SRR-CWDA-2017-00078
Revision 0

FY2017 ANNUAL REVIEW
SALTSTONE DISPOSAL FACILITY (Z AREA)
PERFORMANCE ASSESSMENT

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EXECUTIVE SUMMARY

The Saltstone Disposal Facility (SDF) presently consists of Saltstone Disposal Units (SDUs) 1, 2, 3, 4, 5, and 6 as described in the *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2009-00017), the *FY2013 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2013-00062), the *FY2014 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2014-00006), and the *FY2016 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2016-00072). Future SDUs are planned to be 375-foot diameter SDUs, similar to SDU 6 completed in 2017. The Performance Assessment (PA) establishes controls to govern waste operations and monitoring performance of the SDF. The mechanisms to demonstrate that operations are within the bounds of the Disposal Authorization Statement (DAS) (WDPD-12-49) and the PA are Waste Acceptance Criteria (WAC), an Unreviewed Waste Management Question (UWMQ) program, periodic inspections of disposal unit integrity, quarterly engineering evaluation of inventory and operations, and a comprehensive environmental monitoring program. [X-SD-Z-00001, Manual S4 Procedure ENG.46, SRR-CWDA-2013-00026, Manual SW24.6 Section 2.1, WSRC-TR-2005-00257] Data from these different areas is compared with the critical features, limits, and predictions of the PA to evaluate the performance of the previous fiscal year (FY). The performance evaluation conducted for FY2017 made the following determinations:

- The current performance evaluation conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, SDU Cells 5A/5B, and SDU 6 indicates SDF operations through FY2017 were within the performance expectations of the 2009 SDF PA, the FY2013 SDF Special Analysis (SA), the FY2014 SDF SA, and the FY2016 SDF SA.
- The total inventory of radionuclides accumulated in SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cell 3A and SDU Cells 5A/5B through FY2017 was within acceptable inventory values.
- One Unreviewed Waste Management Question Evaluation (UWMQE) was completed in FY2017 for the SDF. The UWMQE was entitled *Evaluation of Saltstone Disposal Unit 6 As-Built Conditions* (SRR-UWMQE-2017-00001). This UWMQE was generated to document the evaluation of SDU 6 as-build conditions against the 2009 SDF PA and supporting SDF SAs, the Composite Analysis (CA) (SRNL-STI-2009-00512) and the Salt Waste Determination (WD) Basis Document (DOE-WD-2005-001). This UWMQE was issued in March 2017.
- Research was completed in FY2017 with respect to several ongoing studies on properties considered critical to the performance of saltstone. A more in-depth discussion of on-going and future studies can be found in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2018 Implementation Plan*. [SRR-CWDA-2017-00096]
- The routine groundwater monitoring analytical results do not contradict the SDF modeling estimates.
- During FY2017, there were no discovered changes with impacts to the PA.

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ACRONYMS

BFS	Blast Furnace Slag
CA	Composite Analysis
CFR	U.S. Code of Federal Regulations
CY	Calendar Year
DAS	Disposal Authorization Statement
DLM	Dynamic Leaching Method
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FEP	Feature, Event, or Process
FY	Fiscal Year
GWPS	Groundwater Protection Standard
K_d	Distribution Coefficient
kCi	Kilocuries
LAZ	Lower Aquifer Zone
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
MOP	Member of the Public
NDAA	Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005
PA	Performance Assessment
PQL	Practical Quantitation Limit
R&D	Research and Development
SA	Special Analysis
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SHC	Saturated Hydraulic Conductivity
SPF	Saltstone Production Facility
SRNL	Savannah River National Laboratory
SRR	Savannah River Remediation LLC
SRS	Savannah River Site
TCCZ	Tan Clay Confining Zone
UTRA	Upper Three Runs Aquifer
UWMQ	Unreviewed Waste Management Question
UWMQE	Unreviewed Waste Management Question Evaluation
WAC	Waste Acceptance Criteria
WD	Waste Determination

1. PURPOSE OF REVIEW

The Saltstone Disposal Facility (SDF) is managed by Savannah River Remediation LLC (SRR) for the U. S. Department of Energy (DOE). The SDF Performance Assessment (PA) evaluates potential dose impact on a future, hypothetical member of the public (MOP), an inadvertent intruder, as well as impacts to the environment from the Low-Level Waste (LLW) disposal facility. [SRR-CWDA-2009-00017] In addition, the 2009 SDF PA demonstrates a reasonable expectation of compliance with pertinent performance objectives as identified in Chapter IV of DOE Manual 435.1-1 and Title 10, of the U.S. Code of Federal Regulations (CFR) Part 61, *Licensing Requirements for Land Disposal of Radioactive Waste,* Subpart C (10 CFR 61) as required by the *Ronald W. Reagan National Defense Authorization Act (NDAA) for Fiscal Year 2005,* Section 3116 (NDAA_3116).

The DOE, through DOE O 435.1, Chg. 1, requires an active maintenance program for the 2009 SDF PA. A maintenance program is required to continue to reduce uncertainty in the inputs and assumptions in order to provide greater confidence in the results of the analyses and in the long-term plans for public and environmental protection. Additionally, a disciplined process to address potential changes in disposal operations and/or discoveries (e.g., new waste forms, change in disposal unit design) is required to ensure that proposed changes do not adversely affect SDF performance. Another purpose of the PA maintenance program is to confirm the continued adequacy of the PA through annual reviews of the disposal facility activities. In accordance with the DOE Standard, *Disposal Authorization Statement and Tank Closure Documentation* (DOE-STD-5002-2017), the reviews evaluate and document that SDF operations comply with the Disposal Authorization Statement (DAS) (WDPD-12-49) and DOE O 435.1 requirements, and determine if the 2009 SDF PA remains valid or additional actions are required. A review of the 2009 SDF PA was conducted in a systematic manner that incorporates all of the following considerations.

1. Radionuclide inventories, waste volumes, and waste types - The review of waste radionuclide inventories and waste volumes includes a comparison of the actual waste receipts to the evaluated inventory.
2. Research and development (R&D) - The R&D activities are primarily documented in technical reports. The R&D activities are designed and funded to provide additional information for further reduction in the uncertainties associated with PAs results. In addition, Special Analyses (SAs) or Unreviewed Waste Management Question Evaluations (UWMQEs) may be conducted to provide new information or to understand impacts of potential or actual changes to the physical facility, operations, or disposal inventory.
3. PA monitoring - The current monitoring program (SRR-CWDA-2013-00026) includes sampling of the salt waste feed stream in Tank 50 to characterize inventory, evaluation of final waste form composition, periodic sampling of grout raw materials, and monitoring of groundwater to detect changing trends in performance. Physical inspections of structures ensure SDU conditions are consistent with model inputs. Monitoring of system parameters help ensure that the system produces a grout with physical and chemical properties that are consistent with that described in the PA.

All of these factors are reviewed annually to evaluate the need to conduct special studies or to prepare a revision of the 2009 SDF PA.

2. CHANGES POTENTIALLY AFFECTING THE PA, CA OR DAS

2.1 Special Analyses and Unreviewed Waste Management Question Evaluations

2.1.1 Special Analyses

In the first quarter of FY2017, the FY2016 SDF SA was issued. The FY2016 SDF SA was performed to reflect a change in the layout of the SDF in which SDUs 6, 7, 8, and 9 were relocated to reflect updated layout planning. The FY2016 SDF SA also update the model implementation of SDUs 6 and 7 to reflect the observed field conditions; and updated the model implementation of future SDUs (8 through 12) to incorporate lessons learned with respect to the observed conditions of SDU 6 and to provide additional design margins. Based on the observed conditions of SDU 6, additional changes were made to the future 375-foot diameter SDUs in the FY2016 SDF SA. Although the application of lessons learned is expected to reduce the extent of the cracking, SDUs 8 through 12 will be modeled with additional joints through the roof and floor. These additional joints were included to provide additional design margin or as explicit through-cracks to support construction observations. Alternatively, because SDU 7 is the next SDU to be constructed, proof-of-concept will not yet be available that the application of lessons learned will mitigate the extent of cracking through the roof and floor. Therefore, for conservatism, no credit will be taken for the application of the lessons learned; as such, SDU 7 will be modeled with the same properties as SDU 6 (i.e., a higher initial hydraulic conductivity for the roof and floor is assumed). The FY2016 SDF SA builds upon the 2009 SDF PA, the FY2013 SDF SA, and the FY2014 SDF SA and indicated a reduction in peak dose due to the location changes modeled. The changes evaluated by the SA indicate that the conclusions in the PA remain valid.

2.1.2 Unreviewed Waste Management Question Evaluations

One UWMQEs was completed in FY2017 for the SDF. The UWMQE was entitled *Evaluation of Saltstone Disposal Unit 6 As-Built Conditions* (SRR-UWMQE-2017-00001). This UWMQE was generated to document the evaluation of SDU 6 as-build conditions against the 2009 SDF PA and supporting SDF SAs, the Composite Analysis (CA) (SRNL-STI-2009-00512) and the Salt Waste Determination (WD) Basis Document (DOE-WD-2005-001). This evaluation incorporated the installation of pre-stressing wire anchor trees in the core wall as well as an SRNL evaluation (SRNL-STI-2016-00511) of voids in the roof and floor generated from temporary construction structures. As-built conditions were evaluated against the assumptions used for the unit in the 2009 SDF PA and SDF SAs, neither the radionuclide inventory nor the chemical constituents were found to be modified by the evaluation. As such, none of these as-built conditions were found to impact the conclusion of the SDF PA, the associated SDF SAs, the CA or the WD. This UWMQE is summarized in Table 2.1-1. This UWMQE was issued in March 2017. The changes evaluated by the UWMQE indicate that the conclusions in the PA remain valid.

Table 2.1-1: Potential Changes Affecting the PA, CA or DAS

Disposal Facility/Unit	UWMQE	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA or DAS Impacts
SDU 6	SRR-UWMQE-2017-00001	SDU 6 as-built conditions - pre-stressing wire anchor trees and voids in the roof and floor of SDU 6	Radionuclide inventory and chemical constituents unchanged by modeled as-built conditions	N/A	None

2.2 Update the Closure Plan

Management of SRS LLW is regulated under DOE M 435.1-1, *Radioactive Waste Management Manual*. A DAS (WDPD-12-49) revision was issued by DOE on May 22, 2012 authorizing continued operations of the SDF. The DAS specifies the closure plan that complies with DOE M 435.1-1 for SDF must be maintained and modified as needed to reflect facility changes. The SDF closure plan is reviewed annually to determine if a revision is required. The Closure Plan was updated in FY2015 and no modifications to the SDF Closure Plan were deemed necessary or performed in FY2017.

The *Savannah River Site Land Use Plan* (SRNS-RP-2014-00537) provides the framework for integrating the SRS mission and vision with ecological, economic, cultural, and social factors in a regional context and to support decision-making for near-term and long-term use of the site, including the SDF. The *Land Use Plan* describes the current site conditions, defines a vision for the evolution of the site, outlines actions to achieve the vision, and guides the allocation of resources toward attainment of that vision. This plan provides guidance and direction for the future physical development of the site and provides a framework within which detailed analyses will be conducted to determine the courses of action required to reach optimum site configuration. The plan is based on specific assumptions. If these assumptions were to change, the plan would be updated to reflect the changed conditions. The *Land Use Plan* was issued in November 2014 and no modifications have occurred to the plan, therefore there are no impacts to the current SDF PA/SA.

2.3 Update the SDF Monitoring Plan

The *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site* (SRR-CWDA-2013-00026) (hereinafter referred to as the SDF Monitoring Plan), demonstrates compliance with pertinent requirements of DOE O 435.1, Chg. 1 and its associated Manual and Guide. The SDF Monitoring Plan was issued in fiscal year (FY) 2013 based on the 2009 SDF PA to incorporate ongoing activities as required by the DAS. [WDPD-12-49]

The SDF Monitoring Plan that complies with DOE M 435.1-1 must be maintained and modified as needed to reflect facility changes. The Monitoring Plan is reviewed annually to determine if a revision is required. Revision 1 to the SDF Monitoring Plan was completed in August 2015. [SRR-CWDA-2013-00026] The revision incorporated and integrated the ongoing activities

relative to new groundwater wells and the 375-foot diameter SDU design at the SDF. No modifications to the SDF Monitoring Plan were deemed necessary or performed in FY2017.

3. CUMULATIVE EFFECTS OF CHANGES

One UWMQE was performed in FY2017 (SRR-UWMQE-2017-00001). As-built conditions were evaluated against the assumptions used for the unit in the 2009 SDF PA and SDF SAs. None of the as-built conditions were found to impact the conclusion of the SDF PA, the associated SDF SAs, the CA or the WD. No SA is needed to address the as-built conditions as changes were already addressed in FY2016 SA and no change to the PA model was deemed necessary.

4. WASTE RECEIPTS

4.1 Waste Volumes and Radionuclide Inventories

Construction of rectangular shaped SDUs 1 and 4 was completed between February 1986 and July 1988. The Saltstone Production Facility (SPF) started radioactive operations June 1990. Disposal into SDU 1 occurred intermittently from June 1990 to September 1996. Disposal into SDU 4 began in January 1997 and completed in FY2012.

Current operational cylindrical SDUs (2A/2B, 3A/3B and 5A/5B) include six cells, 150 feet in diameter by 22 feet high. Future SDUs are anticipated to consist of single cells, 375 feet in diameter and 45 feet high, such as SDU 6 which was placed into operation in 2017. Figure 4.1-1 shows the March 2017 configuration of SDUs at the SDF. Disposal into SDU Cell 2B commenced in September 2012 and disposal into SDU Cell 2A commenced in December 2012. SDU Cells 2A and 2B have a slightly less nominal useable volume for grout disposal due to an additional one foot of clean pour (Class III sulfate resistant concrete) having been placed on the floor. The pour was performed to address suspected compromised areas detected during water tightness testing. Disposal into SDU Cell 2A concluded in June 2014 and disposal into SDU Cell 2B concluded in July 2014. Disposal into SDU Cell 5B commenced in August 2014 and concluded in February 2017 and disposal into SDU Cell 5A commenced in August 2015 and concluded in August 2016. Disposal into SDU Cell 3A commenced in February 2017. No disposal into SDU Cell 3B or SDU 6 has occurred. Table 4.1-1 summarizes the SDU waste receipts though FY2017.

Future SDUs will be constructed, as needed, in coordination with salt processing production rates. The anticipated quantity and need dates for future SDUs is outlined in the *Liquid Waste System Plan.* [SRR-LWP-2009-00001] The *Liquid Waste System Plan* is updated as necessary to align with the most recent operational, budgetary, and regulatory requirements of the overall Liquid Waste System at the Savannah River Site (SRS). The most recent revision to the plan is Revision 20.

Figure 4.1-1: Saltstone Facility Aerial View (March 2017)

Table 4.1-1: Saltstone Disposal Unit Waste Receipts

Saltstone Disposal Unit	Disposal Volumes (gal) to date	PA-Estimated Disposal Capacity (gal)	Percent Filled (%) Volume	Total Curies Disposed to date (kCi)	PA/CA Impacts
1	5,610,000	10,900,000	50	166	None
4	19,070,000	21,800,000	95	414	None
2	5,540,000	5,600,000	100	30.2	None
3	198,000	5,600,000	3.5	0.281	None
5	5,540,000	5,600,000	100	26.0	None
6	0	32,000,000	0	0	N/A

Note: The "Sum of Fractions or Total curie vs PA Curie Limit" column outlined in the DOE Standard (DOE-STD-5002-2017) is not presented in this table as the individual SDUs do not have a PA curie limit placed on them.

During FY2017, no additional saltstone was disposed in SDU 1, SDU 4, SDU Cells 2A/2B, or SDU Cell 5A, therefore the inventories for these SDUs are revised in this annual review to reflect only current decayed inventories (i.e., end FY2017) and decayed inventories at closure (i.e., start FY2032). Inventories for SDU Cell 5B and SDU Cell 3A were updated to reflect the disposal operations over the past year and to reflect a comparison of decayed inventories at closure to those modeled in the FY2014 SDF SA and FY2016 SDF SA. [SRR-CWDA-2017-00079]

4.1.1 Waste Volumes

The salt solution production history through FY2017 is presented in Table 4.1-2, and new waste receipts into the SDF in FY2017 are detailed in Table 4.1-3. An estimate of the remaining grout capacity of SDUs 1 and 4 can be made by comparing the total grout capacity to the level in each cell times the cell surface area. SDU 1 is currently at 50 % of its volumetric capacity with Cells A, B, and C being full. SDU 1 Cells D, E, and F are empty. Currently, there are no plans to use SDU 1 Cells D, E, and F for saltstone disposal since they are not fitted with the attributes required for saltstone disposal. [SRR-LWP-2009-00001] Therefore, no additional waste receipts were placed in SDU 1 during FY2017.

SDU 4, Cell A contains 10,000 drums (added to SDU 4 in the 1990s) of a non-hazardous cementitious waste form (referred to as saltcrete) generated from the operation of wastewater treatment at the Fuel Material Facility. SDU 4, Cell A also contains the wooden pallets used in the movement of the Fuel Material Facility drums (one pallet to four drums). [ESH-FSS-9000373] The void space surrounding the drums in SDU 4, Cell A is filled with clean grout.

SDU 4 has used 95 % of its capacity for saltstone disposal (930,000 gallons of remaining disposal volume of the 20 million gallon capacity), not including final clean cap installation. [X-CLC-Z-00052] No additional saltstone was disposed in SDU 4 during FY2017 and there are no plans to dispose of additional saltstone in SDU 4 in the future.

SDU Cell 2A has used 100 % of its current operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00070] SDU Cell 2B has used 100 % of its current operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00070]

SDU Cell 5B has used 100 % of its current operational capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00080] SDU Cell 5A has used 100 % of its current operation capacity (21.25 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00078]

SDU Cell 3A has used 7 % of its current operational capacity (1.5 ft of height used relative to 21.25 ft of height available). [X-CLC-Z-00083]

No saltstone grout has been emplaced in SDU Cell 3B or SDU 6 as of the end of FY2017.

This FY2017 performance evaluation, conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cell 3A and SDU Cells 5A/5B, indicates SDF operations were within the performance expectation of the 2009 SDF PA, the FY2013 SDF SA, the FY2014 SDF SA, and the FY2016 SDF SA. [SRR-CWDA-2009-00017, SRR-CWDA-2013-00062, SRR-CWDA-2014-00006, SRR-CWDA-2016-00109] All Saltstone disposal operations are limited by the *Waste Acceptance Criteria for Aqueous Waste Sent to the Z-Area Saltstone Production Facility* (X-SD-Z-00001).

Table 4.1-2: Tank 50 Salt Solution Historical Data

Fiscal Year	Salt Solution Processed (gal)				
	SDU 1	SDU 4	SDU 2	SDU 3	SDU 5
1990	246,660	0	0	0	0
1991	651,279	0	0	0	0
1992	105,391	0	0	0	0
1993	28,020	0	0	0	0
1994	261,058	0	0	0	0
1995	129,900	0	0	0	0
1996	607,774	0	0	0	0
1997	0	212,370	0	0	0
1998	0	339,310	0	0	0
1999	0	0	0	0	0
2000	0	0	0	0	0
2001	0	0	0	0	0
2002	0	263,830	0	0	0
2003	0	1,292,474	0	0	0
2004	0	0	0	0	0
2005	0	0	0	0	0
2006	0	0	0	0	0
2007	0	244,480	0	0	0
2008	0	1,342,930	0	0	0
2009	0	1,525,728	0	0	0
2010	0	1,013,770	0	0	0
2011	0	1,486,842	0	0	0
2012	0	811,710	439,740	0	0
2013	0	0	2,005,340	0	0
2014	0	0	486,474	0	680,146
2015	0	0	0	0	828,128
2016	0	0	0	0	1,506,010
2017	0	0	0	61,600	108,060
SDU Totals:	2,030,082	8,533,444	2,931,554	61,600	3,122,344
Total Salt Solution Processed Through End of September 2017:		16,679,024			

[X-CLC-Z-00080, X-CLC-Z-00081, X-CLC-Z-00082, X-CLC-Z-00083]

Table 4.1-3: Tank 50 Salt Solution Processed

Time Period	Salt Solution Processed (gal)	SDU
1st Quarter FY2017	82,380	5 (Cell B)
2nd Quarter FY2017	70,030	3 (Cell A) and 5 (Cell B)
3rd Quarter FY2017	17,250	3 (Cell A)
4th Quarter FY2017	0	N/A
Total FY2017 Receipts	169,660	3 (Cell A) and 5 (Cell B)

[X-CLC-Z-00080, X-CLC-Z-00081, X-CLC-Z-00082, X-CLC-Z-00083]

4.1.2 Waste Inventory

A disposed radionuclide inventory estimate was developed for use in PA modeling. [SRNS-J2100-2008-00004] The 2009 SDF PA, based on these inventory estimates, met performance objectives. SDF inventories were updated for preparation of the FY2014 SDF SA and documented in *SDF Inventory Estimates for Transport Modeling* (SRR-CWDA-2013-00147). The updated inventories developed for the FY2014 SDF SA were then used for the FY2016 SDF SA.

Determination of SDF Inventories through 9/30/2017 (SRR-CWDA-2017-00079) includes both the original inventory disposed of at the SDF and the current inventory of the SDF through FY2017. The current inventory at the SDF includes decay and ingrowth for SDF operations beginning in 1990 through FY2017. As of the end of FY2017, 636 kilocuries (kCi) have been disposed in the SDF and the current inventory in the SDF as of the end of FY2017, accounting for decay and daughter ingrowth, is 394 kCi. [SRR-CWDA-2017-00079]

In FY2017, 170 kgal of low-level waste was transferred from Tank 50 to the SDF. A total of 396 kgal of saltstone was emplaced in the SDF containing 0.776 kCi. All saltstone in FY2017 was emplaced in SDU Cell 3A and SDU Cell 5B. [SRR-CWDA-2017-00079]

The current inventories were decayed to 10/1/2032 to match the basis date for closure used in the FY2014 SDF SA. For SDU 1 and 4, as well as SDU Cells 2A/2B and SDU Cell 5A, no additional saltstone was disposed in FY2017 and there are no plans to place additional saltstone in these units in the future; therefore, Tables 4.1-4 through 4.1-8 provide only current inventories as of 9/30/2017 and inventories decayed to FY2032.

For SDU Cell 5B and SDU Cell 3A (Tables 4.1-9 and 4.1-10), the current FY2017 inventories (decayed to FY2032) were divided by the FY2014 SDF SA inventories to generate a ratio. This ratio helps in evaluating the inventory that will be in each SDU upon completion of filling. Although two radionuclides (i.e., Cs-135, Nb-94) in Table 4.1-9 have ratios greater than one when compared to the FY2014 SDF SA, they are insignificant contributors to overall dose as described in Section 5.5.1.2 of the FY2014 SDF SA (SRR-CWDA-2014-00006); because of their insignificant dose contributions they do not challenge any performance objectives. These are also inventories that utilize detections limits to determine concentrations.

The total inventory of radionuclides in SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cell 3A and SDU Cells 5A/5B through FY2017 was below that shown to be acceptable and do not contradict the performance objectives of the 2009 SDF PA, the FY2013 SDF SA, the FY2014 SDF SA, or the FY2016 SDF SA.

Table 4.1-4: Saltstone Disposal Facility SDU 1 Inventory

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Ac-227	1.66E-06	2.36E-06
Al-26	2.64E-01	2.64E-01
Am-241	1.96E-03	2.26E-03
Am-242m	6.82E-05	6.33E-05
Am-243	1.42E-03	1.42E-03
Ba-137m[b]	5.99E+00	4.25E+00
C-14	1.31E+00	1.31E+00
Cf-249	8.86E-13	8.60E-13
Cf-251	3.11E-14	3.08E-14
Cl-36	1.93E-07	1.93E-07
Cm-243	4.64E-04	3.25E-04
Cm-244	3.02E-03	1.71E-03
Cm-245	2.73E-04	2.73E-04
Cm-247	1.61E-13	1.61E-13
Cm-248	1.68E-13	1.68E-13
Co-60	4.40E-04	6.29E-05
Cs-135	9.75E-02	9.75E-02
Cs-137	6.35E+00	4.50E+00
Eu-152	1.55E-03	7.24E-04
Eu-154	5.32E-04	1.60E-04
H-3	1.36E+01	5.88E+00
I-129	2.01E-01	2.01E-01
K-40	1.93E-07	1.93E-07
Nb-93m	7.56E-01	7.53E-01
Nb-94	2.03E-03	2.03E-03
Ni-59	2.30E-03	2.30E-03
Ni-63	1.20E-01	1.08E-01
Np-237	3.94E-03	3.94E-03
Pa-231	3.07E-06	3.87E-06
Pd-107	8.38E-03	8.38E-03
Pt-193	1.64E+00	1.34E+00
Pu-238	7.19E-03	6.39E-03
Pu-239	1.43E-02	1.43E-02
Pu-240	1.35E-02	1.35E-02
Pu-241	2.05E-02	1.01E-02
Pu-242	1.57E-03	1.57E-03
Pu-244	1.01E-05	1.01E-05
Ra-226	4.94E-07	8.43E-07
Ra-228	7.68E-06	7.68E-06
Se-79	3.44E-01	3.44E-01
Sm-151	5.54E-03	4.94E-03

Table 4.1-4: Saltstone Disposal Facility SDU 1 Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032[c] (Ci)
Sn-126	1.22E+00	1.22E+00
Sr-90	1.11E-02	7.73E-03
Tc-99	4.93E+01	4.93E+01
Th-229	4.05E-04	5.07E-04
Th-230	4.75E-05	6.12E-05
Th-232	7.68E-06	7.68E-06
U-232	6.55E-04	5.63E-04
U-233	7.79E-02	7.79E-02
U-234	9.98E-02	9.98E-02
U-235	2.53E-03	2.53E-03
U-236	6.54E-03	6.54E-03
U-238	1.07E-02	1.07E-02
Y-90[b]	1.11E-02	7.73E-03
Zr-93	7.68E-01	7.68E-01

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life.
[c] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-5: Saltstone Disposal Facility SDU 4 Inventory

Radionuclide	Current Inventory[a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Ac-227	2.21E-05	3.15E-05
Al-26	9.08E-01	9.08E-01
Am-241	2.05E+01	2.15E+01
Am-242m	1.91E-02	1.77E-02
Am-243	5.18E-01	5.17E-01
Ba-137m[b]	1.61E+05	1.14E+05
C-14	6.51E+00	6.50E+00
Cf-249	2.77E-01	2.69E-01
Cf-251	9.31E-02	9.20E-02
Cl-36	2.94E-02	2.94E-02
Cm-243	8.23E-03	5.76E-03
Cm-244	3.26E+01	1.84E+01
Cm-245	7.78E-01	7.78E-01
Cm-247	1.06E-01	1.06E-01
Cm-248	7.04E-13	7.04E-13
Co-60	5.84E-02	8.35E-03
Cs-135	1.78E+00	1.78E+00
Cs-137	1.70E+05	1.21E+05
Eu-152	7.40E-02	3.45E-02
Eu-154	3.17E+00	9.56E-01
H-3	2.47E+01	1.07E+01
I-129	2.77E-01	2.77E-01
K-40	2.94E-02	2.94E-02
Nb-93m	8.41E+02	1.76E+03
Nb-94	8.93E-02	8.93E-02
Ni-59	7.89E-02	7.89E-02
Ni-63	3.13E+00	2.83E+00
Np-237	5.76E-01	5.76E-01
Pa-231	4.09E-05	5.16E-05
Pd-107	3.52E-02	3.52E-02
Pt-193	8.46E+00	6.88E+00
Pu-238	3.13E+02	2.78E+02
Pu-239	5.86E+01	5.86E+01
Pu-240	7.28E+01	7.27E+01
Pu-241	9.04E+01	4.43E+01
Pu-242	4.12E+00	4.12E+00
Pu-244	1.68E-02	1.68E-02
Ra-226	2.18E-05	4.40E-05
Ra-228	2.08E-04	2.08E-04
Se-79	9.75E+00	9.75E+00
Sm-151	1.97E+01	1.76E+01

Table 4.1-5: Saltstone Disposal Facility SDU 4 Inventory (Continued)

Radionuclide	Current Inventory[a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Sn-126	2.22E+00	2.22E+00
Sr-90	2.38E+03	1.66E+03
Tc-99	6.34E+02	6.34E+02
Th-229	3.63E+00	3.64E+00
Th-230	3.04E-03	3.84E-03
Th-232	2.08E-04	2.08E-04
U-232	1.18E-01	1.01E-01
U-233	8.85E+00	8.85E+00
U-234	5.77E+00	5.78E+00
U-235	3.38E-02	3.38E-02
U-236	8.12E-02	8.12E-02
U-238	7.92E-02	7.92E-02
Y-90[b]	2.38E+03	1.67E+03
Zr-93	7.94E+00	7.94E+00

[a] Total inventories which include decay and ingrowth from SRR-CWDA-207-00079
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life.
[c] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-6: Saltstone Disposal Facility SDU Cell 2A Inventory

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Ac-227	6.58E-07	9.32E-07
Al-26	8.98E-04	8.98E-04
Am-241	5.94E-02	8.62E-02
Am-242m	9.99E-03	9.28E-03
Am-243	4.20E-03	4.22E-03
Ba-137m[b]	5.86E+03	4.15E+03
C-14	2.41E+00	2.41E+00
Cf-249	1.78E-02	1.73E-02
Cf-251	1.34E-02	1.32E-02
Cl-36	1.86E-04	1.86E-04
Cm-243	5.41E-04	3.79E-04
Cm-244	1.97E-01	1.11E-01
Cm-245	1.45E-02	1.45E-02
Cm-247	1.67E-02	1.67E-02
Cm-248	1.21E-13	1.21E-13
Co-60	9.39E-04	1.34E-04
Cs-135	4.01E-02	4.01E-02
Cs-137	6.21E+03	4.40E+03
Eu-152	2.62E-04	1.22E-04
Eu-154	8.36E-03	2.52E-03
H-3	2.35E+00	1.02E+00
I-129	7.31E-02	7.31E-02
K-40	1.86E-04	1.86E-04
Nb-93m	2.79E-01	2.69E-01
Nb-94	1.90E-03	1.89E-03
Ni-59	9.16E-04	9.16E-04
Ni-63	4.45E-02	4.01E-02
Np-237	1.60E-01	1.60E-01
Pa-231	1.21E-06	1.53E-06
Pd-107	6.03E-03	6.03E-03
Pt-193	1.57E+00	1.27E+00
Pu-238	5.72E+00	5.08E+00
Pu-239	5.28E-01	5.28E-01
Pu-240	5.28E-01	5.27E-01
Pu-241	1.68E+00	8.24E-01
Pu-242	3.76E-01	3.76E-01
Pu-244	1.74E-03	1.74E-03
Ra-226	1.54E-06	6.94E-06
Ra-228	1.26E-05	1.26E-05
Se-79	1.34E-01	1.34E-01
Sm-151	1.67E-01	1.48E-01

Table 4.1-6: Saltstone Disposal Facility SDU Cell 2A Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Sn-126	7.62E-01	7.62E-01
Sr-90	1.68E+01	1.17E+01
Tc-99	1.14E+02	1.14E+02
Th-229	2.69E-03	3.93E-03
Th-230	7.91E-04	8.76E-04
Th-232	1.26E-05	1.26E-05
U-232	1.38E-02	1.18E-02
U-233	9.51E-01	9.51E-01
U-234	6.16E-01	6.16E-01
U-235	9.93E-04	9.93E-04
U-236	6.37E-03	6.37E-03
U-238	2.24E-02	2.24E-02
Y-90[b]	1.68E+01	1.17E+01
Zr-93	2.64E-01	2.64E-01

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life.
[c] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-7: Saltstone Disposal Facility SDU Cell 2B Inventory

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Ac-227	8.44E-07	1.20E-06
Al-26	8.55E-04	8.55E-04
Am-241	7.37E-02	9.86E-02
Am-242m	6.35E-03	5.90E-03
Am-243	4.88E-03	4.90E-03
Ba-137m[b]	7.22E+03	5.11E+03
C-14	2.44E+00	2.44E+00
Cf-249	1.47E-02	1.43E-02
Cf-251	1.08E-02	1.07E-02
Cl-36	2.32E-04	2.32E-04
Cm-243	5.37E-04	3.76E-04
Cm-244	2.24E-01	1.26E-01
Cm-245	2.22E-02	2.22E-02
Cm-247	1.41E-02	1.41E-02
Cm-248	1.21E-13	1.21E-13
Co-60	1.05E-03	1.50E-04
Cs-135	4.03E-02	4.03E-02
Cs-137	7.65E+03	5.42E+03
Eu-152	2.63E-04	1.23E-04
Eu-154	1.50E-02	4.52E-03
H-3	1.99E+00	8.62E-01
I-129	6.83E-02	6.83E-02
K-40	2.32E-04	2.32E-04
Nb-93m	4.24E-01	4.00E-01
Nb-94	1.63E-03	1.63E-03
Ni-59	7.32E-04	7.32E-04
Ni-63	3.54E-02	3.20E-02
Np-237	9.61E-02	9.61E-02
Pa-231	1.55E-06	1.95E-06
Pd-107	6.06E-03	6.06E-03
Pt-193	1.56E+00	1.27E+00
Pu-238	5.44E+00	4.83E+00
Pu-239	5.19E-01	5.19E-01
Pu-240	5.19E-01	5.18E-01
Pu-241	1.59E+00	7.82E-01
Pu-242	5.21E-01	5.21E-01
Pu-244	2.42E-03	2.42E-03
Ra-226	9.50E-07	3.95E-06
Ra-228	1.92E-05	1.92E-05
Se-79	1.23E-01	1.23E-01
Sm-151	1.46E-01	1.30E-01

Table 4.1-7: Saltstone Disposal Facility SDU Cell 2B Inventory (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Sn-126	6.83E-01	6.83E-01
Sr-90	2.07E+01	1.44E+01
Tc-99	1.37E+02	1.37E+02
Th-229	6.02E-03	7.75E-03
Th-230	4.04E-04	5.22E-04
Th-232	1.92E-05	1.92E-05
U-232	1.34E-02	1.15E-02
U-233	1.32E+00	1.32E+00
U-234	8.54E-01	8.54E-01
U-235	1.27E-03	1.27E-03
U-236	8.85E-03	8.85E-03
U-238	2.65E-02	2.65E-02
Y-90[b]	2.07E+01	1.44E+01
Zr-93	3.83E-01	3.83E-01

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life.
[c] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-8: Saltstone Disposal Facility SDU Cell 5A Inventory Comparison

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Ac-227	4.38E-05	2.80E-05
Al-26	1.02E-03	1.02E-03
Am-241	8.37E-02	5.27E-01
Am-242m	1.01E-03	9.37E-04
Am-243	3.90E-03	3.93E-03
Ba-137m[b]	3.63E+03	2.57E+03
C-14	3.18E+00	3.17E+00
Cf-249	2.23E-02	2.17E-02
Cf-251	1.68E-02	1.66E-02
Cl-36	5.07E-03	5.07E-03
Cm-243	6.19E-04	4.33E-04
Cm-244	9.77E-02	5.51E-02
Cm-245	1.50E-02	1.50E-02
Cm-247	2.13E-02	2.13E-02
Cm-248	1.29E-13	1.29E-13
Co-60	2.48E-02	3.54E-03
Cs-135	4.29E-02	4.29E-02
Cs-137	3.84E+03	2.72E+03
Eu-152	2.80E-04	1.30E-04
Eu-154	4.33E-03	1.31E-03
H-3	5.72E+00	2.48E+00
I-129	1.39E-01	1.39E-01
K-40	5.07E-03	5.07E-03
Nb-93m	5.43E-01	4.27E-01
Nb-94	2.66E-03	2.65E-03
Ni-59	1.26E-03	1.26E-03
Ni-63	6.22E-02	5.61E-02
Np-237	8.51E-02	8.51E-02
Pa-231	1.87E-06	2.35E-06
Pd-107	6.46E-03	6.46E-03
Pt-193	1.74E+00	1.42E+00
Pu-238	7.59E+01	6.75E+01
Pu-239	1.86E+00	1.85E+00
Pu-240	1.86E+00	1.85E+00
Pu-241	2.66E+01	1.29E+01
Pu-242	4.61E-01	4.61E-01
Pu-244	2.14E-03	2.14E-03
Ra-226	2.58E-07	1.76E-06
Ra-228	1.35E-05	1.35E-05
Se-79	2.72E-01	2.72E-01
Sm-151	2.58E-01	2.30E-01

Table 4.1-8: Saltstone Disposal Facility SDU Cell 5A Inventory Comparison (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [c] (Ci)
Sn-126	1.65E+00	1.65E+00
Sr-90	4.93E+02	3.44E+02
Tc-99	1.75E+02	1.75E+02
Th-229	3.28E-04	1.86E-03
Th-230	1.79E-04	2.83E-04
Th-232	1.35E-05	1.35E-05
U-232	1.45E-02	1.24E-02
U-233	1.17E+00	1.17E+00
U-234	7.56E-01	7.59E-01
U-235	1.53E-03	1.53E-03
U-236	7.82E-03	7.82E-03
U-238	3.28E-02	3.28E-02
Y-90[b]	4.93E+02	3.44E+02
Zr-93	3.05E-01	3.05E-01

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079
[b] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life.
[c] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-9: Saltstone Disposal Facility SDU Cell 5B Inventory Comparison

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [d] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Ac-227	7.27E-05	4.58E-05	8.40E-02	5.46E-04
Al-26	8.59E-04	8.59E-04	2.40E+01	3.58E-05
Am-241	3.89E-02	1.86E-01	1.40E+04	1.33E-05
Am-242m	8.34E-04	7.75E-04	9.10E+00	8.52E-05
Am-243	9.21E-03	9.22E-03	6.90E-02	1.34E-01
Ba-137m[c]	7.50E+03	5.31E+03	N/A	N/A
C-14	3.78E+00	3.77E+00	5.80E+02	6.50E-03
Cf-249	1.83E-02	1.78E-02	N/A	N/A
Cf-251	1.52E-02	1.50E-02	N/A	N/A
Cl-36	1.26E-03	1.26E-03	9.50E-01	1.33E-03
Cm-243	6.01E-04	4.21E-04	2.60E-02	1.62E-02
Cm-244	1.11E-01	6.25E-02	9.40E+01	6.65E-04
Cm-245	1.31E-02	1.31E-02	5.60E-01	2.33E-02
Cm-247	1.77E-02	1.77E-02	N/A	N/A
Cm-248	1.28E-13	1.28E-13	N/A	N/A
Co-60	1.14E-03	1.63E-04	7.10E+00	2.30E-05
Cs-135	4.26E-02	4.26E-02	9.00E-03	4.74E+00
Cs-137	7.95E+03	5.63E+03	2.30E+05	2.45E-02
Eu-152	2.79E-04	1.30E-04	7.80E+00	1.67E-05
Eu-154	4.51E-03	1.36E-03	9.60E+01	1.42E-05
H-3	3.52E+00	1.52E+00	8.20E+02	1.86E-03
I-129	8.68E-02	8.68E-02	9.60E-02	9.04E-01
K-40	2.09E-03	2.09E-03	9.50E-01	2.20E-03
Nb-93m	3.16E-01	2.98E-01	N/A	N/A
Nb-94	2.06E-03	2.06E-03	5.40E-04	3.82E+00
Ni-59	5.15E-04	5.15E-04	2.60E+00	1.98E-04
Ni-63	2.53E-02	2.29E-02	1.80E+02	1.27E-04
Np-237	7.76E-02	7.76E-02	2.70E+01	2.88E-03
Pa-231	1.54E-06	1.95E-06	1.50E-01	1.30E-05
Pd-107	6.42E-03	6.42E-03	9.50E-01	6.76E-03
Pt-193	1.71E+00	1.39E+00	7.30E+01	1.90E-02
Pu-238	2.62E+01	2.33E+01	1.50E+03	1.55E-02
Pu-239	7.39E-01	7.39E-01	1.50E+03	4.92E-04
Pu-240	7.39E-01	7.38E-01	1.50E+03	4.92E-04
Pu-241	8.81E+00	4.29E+00	1.60E+04	2.68E-04
Pu-242	4.21E-01	4.21E-01	4.50E+00	9.35E-02
Pu-244	1.95E-03	1.95E-03	2.10E-02	9.30E-02
Ra-226	2.96E-07	1.68E-06	1.30E+01	1.29E-07
Ra-228	2.26E-05	2.26E-05	2.30E-02	9.82E-04
Se-79	1.68E-01	1.68E-01	8.90E+01	1.89E-03
Sm-151	2.13E-01	1.90E-01	3.70E+03	5.13E-05

Table 4.1-9: Saltstone Disposal Facility SDU Cell 5B Inventory Comparison (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [d] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Sn-126	9.47E-01	9.47E-01	3.90E+02	2.43E-03
Sr-90	1.23E+02	8.57E+01	3.60E+06	2.38E-05
Tc-99	1.20E+02	1.20E+02	5.40E+02	2.22E-01
Th-229	3.12E-04	1.71E-03	1.70E+01	1.01E-04
Th-230	1.66E-04	2.60E-04	1.30E+01	2.00E-05
Th-232	2.26E-05	2.26E-05	2.30E-01	9.82E-05
U-232	1.98E-02	1.70E-02	6.80E-02	2.50E-01
U-233	1.07E+00	1.07E+00	1.60E+01	6.66E-02
U-234	6.87E-01	6.88E-01	9.30E+00	7.40E-02
U-235	1.27E-03	1.27E-03	3.80E-01	3.34E-03
U-236	7.18E-03	7.18E-03	4.30E-01	1.67E-02
U-238	2.85E-02	2.85E-02	1.60E+01	1.78E-03
Y-90[c]	1.23E+02	8.58E+01	N/A	N/A
Zr-93	2.86E-01	2.86E-01	9.50E+01	3.01E-03

N/A – Radionuclide not evaluated in the FY2014 SDF SA (SRR-CWDA-2014-00006) per SRR-CWDA-2013-00147

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079

[b] Evaluated total inventories from FY2014 SDF SA (SRR-CWDA-2014-00006)

[c] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

[d] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

Table 4.1-10: Saltstone Disposal Facility SDU Cell 3A Inventory Comparison

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [d] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Ac-227	3.41E-08	4.83E-08	8.40E-02	5.75E-07
Al-26	2.26E-05	2.26E-05	2.40E+01	9.41E-07
Am-241	3.26E-03	4.27E-02	1.40E+04	3.05E-06
Am-242m	8.35E-06	7.76E-06	9.10E+00	8.52E-07
Am-243	9.18E-05	9.28E-05	6.90E-02	1.34E-03
Ba-137m[c]	9.94E+01	7.04E+01	N/A	N/A
C-14	1.35E-01	1.34E-01	5.80E+02	2.32E-04
Cf-249	8.09E-04	7.85E-04	N/A	N/A
Cf-251	5.54E-04	5.47E-04	N/A	N/A
Cl-36	2.65E-04	2.65E-04	9.50E-01	2.78E-04
Cm-243	2.49E-05	1.74E-05	2.60E-02	6.70E-04
Cm-244	4.54E-04	2.56E-04	9.40E+01	2.72E-06
Cm-245	4.87E-04	4.87E-04	5.60E-01	8.69E-04
Cm-247	7.72E-04	7.72E-04	N/A	N/A
Cm-248	5.08E-15	5.08E-15	N/A	N/A
Co-60	6.56E-05	9.37E-06	7.10E+00	1.32E-06
Cs-135	1.69E-03	1.69E-03	9.00E-03	1.88E-01
Cs-137	1.05E+02	7.46E+01	2.30E+05	3.24E-04
Eu-152	1.10E-05	5.13E-06	7.80E+00	6.58E-07
Eu-154	1.61E-04	4.86E-05	9.60E+01	5.07E-07
H-3	3.04E-01	1.31E-01	8.20E+02	1.60E-04
I-129	9.13E-03	9.13E-03	9.60E-02	9.51E-02
K-40	2.65E-04	2.65E-04	9.50E-01	2.78E-04
Nb-93m	2.32E-02	2.03E-02	N/A	N/A
Nb-94	8.85E-05	8.85E-05	5.40E-04	1.64E-01
Ni-59	4.05E-05	4.05E-05	2.60E+00	1.56E-05
Ni-63	2.02E-03	1.82E-03	1.80E+02	1.01E-05
Np-237	3.00E-03	3.00E-03	2.70E+01	1.11E-04
Pa-231	6.26E-08	7.89E-08	1.50E-01	5.26E-07
Pd-107	2.54E-04	2.54E-04	9.50E-01	2.68E-04
Pt-193	6.94E-02	5.64E-02	7.30E+01	7.73E-04
Pu-238	6.48E+00	5.76E+00	1.50E+03	3.84E-03
Pu-239	1.56E-01	1.56E-01	1.50E+03	1.04E-04
Pu-240	1.56E-01	1.56E-01	1.50E+03	1.04E-04
Pu-241	2.36E+00	1.15E+00	1.60E+04	7.17E-05
Pu-242	1.63E-02	1.63E-02	4.50E+00	3.62E-03
Pu-244	7.56E-05	7.56E-05	2.10E-02	3.60E-03
Ra-226	6.30E-09	3.63E-08	1.30E+01	2.79E-09
Ra-228	4.68E-07	4.68E-07	2.30E-02	2.04E-05
Se-79	6.59E-03	6.59E-03	8.90E+01	7.40E-05
Sm-151	8.42E-03	7.50E-03	3.70E+03	2.03E-06

Table 4.1-10: Saltstone Disposal Facility SDU Cell 3A Inventory Comparison (Continued)

Radionuclide	Current Inventory [a] 9/30/2017 (Ci)	Current Inventory Decayed to 10/1/2032 [d] (Ci)	Evaluated Total Inventory per SDU[b] 10/1/2032 (Ci)	Comparison Ratio
Sn-126	1.12E-01	1.12E-01	3.90E+02	2.88E-04
Sr-90	2.61E+01	1.82E+01	3.60E+06	5.06E-06
Tc-99	1.10E+01	1.10E+01	5.40E+02	2.04E-02
Th-229	5.87E-06	5.99E-05	1.70E+01	3.52E-06
Th-230	2.76E-06	6.46E-06	1.30E+01	4.97E-07
Th-232	4.68E-07	4.68E-07	2.30E-01	2.04E-06
U-232	7.02E-04	6.03E-04	6.80E-02	8.87E-03
U-233	4.12E-02	4.12E-02	1.60E+01	2.57E-03
U-234	2.67E-02	2.69E-02	9.30E+00	2.89E-03
U-235	5.14E-05	5.14E-05	3.80E-01	1.35E-04
U-236	3.07E-04	3.07E-04	4.30E-01	7.15E-04
U-238	9.46E-04	9.46E-04	1.60E+01	5.91E-05
Y-90[c]	2.61E+01	1.82E+01	N/A	N/A
Zr-93	1.74E-02	1.74E-02	9.50E+01	1.84E-04

N/A – Radionuclide not evaluated in the FY2014 SDF SA (SRR-CWDA-2014-00006) per SRR-CWDA-2013-00147

[a] Total inventories which include decay and ingrowth from SRR-CWDA-2017-00079

[b] Evaluated total inventories from FY2014 SDF SA (SRR-CWDA-2014-00006)

[c] Data included for inventory only, radionuclide not included in SDF modeling due to short half-life (SRNL-STI-2009-00115 Section 4.2).

[d] Decayed inventory extracted from SDF-WIDE model, Version 1.5.

5. MONITORING

The environmental monitoring and disposal unit inspection programs were developed to be consistent with the 2009 SDF PA. The monitoring data evaluation is presented in this section.

5.1 Reason for Monitoring

Per the requirements in the DAS issued for the SDF (WDPD-12-49), a monitoring plan shall be written, approved, and implemented within one year of issuance of the DAS and updated at least every five years. This monitoring plan includes annual data review and evaluation. Following this annual data review and evaluation, any modifications to this monitoring plan that may be applicable will be noted and the plan updated, as necessary.

Monitoring to be performed as part of this plan is intended to meet the requirements of DOE O 435.1, Chg. 1 and its associated implementation manual and guide. These documents require disposal facilities to monitor for compliance with the conditions of the DAS. In particular, the following must be addressed:

- The site-specific 2009 SDF PA (SRR-CWDA-2009-00017) and associated composite analysis (CA) (SRNL-STI-2009-00512) were used to determine the media, locations, radionuclides, and other substances to be monitored.
- The environmental monitoring program includes measuring and evaluating releases, migration of radionuclides, SDU subsidence, and changes in disposal facility and disposal site parameters, which may affect long-term performance.
- The environmental monitoring programs is capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the PA performance objectives (DOE M 435.1-1).

5.2 Monitoring Plan

Table 5.2-1 summarizes the monitoring implemented to assess the SDF compliance with the pertinent performance objectives. [SRR-CWDA-2013-00026] Figure 5.2-1 shows the monitoring locations.

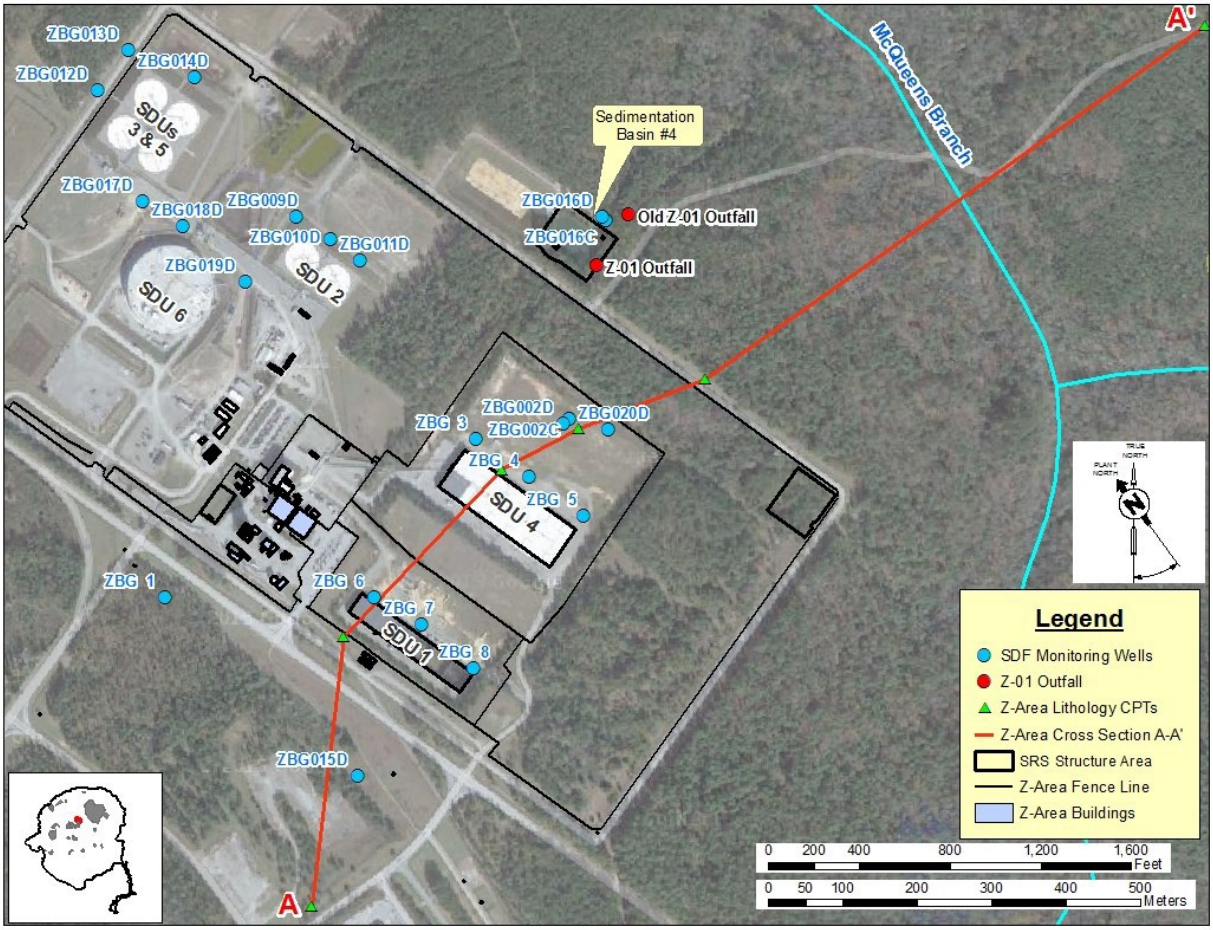
In addition to exposure pathways, certain facility features are relevant to monitoring the release of constituents to the surrounding environment. Per the existing SDF Monitoring Plan, quarterly visual inspection of the SDU integrity is sufficient to indicate conditions that may affect SDU integrity. [SRR-CWDA-2013-00026] The SDF has met this requirement by creating an *Inspection Program Plan for Z-Area Vault 4* (LWO-LWE-2008-00023). In-service inspection of SDU 4 will be performed to provide a historical photographic record of the external SDU condition. Inspections will be made of SDU 4 to document SDU cell wall coating and wall conditions, including baseline inspections.

Table 5.2-1: Summary Monitoring Table

Pathway/ Relevant Feature	Media Features/ Inspection	Monitoring Location	Radionuclide/Other Substance	Sampling Frequency	Sampling Method	Analytical Method	Minimum Detectable Activity/Method Detection Limit
WAC Transfer Compliance	Tank 50 content in compliance with Saltstone WAC	Completed evaluation on file in the Control Room	Tank 50 content as provided in the Waste Characterization System prior to transfer to Salt Feed Tank	WAC Evaluation complete prior to transfer from Tank 50 to Salt Feed Tank	N/A	N/A	Tank 50 content in compliance with Saltstone WAC
SDU integrity	Visual and video inspection of SDUs	Periphery and interior, if accessible, of SDUs	N/A	Monthly, at a minimum	Visual inspections, Video camera	N/A	N/A
Water resource protection	Groundwater	Well clusters ZBG-1 through ZBG-16	Nitrate (nitrate/nitrite) Gross alpha Nonvolatile beta Beta/photon emitters I-129 Tritium	Twice per year	Well sampling	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)
		Well clusters ZBG-1 through ZBG-16	Radium-226 Radium-228 Technetium-99 Benzene Toluene Tetrachloroethylene Trichloroethylene	Once every two years	Well sampling	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)	As designated in the groundwater monitoring plan (WSRC-TR-2005-00257)

N/A - Not Applicable
[SRR-CWDA-2013-00026]

Figure 5.2-1: SDF Existing Monitoring Well Locations



5.3 Evaluation of Monitoring Data

Contamination resulting from previous operational upsets has resulted in minor groundwater contamination being detected below SDU 4. In addition, in 2014, due to concerns of potential groundwater contamination from Sedimentation Basin No. 4, a shallow well (ZBG016D) and a deeper well (ZBG016C) were installed to monitor perched water in the vadose zone, and the groundwater. In 2017, four additional wells (ZBG017D, ZBG018D, ZBG019D, and ZBG020D) were added to the SDF monitoring network. Wells ZBG017D, ZBG018D and ZBG019D were added to monitor SDU 6 and in the future SDUs 7 and 8. Well ZBG020D provides additional downgradient groundwater monitoring of SDU 4. The SDF groundwater monitoring well network and monitoring plan are designed to effectively detect any release associated with SDUs in the SDF. [WSRC-TR-2005-00257] The *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2017* (SRNS-TR-2017-00227) states that the Z-Area groundwater wells ZBG 1 through ZBG016C were sampled during 1QCY17 and the samples were sent to SCDHEC certified labs for analyses. Groundwater monitoring results were compared to Practical Quantitation Limits (PQLs), background concentrations, and Groundwater Protection Standards (GWPSs). PQLs are indicators of laboratory instrument sensitivity, but are not regulatory limits, nor are they risk-based. The PQL is the lowest concentration of an analyte which can be reliably

quantified in a given sample. Background concentrations are based on historical data from two wells (ZBG 1 and ZBG015D) upgradient of the SDF. Data from ZBG015D is used for background comparisons to monitoring data collected at wells downgradient of SDUs 1 and 4. Data from ZBG 1 is used for background comparisons to monitoring data collected at wells downgradient of SDUs 2A, 2B, 3A, 3B, 5A, 5B, and 6. Wells ZBG017D, ZBG018D, ZBG019D, and ZBG020D were sampled after installation in the second quarter of 2017. The second quarter 2017 samples from ZBG017D through ZBG019D will help establish background groundwater chemistry for SDUs 6, 7 and 8 as SDU 6 has not been placed into service.

In 1QCY15, groundwater at well ZBG 2, downgradient of SDU 4, showed continued increases in Tc-99 activity (238 pCi/L), nitrate concentration (9.90 mg/L), and conductivity (102 μS/cm). Per the *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility* (WSRC-TR-2005-00257), two constituents monitored in SDF groundwater have action levels that require additional contingent analyses, strontium-90 and nonvolatile beta. Strontium-90 was not detected in groundwater at the SDF in 1QCY15. The nonvolatile beta groundwater concentrations increased from 110 pCi/L in 3QCY14 to 158 pCi/L in 1QCY15, which initiated all the contingent analyses per the *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility* (WSRC-TR-2005-00257). The only contingent analysis above its PQL was Tc-99 at well ZBG 2. However, Tc-99 and nitrate groundwater concentrations at well ZBG 2 remain below their respective GWPS.

In 1QCY17, groundwater at well ZBG002D showed decreases in nonvolatile beta activity (21.7 pCi/L), Tc-99 activity (28.4 pCi/L), nitrate concentration (2.06 mg/L), and conductivity (46 μS/cm). Although the 1QCY17 nonvolatile beta result for well ZBG002D (21.7 pCi/L) was less than 2015 activities, both the first nonvolatile beta threshold (8 pCi/L) was exceeded and initiated all contingent analyses. None of the results for the contingent analyses were above their method detection limits. Tc-99 and nitrate groundwater concentrations at well ZBG002D remain below their respective GWPS. Exceedance occurrences are summarized in Table 5.3-1.

Well ZBG 2 was screened above the Tan Clay Confining Zone (TCCZ). In 2014, well ZBG002C was installed adjacent to ZBG 2, but screened below the TCCZ in the Upper Three Runs Aquifer – Lower Aquifer Zone (UTRA-LAZ). At UTRA-LAZ wells ZBG002C and ZBG 4, nonvolatile beta groundwater concentrations did not exceed the 8 pCi/L threshold. However, concentrations at both wells exceeded the maximum nonvolatile beta value for background well ZBG015D (2.17 pCi/L), which indicates potential contamination below the TCCZ.

Two groundwater monitoring wells (ZBG016C and ZBG016D) have been installed downgradient of Sedimentation Basin No. 4, one to monitor perched water above the TCCZ (ZBG016D) and one to monitor the water table below the TCCZ (ZBG016C). The 1QCY17 data for ZBG016C indicates there not have been any impacts to the groundwater at Sedimentation Basin No. 4. The screen zone for well ZBG016D has been dry since installation, indicating there was no perched water at this location in 1QCY17. [SRNS-TR-2017-00227]

Analytical results from the groundwater sampling from 1QCY17 are presented in Attachment A of the *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2017* (SRNS-TR-2017-00227). The groundwater analytical and SDU inspection results to date do not contradict 2009 SDF PA model estimates.

Table 5.3-1: SDF PA Compliance Monitoring

Saltstone Monitoring Well	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or Other Regulatory Limit	Action Level	Action Taken	PA Impact
Well ZBG002D	Groundwater Nonvolatile Beta	21.7 pCi/L	8 pCi/L	30 pCi/L	Sr-90 Analyses	None
Wells ZBG002C and ZBG 4	Groundwater Nonvolatile Beta for background well ZBG015D	2.02 pCi/L and 5.8 pCi/L respectively	2.17 pCi/L	30 pCi/L	N/A	None

6. RESEARCH AND DEVELOPMENT

Several studies from FY2017 have continued research on properties considered critical to the performance of saltstone and are described in sections below and summarized in Table 6-1. A more in-depth discussion of on-going and future studies can be found in the *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2018 Implementation Plan* (SRR-CWDA-2017-00096).

Table 6-1: Summary of FY2017 R&D Activities

R&D Document Number	Results/Discussion	PA/CA Impacts
SREL Doc.: R-17-0004	Measurement of Distribution Coefficients in SRS Subsurface Sediments This ongoing study measured the distribution coefficient (K_d) values for various species under oxidizing and reducing conditions in actual subsurface sediments retrieved at the SRS (actual SDF soils used) and cementitious materials, in FY2017 investigation of I-129 in the presence of SRS soils and cementitious materials was conducted. For the SDU concrete samples, the equilibrium pH was high regardless of the initial background solution, indicating that the concrete had a large impact on solution chemistry. All of the observed I-129 K_d values for the SDU concrete materials were < 0.18 mL/g. This ongoing study informs SDF PA I-129 K_d assumptions.	To be determined by future modeling activities
SREL Doc. R-16-0003 and SREL Doc. R-17-0005	Radionuclide Leaching Characteristics from Saltstone Monolith EPA Method 1315 and dynamic leaching testing were continued in FY2017 and encompassed evaluation of radionuclide-spiked saltstone simulants and actual	To be determined by future modeling activities

R&D Document Number	Results/Discussion	PA/CA Impacts
	saltstone cores extracted from SDU Cell 2A to provide empirical leaching (diffusion) data for Tc-99 and I-129. The EPA 1315 leaching data for I-129 from the SDU Cell 2A samples indicated retention within the saltstone when compared to Cs-137 and T-99 results for the same tests. The updated Dynamic Leaching Method (DLM) results for the two SDU Cell 2A saltstone samples and the Tc-99-spiked saltstone simulant provide a unique data set that is difficult to interpret because of variations in the flow rate between the three tests samples and changes in flow rate over time for a given sample. For DLM testing, the concentration of Tc-99 in the leachate from up to approximately 4.5 pore volumes fluctuated between 5E-09 and 1E-08 mol/L with a cumulative Tc-99 release of 0.6 %. The Evaluation Case in the FY2014 SDF SA used 1E-08 mol/L and a sensitivity case was run using 1E-07 mol/L. With respect to saturated hydraulic conductivity (SHC), the Tc-spiked sample has indicated a relatively consistent value that fluctuates ranging between 5E-10 and 2E-09 cm/sec. In contrast, one of the SDU Cell 2A cores indicated a high initial SHC of 1E-08 cm/sec which subsequently dropped to <5E-10 cm/sec after 1.5 pore volume exchanges. The second SDU Cell 2A sample started with an SHC of 2E-09 cm/sec which dropped to <1E-10 cm/sec with less than 1 pore volume exchanged. The FY2014 SDF SA modeled an initial SHC of 6.4E-09 cm/sec, which is conservative.	
SRRA021685-000008 and SRRA021685-000009	Long-Term Radiological Lysimeter Program This ongoing lysimeter effluent testing in conjunction with solid phase analysis of the lysimeter cores and source material provides provide less ambiguous assignment of transport mechanisms, including K_d values. Values taken from the lysimeter solid phase analysis study provide strong support for vadose zone plutonium K_d that are one to two orders of magnitude higher than what is currently used in PA modeling at SRS, bolstering confidence in SDF PA and SA assumptions.	To be determined by future modeling activities

6.1 Measurement of Distribution Coefficients in SRS Subsurface Sediments

This ongoing study measured the distribution coefficient (K_d) values for various species under oxidizing and reducing conditions in actual subsurface sediments retrieved at the SRS (actual SDF soils used). Additionally, testing measured the impact of high pH cement leachate on the subsurface sediments K_d values.

In FY2017, the investigation of I-129 in the presence of SRS soils and cementitious materials was conducted. [SREL Doc.: R-17-0004] While some I-129 sorption was observed for the SDF soils under acidic pH conditions ($K_d \approx 0.18$ to 1.0 mL/g), I-129 partitioning levels were quite low for the soil under alkaline conditions (<0.18 mL/g), making it difficult to discriminate between partitioning to the solid-phase from experimental variation and analytical error. For the SDU

concrete samples, the equilibrium pH was quite high regardless of the initial background solution, indicating that the concrete had a large impact on solution chemistry. In fact all of the observed *Ka* values for the SDU concrete materials were < 0.18 mL/g. For FY2018, the retention of I-129 will be evaluated with respect to intact saltstone monoliths since this sample format is more representative of the field configuration in comparison to size-reduced (crushed) samples utilized for partitioning experiments.

6.2 Radionuclide Leaching Characteristics from Saltstone Monolith

The purpose of this study is two-fold. The first element of the investigation was to evaluate test methods with respect to saltstone leaching utilizing rhenium (Re) and stable iodine (I-127) as non-radioactive surrogates for Tc-99 and I-129. Test methods employed included a standardized semi-dynamic leaching test, U.S. Environmental Protection Agency (EPA) Method 1315, *Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure*, and a dynamic leaching test was developed as part of this scope. [EPA_Method_1315] The dynamic leaching methodology uses the flexible-wall permeameter apparatus that was more commonly used for measuring the SHC of saltstone. The intent is to force leachate through the interior of the saltstone monolith to mimic the eventual ingress of water into saltstone and subsequent pore volume exchange to establish the dynamic leaching behavior of saltstone contaminants. The second element of the investigation was to utilize the tests methods (optimized with non-radioactive surrogates) for characterizing the leaching behavior of saltstone samples spiked with Tc-99 and I-129 in addition to the characterization of saltstone cores retrieved from SDU Cell 2A.

This task will provide empirical leaching (diffusion) data for Tc-99, I-129, and potentially other saltstone contaminants that can be used as direct inputs to the saltstone transport models. In addition, the development of a dynamic leaching test will provide new information regarding the leaching of saltstone associated with multiple pore volume exchanges.

In FY2015, the standardized semi-dynamic leaching, EPA Method 1315, was used to evaluate the leaching characteristics of Tc-spiked saltstone samples cured for three and six months. [EPA_Method_1315] A Tc-spiking concentration of 1.2E-02 mMol/L was utilized for all samples, which is consistent with Tc levels detected in Tank 50 waste solution. Tests were conducted with an artificial groundwater solution equilibrated with respect to three different atmospheres (oxic, anoxic, and reducing). The leaching rate of Tc-99 was observed to decrease over the course of testing but exhibited no clear response to either curing duration (3 or 6 months) or test atmosphere (oxic, anoxic, and reducing). In comparison to Re-spiked samples, the proportion of Tc leached during testing was significantly less than Re (i.e., <0.75 % for Tc compared to 6-9 % for Re). Rhenium is typically considered as a non-radioactive surrogate for Tc but this data, and known differences in redox potential between the two elements, imply that Re does not exhibit equivalent leaching behavior to Tc and as such, it may not be a legitimate surrogate. The effective diffusivities determined via EPA testing for Tc and Re were 2.0-3.7E-10 and 2.7-3.5E-08 cm^2/s, respectively. A value of 1.0E-08 cm^2/s was used in the FY2014 SDF SA, which is conservative.

Dynamic leaching tests utilizing the method developed using Re-spiked samples in FY2014 were conducted on Tc-spiked samples in FY2015. Based on the occurrence of effluent degassing in FY2014, which appeared to prevent the acquisition of consistent data, a bladder accumulator was incorporated into the experimental set up to restrict contact between the “test” solution saturating

the column and the solution in the permeameter. This modification was successful in excluding dissolved gases from the pressurized inlet solution, and subsequent bubble formation in the sample and in the effluent solution. Similar to the EPA measurements, technetium and rhenium were spiked at levels equivalent to those measured in Tank 50 waste. After collecting approximately 45 to 50 mL of leachate for each of the Tc- and Re-spiked samples, the cumulative proportions of technetium and rhenium (as a percentage of the original spike amounts) leached were 0.3 % and 10 %, respectively. The disparity in the data again suggests that rhenium may not be a suitable non-radioactive surrogate for technetium at least in regards to leaching behavior. Based on sample size and a measured porosity of 60 %, 45 to 50 mL equates to the exchange of approximately 1 to 2 pore volumes, though it is acknowledged that not all of the porosity may be involved in liquid transport through the sample. [SREL Doc. R-15-0003]

Both EPA Method 1315 and dynamic leaching testing were continued in FY2017 and encompassed evaluation of radionuclide-spiked saltstone simulants and actual saltstone cores extracted from SDU Cell 2A. The data from these studies is provided in SREL Doc. R-16-0003 and SREL Doc. R-17-0005.

With respect to EPA Method 1315, Tc-99 leaching rates for the spiked saltstone samples appeared to be sensitive to curing duration and the reduction capacity of the blast furnace slag (BFS) used in making the grout. Due to supply cessation of a historically utilized BFS, an alternate, or "new", BFS source was sought and approved for use in processing future saltstone batches at SRS. [SRR-CWDA-2015-00072] Longer curing times and higher reduction capacity for the as-received BFS resulted in lower effective diffusivities. A Tc-spiked, simulant saltstone processed using BFS with a reduction capacity of 1,600 μeq/g and cured for 6 months indicated an effective diffusivity of 5.7E-12 cm^2/sec compared to 3.0E-10 cm^2/sec for a sample processed using BFS with a reduction capacity of approximately 700 μeq/g, and cured for 3 months. Reduction capacity can vary between different BFS sources due to differences in the concentrations of components, in particular sulfur and iron, which are known reductants. As anticipated leaching rates and effective diffusivities from the simulant samples for poorly sorbing contaminants like NO_3^- were much higher than for Tc-99 (E-07 to E-08 cm^2/sec for nitrate compared to E-10 to E-12 cm^2/sec for Tc-99).

Technetium-99 diffusivities (determined via EPA Method 1315 testing) for three intact saltstone samples (retrieved from SDU Cell 2A) ranged from 5.2 to 6.4E-11 cm^2/sec. These diffusivities are higher than observed for the simulant samples processed using the "new" BFS which is expected since the saltstone emplaced in SDU Cell 2A was produced with the historically-utilized BFS with the lower measured reduction capacity. As with the simulant samples, the effective diffusivities of poorly adsorbed nitrates were approximately two orders of magnitude higher than the Tc-99 diffusivities. I-129 and Cs-137 diffusivities for the three SDU Cell 2A cores ranged 1.0E-08 to 5.5E-09 cm^2/sec and 1.1 to 4.9E-10 cm^2/sec, respectively. The leaching behavior for I-129 was similar to that observed for poorly adsorbed NO_3^- as indicated by the high effective diffusivities for both components. [SREL Doc. R-17-0005]

For Dynamic Leaching Method (DLM) testing, the permeameter system was upgraded to accommodate three test samples at the same time by using the laboratory air compressor to provide the driving force for leaching. The three materials tested include a Tc-99-spiked sample described in SREL Doc. R-15-0003, and two actual radioactive saltstone cores extracted from SDU Cell 2A.

Measurement of the Tc-99-spiked sample has been ongoing for almost 30 months with approximately 550 mL of leachate being collected from the sample (equivalent to about 15 pore volumes). The concentration of Tc-99 in the leachate from up to approximately 4.5 pore volumes fluctuated between 5E-09 and 1E-08 mol/L with a cumulative Tc-99 release of 0.6 %. However, leachates collected after the exchange of 4.5 pore volumes indicated a rapid increase in Tc-99 concentration to around 1E-07 mol/L; at the end of FY2016 the cumulative Tc-99 release from the simulant saltstone sample was approaching 2.5 % (after the exchange of 6.25 pore volumes). In contrast, approximately 50 % of the nitrate in the sample has been released which verifies the poor nitrate retention observed for the EPA tests. It is also noteworthy that the nitrate concentration did not indicate a similar spike as compared to Tc-99 after the exchange of approximately 4.5 pore volumes. Phenomena responsible for the sudden increase in Tc-99 leaching have not been established. In addition, the Evaluation Case in the FY2014 SDF SA used 1E-08 mol/L and a sensitivity case was run using 1E-07 mol/L.

During the FY2017 testing of this Tc-spiked saltstone, a process anomaly occurred in which the sample confining pressure was lost and it is possible that the sample was exposed to the atmosphere. The Tc-99 concentration following this anomaly increased by a factor of three (from 1.2E-07 to 3.6E-07 mol/L). More significant, however, was a concurrent order of magnitude increase in the SHC from 4.0E-10 cm/sec to 4.0E-09 cm/sec. As such there is concern that the sample, and therefore the data, after this event may be compromised. However, given the extended length of time the sample had been tested, a decision was made to continue the analysis. The sample has been evaluated for approximately 27 months. Fifteen pore volumes have been exchanged and the Tc-99 and NO_3^- concentrations are currently 3.3E-08 mol/L and 0.02 mol/L, respectively. The pH of the leachate is around 10.8, and as such the Tc-99 concentration is in good agreement with the thermodynamically predicted solubility limit of reduced $TcO_2.xH_2O$ phases. With respect to cumulative percent leached from the saltstone sample the Tc-99 is 11% and the NO_3^- is 94%. The SHC did not decrease to its former value and remains around 2.0E-09 cm/sec.

The SDU Cell 2A cores indicate significantly disparate properties from each other and from the Tc-spiked simulant sample. With respect to SHC, the Tc-spiked sample has indicated a relatively consistent value that fluctuates ranging between 5E-10 and 2E-09 cm/sec. In contrast, one of the SDU Cell 2A cores indicated a high initial SHC of 1E-08 cm/sec which subsequently dropped to <5E-10 cm/sec after 1.5 pore volume exchanges. The second SDU Cell 2A sample started with an SHC of 2E-09 cm/sec which dropped to <1E-10 cm/sec with less than 1 pore volume exchanged. The FY2014 SDF SA modeled an initial SHC of 6.4E-09 cm/sec, which is conservative. Differences in sample SHC pose some potential issues with respect to sample-to-sample comparison. In particular, variations in SHC result in different pore volume exchange rates and therefore different residence times of the leachate within the sample. Varied residence times may subsequently impact contaminant leaching behavior. The evaluation of the SDU Cell 2A samples continued through FY2017 though the sample exhibiting the slowest transport rate was halted after 1.5 pore volumes had been exchanged. The second SDU Cell 2A sample continues to be evaluated and approximately 8 pore volumes have been exchanged for the sample.

The Tc-99 concentrations and cumulative Tc-99 release for the SDU Cell 2A samples are generally higher than previously observed for the Tc-spiked, simulant saltstone. The range of Tc-99 concentrations measured for the Tc-spiked sample is 4.9E-09 to 3.6E-07 mol/L; in comparison, the Tc-99 concentrations for the two SDU Cell 2A samples has ranged 4.1E-08 to 5.0E-07 mol/L.

In contrast, the concentration of nitrate in leachates of all three samples is much more consistent; both SDU Cell 2A samples and the Tc-spiked sample indicate an initial concentration of around 1.0 mol/L that subsequently decreases gradually to less than 0.4 mol/L. At the time of test cessation, the SDU Cell 2A with low flow rate indicated the following key values: NO_3^-, Tc-99, and Cs-137 concentrations of 0.37, 9.5E-08, and 2.3E-09 mol/L and cumulative percentages leached of 34.5, 4.8, and 6.7%, respectively. The final SHC was measured at 6.6E-11 cm/sec. After the exchange of 8 pore volumes, the second SDU Cell 2A sample indicates NO_3^-, Tc-99, and Cs-137 concentrations of 0.02, 4.1E-08, and 2.5E-10 mol/L and cumulative percentages leached of 77.4, 11.7, and 11.7%, respectively. The most recently (December 2017) measured SHC for this sample is 5.3E-10 cm/sec.

The DLM samples described thus far have been evaluated on the originally developed DLM system in which a constant pressure is set and the flow rate allowed to vary based on changes with respect to the sample SHC. The newly designed system utilizes mechanical pumps in which a constant flow rate through the sample can be set. It should be noted that this new system has not performed as intended since the flow rates continue to vary based on changes in sample SHC. The original intent for being able to control the flow rate was two-fold. Firstly, the DLM experiments as currently designed are slow as indicated by the transport of only 15 pore volumes in 27 months for the aforementioned Tc-spiked sample. Secondly, it was envisaged that being able to control the flow rate would enable the impact of permeant residence time to be determined. To date, four samples have been evaluated on this revised DLM system and while the desired flow rates were set between 0.2 and 1.5 mL/day all samples are currently operating at rates at or below 0.1 mL/day. These samples have had less than a pore volume exchanged and as such it is too early to make any determinations with respect to sample-to-sample similarities or differences. In comparison, to the aforementioned Tc-spiked and SDU Cell 2A samples, the Tc-99 concentrations in the leachates is high at currently measured at 1.0E-06 mol/L. However, with leachate pH values in the range of 11.8 to 12.8 these concentrations are generally aligned with the thermodynamically-predicted solubility limits for reduced $TcO_2.xH_2O$ phases.

Plans for FY2018 are predominantly focused around continued DLM evaluation of the Tc-spiked samples and the one remaining SDU Cell 2A core. There are also two additional areas of emphasis. The first is to analyze the leachates from the Tc-spiked samples with respect to the concentration of constituents that are relevant to the pore solution chemistry of saltstone. Key constituents of interest include Na, Ca, K, Al, Mg, Fe, Si, NO_3^-, NO_2^-, CO_3^{2-}, and SO_4^{2-}. It is envisaged that in addition to the influence of pH on Tc-99 solubility, changes in the pore solution constituent concentrations may also influence the Tc-99 leaching characteristics. The second is to utilize DLM to evaluate the leaching behavior of I-129 from spiked laboratory-prepared samples. I-129 is the most significant dose driver and partitioning measurements indicate that it is poorly retained in saltstone. However, those experiments require the saltstone sample to be crushed thereby exposing a larger proportion of the saltstone sample to the leachant solution. In reality, saltstone is comprised of a tortuous, sub-micron pore network which is anticipated to impact the leaching characteristics of I-129.

6.3 Long-Term Radiological Lysimeter Program

As part of a multi-year evaluation of the long-term behavior of radionuclides in the tank farms and saltstone disposal facility (SDF), two reports were issued in September 2017. The first report

(SRRA021685-000008) documented concentrations measured in field lysimeter effluents during FY2017.

Key findings from this report include:

- Lysimeters containing NpO_2NO_3(s) sources (Np in the +5 oxidation state) continue to show measurable Np breakthrough. The variability in these numbers is hypothesized to be caused by heterogeneous flow of water through the lysimeter. Starting in FY2016 and continuing into FY2017, Np was observed in the effluent of lysimeter 32 which contains a relatively insoluble NpO_2(s) source. The observation of Np in the effluent from this lysimeter implies that the NpO_2(s) is becoming oxidized and releasing Np(V) which can transport through the lysimeter with a relatively low K_d.
- Similar to previous years, Co-60 was measured in the effluent. However, the concentrations were much lower than previous sampling events. The majority of the Co-60 was released within the first two years of the experiment and concentrations are now close to detection limits. All cement and saltstone lysimeter sources contained higher concentrations of Co-60 in the effluent relative to a control with the gamma suite of radioisotopes added directly to a filter. It is unclear what is causing this enhanced mobility of a small fraction of Co-60 in the cement and saltstone sources.
- There is a high degree of variability in the amount of water flowing through each lysimeter. It is hypothesized this is due to heterogeneous flow of water through the soil and variations in the localized climate (i.e. wind and rain patterns) above the 4-inch diameter lysimeter opening.

The second report (SRRA021685-000009) documented the detailed solid phase analysis of a field lysimeter with an emplaced colloidal PuO_2(s) source.

Key findings from this report include:

- Consistent with previous lysimeter studies, both downward and upward migration of Pu was observed. A lower degree of upward migration is proposed to be due to the shorter time for Pu diffusion in the current lysimeter (3.4 years) compared with previous lysimeter studies (11 years).
- The downward transport of Pu in the current PuO_2 lysimeter was greater than that observed for previous $PuCl_3$, $Pu(NO_3)_4$, and $Pu(C_2O_4)_2$ bearing lysimeters. This enhanced transport is hypothesized to be due to the colloidal nature of PuO_2(s) which could result in enhanced transport.
- Desorption experiments using Pu contaminated soils retrieved from this lysimeter indicated conditional desorption distribution coefficients of log K = 4.4 ± 0.3 L/kg. There was no apparent difference between unfiltered and ultrafiltered samples during the desorption experiments indicating that either 1) colloids are not present in these samples as hypothesized or 2) colloids sorb strongly to the soil and do not desorb.

Lysimeter effluent testing in conjunction with solid phase analysis of the lysimeter cores and source material provides researchers with a robust data set specific to the Savannah River Site (SRS) that can provide less ambiguous assignment of transport mechanisms, including K_d values,

and bolster confidence in PA modeling assumptions. For example, values taken from the lysimeter solid phase analysis study provide strong support for vadose zone plutonium K_ds that are one to two orders of magnitude higher than what is currently used in PA modeling at SRS.

In FY2018, liquid samples will continue to be collected quarterly from the field lysimeters and transported to Clemson University. For cost savings purposes, only samples taken every other quarter (i.e., biannually) will undergo analysis. Effluent samples collected but not analyzed will continue to be stored at Clemson University and can be analyzed at a later date if funding becomes available. Since breakthrough has been detected for two lysimeters with Np sources, monthly effluent sampling and analysis will be performed for lysimeter 30 (containing a $NpO_2NO_3(s)$ source) and lysimeter 32 (containing a $NpO_2(s)$ source) to better capture the radionuclide's release and transport behavior. Solid phase analysis of lysimeter 41 containing an emplaced Pu(V) source is scheduled for FY2018. This analysis will help to ascertain what impact plutonium's initial valence state plays in its migration behavior.

7. PLANNED OR CONTEMPLATED CHANGES

Sections 7.1 through 7.6 discuss planned work that are part of PA maintenance and monitoring activities. In addition to these activities, the DOE has performed a number of additional activities to support the development of a future revision to the SDF PA. While development of this revision is still in an incipient stage, it is worth noting that a report has been developed which identifies features, events, and processes (FEPs) which will be relevant to the PA (SRR-CWDA-2017-00057). These FEPs shall be used to inform the development of updated conceptual models. In addition to model revisions, the revised PA will also incorporate the latest input values as developed through ongoing studies (see Sections 6 and 7.5) and other recent literature reviews and analyses, as appropriate.

7.1 Revise the Closure Plan

As stipulated in the SDF DAS (WDPD-12-49), and as part of the PA maintenance program, the SDF Closure Plan is reviewed annually to determine if additional revision is required. Although a revision to the SDF Closure Plan is not anticipated in FY2018, the plan will be reviewed to ensure it remains consistent with current SDF facility and operational conditions and, if necessary, an update to the SDF closure plan will be submitted to DOE for approval.

7.2 Revise the SDF Monitoring Plan

As stipulated in the SDF DAS (WDPD-12-49), and as part of the PA maintenance program, the SDF Monitoring Plan is reviewed annually to determine if additional revision is required. Although a revision to the SDF Monitoring Plan is not anticipated in FY2018, the plan will be reviewed to ensure it remains consistent with current SDF facility and operational conditions. If necessary, an update to the SDF Monitoring Plan will be submitted to DOE for approval.

7.3 Special Analyses

As discussed in Section 2.1.1, the FY2016 SDF SA was issued in the first quarter of FY2017. Additional SAs for the SDF will be prepared in the future as new data warrant that may potentially impact the ability to meet performance objectives.

7.4 Unreviewed Waste Management Question Evaluations

A formal system to evaluate disposal practice changes and proposed actions is in place at the SDF. The process consists of providing screening and if necessary UWMQEs of proposed activities and new information. The Unreviewed Waste Management Question (UWMQ) process will continue to be required throughout the life of the facility. This process is implemented via Manual S4 Procedure ENG.46.

7.5 Studies

PA-related testing and research activities are being performed as part of the on-going maintenance activities aimed at reducing uncertainty in the 2009 SDF PA model, or are verification sampling and analysis of materials properties used in the 2009 SDF PA. As ongoing research provides new information or reduces uncertainty, this information will be evaluated (via the UWMQ and SA process) against the information used as a basis for the 2009 SDF PA modeling.

Below is a brief list of testing and research activities currently planned for FY2018.

- Radionuclide Leaching Characteristics from Saltstone Monolith (Simulated and Actual SDU Samples)
- Long-term Radiological Lysimeter Program
- Performance Assessment Monitoring
- Vanderbilt University Recommendations on Reducing SDU Concrete Degradation Conservatisms
- University of Virginia Re-calculation of Closure Cap Infiltration Rates

7.6 Performance Assessment Monitoring

Per the requirements in the DAS issued for the SDF (WDPD-12-49), a monitoring plan shall be written, approved, and implemented within one year of issuance of the DAS and updated at least every five years. This monitoring plan includes annual data review and evaluation. Following this annual data review and evaluation, any modifications to this monitoring plan that may be applicable will be noted and the plan updated, as necessary.

8. STATUS OF DAS CONDITIONS, KEY AND SECONDARY ISSUES

In FY2017 there were no status updates to report on any DAS conditions, key or secondary issues resulting from a Low-Level Waste Disposal Facility Federal Review Group (LFRG) review of the Saltstone Facility's PA and CA or other technical basis documents. There are no additional DAS conditions in effect to report. FY2017 SDF operations comply with the DAS.

9. COMPOSITE ANALYSIS SUMMARY

The annual evaluation of the SRS CA is covered by a separate report prepared by SRNL. The latest evaluation as of the issuance of this review was issued in April 2017 for FY2016 (SRNL-STI-2017-00066).

10. CERTIFICATION OF CONTINUED ADEQUACY OF THE PA, CA AND DAS AND CONCLUSION

The current performance evaluation conducted on SDU 1, SDU 4, SDU Cells 2A/2B, SDU Cells 3A/3B, SDU Cells 5A/5B, and SDU 6 indicates SDF operations through FY2017 were within the performance expectation of the 2009 SDF PA, the FY2013 SDF SA, FY2014 SDF SA, and FY2016 SDF SA and comply with the DAS and DOE O 435.1 requirements.

11. REFERENCES

10 CFR 61, *Energy, Title 10 Code of Federal Regulations, Part 61, Licensing Requirements for Land Disposal of Radioactive Waste*, U.S. Nuclear Regulatory Commission, Washington DC, December 22, 2011.

DOE M 435.1-1, *Radioactive Waste Management Manual.,* U.S. Department of Energy, Washington DC, Chg. 1, January 9, 2007.

DOE O 435.1 Chg. 1, *Radioactive Waste Management*, U.S. Department of Energy, Washington DC, January 9, 2007.

DOE-STD-5002-2017, *DOE Standard Disposal Authorization Statement and Tank Closure Documentation*, U.S. Department of Energy, Washington, DC, May 2017.

DOE-WD-2005-001, *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 0, January 2006.

EPA_Method_1315, *Mass Transfer Rates of Constituents in Monolithic or Compacted Granular Materials Using a Semi-Dynamic Tank Leaching Procedure* (from EPA Manual SW-846), U. S. Environmental Protection Agency, Washington, DC, January 2013.

ESH-FSS-9000373, Odum, J.V., *Naval Fuel Material Facility (FMF) Settlement Agreement 89-06-SW, Item No. 3 Final Disposal of Saltcrete Drums*, Savannah River Site, Aiken, SC, June 20, 1990.

LWO-LWE-2008-00023, Plummer, A.S., *Inspection Program for Z-Area Vault 4,* Savannah River Site, Aiken, SC, February 2008.

Manual S4 Procedure ENG.46, *LW Unreviewed Waste Management Question (UWMQ)*, Savannah River Site, Aiken, SC, Rev. 2, March 23, 2012.

Manual SW24.6 Section 2.1, *Saltstone Processing Integrated Operating Manual, Inter Area Transfer Operation*, Savannah River Site, Aiken, SC, Rev. 24, September 10, 2012.

NDAA_3116, Public Law 108-375, *Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005*, Section 3116, *Defense Site Acceleration Completion*, U.S. Department of Energy, Washington DC, October 28, 2004.

PIT-MISC-0041_OUO, *Discussion Draft, SRS Long Range Comprehensive Plan*, Savannah River Site, Aiken, SC, Rev. 0, December 2000.

SREL Doc. R-15-0003, Seaman, J.C., *Chemical and Physical Properties of ^{99}Tc-Spiked Saltstone as Impacted by Curing Duration and Leaching Atmosphere*, Savannah River Site, Aiken, SC, October 1, 2015.

SREL Doc R-16-0003, Seaman, J.C. et al., *Contaminant Leaching from Saltstone*, Savannah River Site, Aiken, SC, September 29, 2016.

SREL Doc. R-17-0005, Seaman, J.C. et al*., Contaminant Leaching from Saltstone*, Savannah River Site, Aiken, SC, September 29, 2017.

SRNL-STI-2009-00115, Flach, G. P., et al., *Numerical Flow and Transport Simulations Supporting the Saltstone Disposal Facility Performance Assessment*, Savannah River Site, Aiken, SC, Rev. 1, June 17 2009.

SRNL-STI-2009-00473, Kaplan, D.I., *Geochemical Data Package for Performance Assessment Calculations Related to the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, July 22, 2016.

SRNL-STI-2009-00512, *Savannah River Site DOE 435.1 Composite Analysis, Volumes I and II*, Savannah River Site, Aiken SC, Rev. 0, June 10, 2010.

SRNL-STI-2012-00138, Kaplan, D.I., *Revised Guidelines for using Cellulose Degradation Product-Impacted Kd Values for Performance Assessments and Composite Analyses*, Savannah River Site, Aiken, SC, Rev. 0, May 2012.

SRNL-STI-2016-00511, *Evaluation of Saltstone Disposal Unit 7 Floor Penetrations*, Savannah River Site, Aiken, SC, Rev. 0, September 2016.

SRNL-STI-2017-00066, FY2016 *Savannah River Site Composite Analysis Annual Review*, Savannah River Site, Aiken, SC, April 2017.

SRNS-J2100-2008-00004, *Estimated Closure Inventory for the Saltstone Disposal Facility*, Savannah River Site, Aiken, SC, Rev. 2, June 2009.

SRNS-RP-2014-00537, *Savannah River Site Land Use Plan*, Savannah River Site, Aiken, SC, November 2014.

SRNS-TR-2017-00227, *Z-Area Saltstone Disposal Facility Groundwater Monitoring Midyear Report for 2017*, Savannah River Site, Aiken, SC, July 2017.

SRR-CWDA-2009-00017, *Performance Assessment for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 0, October 29, 2009.

SRR-CWDA-2011-00196, *Unreviewed Waste Management Question Requirements Document for Saltstone Facility,* Savannah River Site, Aiken, SC, Rev. 3, October 2014.

SRR-CWDA-2013-00026, *Performance Assessment Monitoring Plan for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 1, August 2015.

SRR-CWDA-2013-00062, *FY2013 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 2, October 2013.

SRR-CWDA-2013-00147, *SDF Inventory Estimates for Transport Modeling,* Savannah River Site, Aiken, SC, Rev. 0, December 9, 2013.

SRR-CWDA-2014-00006, *FY2014 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site*, Savannah River Site, Aiken, SC, Rev. 2, September 16, 2014.

SRR-CWDA-2015-00163, *FY2015 Annual Review Saltstone Disposal Facility (Z-Area) Performance Assessment,* Savannah River Site, Aiken, SC, Rev. 0, January 27, 2016.

SRR-CWDA-2015-00002, *FY2015 Saltstone Core-Drilling Mock-Up Summary*, Savannah River Site, Aiken, SC, Rev. 0, February 2015.

SRR-CWDA-2015-00066, *Summary of Saltstone Disposal Unit Cell 2A Core Drill Activities*, Savannah River Site, Aiken, SC, Rev. 0, May 2015.

SRR-CWDA-2015-00072, *Evaluation of Slag Used in Saltstone Disposal Unit Concrete and Grout Versus Performance Assessment Assumptions*, Savannah River Site, Aiken, SC, Rev. 0, August 31, 2015.

SRR-CWDA-2016-00051, *Property Data for Core Samples Extracted from SDU Cell 2A,* Savannah River Site, Aiken, SC, Rev. 0, April 26, 2016.

SRR-CWDA-2016-00072, *FY2016 Special Analysis for the Saltstone Disposal Facility at the Savannah River Site,* Savannah River Site, Aiken, SC, Rev. 0, October 2016.

SRR-CWDA-2017-00057, *Features, Events, and Processes for the Saltstone Disposal Facility Performance Assessment*, Savannah River Site, Aiken, SC, Rev. 0, August 2017.

SRR-CWDA-2017-00079, *Determination of SDF Inventories through 9/30/2017*, Savannah River Site, Aiken, SC, Rev. 0, November 2017.

SRR-CWDA-2017-00096, *Savannah River Site Liquid Waste Facilities Performance Assessment Maintenance Program FY2018 Implementation Plan*, Savannah River Site, Aiken, SC, Rev. 0, January 2018.

SRR-LWP-2009-00001, *Liquid Waste System Plan,* Savannah River Site, Aiken, SC, Rev. 20, March 21, 2016.

SRR-UWMQE-2017-00001, *Evaluation of Saltstone Disposal Unit 6 As-Built Conditions*, Savannah River Site, Aiken, SC, Rev. 0, March 27, 2017.

SRRA021685SR, Peruski, K. et al., *Determination of Constituent Concentrations in Field Lysimeter Effluents FY2016 Final Report*, Clemson University, Clemson, SC, September 26, 2016.

WDPD-12-49, Folk, J., *Disposal Authorization Statement for the Savannah River Site Saltstone Disposal Facility – Prestart Corrective Actions Complete*, Savannah River Site, Aiken SC, Rev. 0, May 2012.WSRC-TR-2005-00257, *Groundwater Monitoring Plan for the Z-Area Saltstone Disposal Facility*, Savannah River Site, Aiken, SC, Rev. 5, July 2010.

X-CLC-Z-00052, Dixon, K.B., *Saltstone Facility Basis Information for Consent Order of Dismissal Section III.7 Website Data – Third Quarter 2012*, Savannah River Site, Aiken SC, Rev. 0, October 2012.

X-CLC-Z-00070, Utlak, S.A., *Saltstone Facility Basis Information for Consent Order of Dismissal Section III.7 Website Data – Third Quarter 2014,* Savannah River Site, Aiken SC, Rev. 0, November 2014.

X-CLC-Z-00078, Chandler, A.B., *3Q16 Saltstone Facility Basis Information for Section III.7 of the Consent Order of Dismissal*, Savannah River Site, Aiken, SC, Rev. 1, October 2016.

X-CLC-Z-00080, Brown, M.K., *4Q16 Saltstone Facility Basis Information for Section III.7 of the Consent Order of Dismissal*, Savannah River Site, Aiken, SC, Rev. 0, January 2017.

X-CLC-Z-00081, Thompson Jr., T.L., *1Q17 Saltstone Facility Basis Information for Section III.7 of the Consent Order of Dismissal*, Savannah River Site, Aiken, SC, Rev. 0, May 2017.

X-CLC-Z-00082, Chandler, A.B., *2Q17 Saltstone Facility Basis Information for Section III.7 of the Consent Order of Dismissal*, Savannah River Site, Aiken, SC, Rev. 0, July 2017.

X-CLC-Z-00083, Chandler, A.B., *3Q17 Saltstone Facility Basis Information for Section III.7 of the Consent Order of Dismissal*, Savannah River Site, Aiken, SC, Rev. 0, November 2017.

X-SD-Z-00001, Ray, J.W., *Waste Acceptance Criteria for Aqueous Waste Sent to the Z-Area Saltstone Production Facility*, Savannah River Site, Aiken SC, Rev. 17, March, 2017.