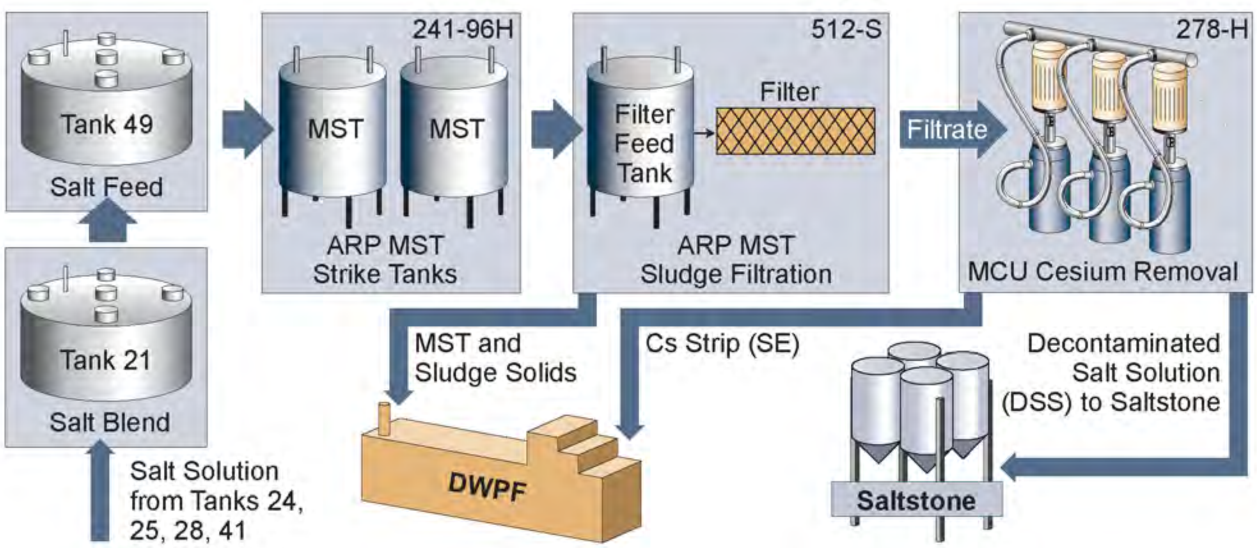


Figure 4-2 — *Schematic of the ARP/MCU Process*

Actions taken since startup of ARP/MCU have demonstrated an increased processing rate from the original design of 1 million gallons per year to approximately 1.4 million gallons per year. Enhancements and improvements include chemistry adjustments at Tank 49, reduced cycle-times, and redesign and replacement of the secondary filter at 512-S.

Efforts continue to improve equipment reliability, reducing unexpected downtime to improve overall attainment. In addition to equipment and processing upgrades, alternative system planning is being done to more efficiently qualify subsequent salt batches to reduce downtime between batches.

Improved Decontamination

In the fourth quarter of FY13, the original solvent formula was replaced with NGS. Operation of ARP/MCU with NGS results in more efficient removal of cesium from the treated salt solution than the original solvent formula. This increased cesium removal efficiency (decontamination factor or DF) allows ARP/MCU to produce a DSS stream with a residual cesium concentration much less than previously achieved. The improved DF will enable continued operation of ARP/MCU while minimizing the curies disposed in the SDF. ARP/MCU will continue to be operated at a nominal 6 gpm until the facility is shut down for SWPF tie-ins. Operations are planned to resume after tie-ins are complete and continue until SWPF starts up.

4.3.2 Tank Closure Cesium Removal (TCCR)

The Tank Closure Cesium Removal (TCCR) initiative consists of an ion exchange process for the removal of cesium from liquid salt waste to provide a supplemental treatment capability and improved confidence in supporting the desired acceleration of waste retrieval and tank closure efforts. Building on the experience of modular commercial nuclear plant decontamination and following the disaster response associated with Fukushima, the technology exists in industry, and appears to have matured in capability and reliability, to accomplish larger scale, selective removal of the cesium component of the bulk salt waste effectively and efficiently. A commercial supplier would design, fabricate, test, and deliver a cesium removal system to be deployed at SRS for the treatment of liquid salt waste. The desired configuration is an “at-tank” modular arrangement.

Case 1 of this *Plan* assumes successful demonstration of this system in HTF to treat dissolved salt waste from Tank 10. The configuration is expected to consist of temporary process structures located near Tank 10 and Tank 11 so the cesium removal process would take place outside of the tank. The DSS will be temporarily stored in Tank 11 before transfer to Tank 50 and then to SPF for disposal.

Case 3 of this *Plan* assumes an additional successful deployment of this system in FTF to treat dissolved waste from Tank 1, Tank 2, and Tank 3. Tank 4 and Tank 7 are used to support salt dissolution and feed batch preparation. The temporary process structures would be located near Tank 4 with the cesium removal process taking place outside the tank. The HTF system deployed as described in Case 1 would also treat salt waste from Tank 9 and Tank 14 in addition to the salt waste from Tank 10.

Once the ion exchange media in a column becomes loaded with cesium to the extent practical (“spent”), the column (with media) will be removed from the system and replaced with a new ion exchange column loaded with fresh media. The spent column will be transported to an Interim Safe Storage (ISS) location within the tank farms. While the spent column is designed to be able to be dispositioned via DWPF, the ISS concept reduces initial process facilities and costs while also allowing for identification and evaluation of potential future disposal alternatives. For planning purposes, this *Plan* assumes an alternate disposal option is approved by regulatory authorities and implemented.

4.3.3 Salt Waste Processing Facility (SWPF)

The SWPF processing rate is based on an assumed 100% availability for the Tank Farm feed as well as DWPF and SPF receipt of the SWPF discharge streams. The SWPF treatment process is planned to produce DSS that meets the SPF WAC limit.

The current configuration of DWPF limits throughput to 6 Mgal/yr. Factors limiting salt processing capacity include:

- Transfer lines and equipment for transferring feed from the Tank Farms to SWPF and the effluent from SWPF to SPF and DWPF
- Provision of blend tanks to provide feed to support feeding SWPF at the rated capacity
- Total cycle time in SWPF
- SE & MST processing in DWPF at the planned rates. Achieving greater than 7.2 Mgal/yr of SWPF processing will require reducing the SE volume
- DSS processing in SPF at the planned rates. ELAWD phase II, along with 24/7 operations, are required to ensure SPF’s ability to process the DSS stream from SWPF.

To mitigate these limitations, modifications to the facilities are planned, including:

- **Infrastructure**: Completion of Salt Disposition Initiative (SDI) activities for physical tie-in to SWPF
- **Tank Farms**: Salt dissolution, blending, batching, and qualification at a pace sufficient to provide feed at design rates and enable additional tanks to enter blend tank service
- **SWPF**: Conversion to the NGS enable reduced cycle times within SWPF. It also reduces the relative SE and MST volume so that they are within DWPF feed limitations at a production rate of 9 Mgal/yr. Conversion to

NGS allows a forecast SWPF rate of 9 Mgal/yr beginning in FY22 in Case 1. Case 3 assumes conversion a year earlier, in FY21
- **DWPF**: Improvements described in Section 4.2 (above) enhance the ability to process SE to support an SWPF feed rate greater than 6 Mgal/yr
- **SPF**: ELAWD II improvements described in Section 4.4 (below) enhance SPF's ability to process the DSS stream from SWPF to support an SWPF feed rate greater than 6 Mgal/yr.

Additionally, storage for the resultant waste streams must be provided, including:
- Construction of future SDUs to support disposition of grout from SWPF DSS stream processing at design rates
- Construction of future glass waste storage capability to support canister storage for SWPF SE & MST stream processing at design rates

4.4 *Saltstone Operations*

The Saltstone operation consists of two main components. The Saltstone Production Facility (SPF) contains the tanks and equipment necessary to receive DSS and treat and process it into saltstone grout. The grout is pumped from SPF into the Saltstone Disposal Facility (SDF), consisting of several Saltstone Disposal Units (SDU) for final disposition.

Saltstone Production Facility

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 SDUs, located in SDF, where the Saltstone grout solidifies into a monolithic, non-hazardous, solid LLW form.

To enable SPF to accommodate the increases in DSS influents from SWPF, streamlining the SPF dry feed preparation system is required for SWPF, which will be accomplished in the second phase of ELAWD. Additionally, to support SWPF processing rates above 6 Mgal/yr, SPF operations will be conducted on a 24/7 schedule which will require increased staffing over the current 4/10 schedule.

ELAWD phase II (SPF Dry Feed Mods)

Several operations and equipment reliability improvements are required to enhance the operation of SPF feeding SDF:
- **Silo bin discharge —** Rework existing silo bin discharge system to allow silos to operate at full capacity. Implement software changes that will allow air to be pulsed through the silo during downtimes to prevent packing and bridging. Also, install air cannons or equivalent device on silo to address rare cases that bridging may occur
- **Knife Gate valve or equivalent** — Install knife gate valve assembly at each silo to enhance the system's abilities to handle inconsistencies with bulk materials and aid in dry material recipe accuracy
- **Diversion chute** — Install a duct system (diversion chute) which will divert the flow of dry materials to the mixer and send the materials to a holding area for screw feeder operational testing prior to salt waste treatment
- **Screw feeder** — Replace the existing obsolete screw feeder
- **Weather protection** — Enclose the Premix Feed Bin and Loss-In-Weight hopper to protect the many flexible couplings and joints that are susceptible to water intrusion
- **Flexible couplings —** Upgrade each flexible coupling to provide improved sealing and weather resistance
- **Dust collectors —** Update Silo 2 dust collector to improve simultaneous truck unloading capacity for Silos 1, 2, and 3.

Saltstone 24/7 Operations

Operations and equipment reliability improvements are required to enable 24/7 operation of SPF feeding SDF:
- **Lighting upgrades –** Install additional lighting in the Saltstone area to accommodate a 24/7 shift operation at Saltstone and to promote personnel safety and efficiency
- **Lightning protection upgrades** – Install lightning protection throughout the Saltstone facility to minimize process equipment damage during inclement weather and to maximize critical process equipment availability
- **Process air compressor replacement** – Replace outdated process air compressors to support dry feed system operations and serves as a backup supply to the 210-Z instrument air system.

Saltstone Disposal Facility

The current active SDUs, SDU-3, and SDU-5 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 2,300 kgal. Nominally, 1.76 gallons of grout is produced for each gallon of DSS feed, thus yielding a nominal cell capacity of approximately 1,300 kgal of DSS. SDU-6 consists of a single cell 375 feet in diameter by 43 feet high. The total capacity SDU-6 will be 32 Mgal, which will have a capability, after accounting for cold cap requirements, of dispositioning 30 Mgal of contaminated grout or 17.1 Mgal of DSS. In the base case of this *Plan*, SDU-6 is required to begin operations by February 2018. Future SDUs are, for planning purposes, assumed to be of a similar design to SDU-6.

4.5 *Waste Removal and Tank Closure*

4.5.1 Waste Removal and Tank Cleaning

The first step in the disposition of sludge and salt waste is BWRE. Sludge is removed from the waste tank and sent to a hub tank or directly to the feed preparation tank ensuring sludge waste is continuously available for treatment at DWPF. Salt is dissolved, removed, and staged for treatment at ARP/MCU or SWPF.

Bulk Waste Removal Efforts

If permanent infrastructure is available, sludge removal planning maximizes the use of this infrastructure to most effectively remove waste. This planning includes the use of structural steel, cable trays, existing slurry pumps, transfer pumps, and ventilation. If permanent infrastructure is not available, the waste on wheels (WOW) concept may be used on some waste tanks to perform BWRE (see Figure 4-3). Portable and temporary equipment would then meet tank infrastructure needs. Additional purchased pumps and equipment perform accelerated BWRE operations concurrently in both Tank Farms.

The primary components of the WOW system are:

- Reusable submersible mixer pumps (SMP)
- 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.

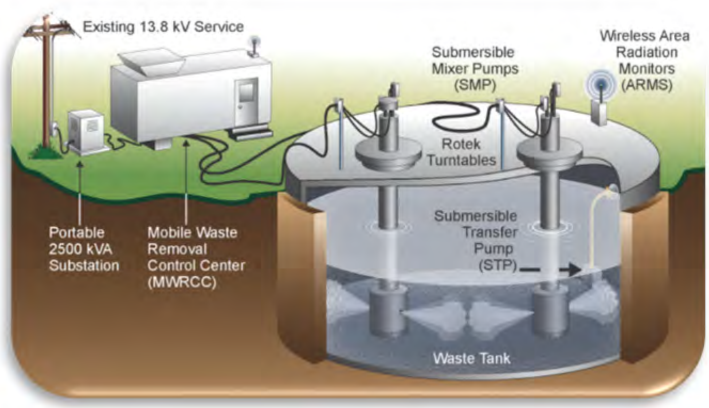


Figure 4-3 — *WOW Deployment for BWRE*

WOW equipment is deployed at the tank as a field operating station, providing temporary power and control for BWRE equipment. When BWRE is completed on one tank, the WOW equipment is reconfigured to support waste removal on the next tank. Pumps are sized to fit through the 24-inch openings in old style tanks. To the extent that risers are available, pumps are set in optimal configurations within the waste tanks. Product lubricated bearings and motor cooling eliminate the need for bearing and seal water supply. These pumps have exterior fittings and fixtures so the pumps can be decontaminated, minimizing radiation exposure to personnel during relocation to another tank. Disposable transfer pumps transfer the waste to a receipt or hub 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 minimize exposure to personnel.

Sludge Removal

Sludge removal operations are typically conducted with two, three, or four mixing pumps. Sufficient liquid is added to the tank to suspend sludge solids. Existing supernate is used, when practical, 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 remaining contents of the tank can no longer be effectively removed by this method.

Sludge batches were originally configured to preferentially remove sludge from Type I, II, and IV tanks. Bulk sludge has been successfully removed from all old-style tanks except Tank 15, which is currently being prepared for BWRE. Ideally, sludge batch configurations balance the sludge batch composition of the PUREX and the HM sludges, to optimize sludge batch preparation and processing in DWPF (see §7.1 for a description of these sludge types). Tank 13, a Type II tank in HTF, is being used to store and transfer sludge from other tanks, as necessary, until Tank 13 heel removal is performed in FY26. Tanks 33, 34, 35, and 39, Type III tanks, are also planned for use as sludge hub tanks, as needed.

Salt Removal

Salt waste removal may be accomplished using a modified density gradient process (see Figure 4-4) followed by mechanical agitation, or semi-continuous dissolution (see Figure 4-5)

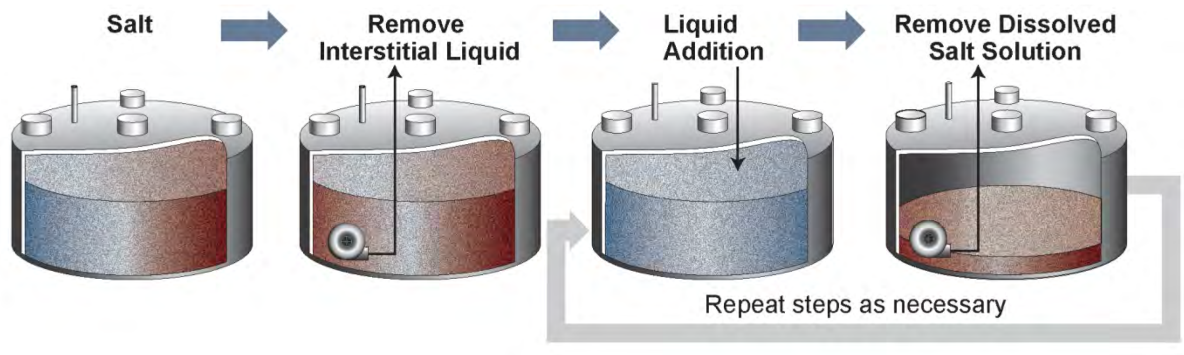


Figure 4-4 — *Modified Density Gradient Salt Removal*

During modified density gradient salt dissolution, 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. Liquid (e.g., IW, WW, Recycle) 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 except the transfer pump. DWPF recycle may be used where possible to dissolve salt in order to conserve new-style tank space. 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 may blanket the underlying salt and the dissolution rate can decrease significantly. Removal of salt and insoluble solids from the bottom of the tank may require installation of mixing pumps to complete waste removal. Mixer pumps suspend and remove insoluble solids at the end of the dissolution step, similar to sludge removal.

An alternative to the Modified Density Gradient Salt Removal process is Semi-Continuous Dissolution (SCD) utilizing a Dissolution Water Skid (DWS) (see Figure 4-5 — *Dissolution Water Skid*). This process adds well water to the tank via the DWS, and transfers dissolved salt solution from the tank at approximately the same rate. The well water is distributed evenly to several (nominally three) risers in the tank. Each of the risers is equipped with a low volume mixing eductor installed above the salt cake, but below the supernate level. During dissolution, the saltcake level is periodically checked, and the low volume mixing eductors and transfer pump are gradually lowered as the saltcake level decreases.

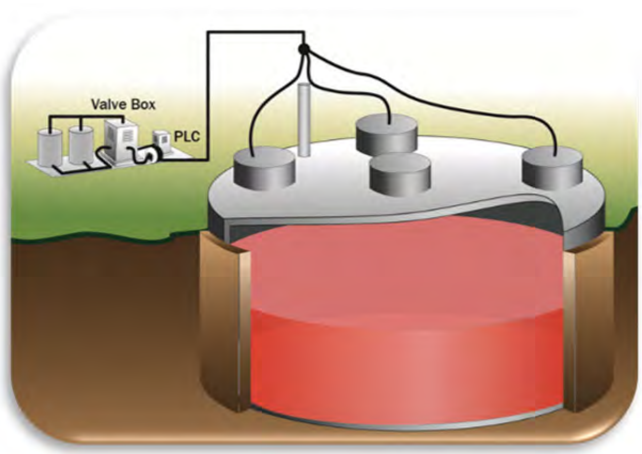


Figure 4-5 — *Dissolution Water Skid*

Other methods of salt dissolution may be pursued on a case-by-case basis. For example, beginning in late FY10 and continuing to the present, Tank 41 salt dissolution has been achieved gradually by receiving recycle directly from DWPF until the level is approximately twelve inches above the saltcake. It is then recirculated with a transfer pump for several days just prior to transferring out to Tank 23 for use in a salt batch. The resultant dissolved salt has been used in the make-up of ARP/MCU salt batches beginning with Salt Batch #5.

Heel Removal

After BWRE has removed the material that can be removed with the technologies discussed above, heel removal is performed. Heel Removal can consist of a combination of mechanical heel removal and chemical cleaning. In general mechanical heel removal is done prior to chemical cleaning, and is discussed below in some detail. Depending on tank conditions, however, chemical cleaning may be performed prior to mechanical heel removal or some mechanical heel removal and some chemical heel removal may be performed back and forth to provide removal to the extent technically practicable from an engineering perspective and the highly radioactive radionuclides removed to the maximum extent practical.

Mechanical Heel Removal

For mechanical heel removal, this *Plan* assumes vigorous mixing continues, using mixing pumps, until approximately 5 kgal or less of material remain. Additional mechanical removal may be achieved through directing pumps discharges in specific patterns to impact remaining material.

Chemical Cleaning

Chemical cleaning may be performed on sludge tanks when mechanical heel removal has not removed the material to the extent technically practicable from an engineering perspective and the highly radioactive radionuclides removed to the maximum extent practical. In bulk oxalic acid (OA) cleaning, the tank is modified to address chemical compatibility concerns and OA is added to the tank and mixing pumps operated. The contents of the tank are agitated for a short period and then transferred to a receipt tank for neutralization. In caustic cleaning, a sludge heel is subjected to LTAD conditions (see § 4.1) to dissolve a significant amount of aluminum solids. This process is repeated one to three times based on chemical flowsheet projections.

Tanks with Documented Leak Sites

Several Type I, II, and IV tanks have documented leak sites. All Type IV tanks having documented leak sites have been operationally closed; however, waste removal operations on some of the Type I and II tanks could potentially reactivate old leak sites or expose new leak sites in those tanks. Contingency equipment and procedures will be utilized to contain leakage and prevent release to the environment. Specific plans will avoid liquid levels above known leak sites, when feasible, and focused monitoring will be employed where these levels cannot be avoided. As a result of program progress to date, of the 14 SRS tanks (all old-style tanks) with leakage history:

- 5 are operationally closed and grouted (Tanks 5, 6, 16, 19, and 20)
- 1 is being grouted (Tank 12)
- 1 is currently being prepared for BWRE (Tank 15)
- 4 contain essentially dry waste, with little or no free liquid supernate (Tanks 1, 9, 10, and 14)
- 3 contain liquid supernate at a level below known leak sites (Tanks 4, 11, and 13)

Of the remaining 10 old-style tanks (none of which have any known leakage history):

- 2 are operationally closed and grouted (Tanks 17 and 18)
- 2 contain essentially dry waste, with little or no free liquid supernate (Tanks 2 and 3)
- 6 contain liquid supernate. (Tanks 7, 8, and 21 through 24)

Annulus Cleaning

Some Type I and II tanks have waste in the annulus space, typically a soluble form of salt appearing as dried nodules on tank walls at leak sites and at the bottom of the annulus pan. These tanks will be inspected to determine if Annulus Cleaning is required. For those tanks requiring annulus cleaning, this waste will be removed from the annulus to the extent technically practicable from an engineering perspective and the highly radioactive radionuclides removed to the maximum extent practical before declaring the tank ready for grouting

4.5.2 Tank Closure and Stabilization

Type I, II, and IV tanks are planned for operational closure in accordance with a formal agreement between the DOE, Region IV of the EPA, and SCDHEC as expressed in the SRS currently approved FFA. Seven of these tanks; Tanks 5, 6, 16, 17, 18, 19, and 20; were operationally closed and stabilized (grouted) — FTF Tanks 17 and 20 in 1997, Tanks 18 and 19 in 2012, Tanks 5 and 6 in 2013, and HTF Tank 16 in 2015.

Operational closure and stabilization 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, including:

- Sampling and Characterization

- Developing tank-specific regulatory documents
- 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)
- Stabilizing by grouting of the primary tank, remaining equipment, annulus, and cooling coils
- Capping of select tank risers.

This *Plan* assumes thirty months from the last removal of any material until completion of grouting.

Sampling and Characterization

Before declaring a tank ready for grouting, the tank and annulus are inspected, the residual volume is determined, and the residual is sampled in accordance with a sample plan. Laboratory analysis of the samples yields concentrations of radiological and non-radiological constituents in the remaining material. The SCDHEC approved Sampling Analysis Program Plan and associated Quality Assurance Program Plan currently recognizes SRNL as the laboratory that performs residual characterization. Concentration and volume data are used to characterize the residual material to produce radiological and non-radiological inventories for the Closure Module (CM). Tank-specific closure documents are prepared to demonstrate compliance with State and DOE regulatory requirements as well as NDAA §3116.

Tank Isolation

Tank isolation is the physical process of isolating transfer lines and services from the tank. Isolating the tank from tank farm systems and services prohibits chemical additions or waste transfers into or out of the tank. Further isolation of a tank, after filling with grout, is planned to include cutting and capping or blanking mechanical system components (air piping/tubing, steam piping, etc.) and disconnecting electrical power to process components on the tank.

Closure Documentation Development

An area-specific WD approach ensures the NDAA §3116 tank closure process is implemented as efficiently as possible. Performance Assessments (PA) and NDAA §3116 Basis Documents have been generated for each Tank Farm — one for FTF and one for HTF. The NDAA §3116 Basis Documents include the waste tanks as well as ancillary structures located within the boundary of the respective Tank Farm. An area-specific General Closure Plan has been developed for each of the Tank Farms and approved by SCDHEC.

DOE Radioactive Waste Management Manual 435.1-1 mandates a Tier 1 Closure Plan and associated Tier 2 Closure Plans. The Tier 1 plans are area-specific and provide the bases and process for moving forward with tank grouting. 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 documents, and are locally approved by DOE-SR.

Development of a tank specific CM, per the State-approved area-specific General Closure Plans, follows completion of tank cleaning activities. The CM describes the waste removal and cleaning activities performed and documents the proposed end state. Final characterization data supports the performance of a Special Analysis which determines if final residual inventories continue to support the conclusions of the area-wide PA.

Grout Selection and Manufacture

A reducing grout provides long-term chemical durability and minimizes leaching of residual waste over time. The reducing grout selected is self-leveling, and encapsulates the equipment remaining inside the tank and annulus. The grout also provides for intruder prevention in tanks that do not have a thick concrete roof. Grouting activities include field modifications, temporary ventilation installation, grout plant mobilization, and grout procurement.

Grout Placement

Grout fill operations, including site preparation, pumper truck set up, grout plant set up (if required), grout delivery lines, and grout equipment setup are established around the tanks (see Figure 4-6). A sequence for tanks with an annulus will be developed so that voids are filled and the structural integrity of the tank is maintained. Generally, grouting the annulus and primary tank in alternating steps provides structural support for the tank wall.

Figure 4-6 — *Grout Placement*

Equipment Grouting

For tanks with installed equipment or cooling coils, internal voids are filled with a flowable grout mixture. In those tanks where the cooling coils have broken, alternative techniques are used to minimize voids in the grout matrix.

Riser Grouting and Capping

The final step, after filling the tank, may include encapsulating select risers. When necessary, forms are built around the risers and grout is used to encapsulate the risers providing a final barrier to in-leakage and intrusion. The final grouted tank configuration is an integral monolith free of voids and ensuring long-lasting protection of human health and the environment (see Figure 4-7).

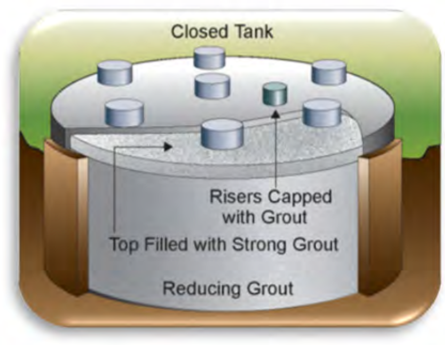


Figure 4-7 — *Grouted Tank*

4.6 *Base Operations*

4.6.1 Supporting Nuclear Material Stabilization

A continuing portion of the mission of the Tank Farms, especially HTF, 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 2025 with shutdown flows through 2026. Tank 39 will continue to be used for H-Canyon receipt through shutdown of H-Canyon. It may be supplemented as necessary, however, with Tank 35 during BWRE campaigns in Tank 39. The 3H Evaporator system will continue to operate.

This *Plan* assumes the maximum volume that can be received in Tank 39 from H-Canyon is 200 kgal/yr in FY16 and FY17 per the *Revised Projected High Level Liquid Waste (HLLW) Volumes Limitations, (Letter Lovett to Temple, Projected HLLW Volumes Limitations, 07/15/14)*[21]. Beginning in FY18, HTF is forecast to receive up to 300 kgal/yr from H-Canyon through FY25. The shutdown flow volume of 50 kgal, as outlined in *H-Canyon Liquid Waste Generation Forecast for H-Tank Farm Transfer*[22], is assumed in FY26.

An alternate disposal path for some waste (e.g., Pu or Np bearing waste) allows insertion into a DWPF sludge batch "just-in-time" via receipt into the sludge processing tank (Tank 51) or the DWPF feed tank (Tank 40). Plutonium discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings or failing to comply with canister fissile material concentration limits. Additionally, LLW is transferred from H-Canyon into Tank 50 for direct disposal in SPF.

It is recognized that the H-Canyon mission may be changed in the coming years such that new waste streams may be received into the LW system. As new streams are identified, they will be evaluated and impacts to LW processing will be reviewed and included in future revisions of this *Plan* as necessary.

4.6.2 DWPF Recycle Handling

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. The DWPF recycle rate will remain between 1.5 and 1.9 Mgal/yr prior to SWPF 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 SE stream and MST slurry and because the higher Cs-137 concentrations could require the operation of two SAS stages in the DWPF melter offgas system; currently, only one SAS stage is operated. This higher rate, however, could be mitigated by the DWPF recycle reduction initiatives discussed in §4.2, above. DWPF recycle is exclusively evaporated in the 2H Evaporator System due to chemical incompatibility with other waste streams. It may, however, be beneficially reused for salt solution molarity adjustment, salt dissolution, heel removal, etc. Beneficial reuse minimizes the utilization of the 2H Evaporator. LW system modeling forecasts that the life cycle processing outlined herein can adequately handle the DWPF recycle stream through the end of the *Plan*. DWPF recycle will be supplemented by Inhibited Water (IW), as required, for salt dissolution and adjustment.

4.6.3 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 SWPF. Because of the greatly increased pace of transfers after the startup of SWPF, short downtimes due to unexpected conditions requiring repair will be more difficult to accommodate without impact because the idle time of transfer lines will be reduced.

New infrastructure is required to accomplish transfers to support SWPF, while also continuing activities that have been historically performed, such as waste removal and evaporation. Discoveries of unexpected conditions in existing transfer systems 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. This *Plan*, however, does not attempt to explain all the modifications needed or the failure of specific pieces of transfer equipment.

4.6.4 Tank 48 Treatment

Tank 48 contains legacy organic from previous salt treatment processes. Several technologies have been considered, including Fluidized Bed Steam Reforming and Copper Catalyzed Peroxide Oxidation, to treat the organic components and enable the waste to be dispositioned as grout or vitrified glass. Technology selection and design is assumed to begin around 2022. Once the bulk of the Tank 48 waste has been treated, the residuals will be grouted in place as part of Tank 48 closure.

4.6.5 Effluent Treatment Project

The Effluent Treatment Project (ETP), located in H-Area, collects and treats process wastewater that may be contaminated with small quantities of radionuclides and process chemicals. The primary sources of wastewater include the 2H and 3H Evaporator overheads and H-Canyon. The wastewater is processed through the treatment plant and pumped to Upper Three Runs Creek for discharge at an NPDES permitted outfall. Tank 50 receives ETP residual waste for storage prior to treatment at SPF and final disposal at SDF. A 35-kgal Waste Concentrate Hold Tank provides storage capacity at ETP to minimize transfer impacts directly to Tank 50 or SPF during SWPF operations.

4.6.6 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 removal from service, etc. Limited waste storage space exists in Type III/IIIA tanks in both FTF and HTF. There is a risk (cf. ROMP) that a leak in a primary tank or other adverse event could occur that might impair execution of this *Plan.*

In the 3H Evaporator System, 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 or concentrate 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.” Deliquoring both the 2H and 3H Evaporators and salt removal from Tank 37, a 3H Evaporator concentrate receipt tank, are planned on a regular basis to ensure continued viability of the Evaporators.

During the approval process of this *Plan*, a leak was detected in the 3H Evaporator pot. The impact of the leak could not be fully assessed as of the publication of this *Plan*, however, early projections indicate a manageable impact on the goals of this *Plan*. A full treatment of compensatory measures will be modeled and included in the next revision of this *Plan*.

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. Lack of evaporator working space would hinder tank removals from service, canister production rate at the DWPF, or H-Canyon support.

This *Plan,* as did previous revisions of the *Plan,* utilizes Type I, II, and IV tanks to store supernate to facilitate achieving program objectives:

- Tank 8 stores aluminum-laden supernate from LTAD of Sludge Batches 5, 6, 10, 11, 12, and 13
- Tank 4 stores dissolved salt solution and aluminum-laden supernate from LTAD
- Tank 7 stores dissolved salt solution
- Tank 7 will support waste removal activities from Tanks 1, 2, and 3 and Tank 11 from Tanks 9 and 10
- After Tank 8 aluminum-laden supernate is processed, Tank 8 will store dissolved salt solution

- Tank 11 stores salt dissolution material
- Tank 13 serves as a hub for Sludge Removal from Tanks 14 and 15, supports Heel Removal /Chemical Cleaning from Tanks 9, 10, 11, 14 and 15, and supports Tank 14 salt dissolution. Additionally, Tank 13 supports storage of evaporator concentrate to allow Tank 34 sludge removal.
- Tank 21 through Tank 24 will remain in service through until sufficient Type III space is available in HTF:
  - — Tank 21 will continue service as a salt blend tank for ARP/MCU and SWPF
  - — Tank 22 will continue to receive DWPF recycle
  - — Tank 23 will continue to stage dissolved salt solution for salt batch preparation
  - — Tank 24 will continue to store evaporator concentrate.

Tank 8 will continue to store aluminum-laden supernate[23], Tank 7 will continue to support closure of Tanks 5 and 6 by storing liquids from cooling coil flushes, and Tank 11 to support BWRE in Tank 10 by receiving dissolved salt solution from Tank 10 until it is transferred to Tank 21 for inclusion in Salt Batch 7 and heel removal activities in Tank 12 by receiving and storing dewatering material from Tank 12[24,25]. For tanks for which BWRE completion has been declared, pre-decisional presentations have been made to regulatory agencies regarding plans for continued reuse.

4.7 *Closure Sequence for the Liquid Waste System*

After the HTF and FTF tanks and ancillary equipment has been closed the LW facilities outside the Tank Farm — DWPF, SWPF, ARP/MCU, SPF, SDF, and associated ancillary equipment — will be available for beneficial reuse, if required. Otherwise, these facilities will be available for removal from service.

While the general priority is to close geographically proximate equipment and facilities, thus minimizing cost, the actual sequence of the shutdowns is predicated on the capability of the facilities to process the particular blends required by the salt and sludge treatment processes. The priority (but not necessarily the sequence) for shutdowns as modeled is:

1. Type I, II, and IV tanks
2. F-Area waste tanks, the 2F Evaporator, and ancillary equipment (including 1F Evaporator and the concentrate transfer system)
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, SDF/SPF).
6. ETP is not addressed in this plan as it processes streams from facilities outside the scope of this plan (e.g., the Mixed Oxide Facility)

The key elements of the systematic closure sequence for shutting down and closing the LW System are summarized in Table 4-2:

Table 4-2 — *Closure Activities*

FY25-FY33	- H-Canyon processing influents cease (FY25) - H-Canyon shutdown flow influents cease (FY26) - Waste removal is complete from all Type I, II, and IV tanks (FY32) - 3H Evaporator shut down (FY33) - FTF waste removal is completed (FY33) - SWPF shut down (FY32) - Inter-Area Line (IAL) removed from service (FY33)
FY34–FY36	- 2H Evaporator shut down (FY34) - HTF (West Hill) waste removal is complete (FY35) - FTF Type III tanks are operationally closed (FY35) - All Type I, II, and IV tanks are operationally closed (FY36)
FY37–FY42	- HTF (East Hill) HLW removal is complete (FY38) - DWPF shut down (FY38) - SPF shut down (FY40) - All Type III tanks are operationally closed (FY41)

Once closure activities are complete, the remaining facilities may be chemically cleaned and flushed as necessary.

5. Alternative Analyses

Introduction

This *Plan* provides three cases.

- Case 1 (the base case) assumes an aggressive SWPF startup schedule of December 2018 and a stable funding profile. This case prioritizes bringing SWPF up to full processing as soon as possible as well as waste removal and closure from old style tanks as soon as practical. Additionally, it introduces the TCCR for treatment of salt waste
- Case 2 assumes SWPF startup in January 2021 and a stable funding profile. This case prioritizes also prioritizes bringing SWPF up to full processing as soon as possible as well as waste removal and closure from old style tanks as soon as practical
- Case 3 is an alternative case to demonstrate isolation of FTF by FY30. To accomplish this, it assumes that additional waste processing can be performed using an additional TCCR process in FTF and extended use of the TCCR in HTF. The waste processed via TCCR supplementing, SWPF Startup in December 2018, and expedited conversion to NGS are required to isolate FTF by FY30. Additionally, completion of FTF waste removal accelerates the F-H IAL transfer line decommissioning.

5.1 *Case 2 — SWPF Start-up Delayed until January 2021*

Case 2 assumes SWPF start-up date of January 2021, 25 months later than the December 2018 of Case 1. This case was not modeled specifically, but, based on previous modeling of this type of delay, the following results are expected. This delay increases the ARP/MCU operating time. In FY24, SWPF enters an outage to convert to NGS use, increasing the processing rate to a nominal 9 Mgal/yr. The delay in SWPF operation leads to a 25-month extension in the LW life-cycle. Type IV tank closures are forecast to be complete in April 2037 as compared to March 2035 in Case 1. Closure of the last tank is forecast for April 2041 as compared to March 2039 in Case 1.

5.2 *Case 3 — Objective: Isolate FTF by 2030*

The question of how much additional treatment could be accomplished by maximizing the use of ion exchange technology is addressed in Case 3. An additional condition is the isolation of FTF by the end of FY30, which also allows the IAL to be decommissioned.

SWPF is assumed to start-up in December of 2018 as in Case 1. TCCR processes are deployed in FTF and in HTF.

Salt Processing via ARP/MCU

There is essentially no difference in Case 3 ARP/MCU processing when compared to Case 1. The accelerated salt processing is achieved via additional TCCR processing and expedited NGS conversion in SWPF. The difference in processing by year is a result of when the SWPF tie-in outage begins (July 2017 in Case 1 vs. September 2017 in Case 3) and, additionally, a one month SWPF hot tie-in outage in the Case 1 model.

Supplemental Salt Processing via TCCR

More salt waste processing is required than can be accomplished via CSSX processes to remove all the salt waste from FTF prior to FY25. This additional salt processing is provided by several TCCR processes.

F-Tank Farm TCCR

The TCCR process will be installed in the vicinity of Tanks 4 and 7. The batches are prepared in two combined blend/feed tanks, Tank 4 and 7. The FTF TCCR will process salt from Tank 1, Tank 2, and Tank 3.

The F-Area TCCR will treat up to 1 Mgal/yr.

H-Tank Farm TCCR

The TCCR process will be installed in the vicinity of Tank 10. The salt solution is prepared in the source tank. The HTF TCCR will process salt from Tank 9, Tank 10, and Tank 14.

The H- Area TCCR will treat approximately 1 Mgal/yr.

Accelerated Salt Processing via SWPF

Accelerated SWPF processing is accomplished by expediting the conversion to NGS processing by one year.

Sludge Batch Impacts

The emphasis on waste removal from FTF results in less than optimum sludge blending. FTF contains quantities of sludge from PUREX processing and HTF contains mainly waste from the HM process. Ideally, sludge batches are made by blending the two waste types. In Case 3, the FTF Purex sludge is dispositioned earlier than in the base case, resulting in the later batches having more HM process sludge. These batches require the addition of synthetic sludge to maintain the required aluminum to iron ratio. The later batches also have higher uranium enrichment levels and may require additions of lower enriched uranium for processing.

Summary of Results

- Salt Waste processing peaks in FY22 at about 11 Mgal
- SDU construction schedule is accelerated
- DWPF canisters increase to 8,210
- Old style Tanks 21 thru 24 usage is extended
- Last old style tank is closed in FY32
- Last new style tank closed in FY39
- Salt Waste Processing ends in FY30 roughly coincident with the end of bulk sludge processing
- The IAL can be decommissioned at the end of FY28
- The last FTF tank is closed by the end of FY30.

6. Description of Assumptions and Bases

The major assumptions and planning bases are the results of an agreement between SRR and DOE[2]. These assumptions address the planning period to the end of the program.

6.1 *Priorities for Plan Development*

1. Continual safe storage of LW in tanks and vitrified canisters in storage.
2. Risk Reduction through Waste Disposition, i.e., maximize processing of saltcake from old-style tanks with a special focus in meeting FY16 and FY17 BWRE commitments, match sludge processing to salt processing needs, and minimize the total life cycle. Target date to empty (BWR) old-style tanks by 9/30/2022. Tanks 21-24 are the last four to perform BWRE.
3. Tank Cleaning and Stabilization of Tank 12 by 5/31/2016 and make progress on additional tanks as funding permits.

6.2 *Funding*

This *Plan* was developed assuming the funding required to achieve the planned project and operations activities will be available, within the following restrictions:

- Funding profile to be used for Cases l and 2 is as follows:
  - $446M in FY16
  - $475M in FY17
  - $490M in FY18
  - $500M in FY19
  - $520M in FY20
  - $525M/yr beginning in FY2l and escalated 1% thereafter, until the end of the program
- Beginning in FY19, an additional $80M per year in operating funds is available for SWPF operations
- Includes Line Item funding, including assigned contingency, for SDU beginning with SDU-7
- Includes Line Item funding, including assigned contingency, for a Glass Waste Storage Project (GWSP)
- The following items are not included in the LW contractor funding and will be funded separately: SWPF (project and operation through end of FY21), Landlord Services, Essential Site Services (ESS - Section J), DOE Managed, and pension and legacy cost (e.g., Section J and SLAs)
- No "re-pricing" for site services is realized.

6.3 *Regulatory Drivers*

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

- **Federal Facility Agreement (FFA) –** Commits DOE to operationally close the Type I, II, and IV tanks (Tanks 1–24) no later than 2022. The specific schedule for the Type I, II, and IV 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*[17], with an amendment for Tank 12 in *Statement of Resolution of Dispute Concerning Extension of Federal Facility Agreement (FFA) Closure Date*[18], which document the schedule for the currently approved FFA.
- **Site Treatment Plan (STP) –** Per the 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 the waste removed in compliance with the FFA above.

Timely regulatory approvals are necessary to support this Plan.

6.4 *Waste Removal and Tank Removal from Service Program*

The following technical assumptions were used as input to the modeling of this *Plan*:

Waste Removal

- Types I, II, and IV tanks (Tanks 1–24):
  - Waste Removal and Tank Removal from Service commitments are per the FFA
    - Types I, II, and IV tanks (including Tanks 4, 7, 8, 11, and 21 through 24) may be used to optimize output of the Plan
- Type III and IIIA (Tanks 25–51)

- While the Type III and IIIA tanks are not included in the FFA, commitment for completion of waste removal (bulk waste and heel) from all tanks is per the STP
- Tanks are not required to be isolated and grouted to meet the STP

- Waste removal and cleaning activities could include mechanical, chemical, and water washing operations
- Two Phases of Waste Heel Removal are available for use:
  - Mechanical Cleaning uses mechanical agitation
    - Assumed to take three months of operation unless otherwise stated
    - Heel solids volume reduced to less than 5 kgal
  - If needed, Chemical Cleaning uses LTAD, OA, or advanced/specialized mechanical or chemical technology
    - Assumed to take three months of operation unless otherwise stated
  - For some tanks with high waste turnover, e.g. Tank 8, mechanical cleaning may not be required; however, flushing could be required prior to chemical cleaning
  - This *Plan* assumes Tanks 4, 7, 8, 11, 13, 14, 15, 26, 32, 33, 34, 35, 39, 42, 43, 47 are the sludge tanks that have chemical cleaning. No other tanks are planned for chemical cleaning. These tanks will be sampled and analyzed after BWRE complete to determine the amount of chemical cleaning necessary
  - Monitoring during heel removal will inform the decision to do mechanical or chemical cleaning.

Annulus Cleaning

- All tanks that have experienced leaks will undergo inspection and, potentially, sampling and analysis to determine the necessity for annulus cleaning. The amount of material used for annulus cleaning depends on the extent of waste present.

Tank Removal from Service

- Stabilization of a waste tank (i.e. grouting of primary tank, annulus space, and cooling coils as specified in the applicable CM is to be completed within 30 months of receipt of concurrence to enter the residual waste sampling and analysis phase
  - Drying & Sampling (6 months on critical path): including Tank Drying, Sample Prep Documents, Volume Determination Cessation Presentation and Sampling
  - Sample Analysis (7 months on critical path): including Lab Analysis and Sample Analysis Report (SAR)
  - Closure Documentation (14 months on critical path): including DQA, Inventory Determination, Special Analysis, MEP, Class C Calculation, CM, and Tier 2
  - Grouting (3 months on critical path)
- SRNL infrastructure will be enhanced or additional labs will be qualified to enable the receipt, analysis, and report for as many tanks as needed
- Overall tank closure priority will support area closure in the following order, as feasible:
  1. FTF
  2. HTF West Hill
  3. HTF East Hill
- Within six months of stabilization, tank waste systems will be removed from the *F and H Area High Level Radioactive Waste Tank Farms Construction Permit No. 17424-IW* in accordance with the applicable and approved Interim Record of Decision.

Regulatory Approvals

- SCDHEC will approve activities associated with waste removal, stabilization, and operational closure and maintenance and monitoring of waste tank systems will be performed and completed as described in the *Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems*[26] or the *Industrial Wastewater General Closure Plan for H-Area Waste Tank Systems*[27]. Operational closure activities will be performed and completed as described in tank-specific CMs which are generated per the approved General Closure Plan
- EPA will approve the agreement to cease waste removal
- DOE will maintain NEPA documentation necessary to support this *Plan*.

6.5 ***DWPF Production***

- The *Plan* assumes Melter #2 replacement in a four-month outage beginning in FY17, coincident with an MCU contactor outage. In the event of a melter replacement outage before FY17, ARP/MCU will enter a forced outage and an evaluation will be performed to determine the prudence of initiating premature contactor bearing replacement
- Performing replacement of Melter #2 during this outage will require DOE concurrence

- After that, the Plan assumes a four-month melter replacement outage every 96 months (eight years) continues through the life of the program (i.e., 92 months of operations with four months of outage every 96 months). Even though replacement is assumed in this Plan every 96 months, actual replacement will be done upon failure of the Melter
- A six-month DWPF outage, beginning July 2017, is required for SWPF tie-ins immediately prior to SWPF becoming operational. During this outage DWPF plans to implement productivity enhancements to support increased influents from SWPF. Note that this outage in coincident with the four-month melter outage
- DWPF recycle is beneficially reused
- The current washing plan assumes washing to 1.25 M Na
- DWPF canisters will maintain a concentration limit of 897 g/m^3 of fissile material in the glass[28]. Sludge batch preparation will supply feed for the DWPF to ensure the canisters remain within this requirement
- GWSB #1 will be converted to allow stacking two canisters in each currently available storage position
- Additional canister storage capacity will be available, as necessary, after the GWSB #2 and the stacked GWSB #1 are filled
- The canister heat load will be less than 834 watts per canister for a canister in a single stack location or 500 watts for a canister in either position of a double stack location
- Pu 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
- Shipment of canisters off-site for final disposition is not in the scope of this *Plan.*

6.6 ***Salt Program***

ARP/MCU

- ARP/MCU processing rates:
  - No major modifications to ARP/MCU will be implemented to increase processing capacity to over 3 million gallons per year. Modifications that may be made include upgrading ARP/MCU facilities as required to maintain the operating rate for the extended life
  - ARP/MCU facilities operate to ensure the total Interim Salt Treatment curies emplaced in SPF are within the amount identified in *Savannah River Site – Liquid Waste Disposition Processing Strategy*[13] (SRS LW Strategy), as amended by letter from the SCDHEC to DOE-SR[14] and the *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*[8]
  - A seven-month outage beginning in FY17 is planned, coincident with a DWPF melter change-out. This outage will allow for ARP/MCU facility upgrades, which may include contactor bearings, weir adjustment, etc.
  - Nominally ARP/MCU will produce:
    - For each gallon processed, ~1.2 gal of DSS for SPF
    - For each gallon processed, ~0.08 gal of SE for DWPF
    - For each gallon processed, ~0.02 gal of MST solids/sludge for DWPF

      Note: actual operating experience in ARP/MCU since beginning NGS processing varies slightly from these assumptions. As the process is being optimized and data is still being collected and analyzed, however, these rates are assumed for this *Plan*.

SWPF

- SWPF becomes operational December 3, 2018
- Required Tank Farms, DWPF, and SPF Modifications (e.g., Salt Disposition Integration [SDI]) for SWPF, through Readiness Assessment (RA), will be complete two months prior to the initiation of the SWPF Operational Readiness Review (ORR)
- The SWPF nominal maximum capacity is:
  - 4.625 Mgal for the first year of operation
  - 7.2 Mgal/yr for the next two years of operation
- An SWPF outage is assumed at an appropriate time after SWPF first year of operation to perform NGS implementation to increase facility capacity to 9.0 million gallons per year
- Nominally SWPF will produce:
  - For each gallon processed, ~1.28 gal of DSS for SPF
  - For each gallon processed, ~0.08 gal of SE for DWPF
  - For each gallon processed, ~0.02 gal of MST solids/sludge for DWPF

    Note: when production exceeds 7.2 Mgal/yr, SE will be limited to 576 kgal/yr
- The SWPF feed chemistry is per SWPF Feed Specification Radionuclide Limits of the SWPF *Waste Acceptance Criteria*[29] including:

- the initial one million gallons of feed to SWPF will be (at 6.44 M Na):
  - ≤ 1.0 Curies per gallon (Ci/gal)
- all batches are planned to be at 6.44 M Na
- additional blending may be required to meet other feed criteria, such as:
  - 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

- Every effort will be made to optimize the LW System performance to maximize SWPF performance
- Tank Farm feed preparation infrastructure modifications required to support SWPF processing rates including:
  - HTF Blend tanks readiness for salt solution preparation
  - FTF Blend tanks readiness for salt solution preparation
  - Tank 49 readiness as SWPF feed tank
  - Mixing capabilities
  - Enhanced transfer capabilities
  - Transfer routes provided to feed tank.

6.7 *Saltstone Production*

SPF is capable of processing at a rate that supports other waste treatment operations as follows:

- During ARP/MCU operations:
  - May require operation of more than one cell and the use of "cold caps" to meet radiological control requirements
- During SWPF operation:
  - SPF and SDF will support SWPF processing rates
  - Additional operational time (i.e., multiple shifts, additional operating days each week, etc.) and adequate SDU receipt space to match production streams from SWPF are planned
  - Modifications will provide sufficient contingency storage capacity to minimize impacts to SWPF or ETP due to SPF or SDF outages
- 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 SDUs, SDU-3, and SDU-5 are in service. Neither Vault 1, Vault 4, or the filled SDU-2, are planned to receive additional saltstone grout:
  - Each gallon of DSS feed, when added to the cement, flyash, and slag, makes 1.76 gallons of grout
  - SDU-3, and SDU-5 have two 150-foot diameter by 20-foot tall disposal cells. Each cell will contain ~2,300 kgal of grout. Therefore, each cell holds ~1,300 kgal of Tank 50-material feed solution; each SDU holds ~ 2,580 kgal of Tank 50-material feed solution
  - SDU-6–will is a single 375-foot diameter by 43-foot tall disposal cell which can contain 32 Mgal of grout. With the cold cap it will have a capacity of 30 Mgal of contaminated grout or 17.1 Mgal of Tank 50-material feed solution.
  - Future SDUs will be similar to SDU-6

6.8 *Base Operations*

Evaporation

The primary influents into the Tank Farms are DWPF recycle and H-Canyon waste 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 are two evaporators in H-Area.

DWPF recycle has a high concentration of silica due to the vitrification process. When this stream is mixed with aluminum streams from PUREX and 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 3H Evaporator 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 3H Evaporator is used to process streams that minimize scale production, i.e., canyon wastes and sludge batch decants. The evaporator system feed and concentrate receipt tanks configuration is:
  - 3H: Feed – Tank 32; Receipt – Tanks 30 and Tank 37
  - 2H: Feed – Tank 43; Receipt – Tank 38
- Evaporator Capacity – The following evaporator utilities and capacity are based on historical experience.

Table 6-1 — *Evaporator Capacity*

Evaporator	Space Gain Capacity
2H	200 kgal/mo
3H	100 kgal/mo

General Assumptions

- A minor influent is the 299-H Maintenance Facility. The influents mainly consist of a dilute nitric acid stream, decontamination solutions, and steam condensate. These waste streams are collected from decontaminating equipment and collected in the 299-H pump tank, neutralized and sent to Tank 39.
- Tank Farm infrastructure is maintained to support SWPF, DWPF, and SPF processing rates and tank operational closure schedules.

Separations Canyon Operations

- Sufficient tank space volume is available to support the projected receipt of HLW into Tank 39 from H-Canyon operations through FY25. LLW waste, mainly from the General Purpose (GP) Evaporator, dispositioned in SPF are received into Tank 50 and direct discards of Pu and neptunium materials to the DWPF feed system are received into Tank 40 or Tank 51
- Shutdown flows for H-Canyon are assumed in FY26 and are as outlined in *H-Canyon Liquid Waste Generation Forecast for H-Tank Farm Transfer*[22]
- Additional material sent directly to sludge batches increases total DWPF canister count by as much as 100 canisters (these additional canisters are included in the 8,170 forecast canisters of this *Plan*):
  - Fissile isotope concentration of SRS HLW canisters will be maintained below 897 g/m^3
  - Pu discards from H-Canyon will be supported to the extent allowable without negatively impacting planned canister waste loadings and complying with canister fissile material concentration limits.

Effluent Treatment Facility

- ETP is assumed to receive an average of 11 Mgal/yr:
  - LW Evaporators: 5 Mgal/yr
  - Savannah River Nuclear Solutions (SRNS) Facilities: 6 Mgal/yr
    Note: the Agreement between SRNS and SRR for LW 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.

Dismantlement and Decommissioning (D&D)

- LW Areas transferred to D&D on an Area-by-Area basis upon closure of their included facilities.

6.9 *Notable Differences between Rev 20 and Rev 19 Assumptions*

Rev 19	Rev 20
Priorities 1. Continual Safe Storage of LW in tanks and vitrified canisters in storage 2. Risk Reduction through Waste Disposition 3. Tank Cleaning and Grouting.	1. Continual safe storage of LW in tanks and vitrified canisters in storage. 2. Risk Reduction through Waste Disposition, i.e., maximize processing of saltcake from old-style tanks with a special focus in meeting FY16 and FY17 BWRE commitments, match sludge processing to salt processing needs, and minimize the total life cycle. Target date to empty (BWR) old-style tanks by 9/30/2022. Tanks 21-24 are the last four to perform BWRE. 3. Tank Cleaning and Stabilization of Tank 12 by 5/31/2016 and make progress on additional

Rev 19	Rev 20
	tanks as funding permits.
Funding ● $430M/yr (constant dollar funding) to the LW contractor in FY15 through FY19 ● OMB recommended escalation factors will be used to determine projected buying power of this constant dollar funding in outyears ● Includes GWSP Line Item beginning in FY15 ● Does not include funding for the initial twelve months of SWPF operations ● $525M/yr (in FY20 and escalated thereafter) per year to the LW contractor until the end of the program ● Includes Line Item funding, including assigned contingency, for SDUs beginning with SDU-7 ● Includes $56.25M for operations of SWPF in FY20 ● Includes $75M/yr (in FY20 and escalated thereafter) for operation of SWPF thereafter	— Funding profile to be used for Cases l and 2 is as follows: – $446M in FY16 – $475M in FY17 – $490M in FY18 – $500M in FY19 – $520M in FY20 – $525M/yr beginning in FY2l and escalated 1% thereafter, until the end of the program — Includes Line Item funding, including assigned contingency, for SDU beginning with SDU-7 — Includes Line Item funding, including assigned contingency, for a GWSP
ARP/MCU – ARP/MCU nominal processing rate from Tank 49 will be paced by the limitation of funds and projected availability of SDU space, and is expected to be approximately 1 million gallons per year – The ARP/MCU facilities will operate until permanently shut down six months in advance of the startup of SWPF to allow for SWPF tie-ins and modifications to Tank 49.	– No major modifications to ARP/MCU will be implemented to increase processing capacity to over 3 million gallons per year *(No assumption re: shutdown of ARP/MCU for SWPF tie-ins)*
SWPF … assume SWPF becomes available for operations beginning September 30, 2018.	– SWPF becomes available for operations beginning December 3, 2018 – Required Tank Farms, DWPF, and SPF Modifications (e.g., Salt Disposition Integration [SDI]) for SWPF, through Readiness Assessment (RA), will be complete two months prior to the initiation of the SWPF Operational Readiness Review (ORR)
DWPF Operations ● Melter #2 is performing well past its planned life. Replacement of Melter #2 may be required as early as FY14. The Plan assumes its replacement in a four-month outage in FY16, coincident with an MCU contactor outage. In the event of a melter replacement outage before FY16, ARP/MCU will enter a forced outage and an evaluation will be performed to determine the prudence of initiating premature contactor bearing replacement. After that, the Plan assumes a four-month melter replacement outage every 96 months (eight years) continues through the life of the program (i.e., 92 months of operations with four months of outage every 96 months). Even though replacement is assumed in this Plan every 96 months, actual replacement will be done upon failure of the Melter ● A four-month DWPF outage is required for SWPF tie-ins immediately prior to SWPF becoming operational. If a melter replacement occurred in	— Modeling will determine the need date for additional glass waste storage (i.e., GWSP), assuming modification of GWSB #1 to provide additional capacity via “double-stacking”

Rev 19	Rev 20
FY16, it is not expected that the melter will require replacement during the SWPF tie-in outage. — GWSP is expected to be available no sooner than April 2019	
Tank Farm Operations — Target sufficient tank space volume to support the receipt of up to 300 kgal per year, dependent on funding, from H-Canyon operations through 2025 with provision for shutdown flows through 2026. The receipt of waste from H-Canyon may be impacted by the constrained operation of ARP/MCU resulting from limited funding for LW. This is not inclusive of direct discards of uranium, plutonium, or other materials to the DWPF feed system	— Sufficient tank space volume is assumed to support the receipt of up to 300 kgal per year from H-Canyon operations through 2025 with provision for shutdown flows through 2026 (actual forecast support will be determined by modeling). Special discards (including plutonium, neptunium, etc.) directly into sludge batches from H-Canyon will be supported to the extent allowable and up to 30 kgal per year, through 2026, of LLW into the Saltstone feed system is assumed.

Cases	— Case 1 assumes funding and SWPF startup per above
	— Case 2 assumes funding per above with SWPF startup delayed until January 31, 2021
	— Case 3 assumes additional funding with the December 2018 SWPF startup and prioritization of acceleration of FTF isolation with a target date of 2030.
	• Use Tank Closure Cesium Removal (TCCR) technology (1Mgal/yr)- 1 unit in each Tank Farm
	• Operate TCCR in old-style tanks up to the time of SWPF startup
	• Add actinide removal through the use of Large Tank Monosodium Titanate Strike to TCCR post SWPF startup
	• Implement NGS in SWPF in the second year of SWPF operations to run with NGS in the third year
	• Work will be prioritized as follows:
	  • Empty tanks 9 through 15
	  • Empty Old-style tanks in F Area
	  • Empty New tanks in F Area
	  • Grout F-Area tanks efficiently
	  • Empty and grout Tanks 21-24
	• Reuse Tanks 21-24 until HTF Type III tanks become available to fulfill their function

7. System Description

7.1 *History*

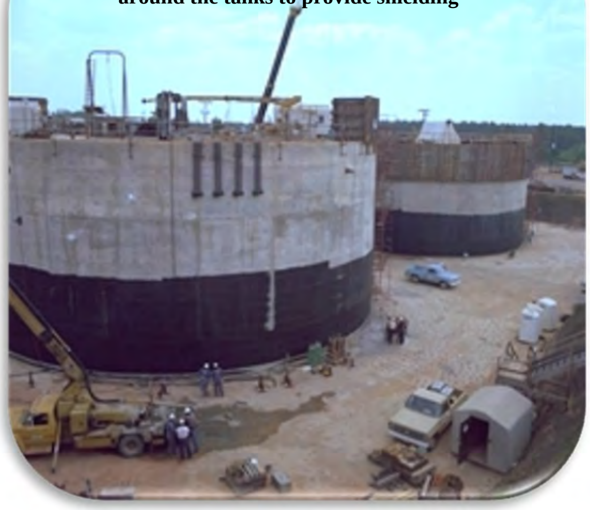
The LW System is the integrated series of facilities at SRS that safely manage the existing waste inventory and disposition waste stored in the tanks into a final glass or grout form. This system includes facilities for storage, evaporation, waste removal, pre-treatment, vitrification, and disposal.

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 over 160 Mgal of radioactive waste. As of December 2015, approximately 36 Mgal[30] of radioactive waste are currently stored onsite in large underground waste storage tanks 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 Reduction 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 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 material processed by 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 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 saltcake for tank removal from service, 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 high capacity salt waste processing can begin.

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



Continued long-term storage of these radioactive wastes poses a potential environmental risk. Therefore, since 1996, DOE and its contractors 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 7-2 — Process Flowsheet*). As of January 2, 2015, DWPF had produced 4,000 vitrified waste canisters (see Figure 7-3 — *Liquid Waste Program — Current Status*).

7.2 *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. 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. Four Type IV tanks, Tanks 17 through 20; two Type I tanks, Tank 5 and Tank 6—all in FTF —; and one Type II tank, Tank 16 in HTF have been isolated, operationally closed, and grouted. Fourteen tanks without full secondary containment have a history of leakage[31]. As a result of program progress to date, of these 14 SRS tanks (all old-style tanks) with leakage history:

- 5 are operationally closed and grouted (Tanks 5, 6, 16, 19, and 20)
- 1 is being grouted (Tank 12)
- 1 is currently being prepared for BWRE (Tank 15)
- 4 contain essentially dry waste, with little or no free liquid supernate (Tanks 1, 9, 10, and 14)
- 3 contain liquid supernate at a level below known leak sites (Tanks 4, 11, and 13)

Of the remaining 10 old-style tanks (none of which have any known leakage history):

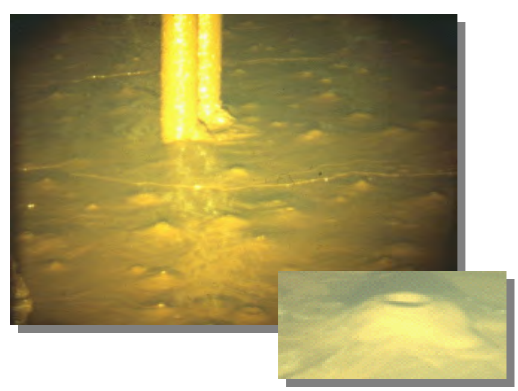
- 2 are operationally closed and grouted (Tanks 17 and 18)
- 2 contain essentially dry waste, with little or no free liquid supernate (Tanks 2 and 3)
- 6 contain liquid supernate. (Tanks 7, 8, and 21 through 24)

When waste disposition began in 1996, the inventory of waste in the SRS tank system contained approximately 550 Million curies. Currently, 36 Mgal of radioactive waste, containing 250 million curies (MCi)[30] of radioactivity, are stored in 43 active waste storage tanks located in two separate locations, H-Tank Farm (27 tanks) and F-Tank Farm (16 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.

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.

The sludge component of the radioactive waste represents approximately 2.6 Mgal (7% of total) of waste but contains approximately 128 MCi (51% of total). The salt waste makes up the remaining 33.4 Mgal (93% of total) of waste and contains approximately 122 MCi (49% of total). Of that salt waste, the supernate accounts for 17.5 Mgal and 110 MCi and saltcake accounts for the remaining 15.9 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 while the salt is being separated in the ARP/MCU process into a higher level component being stabilized in DWPF and a lower level component being dispositioned in SPF.

Radioactive waste volumes and radioactivity inventories reported herein are based on the Waste Characterization System (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.

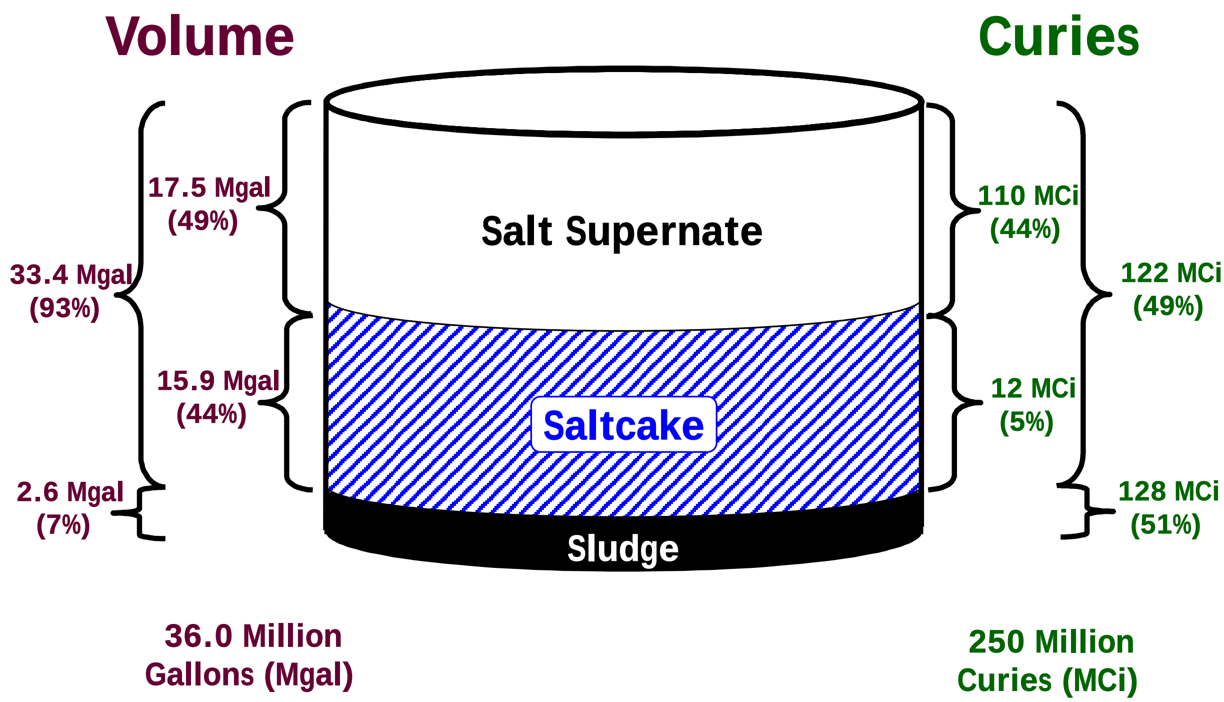


Sludge consists of insoluble solids that settle to the bottom of a tank. Note the offgas bubbles, including hydrogen generated from radiolysis.

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[32]. 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.

Figure 7-1 — *Waste Tank Composite Inventory (as of December 31, 2015)*[30]



7.3 *Waste Tank Space Management*

To make better use of available tank storage capacity, incoming LW is evaporated to reduce its volume. This is important because most of the SRS Type III waste storage tanks are already near full capacity. Since 1951, the Tank Farms have received over 160 Mgal of LW, of which over 110 Mgal have been evaporated, leaving approximately 36 Mgal in the storage tanks. Projected available tank space is carefully tracked to ensure that the Tank Farms do not become "water logged," meaning that so much of the usable Type III tank space has been filled that normal operations and waste removal and processing operations cannot continue. A contingency allotment of 1.3 Mgal is not included as working space. This amount is equivalent to the size of the largest tank and is reserved for the unlikely event that a full tank failed such that all its material had to be removed. Waste receipts and transfers are normal Tank Farm activities as the Tank Farms receive new or "fresh" waste from the H-Canyon stabilization program, LW 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. Since initiation of interim salt waste treatment (DAA and ARP/MCU), the working capacity of the Tank Farms has been maintained. Two evaporator systems are currently operating at SRS — the 2H and 3H systems.

Space in new-style tanks is used for various operations for waste processing and disposal. Tank space is recovered through evaporator operations, DWPF vitrification, ARP/MCU Treatment, and saltstone disposal. This valuable space has been used to: (1) retrieve waste from and clean old-style tanks; (2) prepare, qualify, and treat sludge waste for disposal; (3) prepare, qualify, treat, and dispose salt waste; and (4) support nuclear materials stabilization and disposal in H-Canyon through 2025 with shut down flows in 2026. The Tank Farm space management strategy is based on a set of key assumptions involving projections of DWPF canister production rates, influent stream volumes, Tank Farm evaporator performance, and space gain initiative implementation. The processing of salt and sludge utilizes new-style tank space to retrieve and prepare waste from old-style tanks, and therefore nominal empty space in new-style tanks will increase only after all waste in old-style tanks is processed. Sludge processing through DWPF removes the highest risk material from the old-style tanks. However, for every gallon of sludge processed, 1.3 gallons of salt waste is formed due to sludge washing and DWPF processing operations to return the resulting low hazard salt waste to the Tank Farm. Similarly, salt waste retrieval, preparation, and batching typically require the use of four gallons of tank space per gallon of salt waste treated. Given these parameters, the "key to reducing the overall risk is processing high-level waste as expeditiously as possible and managing the total tank space efficiently," as recognized by the DNFSB letter dated January 7, 2010[15].

New-style tank space is a currency used to prepare for permanent immobilization and disposition of HLW in a vitrified waste form and low-level waste in a grouted waste form. Additionally, some "old-style" tanks (e.g., Tank 21–Tank 24) support immobilization and disposition of high-level waste. The tank space management program maintains sufficient space to allow continued DWPF operations. The tank space management program also provides the necessary tank space to support staging of salt solutions to sustain salt waste disposition currently through ARP/MCU and subsequently through SWPF. Of the 27 new-style tanks (with a total nominal volume of 35.1 million gallons) in the SRS LW System:

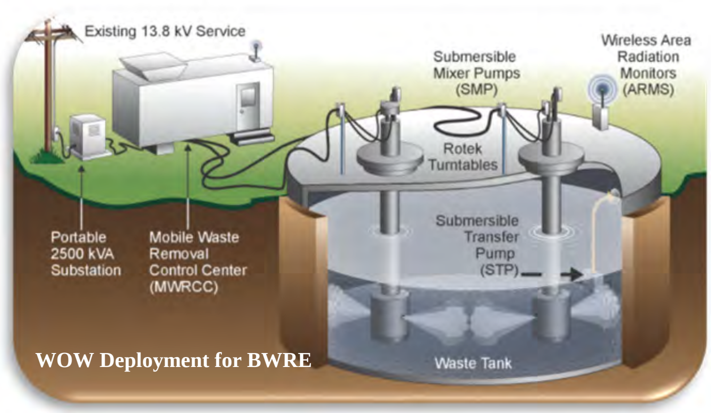
- 5 (Tanks 38, 41, 43, 49, and 50) are dedicated to salt batching, qualification, and disposition (including DWPF recycle beneficial reuse and the 2H Evaporator)
- 6 (Tanks 29, 30, 32, 37, 40, and 51) are dedicated to sludge batching, qualification, and disposition (including the 3H Evaporator)
- 1 (Tank 39) is dedicated to uninterrupted H-Canyon waste receipts
- 15 (Tanks 25, 26, 27, 28, 31, 33, 34, 35, 36, 42, 44, 45, 46, 47, and 48) are dedicated to safe storage of legacy LW pending retrieval and disposition.

There are currently ~7.5 Mgal of empty space (~21%) in these new-style tanks:

- 3.2 Mgal is margin as defense-in-depth operational control coupled with Safety Class or Safety Significant (SC/SS) structures, systems, or components (SSC) to facilitate reasonably conservative assurance of more than adequate dilution and ventilation of potentially flammable vapors
- 1.3 Mgal is procedurally-required minimum contingency space for recovery from the unlikely event of a bulk waste leak elsewhere in the system
- 3.0 Mgal is operational "working" space variously used to provide:
  - Additional contingency transfer space as operational excess margin above the procedurally-required minimum
  - Excess margin to preserve salt batch quality and maintain uninterrupted treatment and disposition through ARP/MCU and Saltstone
  - Excess margin to preserve sludge batch quality and maintain uninterrupted immobilization through DWPF
  - Excess margin to preserve uninterrupted support for H-Canyon.

7.4 ***Waste Removal from Tanks***

The first step in the disposition of sludge and salt waste is bulk waste removal efforts (BWRE). Sludge is removed from the tank and transferred to a feed preparation tank ensuring sludge waste is continuously available for treatment at DWPF. Salt is dissolved, removed, and staged for treatment at ARP/MCU or SWPF.



WOW Deployment for BWRE

If permanent infrastructure is available, sludge removal planning maximizes the use of this infrastructure to most effectively remove waste. This planning includes the use of structural steel, cable trays, existing slurry pumps, transfer pumps, and ventilation. However, to reduce the two-to-four year period required for installation of substantial structural steel and large mixing and transfer pumps — with their attendant infrastructure — required for BWRE, a Waste on Wheels (WOW) innovation was developed. The WOW concept minimizes new infrastructure. Portable and temporary equipment meet tank infrastructure needs. Additional purchased pumps and WOW equipment perform accelerated BWRE operations concurrently in both Tank Farms. The primary components of the WOW system are:

- Reusable SMPs
- 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 commercial transfer pumps

WOW equipment is deployed at the tank as a field operating station, providing temporary power and control for BWRE equipment. When BWRE 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 in old style tanks. To the extent that risers are available, pumps are set in optimal configurations within the waste tanks. Product lubricated bearings and motor cooling eliminate the need for bearing and seal water supply. These pumps have exterior fittings and fixtures so the pumps can be decontaminated, minimizing radiation exposure to personnel during relocation to another tank. Disposable transfer pumps transfer the waste to a receipt or hub 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.

7.5 *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 over 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 2018, this separation will be accomplished in SWPF. However, until the startup of SWPF, ARP/MCU accomplishes this separation. ARP/MCU and SWPF will be supplemented with TCCR processing to accelerate the disposition of salt waste

7.6 *Salt Processing*

Five different processes treat salt:

- **Deliquification, Dissolution, and Adjustment** (DDA) –**D**eliquification (i.e., extracting the interstitial liquid) is an effective decontamination process because the primary radionuclide in salt is Cs-137, which is highly soluble. To accomplish the process, the salt was first deliquified by draining and pumping. The deliquified salt was then **D**issolved by adding water and pumping out the salt solution. The resulting salt solution was aggregated with other Tank Farm waste to **A**djust batch chemistry for processing at SPF. For salt in Tank 41 as of June 9, 2003, which was relatively low in radioactive content, treatment using DDA-solely was sufficient to meet the SPF WAC. Tank 41 has since received additional salt dissolution from Tank 25 and there is no longer any qualified feed for the DDA-solely process. No further DDA-solely treatment is planned.
- **Actinide Removal Process** (ARP) – For salt, 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. 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. The solids, containing the MST with the actinides, are dispositioned at DWPF. In 2016, a demonstration of ARP was initiated to demonstrate that, with the correct salt batch makeup, MST addition is not necessary to meet the SPF WAC.
- **Modular CSSX Unit** (MCU) – The ARP low-level waste stream requires reduction in the concentration of Cs-137 using the CSSX process. MCU is a solvent extraction process for removal of Cs-137 from caustic salt solutions. The solvent used is a four-part solvent with the key ingredient being the cesium extractant (previously BoB Calix but, beginning September 2013, the NGS is Max Calix). This solvent is fed to a bank of centrifugal contactors while the waste is fed to the other end in a counter-current flow. The solvent extracts the cesium, with each successive contactor stage extracting more, resulting in a DSS stream and a cesium-laden solvent stream. The solvent stream is stripped of its cesium, washed, and the solvent is reused. The cesium-laden SE is transferred to DWPF. MCU has a dual purpose:
  - demonstrating the CSSX flowsheet
  - treating salt waste to enable accelerated closure of Type I, II, and IV tanks and uninterrupted vitrification of HLW at DWPF
- **Salt Waste Processing Facility** (SWPF) – This is the full-scale CSSX process. This planned facility will incorporate both the ARP and CSSX processes in a full-scale shielded facility capable of handling salt with high levels of radioactivity.
- **Tank Closure Cesium Removal** (TCCR) – This consists of an ion exchange process for the removal of cesium from liquid salt waste to provide supplemental treatment capability. Building on the experience of modular commercial nuclear plant decontamination and following the disaster response associated with Fukushima,

technology exists to efficiently accomplish large scale, selective removal of the cesium component of the bulk salt waste. The configuration is envisioned as an "at-tank" modular arrangement. The configuration is expected to consist of temporary process structures located near a Type I tank so the cesium removal process would take place outside of the tank. The DSS may be temporarily stored before transfer to Tank 50 for disposition via SPF. Once the ion exchange media in a column becomes loaded with cesium to the extent practical ("spent"), the column (with media) will be removed from the system and replaced with a new ion exchange column loaded with fresh media. The spent column will be transported to an Interim Safe Storage (ISS) location within the tank farm.

7.7 *Sludge Processing*

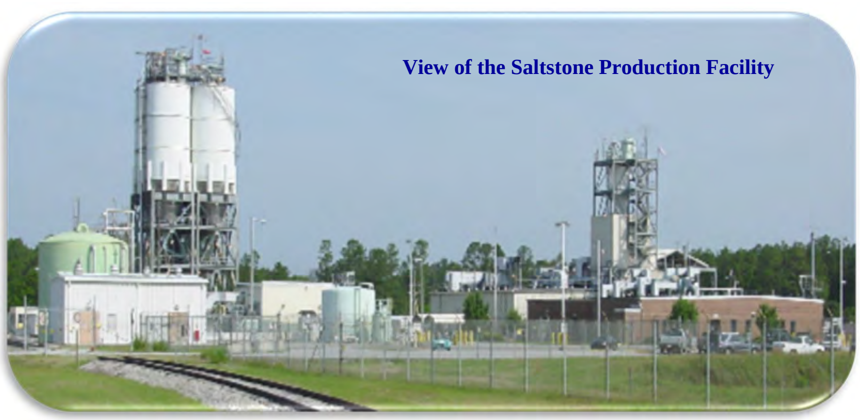
Sludge is washed to reduce the amount of non-radioactive soluble salts remaining in the sludge slurry. During sludge processing, large volumes of wash water are generated and must be volume-reduced by evaporation or beneficially reused. Over the life of the waste removal program, the sludge currently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

7.8 *DWPF Vitrification*

Final processing for the washed sludge and salt waste occurs at DWPF. This waste includes MST/sludge from ARP or SWPF, the cesium SE 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 a canister has cooled, it is 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 canister is then ready to be stored on an interim basis on-site. 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

7.9 *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 Saltstone Disposal Units (SDU), 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.

Future salt waste processing will impose significantly greater production demands. After SWPF startup, feed of DSS to the SPF could reach as high as 12.8 Mgal/yr. In anticipation of this future demand, SRS completed installation of Enhanced Low Activity Waste Disposal (ELAWD) improvements. The ELAWD Phase 1 improvements provided equipment modifications to increase operating margins, reliability, and controls. Also, during the ELAWD Phase 1 outage, the Mixing and Transfer System was modified to connect SPF to SDU-2.

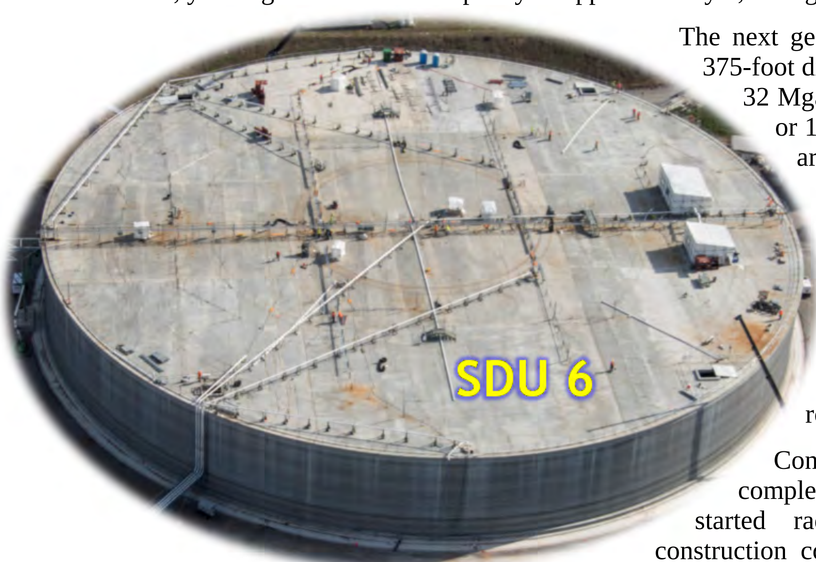
ELAWD Phase 2 will modify the dry feeds system and connect SPF to new larger capacity salt solution feed receipt tanks. Lastly, modifications that support converting from the present day-shift staffing to 24/7 operations are planned.

The SDF will contain several large concrete SDUs. Each of the SDUs will be filled with solid Saltstone grout. The grout itself provides primary containment of the waste, and the walls, floor, and roof of the SDUs provide secondary containment.

Approximately 15 feet of overburden were removed to prepare and level the site for SDU construction. All SDUs 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 run-off controls are installed to minimize site erosion during the operational period.

The first SDU (Vault 1), ~100 feet by 600 feet by 25 feet high, is divided into six cells. The second SDU (Vault 4), ~200 feet by 600 feet 26 feet high, has twelve cells. No more contaminated grout is planned for these SDUs.

SDU-2 (which is full), SDU-3, and SDU-5 (currently in use), have two cells, each being 150 feet diameter by 22 feet high. 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 2,300 kgal. Recent operating experience averages 1.76 gallons of grout produced for each gallon of DSS feed, yielding a nominal cell capacity of approximately 1,300 kgal of DSS.



The next generation of units, beginning with SDU-6 will be a 375-foot diameter 43-foot tall single-cell design. SDU-6, with a 32 Mgal capacity, will hold 30 Mgal of contaminated grout or 17.1 Mgal of DSS feed plus a clean cap. Future SDUs are assumed to have a design similar to SDU-6.

Closure operations will begin near the end of the active disposal period in the SDF, i.e., after most or all of the SDUs have been constructed and filled. Backfill of native soil will be placed around the SDUs. 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 vaults were completed between February 1986 and July 1988. The SDF started radioactive operations June 12, 1990. SDU-2, construction complete in June 2012, began filling in September 2012 and completed filling in July 2014. SDU-3 and SDU-5 were construction complete in September 2013 and SDU-5 began filling in October 2013. The large SDU-6 construction began in December 2013. Future SDUs will be constructed on a “just-in-time” basis in coordination with salt processing production rates.

Figure 7-2 — *Process Flowsheet*

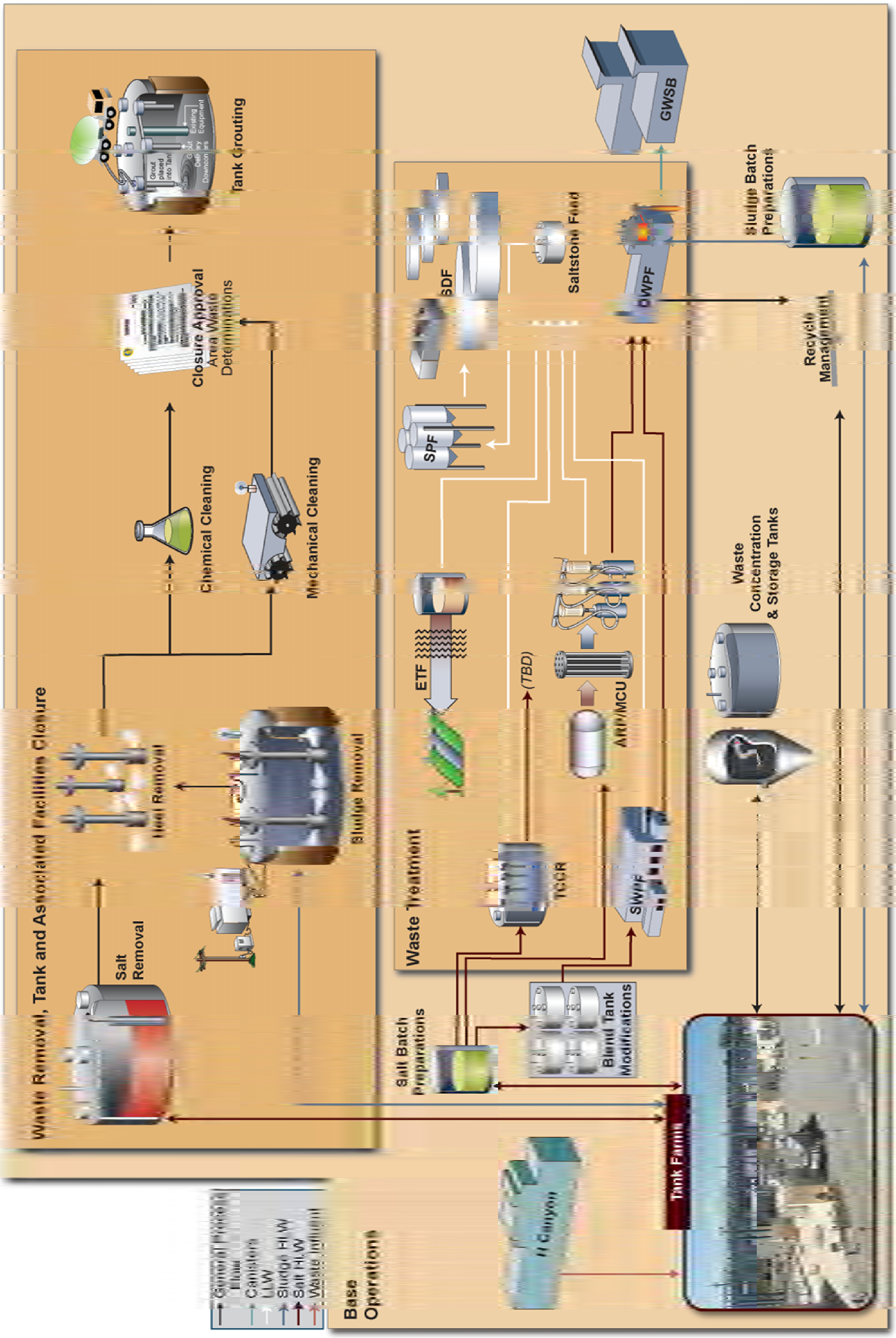
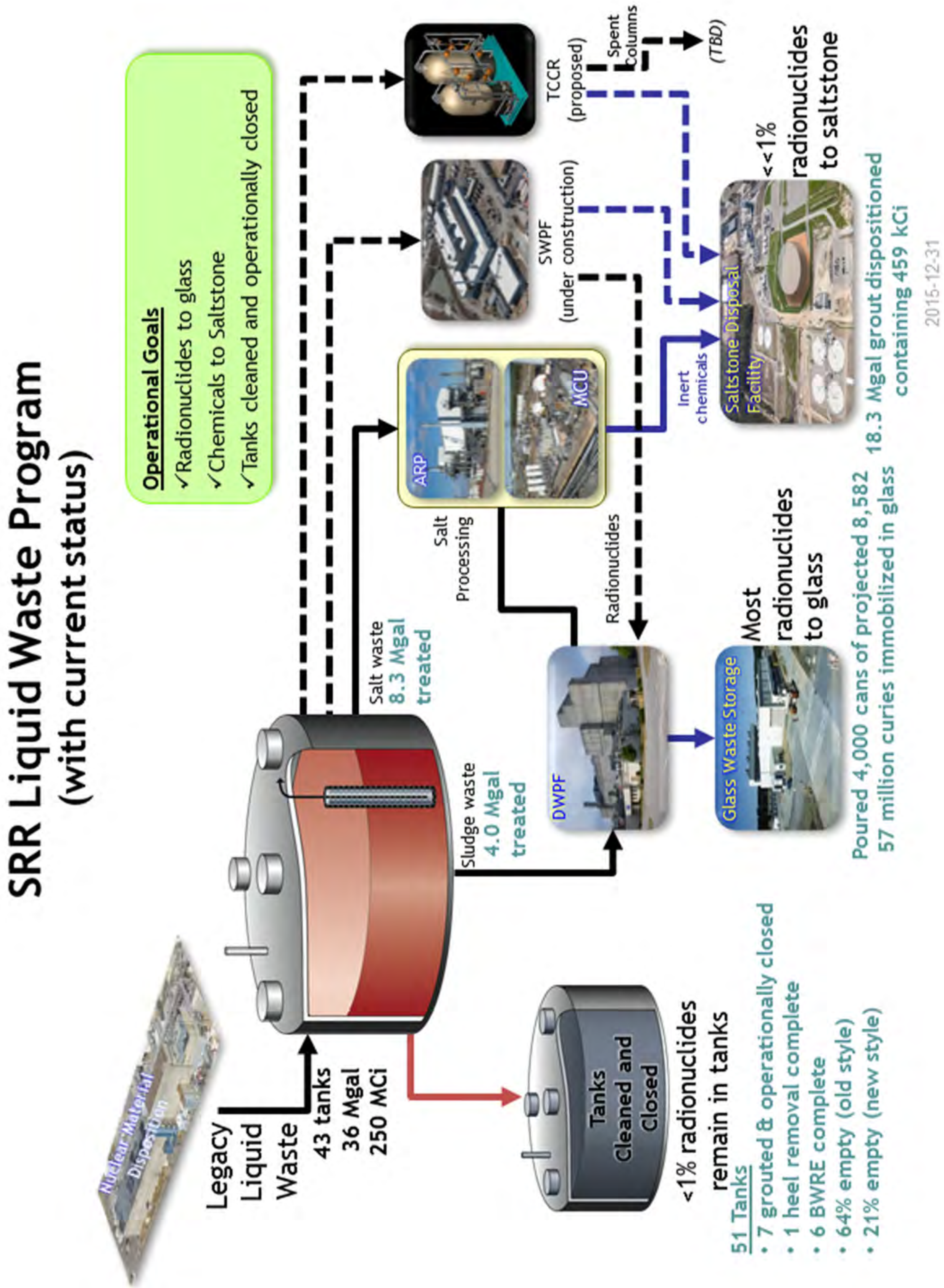


Figure 7-3 — *Liquid Waste Program — Current Status*



Case 1: Appendix A — *Canister Storage*

End of Fiscal Year	SRS Cans Poured		SRS Cans in GWSB #1 (4,521 capacity)[a]		SRS Cans in GWSB #2 (2,339 capacity)[b]		SRS Cans in Supplemental Storage[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	*192*	*2,987*	*3*	*2,244*	*183*	*737*	[d]	*6*
FY11	*264*	*3,251*		*2,244*	*260*	*997*		*10*
FY12	*277*	*3,528*		*2,244*	*277*	*1,269*		*15*
FY13	*224*	*3,752*		*2,244*	*224*	*1,493*		*15*
FY14	*125*	*3,877*		*2,244*	*125*	*1,629*		*4*
FY15	*93*	*3,970*	*(193)*	*2,051*	*281*	*1,910*		*9*
FY16	150	4,120	(150)	1,901	300	2,210		
FY17	90	4,210		1,901	90	2,300		
FY18	117	4,327	78	1,979	39	2,339		
FY19	166	4,493	166	2,145		2,339		
FY20	248	4,741	300	2,445	(52)	2,287		
FY21	264	5,005	300	2,745	(36)	2,251		
FY22	198	5,203	300	3,045	(102)	2,149		
FY23	264	5,467	300	3,345	(36)	2,113		
FY24	264	5,731	300	3,645	(36)	2,077		
FY25	180	5,911	300	3,945	(120)	1,957		
FY26	288	6,199	300	4,245	(12)	1,945		
FY27	288	6,487	276	4,521	12	1,957		
FY28	288	6,775		4,521	288	2,245		
FY29	288	7,063		4,521	94	2,339	194	194
FY30	282	7,345		4,521		2,339	282	476
FY31	264	7,609		4,521		2,339	264	740
FY32	264	7,873		4,521		2,339	264	1,004
FY33	60	7,933		4,521		2,339	60	1,064
FY34	120	8,053		4,521		2,339	120	1,184
FY35	60	8,113		4,521		2,339	60	1,244
FY36	57	8,170		4,521		2,339	66	1,310

Numbers in italics are actuals — through FY15. FY16 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 locations. Beginning in FY15, 293 canisters will be moved to GWSB #2 to enable conversion of GWSB #1 for stacking two canisters in each storage location yielding a 4,521 radioactive canister capacity. When conversion is complete, canisters will be moved from GWSB #2 to GWSB #1.

[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 FY29. Note: its design does not accomodate stacking canisters.

[c] This *Plan* assumes supplemental canister storage is available in FY29.

[d] Typically, several canisters are in the vitirification building pending transfer to canister storage. All cans will be transferred to canister storage before the DWPF is cleaned and flushed.

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

Case 1: Appendix B — *Salt Solution Processing*

End of	Salt Solution (kgal)					to Tank 50 (kgal)				Tank 50	SDU
Fiscal Year	DDA-solely	ARP/MCU	TCCR	SWPF	Total [a]	DSS	H-Can	512-S	ETP	to SPF	Numbers [c]
Total as of end of FY10	2,800	980			3,780	3,151	682		3,019	3,881	4
FY11		1,063			1,063	1,487	200		64	1,487	4
FY12		706			706	901	19		24	1,252	4 & 2
FY13		1,317			1,317	1,566	24	65	69	2,005	2
FY14		551			551	697	15	12	47	1,167	2– 5
FY15		752			752	919	12	18	45	828	3 & 5
FY16		1,500			1,500	1,800	16	-	96	1,500	3 & 5
FY17		995			995	1,193	30	-	96	1,896	3 & 5
FY18		1,496	779		2,275	2,574	30	-	96	2,700	3 –6
FY19		175		3,854	4,029	5,161	30	-	96	5,287	6
FY20				6,771	6,771	8,677	30	-	96	8,803	6
FY21				7,200	7,200	9,227	30	-	96	9,353	6–7
FY22				6,750	6,750	8,650	30	-	96	8,776	7
FY23				9,000	9,000	11,534	30	-	96	11,660	7–8
FY24				9,000	9,000	11,534	30	-	96	11,660	8–9
FY25				6,000	6,000	7,689	30	-	96	7,815	9
FY26				9,000	9,000	11,534	18	-	96	11,648	9–10
FY27				9,000	9,000	11,534		-	96	11,630	10–11
FY28				9,000	9,000	11,534		-	96	11,630	11
FY29				9,000	9,000	11,534		-	96	11,630	11–12
FY30				9,000	9,000	11,534		-	96	11,630	12–13
FY31				8,000	8,000	10,252		-	96	10,348	13
FY32				8,000	8,000	10,252		-	96	10,348	13–14
FY33					-	-		-	-	-	14
Total	**2,800**	**9,536**	**779**	**109,575**	**122,690**	**154,930**	**1,256**		**4,898**	**158,932**	

[a] *Salt Solution* is a total of salt solution treated via the DDA-solely, ARP/MCU, TCCR, and SWPF processes. Each gallon of salt solution treated via ARP/MCU yields ~1.2 gal of DSS, ~1.28 gallons for SWPF and ~1 gallon for TCCR.

[b] LLW receipts to Tank 50 include the DSS from salt processing, LLW from H-Canyon, ARP (512-S) filter cleaning discards, and the ETP low level stream.

[c]
- SDU-2 (being full), SDU-1, and SDU-4, are no longer planned to receive contaminated grout
- SDU-3 and SDU-5 have two ~2.9-Mgal cylindrical cells, each capable of receiving ~1.3 Mgal of Tank 50 DSS
- SDU-6 is a single 32 Mgal cylindrical cell, capable of receiving ~17 Mgal of DSS to produce 30 Mgal of radioactive grout
- Future SDUs are assumed to have a similar design to SDU-6.
- Each gallon of Tank 50 feed, when added to the cement, flyash, and slag, generates approximately 1.76 gallons of grout
- Bleed water recycling consumes 5% of the vault space, reducing the available space for feed solution.

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

Case 1: Appendix C — *Tank Farm Influents and Effluents*

End of Fiscal Year	Influents (kgal)						Effluents (kgal)		Total Inventory[e]
	H-Canyon[a]			DWPF					
	HLW	LLW	Other Mat'l[b]	Recycle[c]	299-H	ETF	DSS to SPF	Sludge to DWPF	
FY16	200	30	-	1,256	12	96	1,500	166	32,608
FY17	200	30	-	898	12	96	1,896	126	31,923
FY18	300	30	-	1,085	12	96	2,700	88	30,911
FY19	300	30	-	1,581	12	96	5,287	172	30,613
FY20	300	30	-	2,269	12	96	8,803	214	29,290
FY21	300	30		2,393	12	96	9,353	272	26,490
FY22	300	30		2,009	12	96	8,776	201	26,101
FY23	300	30		2,567	12	96	11,660	266	24,066
FY24	300	30		2,567	12	96	11,660	271	20,993
FY25	300	30		1,844	12	96	7,815	180	21,424
FY26	50	18		2,690	12	96	11,648	268	18,537
FY27	-	-		2,690	d	96	11,630	268	17,582
FY28				2,690		96	11,630	268	15,148
FY29				2,690		96	11,630	268	13,400
FY30				2,659		96	11,630	280	8,887
FY31				2,470		96	10,348	319	8,257
FY32				2,470		96	10,348	296	2,923
FY33						96	-	182	2,490
FY34						96	-	250	2,131
FY35						96	-	-	702
FY36						96	-	118	650
FY37						96	-	44	-
FY38							-		

[a] H-Canyon receipts are based on *Revised Projected High Level Liquid Waste (HLLW) Volumes Limitations, (Letter Lovett to Temple, Projected HLLW Volumes Limitations, 07/15/14)*[21] with shutdown flow volume as outlined in *H-Canyon Liquid Waste Generation Forecast For H-Tank Farm Transfer*[22] in FY26.

- LW is the main component of H-Canyon waste and is received into Tank 39
- LLW consists primarily of GPE concentrate received in Tank 50

[b] Various nuclear materials, including plutonium, uranium, neptunium, etc., from H-Canyon may be introduced directly into sludge batches, via either the sludge preparation tank (Tank 51) or the DWPF feed tank (Tank 40) to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with the canister fissile material concentration limits. The H-Canyon forecast for these materials will be included in future versions of this *Plan*, as it is made available.

[c] DWPF Recycle receipts reflect modifications made in the DWPF to reduce recycle. Additionally, DWPF recycle is beneficially reused to minimize IW addition required for salt dissolution and molarity adjustments within the Tank Farms.

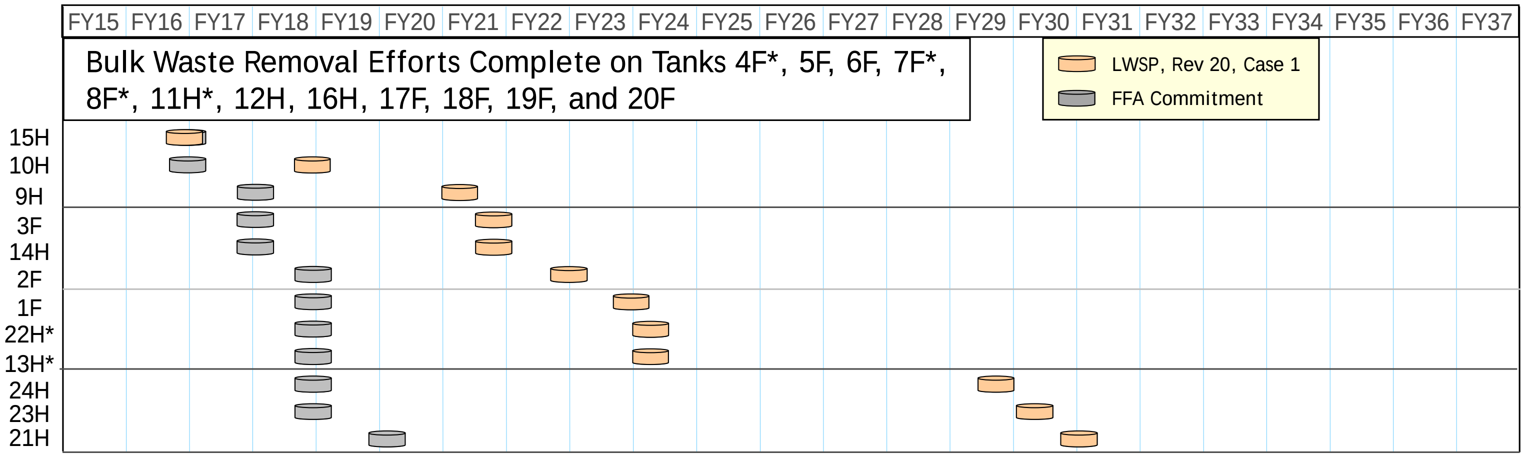
[d] Maintenance Facility (299-H) receipts mainly consists of dilute nitric acid stream, decon solutions, and steam condensate. These waste streams from decontaminating equipment are collected in the 299-H pump tank, neutralized, and sent to Tank 39. Since utilities are provided by H-Canyon, when it is shut down, maintenance activities will be performed in the DWPF maintenance cell.

[e] 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 LW from tank to tank. Volume from the transfer steam accounts for 4% of the volume being transferred for intra-area transfers and 6% for IAL. 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.

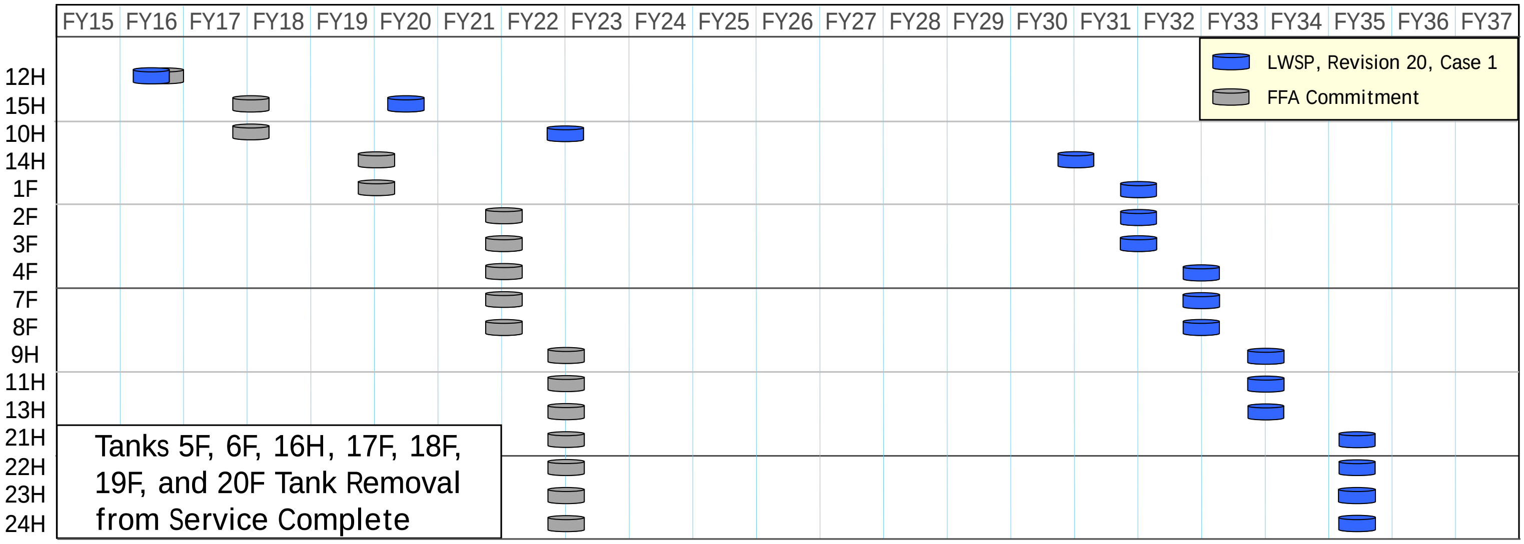
Case 1: Appendix D — *Type I, II, & IV Tanks BWRE & Removal from Service*

Bulk Waste Removal Efforts



*These tanks are planned to receive and store material after completion of BWRE (see §4.6.6 — *Managing Type III Tank Space*).

Tank Removal from Service



Note: Tank 10 and 15 as shown are not currently within the funding profile. Without additional funding Tank 10 closure could be delayed by as much as 12 years and Tank 15 by as much as 10 years within the current assumptions and forecast.

Case 1: Appendix E — *LW System Plan — Revision 20 Summary*

(see attached foldout chart)

Case 1: Appendix F — *Sludge Processing*

Sludge Batch	Source Tanks [a]	Projected SOL (weight %)	Actual Cans @ Projected SOL	Date Batch Finished @ Projected SOL[b]
Actual canisters poured through December 2015 (Sludge Batches 1 through 8)			4,000	
SB8 (to completion)	13, 12 Heel Removal	36%	35	Feb 2016
SB9	13, 12 Chemical Cleaning, 22 (solids from DWPF)	36%	175	Jun 2017
DWPF Melter Replacement — July 2017 thru December 2017 (with SWPF Tie-ins)				
SB9 (to completion)	(cont'd)	36%	26	Feb 2018
SB10	22 Solids from DWPF, 15 (via 13) (HM HAW), LTAD, 26 (PUREX); Iron	36%	417	May 2020
SB11	14, 15 (via 13) (HM HAW), 35 (HM HAW), LTAD, 26 (PUREX)	36%	352	Sep 2021
Next Generation Solvent Outage for SWPF — October 2021 thru December 2021				
SB11 (to completion)	(cont'd)	36%	44	Feb 2022
SB12	22 Solids from DWPF, 35 (HM HAW), LTAD, 34 (PUREX)	36%	396	Aug 2023
SB13	22 Solids from DWPF, 39 (HM HAW), LTAD, Sludge Modifier (Iron)	40%	418	Mar 2025
SB14	22 Solids from DWPF, 35 (HM HAW plus DWPF Solids), 39 (HM HAW), 33 (PUREX), Sludge Modifier (Iron)	40%	48	May 2025
DWPF Melter Replacement — June 2025 thru September 2025				
SB14 (to completion)	(cont'd)	40%	288	Sep 2026
SB15	35 (Incl 42 HM HAW plus DWPF Solids), 39 (Incl 32) (HM HAW), 33, 47 (PUREX), 22 Solids from DWPF, 24 Zeolite, Sludge Modifier (Iron)	40%	360	Dec 2027
SB16	35 (HM HAW plus DWPF Solids), 39 (Incl 32) (HM HAW), 33, 47 (PUREX)	40%	360	Mar 2029
SB17	35 (HM HAW plus DWPF Solids), 39 (Incl Zeolite From 24, 32), 33 (PUREX),	40%	360	Jun 2030
SB18	39 (Incl MST from 21, 32), 33 (PUREX), 43H (HM LAW)	36%	330	Sep 2031
SB19	35 (HM HAW plus DWPF Solids), 39 (Incl 32 HM HAW, 43 HM LAW), 33 (PUREX), Sludge Modifier (Iron)	36%	284	Jan 2033
SB20	35, 39 (32, 42, 43), (Mixed HM HAW, HM LAW), 33 (PUREX), Sludge Modifier (Iron)	36%	40	May 2033
DWPF Melter Replacement — June 2033 thru September 2033				
SB20 (to completion)	(cont'd)	36%	120	Sep 2034
Outage to collect and prepare final heels in Tank 40 - October 2034 thru March 2036				
SB21 (Heel Batch in Tk40)	43 (incl 33, 35, 51, 39 Heels) (Mixed HM HAW, HM LAW)	32%	60	Sep 2036
SB22 Tk40 Clean and Flush	40 Heel Flush Material	30%	57	Mar 2037
			8,170	

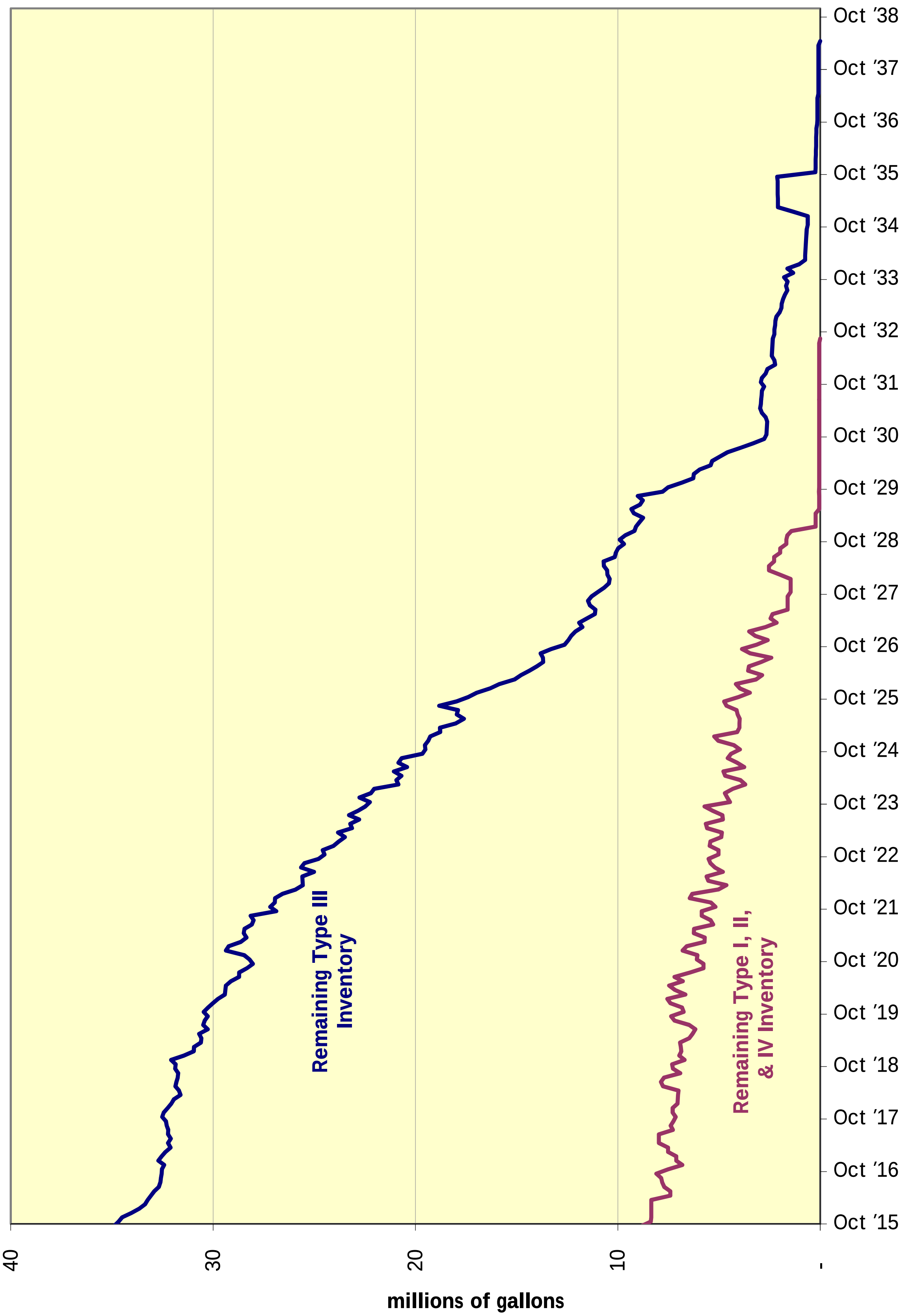
[a] The indicated tanks are the sources of the major components of each sludge batch, not necessarily the sludge location just prior to receipt for sludge washing. Tanks 33 and 35, for example, are also used to stage sludge that is removed from other tanks. Some BWRE may be accelerated with respect to this table as conditions dictate.

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

[c] Longer processing assumed for dilute heel processing

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

<u>Case 1: Appendix G — *Remaining Tank Inventory*</u>



Case 3: Appendix A — *Canister Storage*

End of Fiscal Year	SRS Cans Poured		SRS Cans in GWSB #1 (4,521 capacity)[a]		SRS Cans in GWSB #2 (2,339 capacity)[b]		SRS Cans in Supplemental Storage [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	192	2,987	3	2,244	183	737	[d]	6
FY11	264	3,251		2,244	260	997		10
FY12	277	3,528		2,244	277	1,269		15
FY13	224	3,752		2,244	224	1,493		15
FY14	125	3,877		2,244	125	1,629		4
FY15	93	3,970	(193)	2,051	281	1,910		9
FY16	156	4,126	(150)	1,901	306	2,216		
FY17	143	4,269	20	1,921	123	2,339		
FY18	78	4,347	78	1,999		2,339		
FY19	166	4,513	166	2,165		2,339		
FY20	248	4,761	248	2,413		2,339		
FY21	198	4,959	198	2,611		2,339		
FY22	264	5,223	264	2,875		2,339		
FY23	264	5,487	264	3,139		2,339		
FY24	264	5,751	264	3,403		2,339		
FY25	176	5,927	176	3,579		2,339		
FY26	264	6,191	264	3,843		2,339		
FY27	264	6,455	264	4,107		2,339		
FY28	264	6,719	264	4,371		2,339		
FY29	264	6,983	150	4,521		2,339	114	114
FY30	258	7,241		4,521		2,339	258	372
FY31	264	7,505		4,521		2,339	264	636
FY32	216	7,721		4,521		2,339	216	852
FY33	132	7,853		4,521		2,339	132	984
FY34	180	8,033		4,521		2,339	180	1,164
FY35	120	8,153		4,521		2,339	120	1,284
FY36	57	8,210		4,521		2,339	57	1,341
FY37		8,210		4,521		2,339	9	1,350
FY38		8,210		4,521		2,339		1,350

Numbers in italics are actuals — through FY13. FY14 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 locations. Beginning in FY15, 293 canisters will be moved to GWSB #2 to enable conversion of GWSB #1 for stacking two canisters in each storage location yielding a 4,521 radioactive canister capacity. When conversion is complete, canisters will be moved from GWSB #2 to GWSB #1.

[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 FY29. Note: its design does not accomodate stacking canisters.

[c] This *Plan* assumes supplemental canister storage is available in FY29.

[d] Typically, several canisters are in the vitirification building pending transfer to canister storage. All cans will be transferred to canister storage before the DWPF is cleaned and flushed.

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

Case 3: Appendix B — *Salt Solution Processing*

End of	Salt Solution (kgal)						to Tank 50 (kgal)				Tank 50	SDU
Fiscal Year	DDA-solely	ARP/MCU	H-TCCR	F-TCCR	SWPF	Total [a]	DSS	H-Can	512-S/Tk48	ETP	to SPF	Numbers [c]
Total as of end of FY10	2,800	980				3,780	3,151	682		3,019	3,881	4
FY11		1,063				1,063	1,487	200		64	1,487	4
FY12		706				706	901	19		24	1,252	4 & 2
FY13		1,317				1,317	1,566	24	65	69	2,005	2
FY14		551				551	697	15	12	47	1,167	2– 5
FY15		841				841	1,067	10	23	30	1,200	3 & 5
FY16		1,504				1,504	1,909	16		96	1,950	3 & 5
FY17		1,377				1,377	1,747	16		96	1,859	3 –6
FY18		1,003	886			1,889	2,159	16		96	2,270	6
FY19		300	1,011	1,000	3,854	6,166	7,331	16		96	7,443	6
FY20			1,011	1,000	6,771	8,782	10,688	16		96	10,800	6–7
FY21			1,263	1,000	6,750	9,013	10,914	16		96	11,025	7
FY22			935	1,000	9,000	10,935	13,469	16		96	13,580	7–8
FY23			208	1,000	9,000	10,208	12,742	16		96	12,854	8–9
FY24				1,000	9,000	10,000	12,534	16		96	12,645	9–10
FY25				500	6,000	6,500	8,189	16	150	96	8,451	10
FY26					9,000	9,000	11,534	18	150	96	11,798	10–11
FY27					9,000	9,000	11,534			96	11,630	11–12
FY28					8,000	8,000	10,252			96	10,348	12
FY29					8,000	8,000	10,252			96	10,348	12–13
FY30					7,767	7,767	9,954			96	10,050	13
Total	**2,800**	**9,643**	**5,316**	**6,500**	**92,142**	**116,401**	**144,073**	**1,125**		**4,692**	**148,043**	

[a] *Salt Solution* is a total of salt solution treated via the DDA-solely, ARP/MCU, TCCR, and SWPF processes. Each gallon of salt solution treated via ARP/MCU yields ~1.2 gal of DSS, ~1.28 gallons for SWPF and ~1 gallon for TCCR.

[b] LLW receipts to Tank 50 include the DSS from salt processing, LLW from H-Canyon, ARP (512-S) filter cleaning discards, and the ETP low level stream.

[c]
- SDU-2 (being full), SDU-1, and SDU-4, are no longer planned to receive contaminated grout
- SDU-3 and SDU-5 have two ~2.9-Mgal cylindrical cells, each capable of receiving ~1.3 Mgal of Tank 50 DSS
- SDU-6 is a single 32 Mgal cylindrical cell, capable of receiving ~17 Mgal of DSS to produce 30 Mgal of radioactive grout
- Future SDUs are assumed to have a similar design to SDU-6.
- Each gallon of Tank 50 feed, when added to the cement, flyash, and slag, generates approximately 1.76 gallons of grout
- Bleed water recycling consumes 5% of the vault space, reducing the available space for feed solution.

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

Case 3: Appendix C — *Tank Farm Influents and Effluents*

End of Fiscal Year	Influents (kgal) H-Canyon[a] HLW	Influents (kgal) H-Canyon[a] LLW	Influents (kgal) H-Canyon[a] Other Mat'l[b]	Influents (kgal) DWPF Recycle[c]	Influents (kgal) 299-H	Influents (kgal) ETF	Effluents (kgal) DSS to SPF	Effluents (kgal) Sludge to DWPF	Total Inventory[e]
FY16	200	18	-	1,286	12	96	1,950	166	**32,546**
FY17	200	18	-	1,207	12	96	1,859	126	**32,337**
FY18	300	18	-	836	12	96	2,270	217	**31,875**
FY19	300	18	-	1,597	12	96	7,443	420	**30,264**
FY20	300	18	-	2,269	12	96	10,800	378	**28,033**
FY21	300	18		2,009	12	96	11,025	258	**26,881**
FY22	300	18		2,567	12	96	13,580	196	**24,790**
FY23	300	18		2,567	12	96	12,854	311	**22,486**
FY24	300	18		2,567	12	96	12,645	372	**19,658**
FY25	300	18		1,824	12	96	8,451	273	**17,967**
FY26	50	18		2,567	12	96	11,798	402	**13,306**
FY27	-	-		2,567	d	96	11,630	404	**11,295**
FY28				2,470		96	10,348	422	**9,704**
FY29				2,470		96	10,348	438	**7,778**
FY30				1,441		96	10,050	446	**2,772**
FY31						96	-	448	**2,772**
FY32						96	-	453	**2,268**
FY33						96	-	-	**1,612**
FY34							-	132	**671**
FY35							-	55	**2,132**
FY36							-		**145**
FY37							-		**-**

[a] H-Canyon receipts are based on *Revised Projected High Level Liquid Waste (HLLW) Volumes Limitations, (Letter Lovett to Temple, Projected HLLW Volumes Limitations, 07/15/14)*[21] with shutdown flow volume as outlined in *H-Canyon Liquid Waste Generation Forecast For H-Tank Farm Transfer*[22] in FY26.

- LW is the main component of H-Canyon waste and is received into Tank 39
- LLW consists primarily of GPE concentrate received in Tank 50

[b] Various nuclear materials, including plutonium, uranium, neptunium, etc., from H-Canyon may be introduced directly into sludge batches, via either the sludge preparation tank (Tank 51) or the DWPF feed tank (Tank 40) to the extent allowable without negatively impacting planned canister waste loadings while continuing to comply with the canister fissile material concentration limits. The H-Canyon forecast for these materials will be included in future versions of this *Plan*, as it is made available.

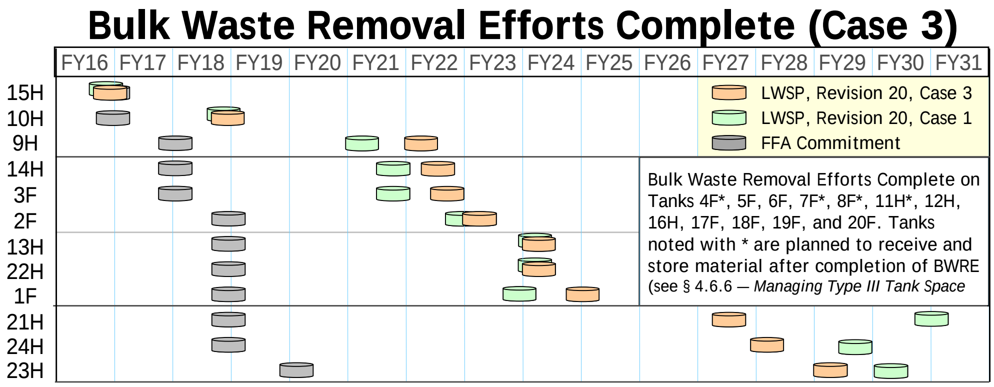
[c] DWPF Recycle receipts reflect modifications made in the DWPF to reduce recycle. Additionally, DWPF recycle is beneficially reused to minimize IW addition required for salt dissolution and molarity adjustments within the Tank Farms.

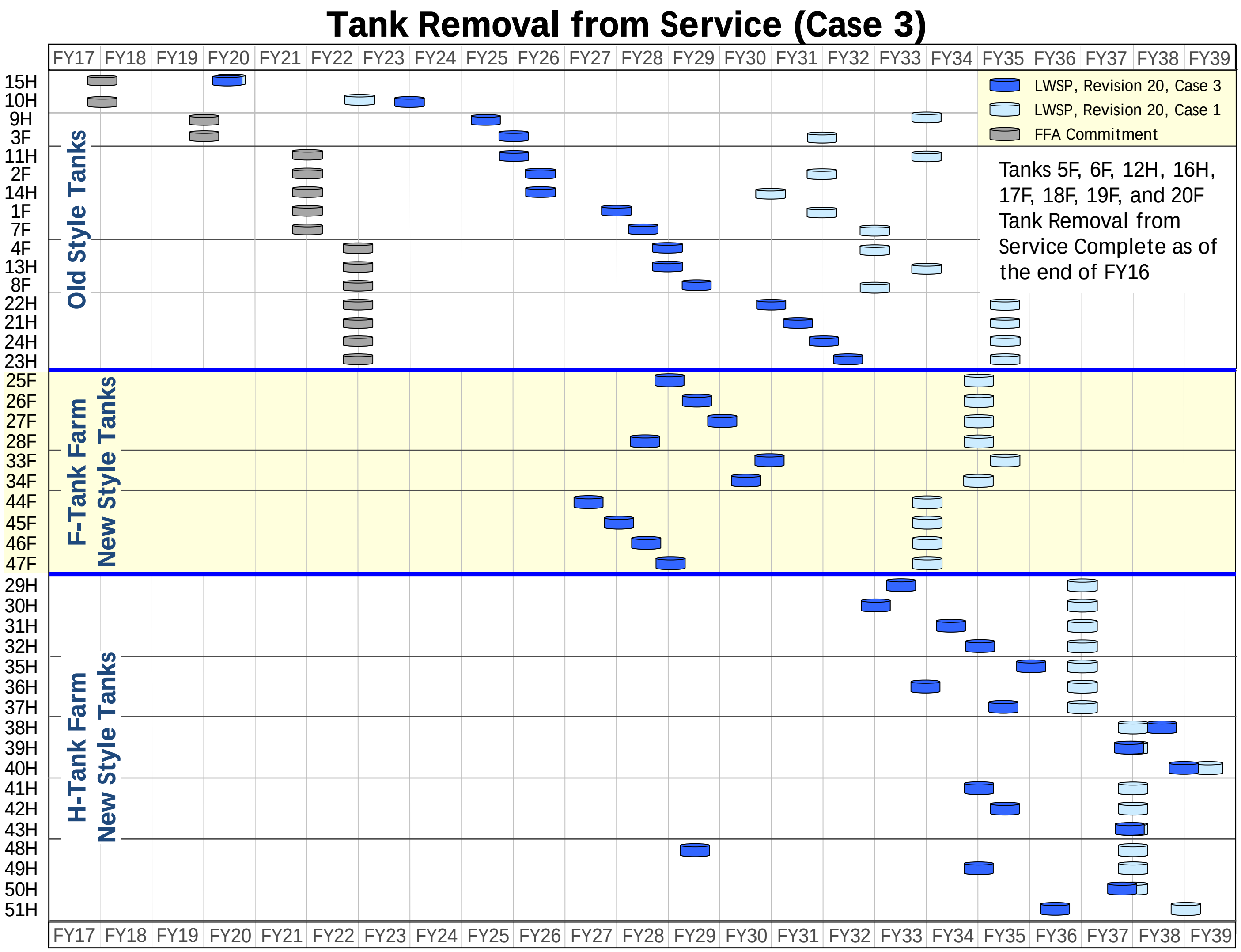
[d] Maintenance Facility (299-H) receipts mainly consists of dilute nitric acid stream, decon solutions, and steam condensate. These waste streams from decontaminating equipment are collected in the 299-H pump tank, neutralized, and sent to Tank 39. Since utilities are provided by H-Canyon, when it is shut down, maintenance activities will be performed in the DWPF maintenance cell.

[e] 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 LW from tank to tank. Volume from the transfer steam accounts for 4% of the volume being transferred for intra-area transfers and 6% for IAL. 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.

Case 3: Appendix D — *BWRE & Removal from Service*





<u>Case 3: Appendix E — *LW System Plan — Revision 20 Summary*</u>

(see attached foldout chart)

Acronyms

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
BWRE **Bulk Waste Removal Efforts**
Ci/gal Curies per gallon
CM **Closure Module**
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.
D&D **Dismantlement and Decommissioning**
DDA **Deliquification, Dissolution, and Adjustment**
DF **decontamination factor**
DNFSB **Defense Nuclear Facilities Safety Board**
DOE **Department of Energy**
DOE-SR The **DOE Savannah River** Operations Office
DSS **Decontaminated Salt Solution –** the decontaminated stream from any of the salt processes – DDA, ARP/MCU, or SWPF
DWPF **Defense Waste Processing Facility –** SRS facility in which LW is vitrified (turned into glass)
DWS **Dissolution Water Skid**
EA **Environmental Assessment**
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
FESV **Failed Equipment Storage Vault**
FTF **F-Tank Farm**
FY **Fiscal 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
GWSP **Glass Waste Storage Project**
HLW **High Level Waste**
HM **H Modified** – the modified PUREX process in H-Canyon for separation of special nuclear materials and enriched uranium
HTF **H-Tank Farm**
IAL **Inter-Area Line**
IPABS **Integrated Planning, Accountability, & Budgeting System**
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**
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**
MST **monosodium titanate**
NDAA Ronald W. Reagan **National Defense Authorization Act** for Fiscal Year 2005, Public Law 108-375
NDAA §3116 **Section 3116** – Defense Site Acceleration Completion — of the **NDAA**
NEPA **National Environmental Policy Act**
NGS **Next Generation Solvent**
NPDES **National Pollution Discharge Elimination Systems**
NRC **Nuclear Regulatory Commission**
OA **Oxalic Acid**
PA **Performance Assessment**
PEIS **Programmatic Environmental Impact Statement**
PUREX **Plutonium Uranium Reduction Extraction**
RCRA **Resource Conservation and Recovery Act**
ROMP **Risk** and **Opportunity Management Plan**
SAS **Steam Atomized Scrubber**
SB **Sludge Batch**
SC **Safety Class**
SCD **Semi-Continuous Dissolution**
SCDHEC **South Carolina Department of Health and Environmental Control** – state

agency that regulates hazardous wastes at SRS

SDI **Salt Disposition Initiative**

SDF **Saltstone Disposal Facility** – SRS facility containing Saltstone Disposal Units

SDU **Saltstone Disposal Units** – Disposal Units that receive wet grout from SPF, where it cures into a solid, non-hazardous Saltstone

SE **Strip Effluent**

SEIS **Supplemental Environmental Impact Statement**

SME **Slurry Mix Evaporator**

SMP **Submersible Mixer Pump**

SOL **Solids 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**

SS **Safety Significant**

SSC **Structure, System, or Component**

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

WAC **Waste Acceptance Criteria**

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**

wt% **weight percent**

References

[1] Chew, D.P & Hamm, B.A., SRR-LWP-2009-00001, *Liquid Waste System Plan*, Revision 19, May 2014

[2] WDPD-15-54, C.N. Smith to J.J. Bair, *SRR Contract DE-AC09-09SR22505 - Revised Key Inputs and Assumptions for the Development of System Plan Revision 20*, September 2015

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

[4] Dickert, V.G., CBU-SPT-2004-00041, *Progress in Implementation of Common Goals and Values*, February 2004

[5] WSRC-OS-94-42, *Federal Facility Agreement for the Savannah River Site*, August 1993, as amended through March 2010

[6] SRNS-TR-2008-00101, *Savannah River Site Approved Site Treatment Plan, 2011 Annual Update*, Revision 3, November 2011

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

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

[9] Chu, S, DOE-WD-2012-001, *Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*, Revision 0, March 2012

[10] DOE/SRS-WD-2012-001, *Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site*, Revision 0, March 2012

[11] Moniz, E.J., DOE-WD-2014-001, *Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*, Revision 0, December 2014

[12] DOE/SRS-WD-2014-001, *Basis for Section 3116 Determination for Closure of H-Tank Farm at the Savannah River Site*, Revision 0, December 2014

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

[14] Kent M. Coleman, P.G., to Dr. David C. Moody, *Savannah River Site Z-Area Saltstone Disposal Facility Permit Facility ID No. 02550-1603 Aiken County*, August 2011

[15] Mansfield, J.E. to Chu, S, January 7, 2010

[16] Winship, G.C., Y-RAR-G-00022, *PBS-SR-0014, Radioactive Liquid Tank Waste Stabilization and Disposition, Risk and Opportunity Management Plan*, Revision 11, Draft 2016

[17] FFA Appendix L, Statements of Dispute Resolution, *Statement of Resolution of Dispute Concerning Extension of Closure Dates for Savannah River Site High-Level Radioactive Waste Tanks 19 and 18*, November 2007, and amendments

[18] FFA Appendix L, Statements of Dispute Resolution, *Statement of Resolution of Dispute Concerning Extension of Federal Facility Agreement (FFA) Closure Date*, April 2015

[19] Gillam, J.M. and Shafer, A.R., SRR-LWP-2016-00006., *Sludge Batch Plan in Support of System Plan Revision 20*, Draft, 2016

[20] Le, T.A., SRR-LWP-2016-00005, *Salt Batch Plan in Support of System Plan R-20*, Draft, 2016

[21] AMNMS-15-000 I, J. Lovett, Jr. to J. W. Temple, *Revised Projected High Level Liquid Waste (HLLW) Volumes Limitations, (Letter Lovett to Temple, Projected HLLW Volumes Limitations, 07/15/14)*, October 2014

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

---

[23] Folk, J.L., WDPD-10-84, *Request to Store Supernate in Tank 8 After Completion of Bulk Waste Removal Efforts*, September 2010

[24] R.H. Pope to B.T. Hennessey, March 7, 2013

[25] P.G. Van Keisler to B.T. Hennessey, *Letter, Hennessey to Keisler and Pope, Approval for Continued Usage of High Level Waste Tanks 7F and 11H, dated March 1, 2013*, March 7, 2013

[26] Birk, M.B., LWO-RIP-2009-00009, *Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems, Industrial Wastewater Construction Permit #17424-IW*, Revision 3, January 2011

[27] Birk, M.B., SRR-CWDA-2011-00022, *Industrial Wastewater General Closure Plan for H-Area Waste Tank Systems*, Revision 0, May 2012

[28] MGR-10-037, *Fissile Limits in Defense Waste Processing Facility Canisters*, April 2010

[29] X-ESR-J-00001, *Waste Acceptance Criteria*, Revision 1, September 2009

[30] Lynn, J., SRR-LWP-2016-00004, *12/31/2015–December 2015 Curie and Volume Inventory Report*, Revision 0, January 2016

[31] Waltz, R. S., Jr., C-ESR-G-00003, *SRS High Level Waste Tank Crack and Leak Information*, Revision 13, October 2015

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

DOE-SR
J. L. Folk, Jr., 704-S (40)
J. L. Reynolds, 703-41A

SRR-Sr. Staff
G. G. Campbell, 766-H
L. T. Ling, 766-H
M. A. Schmitz, 766-H

SRR-Staff
P. M. Allen, 766-H (7)
L. T. Blackford, 704-56H (10)
R. W. Blackmon, 766-H (5)
M. N. Borders, 704-56H (10)
S. P. Fairchild, 766-H (10)
J. K. Fortenberry, 766-H (10)
V. A. Franklin, 705-1C (10)
K. A. Hauer, 766-H (7)
A. K. Joslin, 766-H (5)
G. J. Matis, 704-S (10)
J. E. Rugg, 766-H (7)

SRNS
W. C. Clark, Jr, 703-H (5)
S. L. Marra, 773-A

DNFSB
D. L. Burnfield, 703-41A
D. M. Gutowski, DNFSB
Z. C. McCabe, 703-41A
M. T. Sautman, 703-41A
S. Sircar, DNFSB

File
ECATS (DOE), 730-1B
D. P. Chew (300), 766-H
Records Administration, 773-52A

SRR-LWP-2009-00001
March 2016

Case 1: Appendix E — LW System Plan — Revision 20, Summary

Case 3: Appendix E — LW System Plan — Revision 20, Summary

SRR-LWP-2009-00001
March 2016