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FY2022 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility

February 2023

SRNS-RP-2023-00140 / SRNL-STI-2023-00008

SAVANNAH RIVER SITE • AIKEN, SOUTH CAROLINA

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Printed in the United States of America

Prepared for
U.S. Department of Energy

Keywords: *Trench, LAWV, ILV, CIG, NRCDA, ELLWF, DOE Order 435.1*

Retention: *Permanent*

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EXECUTIVE SUMMARY

The Savannah River Site (SRS) E-Area Low-Level Waste Facility (ELLWF) consists of six types of disposal units described in the Performance Assessment (PA) (WSRC, 2008): Low Activity Waste Vault (LAWV), Intermediate Level Vault (ILV), Trenches [Slit Trenches (STs), Engineered Trenches (ETs), and Component-in-Grout (CIG) Trenches], and Naval Reactor Component Disposal Areas (NRCDAs). The ELLWF is a part of the Solid Waste Management Facility (SWMF). SWMF is managed and operated by the SRS Management and Operations prime contractor, Savannah River Nuclear Solutions (SRNS). The Solid Waste Management (SWM) organization within SRNS is responsible for operating the SWMF and the Savannah River National Laboratory (SRNL) is the technical agent that SRNS has contracted for preparing and maintaining the PA. SWMF operations have been performed at SRS since 1952. The mission of the SWMF is to provide storage, processing, disposal, and shipment of radioactive, hazardous, and mixed waste. The SWMF is committed to treat, store, and dispose of these waste products in a manner that protects the environment and the health and safety of the facility worker, the co-located worker, and the offsite general public. Wastes handled in the SWMF include low level waste, transuranic waste, hazardous waste, Toxic Substances Control Act waste, and mixed waste (containing both hazardous and radioactive constituents).

SRS low-level waste management at ELLWF is regulated under Department of Energy (DOE) Manual 435.1-1 (DOE, 2021) and is authorized under a Disposal Authorization Statement (DAS) as a federal permit. The original DAS was issued by Department of Energy-Headquarters (DOE-HQ) on September 28, 1999 (DOE, 1999) for the operation of the ELLWF and the Saltstone Disposal Facility. Those portions of that DAS applicable to the ELLWF were superseded by Revision 1 of the DAS on July 15, 2008 (DOE, 2008a). The 2008 PA and 2008 DAS were officially implemented by the facility on October 31, 2008 and are the authorization documents for this Fiscal Year (FY) 2022 Annual Review.

Approximately 6,880 cubic meters of low-level waste were disposed in ELLWF disposal units during FY2022. All disposal units remain in conformance with their disposal limits (McGill, 2022).

Most action-level lysimeter locations, approximately 88%, remained below administrative limits in FY2022. A majority of the action-level (AL) lysimeters would need to reach, with some exceeding, their administrative limit in order to exceed a groundwater performance objective (PO) or measure. Because administrative limits are set at $1/4^{th}$ of the concentration predicted to result in an exceedance in the groundwater, the remaining 12% of the AL lysimeters spread over seven trenches are not expected to result in an exceedance at the 100-m point of assessment (POA). Trench cover monitoring in FY2022 revealed a tear in the CIG storm water runoff cover. Repairs will be made in F2023. Other observed defects were minor (e.g., cover depressions, erosion areas, and fasteners) and are not expected to affect the performance of these interim barriers. Finally, sump water samples were all found to be below administrative limits before being discharged. Impacts to surface waters downstream from the ELLWF (i.e., Upper Three Runs, Savannah River) continue to fall well below DOE public dose limits based on annual compliance monitoring.

The number of proposed changes to data, models and operational plans for the ELLWF since the 2008 PA are enough to warrant a revision. Therefore, a revision to the PA is in preparation and is scheduled to be reviewed by the DOE Low-Level Waste Disposal Facility Federal Review Group (LFRG) in FY2023. Operational restrictions remain in place from a Special Analysis (SA) (Hamm et al., 2018) that evaluated new groundwater flow predictions. These measures ensure that POs will continue to be met (LaBone et al. 2022) until the ongoing PA revision is completed, approved and implemented.

The FY2022 PA Annual Review for the ELLWF affirms that the disposal facility continued to operate within the bounds of the current PA and Composite Analysis (CA) baseline and the subsequent SA's and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS (DOE, 2008a), RWMB (McGill, 2022), and ELLWF Low-Level Waste Acceptance Criteria (SRS-1S, 2021). This annual review affirms that the supporting studies performed in FY2022 do not alter the conclusions of the ELLWF PA (WSRC, 2008) and that there is a reasonable expectation that the ELLWF will meet the POs delineated in DOE Manual 435.1-1 (DOE, 2021).

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AL	Action Level
AP	All-Pathways
CA	Composite Analysis
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CIG	Components-in-Grout
CWTS	Consolidated Waste Tracking System
DAS	Disposal Authorization Statement
DOE	Department of Energy
DOE-HQ	Department of Energy – Headquarters
DOE-SR	Department of Energy – Savannah River
dpm	disintegrations per minute
DRF	Dose Release Factor
DU	Disposal Unit
ELLWF	E-Area Low-Level Waste Facility
ET	Engineered Trench
FEPs	Features, Events and Processes
FY	Fiscal Year
GSA	General Separations Area
HELP	Hydrologic Evaluation of Landfill Performance
ILV	Intermediate Level (Waste) Vault
L	liter
LAWV	Low Activity Waste Vault
LFRG	Low-Level Waste Disposal Facility Federal Review Group
LLW	Low-Level Waste
m^3	cubic meters
mL	milliliter
MOP	Member of the Public
MWMF	Mixed Waste Management Facility
N/A	Not Applicable
NRCDA	Naval Reactor Component Disposal Area
PA	Performance Assessment
PARC	Performance Assessment Review Committee
pCi	picocuries
PEST	Parameter ESTimation software

PIF	Plume Interaction Factor
PO	Performance Objective
POA	Point of Assessment
QA	Quality Assurance
R&D	Research & Development
RWMB	Radioactive Waste Management Basis
SA	Special Analysis
SCDHEC	South Carolina Department of Health and Environmental Control
SOF	Sum-of-Fractions
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
ST	Slit Trench
SWM	Solid Waste Management
SWMF	Solid Waste Management Facility
SZ	Saturated Zone
TPBAR	Tritium Producing Burnable Absorber Rod
UCAQE	Unreviewed Composite Analysis Question Evaluation
UDQE	Unreviewed Disposal Question Evaluation
VOCs	Volatile Organic Compounds
VZMS	Vadose Zone Monitoring System
WAC	Waste Acceptance Criteria
WITS	Waste Information Tracking System
1D	One-Dimensional
3D	Three-Dimensional

1.0 Facility Background/History

The Savannah River Site (SRS) E-Area Low-Level Waste Facility (ELLWF) consists of six types of disposal units described in the Performance Assessment (PA) (WSRC, 2008): Low Activity Waste Vault (LAWV), Intermediate Level Vault (ILV), Slit Trenches (STs), Engineered Trenches (ETs), Component-in-Grout (CIG) Trenches, and Naval Reactor Component Disposal Areas (NRCDAs). This annual review evaluates the adequacy of the approved 2008 ELLWF PA, along with the Special Analyses (SAs) approved since the 2008 ELLWF PA was issued, the 2008 Disposal Authorization Statement (DAS) (DOE, 2008a), and the ELLWF Waste Acceptance Criteria (SRS-1S, 2021). The review also verifies that the Fiscal Year (FY) 2022 low-level waste (LLW) disposal operations were conducted within the bounds of the PA/SA baseline and the DAS. Important factors considered in this review include waste receipts, results from monitoring, research and development (R&D) programs, and the adequacy of controls derived from the PA/SA baseline.

SRS LLW management at ELLWF is regulated under Department of Energy (DOE) Manual 435.1-1 (DOE, 2021) and is authorized under a DAS as a federal permit. The original DAS was issued by Department of Energy-Headquarters (DOE-HQ) on September 28, 1999 (DOE, 1999) for the operation of the ELLWF and the Saltstone Disposal Facility. Those portions of that DAS applicable to the ELLWF were superseded by Revision 1 of the DAS on July 15, 2008 (DOE, 2008a). The 2008 ELLWF PA and 2008 DAS were officially implemented by the facility on October 31, 2008 and are the authorization documents for this FY2022 Annual Review.

The ELLWF is a part of the Solid Waste Management Facility (SWMF). SWMF is managed and operated by the SRS Management and Operating prime contractor, Savannah River Nuclear Solutions (SRNS). The Solid Waste Management (SWM) organization within SRNS is responsible for operating the SWMF and the Savannah River National Laboratory (SRNL) is the technical agent that SRNS has contracted for preparing and maintaining the PA. SWMF operations have been performed at SRS for 70 years. The mission of the SWMF is to variously provide for the storage, processing, disposal, and shipment of radioactive, hazardous, and mixed waste as appropriate. The SWMF is committed to treat, store, and dispose of these waste products in such a manner that the health and safety of the facility worker, the co-located worker, the offsite general public, and the environment are protected. Wastes handled in the SWMF include low level waste, transuranic waste, hazardous waste, Toxic Substances Control Act waste, and mixed waste (containing both hazardous and radioactive constituents). The SWMF consists of E-Area and a portion of H-Area within SRS. The majority of the SWMF processes, including ELLWF, are located in the E-Area near the center of SRS.

2.0 Changes Potentially Affecting the PA, CA, DAS OR RWMB

Many of the research and development tasks summarized in recent Annual Reviews (Hiergesell et al., 2016; Crapse et al., 2017; Hang et al., 2018; Kubilius et al., 2019; Wohlwend et al., 2020; LaBone et al., 2021; LaBone et al., 2022) as well as in this report (see Section 6.0), have been in preparation for the revision of the 2008 ELLWF PA (WSRC, 2008). The DOE requires that the PA demonstrate a reasonable expectation that LLW disposal will meet the radiological performance objectives (POs)/measures established in DOE Manual 435.1-1 (DOE, 2021). A revision to the ELLWF PA was started in January 2019.

PA/CA. There were no Unreviewed Disposal Question Evaluations (UDQEs) or Special Analyses (SAs) completed in FY2022. The interim measures implemented in FY2021 by SWM in response to SRNS-TR-2020-00005 (Simmons, 2020) and described in last year’s ASR (LaBone et al., 2022) remain in place until the ongoing PA revision is completed, approved and implemented.

DAS. SRS continued to conduct ELLWF disposals in accordance with requirements, conditions and limitations set out in the DAS (DOE, 2008a). No baseline document listed in the DAS required revisions in FY2022. LLW disposal facility designs and operational practices continue to conform to the conceptual models used in the PA. Secondary issues identified in the Low-Level Waste Disposal Facility Federal Review Group (LFRG) review team report (DOE, 2008b) have been closed and improvements are to be addressed in the upcoming PA revision. Thus, this annual review affirms the continued adequacy of the DAS in FY2022.

RWMB. The Radioactive Waste Management Basis (RWMB), as updated and approved by Department of Energy - Savannah River (DOE-SR), is adequate for providing the waste controls, processes, and procedures to define the conditions under which the facility may operate with respect to low-level radioactive waste. The RWMB was updated in FY2022 (McGill, 2022) to ensure that it is consistent with facility operations and the radioactive waste management order.

3.0 Cumulative Effects of Changes

Based on the information described in Section 2.0, there will have been no impacts on the current ELLWF operations or disposal limits.

4.0 Waste Receipts

Waste acceptance criteria for disposal of LLW at the ELLWF are found in Chapter 5 of the 1S SRS Radioactive Waste Requirements procedure manual. Chapter 5 identifies the specific Waste Acceptance Criteria (WAC) by waste form, general Consolidated Waste Tracking System (CWTS) limits, and a LLW disposal unit decision tree. This LLW WAC procedure is periodically reviewed and updated (SRS-1S, 2021).

As required by the WAC (SRS-1S, 2021), waste generators must fill out a waste stream characterization form for each waste stream and forward it to SWM for approval prior to shipping. This characterization form includes the waste type and description. SWM reviews the characterization form for compliance with the WAC. Currently, there are over 2,400 approved waste streams in CWTS with approximately 132 approved waste streams active as of the end of FY2022. All waste types received in the E-Area disposal units were included and analyzed in the PA or supporting SAs.

The disposed radionuclide and volumetric inventories in FY2022 (between 10/1/21 and 9/30/22) were compared against the applicable PA/SA-limits for each of the LLW disposal units in ELLWF and met POs. These disposal units included the E-Area Vaults (LAWV, ILV) and the disposal trenches (STs and ETs).

The radionuclide inventory limits calculated in the PA/SA are implemented in the WAC. Disposed inventory is tracked as fractions of the individual radionuclide limits in the ELLWF waste tracking system. The sum of these fractions for each disposal unit is controlled to less than or equal to one to ensure compliance with each PA performance measure’s limit. SWM typically operates most low-level waste facilities with a 0.95 sum of fractions (SOF) administrative limit. The SOFs for disposed radionuclide inventories for all disposal units are less than one.

Because of waste minimization and volume reduction programs at SRS, future inventory estimates indicate that only a single LAWV and a single ILV will be needed for low-level radioactive waste disposal over the operational period (i.e., no new vaults need to be constructed). After 28 years of LAWV operation, approximately 33% of the available volume is filled with waste that contains approximately 15% of the allowable radionuclide inventory. After 28 years of ILV operation, approximately 59% of the available volume in the nine cells is filled with waste that contains approximately 9% of the allowable radionuclide inventory.

Table 4-1 provides the volume disposed of in FY2022, PA-estimated disposal capacity, percent filled, limiting SOFs for the selected performance measures, and the PA/Composite Analysis (CA) impact as of 9/30/22 for each disposal unit (DU). Final DU inventory limits are established by taking their preliminary inventory limits (i.e., computed in isolation from other neighboring DUs) and factoring in a plume interaction factor (PIF) that explicitly addresses for each DU its plume overlap from neighboring DUs. SOF calculations are based on these final inventory limits and as such implicitly account for all possible plume overlap contributions. The PIF method is constructed to be a conservative estimator of plume overlap. Thus, if individual DU's are compliant the overall facility is as well. For all ELLWF units, the groundwater beta-gamma performance measure is the controlling pathway at various time intervals depending on the disposal unit. Dose impact was calculated using the most limiting SOF and the corresponding PO. The dose associated with each disposal unit is below the PO limit.

Table 4-1. Waste Receipts.

Disposal Unit	Volume Disposed During FY2022 (m^3)	PA-Estimated Disposal Capacity (m^3)	Percent Filled FY2022 (%)	Sum of Fractions	PA/CA Impact (mrem/yr)
LAWV	182	30,600	33	0.15	0.60 of 4
ILV	19	4,284	59	0.09	0.36 of 4
ST1 (closed)	0	14,264	100	0.85	3.40 of 4
ST2 (closed)	0	15,560	100	0.87	3.48 of 4
ST3 (closed)	0	16,953	100	0.94	3.76 of 4
ST4 (closed)	0	19,193	100	0.95	3.80 of 4
ST5 (closed)	0	28,125	100	0.99	3.96 of 4
ST6	0	23,000	91	0.82	3.28 of 4
ST7	0	15,900	66	0.55	2.20 of 4
ST8	0	16,275	95	0.89	3.56 of 4
ST9	983	21,000	99	0.89	3.56 of 4
ST14	391	19,500	94	0.90	3.60 of 4
ET1 (closed)	0	35,660	100	0.87	3.48 of 4
ET2	535	35,500	81	0.85	3.40 of 4
ET3 (closed during FY22)	2,583	29,654	100	0.93	3.72 of 4
ET4	2,189	35,000	6	0.16	0.64 of 4
NRCDA (643-7E) (closed)	0	701	100	0.03	0.12 of 4
NRCDA (643-26E)	0	6,000	8	0.03	0.12 of 4
CIG 1	0	6,500	28	0.44	1.76 of 4

5.0 Monitoring

The E-Area Performance Monitoring Program ensures that the monitoring results from the vadose zone, sump water, soil cover, stormwater runoff covers, and vaults are evaluated and that they meet the ELLWF POs. The monitoring program is implemented in accordance with DOE Manual 435.1 (DOE 2021) and its objectives are to: 1) monitor trends in performance, 2) evaluate whether a facility is operating and behaving as expected and predicted by the PA, 3) evaluate the conservativeness of the PA conclusions, 4) provide input for refining the PA and building integrity in the PA analyses, and 5) provide a means to evaluate the potential for future regulatory exceedances. A summary of the monitoring performed for the ELLWF is provided in Table 5-1, and the performance modeling results that differ from expected behavior are given in Table 5-2.

Table 5-1. Current PA Monitoring Summary.

Area	Monitoring Location	Sampling Frequency	Radionuclide / Other Substance	Administrative Limits
Vadose Zone	Beneath and adjacent to the trenches	Twice per year	Tritium	East ST – 63.8 pCi/mL Center ST – 61.2 pCi/mL West ST – 46.9 pCi/mL ET 1 & 2 – 101.3 pCi/mL ET3 – 43.7 pCi/mL[1] CIG – 29.6 pCi/mL
Sump Water	Vault Sumps	Prior to pumping when threshold liquid levels are exceeded	Gross Alpha	1.35E+3 pCi/L (or ≥ 3.0 dpm/mL)
			Nonvolatile Beta	7.20E+3 pCi/L (or ≥ 16.0 dpm/mL)
			Tritium	8.0E+8 pCi/L (or ≥ 1.78E+6 dpm/mL)
	Engineered Trench 2 Sump	Prior to pumping when threshold liquid levels are exceeded	Gross Alpha	1.35E+3 pCi/L (or ≥ 3.0 dpm/mL)
			Nonvolatile Beta	7.20E+3 pCi/L (or ≥ 16.0 dpm/mL)
Groundwater	Not monitored by ELLWF because there is an existing tritium plume beneath parts of ELLWF that is from a different facility which monitors and reports on the groundwater per a RCRA permit. [2]			
Vault Concrete	Inspections of vaults; subsidence inspections	Every two years	N/A	N/A
Trench Cover Monitoring	Inspections of trench covers	Four times a year	N/A	N/A

[1] Calculated using peak fraction flux of 0.125 Ci/yr per Ci disposed (Hamm et al., 2013) and inventory limit of 4.2 Ci for the disposal unit (Butcher, 2017).
[2] Monitored and reported in accordance with the Office of Environmental Quality Control Bureau of Land and Waste Management Hazardous and Mixed Waste Permit SC1 890 008 989 (SCDHEC, 2014). A revision to the PA monitoring plan is scheduled for FY2023 or later that will include a saturated zone monitoring component.

Table 5-2. Performance Monitoring Results that Differ from the Expected Results.

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 1 VL 6 SC	Radionuclide Transport	• 175 pCi/mL • Concentrations in the action-level lysimeter decreased in FY2021 from a peak of 786 pCi/mL in FY2020. This decreasing trend continued in FY2022. The lysimeter above the action level lysimeter also shows a decreasing trend. This suggests the concentration in the action level lysimeter may continue to decrease in the future. See Section 5.1.1.	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 1 VL 15	Radionuclide Transport	• 1320 pCi/mL • VL-15 is on an increasing trend with concentrations in FY2022 reaching 1320 pCi/mL. This is the highest concentration measured to date for this lysimeter. Concentrations in the shallower lysimeters are elevated and generally increasing. This suggests that VL-15 may increase in the future. See Section 5.1.1.	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 1 VL 17	Radionuclide Transport	• 68.5 pCi/mL • VL-17 exceeded the action level for the first time in the fall sampling event for FY2020 when the tritium concentration spiked to 199 pCi/mL. Although this measurement appears to be an outlier, the tritium concentration in this lysimeter has been steadily increasing. All measurements since the FY2020 exceedance have been below the administrative limit including the FY2022 concentration of 68.5 pCi/mL. However, concentrations in this lysimeter have been trending upward. Concentrations in the upper lysimeter peaked in 2014 and declined through 2017 when they began to increase again. This trend continued in FY22. This suggests this lysimeter may continue to increase in the future. See Section 5.1.1.	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 1 VL 22	Radionuclide Transport	• 230 pCi/mL • VL-22 reached a peak of 300 pCi/mL in FY2020. In FY2021, concentrations began a decreasing trend which continued in FY2022. Concentrations in the shallow lysimeter had trended downward since FY2016 but increased in FY2022. This suggests this lysimeter may increase in the future. See Section 5.1.1.	101.3 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 2 ET2-VL-5	Radionuclide Transport	• 1410 pCi/mL • Although elevated, concentrations in this lysimeter have trended downward since the peak of 2822 pCi/mL in FY2018. Recent measurements have been comparable in magnitude. However, concentrations in the shallow lysimeter are generally trending downward. This suggests that ET2 VL 5 may decrease in the future. See Section 5.5.2.	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Engineered Trench 2 ET2-VL-6	Radionuclide Transport	• 149 pCi/mL • ET2 VL 6 exceeded the administrative limit for the first time in FY2021 when the concentration spiked to 924 pCi/mL. Concentrations declined in FY2022 with the fall measurement of 149 pCi/mL remaining above the administrative limit. However, the spring 2022 measurement was 26.9 pCi/mL, which is below the limit. The shallow lysimeters at this location are at background levels. This suggest that ET2-VL-6 may be below the administrative limit in FY2023. See Section 5.1.2.	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Engineered Trench 2 ET2-VL-15	Radionuclide Transport	• 168 pCi/mL • Concentrations in the action-level lysimeter have shown a decreasing trend since FY2020. FY2022 concentrations are slightly higher than recent measurements. Concentrations in the upper lysimeter are trending downward. This suggests that concentrations at ET2 VL 15 may continue to decline in the future. See Section 5.1.2.	101.3 pCi/mL	Operational soil cover was extended past ET2-VL-5, ET2-VL-6, and ET2-VL-15 during FY2019. This should reduce infiltration and eliminate funneling of rainwater near the lysimeters. Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 1 AT 6	Radionuclide Transport	• 60.9 pCi/mL • AT 6 first exceeded the administrative limit in fall 2016. Since that time, concentrations have hovered around the administrative limit. FY2022 measurements were slightly below the limit. The shallow lysimeters at this location show a decreasing trend but have stabilized in recent sampling events. This suggests that the tritium concentration in AT 6 is likely to continue hovering around the administrative limit. See Section 5.1.3.	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 1 VL-26-West	Radionuclide Transport	• 437 pCi/mL • Concentrations in the action-level lysimeter are on a slight decreasing trend. The tritium concentration in the lysimeter above the action level lysimeter has been trending downward. This suggests the concentration in the action-level lysimeter may continue to decline in the future. See Section 5.1.3.	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 4 ST4-VL-5	Radionuclide Transport	• 134 pCi/mL • Concentrations in the action-level lysimeter have been slowly trending upward. This trend continued in FY2022. The tritium concentration in the shallow lysimeter is also elevated. After peaking in fall 2009, concentrations in the shallow lysimeter declined through fall 2012. Since fall 2020, the concentration has been increasing. This suggests that tritium concentrations in ST4 VL 5 may continue to slowly increase. See Section 5.1.4.	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 7 ST7-VL-2	Radionuclide Transport	• 706 pCi/mL • Concentrations in the action-level lysimeter continue to increase. The fall 2021 concentration reached a peak of 706 pCi/mL. However, the spring concentration declined slightly to 692 pCi/mL. Concentrations in the upper lysimeters are at background. See Section 5.1.5.	61.2 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met
ELLWF Slit Trench 8 ST8-VL-6	Radionuclide Transport	• 47.1 pCi/mL • Concentrations in the action-level lysimeter have started to decline from the peak of 64.5 pCi/mL measured in fall 2020. This decreasing trend continued in FY2022. Although the fall 2021 measurement of 47.1 pCi/mL is slightly above the administrative limit, the spring 2022 measurement of 24.3 pCi/mL is below the limit. The shallow lysimeter is also on a decreasing trend. This suggests that this lysimeter will continue to decline in the future. See Section 5.1.6.	46.9 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

Disposal Facility/Unit	Monitoring Purpose	Monitoring Results [1]	PA Expected Behavior (Below)	Action Taken	PA/CA Impacts
ELLWF Slit Trench 14 ST14-VL-3	Radionuclide Transport	• 189 pCi/mL • Concentrations in the action-level lysimeter reached a peak concentration of 209 pCi/mL in fall 2020. Since that time, concentrations have started declining. This trend continued in FY2022. The shallow lysimeter is trending upward. See Section 5.1.7.	63.8 pCi/mL	Will continue to monitor this location as part of vadose zone monitoring program.	Expect POs to be met

[1] Trends discussed in more depth within the text. Concentrations shown are maximum values for FY2022.

The PA Monitoring Plan was last revised in 2012 (Millings, 2012) and a revision is planned in FY2023. The revision will establish new administrative limits for the various waste disposal units based on results from the revised PA. The revised PA Monitoring Plan will also implement an updated approach to the overall performance monitoring strategy that adds a saturated zone (water table) monitoring component to the existing vadose zone monitoring program. With this new approach, groundwater in the water table aquifer beneath ELLWF will be monitored for tritium as part of the PA monitoring program. Although saturated zone monitoring is not yet part of the PA monitoring program, groundwater was collected from several ELLWF water table wells in FY2022. These results are presented in Section 5.2.

5.1 Vadose Zone Monitoring

Groundwater in the vadose zone beneath the ELLWF undergoes semiannual performance monitoring to verify that tritium concentrations are not high enough to cause saturated zone groundwater to exceed the tritium maximum concentration limit at or beyond the facility point of assessment (POA). Measured vadose zone tritium concentrations are compared to administrative limits, which were established in the ELLWF Monitoring Plan (Millings, 2012) and are based on PA predictions (WSRC, 2008). The administrative limit for a given trench is 25% of the tritium concentration in the vadose zone which, if it occurred beneath the entire areal footprint of the trench, would cause groundwater tritium concentrations at the 100-meter boundary to reach the maximum concentration limit (20 pCi/mL). These conservative limits are used as indicators for whether further investigation is necessary. Due to the conservative assumptions used to calculate the administrative limits, it is important to note that reaching or exceeding the limit does not mean that the drinking water standard will be exceeded at the compliance point.

The vadose zone monitoring program consists of 307 suction lysimeters at 102 stations surrounding 14 waste trenches (Figure 5-1). Vadose zone moisture is collected from the lysimeters on a semi-annual basis and analyzed for tritium. At 93 of 102 lysimeter stations, a deep lysimeter is designated as an AL lysimeter (Halverson and Millings, 2017). This is usually the deepest (i.e., closest to the water table) active lysimeter in the cluster. Tritium concentrations in AL lysimeters are those that are compared to the administrative limits.

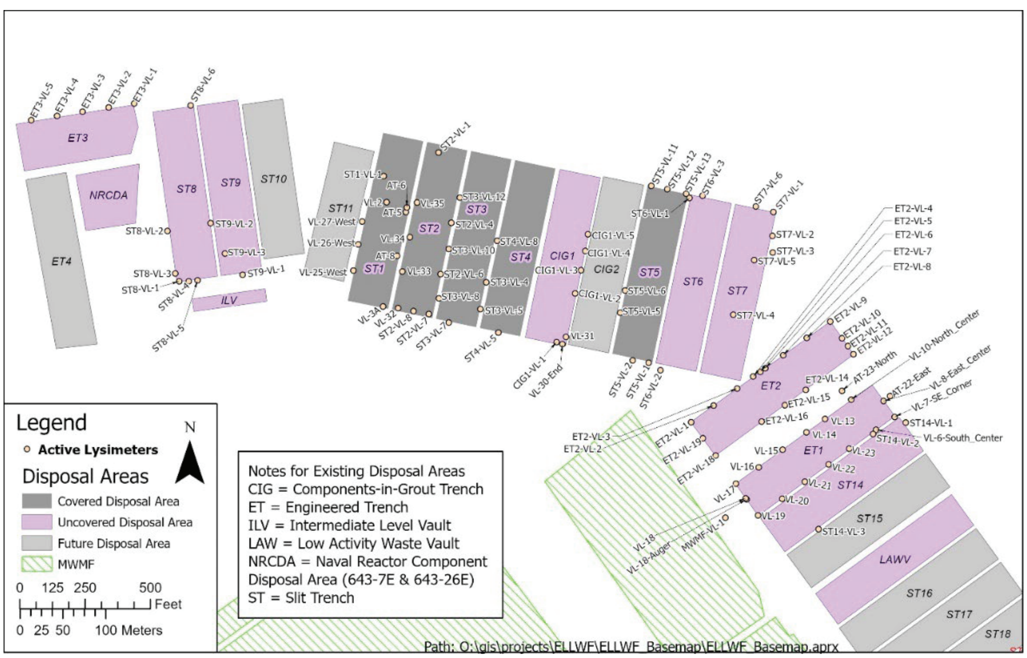

Figure 5-1. Layout showing disposal units, active lysimeters, and stormwater runoff covers.

Nine lysimeter clusters do not have an AL lysimeter; one cluster (MWMF-VL-1) is a "background" cluster not associated with a trench, and eight clusters have no active lysimeter at an appropriate elevation: one at ET1 (VL-23), two at ET2 (ET2-VL-4, ET2-VL-8), one at ST1 (VL-3A), two at ST2 (ST2-VL-1, ST2-VL-6), one at ST3 (ST3-VL-7) and one at ST8 (ST8-VL-3). These nine clusters are still sampled, and the results are reviewed for notable changes.

In FY2022, samples were collected at 92 of the 93 AL lysimeters. AT-5 (226) did not yield a sample in either the fall or spring sampling event. Repairs were made to the tubing on AT-5 (226) following the spring sampling event. After the repairs were complete, the lysimeter held vacuum which suggests that sampling may be successful in the future. All other AL lysimeters were successfully sampled in either the fall or spring sampling event.

Analytical results in FY2022 were at or below administrative limits at 81 of the 92 sampled AL lysimeters. Table 5-2 provides a summary of FY2022 tritium data for each of the AL lysimeters above administrative limits (where the PA Expected Behavior is the administrative limit for that DU). Table 5-3 provides summary data for all AL lysimeters. Tritium concentrations in eleven AL lysimeters exceeded administrative limits: three each at ET1and ET2, and one each at ST1, ST4, ST7, ST8, and ST14 (locations shown in Figure 5-2). All eleven lysimeters above the administrative limit have been above the limit at least once in previous sampling events. Therefore, in FY2022, there were no AL lysimeters that were above the limit for the first time.

An analytical result that is greater than the administrative limit does not indicate that groundwater concentrations will exceed the Environmental Protection Agency drinking water standard (SRS groundwater protection requirement) at the compliance point. The administrative limit would have to be simultaneously exceeded by a factor of four over a significant portion of the trench in several of the deepest lysimeters (closest to the aquifer) before there would be a risk of exceeding drinking water standards. This is because the administrative limits are set to $1/4^{th}$ of the concentration that would result in an exceedance of the drinking water standard at the 100-m compliance point as predicted by the PA model (Millings, 2012). Of the 92 AL lysimeters that were successfully sampled, only four exceeded the administrative limit by greater than a factor of four. In FY2022, no individual disposal unit had more than one AL lysimeter that exceeded the administrative limit by a factor of four. When an action-level is first exceeded, data are reviewed to establish temporal trends and to evaluate depth and geographic occurrence (Millings, 2012). A graded hierarchal approach is used to evaluate the collected data versus projected results from the PA. The graded approach may consist of continued monitoring, additional sampling, testing, and research studies implemented through the PA/CA maintenance program. All AL lysimeters which exceeded their administrative limits in FY2022 or earlier are discussed individually below.

5.1.1 Engineered Trench 1

There are 17 AL lysimeters associated with Engineered Trench 1 and all were successfully sampled in FY2022. Three of the 17 AL lysimeters exceeded the tritium concentration administrative limit of 101 pCi/mL: those in clusters VL-6-South Center (VL-6-SC), VL-15, and VL-22. These same three lysimeters were above the limit in FY2021. VL-17 exceeded the administrative limit in FY2020 but was below the limit in FY2021 and FY2022.

VL-6-SC. This AL lysimeter first exceeded the tritium administrative limit in FY2014, with a result of 502 pCi/mL, representing a substantial increase from 58 pCi/mL obtained in the previous sampling event. This prompted a detailed data review for VL-6-SC including disposal records, local hydrogeology, and rainfall data (Millings et al., 2014). Nothing remarkable was found in these data that could definitively explain the elevated tritium concentrations in VL-6-SC. From 2014 through 2019, concentrations in the AL lysimeter were generally decreasing, reaching a minimum of 312 pCi/mL in spring 2019.

Table 5-3 Summary FY2022 Tritium Data (pCi/mL) for Action-Level Lysimeters.

Well ID (Elevation in ft msl)	FY2022 Sampling Events Fall +	FY2022 Sampling Events Spring +
CIG Trench (Administrative Limit = 29.6 pCi/mL)		
CIG1-VL-1 (236)	15	16
CIG1-VL-2 (237)	3	3
CIG1-VL-3 (233)	5	4
CIG1-VL-4 (232)	21	21
CIG1-VL-5 (238)	3	3
VL-30-End (240)	4	3
VL-31 (241)	4	3
Engineered Trench 1 (Administrative Limit = 101.3 pCi/mL)		
AT-22-East (233)	3	3
AT-23-North (237)	2	2
VL-6-South_Center (233)	*	175
VL-7-SE_Corner (235.7)	11	10
VL-8-East_Center (234.9)	49	48
VL-10-North_Center (233)	8	7
VL-13 (237)	8	8
VL-14 (239)	25	21
VL-15 (235)	1320	1320
VL-16 (235)	3	3
VL-17 (238)	69	67
VL-18 (234)	*	4
VL-18-Auger (234)	3	3
VL-19 (238)	3	4
VL-20 (243)	*	5
VL-21 (239)	13	12
VL-22 (241)	230	195
Engineered Trench 2 (Administrative Limit = 101.3 pCi/mL)		
ET2-VL-1 (242)	4	3
ET2-VL-2 (242)	5	5
ET2-VL-3 (245)	3	4
ET2-VL-5 (247)	1410	1230
ET2-VL-6 (244)	149	27
ET2-VL-7 (245)	11	11
ET2-VL-9 (242)	2	3
ET2-VL-10 (242)	2	3
ET2-VL-11 (246)	2	2
ET2-VL-12 (240)	3	3
ET2-VL-14 (240)	12	13
ET2-VL-15 (247)	168	162
ET2-VL-16 (242)	2	2
ET2-VL-18 (242)	5	5
ET2-VL-19 (248)	36	36
Engineered Trench 3 (Administrative Limit = 43.7 pCi/mL)		
ET3-VL-1 (221)	3	3
ET3-VL-2 (226)	3	3
ET3-VL-3 (222)	4	3
ET3-VL-4 (224)	1	1
ET3-VL-5 (222)	33	31
Slit Trench 1 (Administrative Limit = 61.2 pCi/mL)		
AT-5 (226)	*	*
AT-6 (227)	61	60
AT-8 (232)	3	3
ST1-VL-1 (245)	3	3
VL-2 (225)	7	7
VL-25-West (246)	2	3
VL-26-West (245)	437	431
VL-27-West (245)	5	5

Well ID (Elevation in ft msl)	FY2022 Sampling Events Fall +	FY2022 Sampling Events Spring +
Slit Trench 2 (Administrative Limit = 61.2 pCi/mL)		
ST2-VL-4 (232)	3	3
ST2-VL-7 (231)	12	11
ST2-VL-8 (240)	4	4
VL-32 (231)	4	4
VL-33 (229)	4	4
VL-34 (227)	4	4
VL-35 (227)	2	3
Slit Trench 3 (Administrative Limit = 61.2 pCi/mL)		
ST3-VL-4 (234)	21	20
ST3-VL-5 (236)	*	22
ST3-VL-8 (238)	3	3
ST3-VL-10 (240)	4	3
ST3-VL-12 (243)	3	3
Slit Trench 4 (Administrative Limit = 61.2 pCi/mL)		
ST4-VL-5 (238)	134	133
ST4-VL-8 (239)	3	3
Slit Trench 5 (Administrative Limit = 61.2 pCi/mL)		
ST5-VL-1 (237)	21	25
ST5-VL-2 (252)	2	2
ST5-VL-5 (239)	3	3
ST5-VL-6 (244)	3	3
ST5-VL-11 (237)	2	2
ST5-VL-12 (231)	2	4
ST5-VL-13 (236)	2	2
Slit Trench 6 (Administrative Limit = 61.2 pCi/mL)		
ST6-VL-1 (233)	2	2
ST6-VL-2 (241)	3	3
ST6-VL-3 (235)	2	2
Slit Trench 7 (Administrative Limit = 61.2 pCi/mL)		
ST7-VL-1 (233.5)	2	2
ST7-VL-2 (231.7)	706	692
ST7-VL-3 (232)	3	2
ST7-VL-4 (232)	3	3
ST7-VL-5 (229)	2	2
ST7-VL-6 (229)	2	1
Slit Trench 8 (Administrative Limit = 46.9 pCi/mL)		
ST8-VL-1 (235.5)	13	16
ST8-VL-2 (227)	2	2
ST8-VL-4 (230)	3	2
ST8-VL-5 (229)	3	2
ST8-VL-6 (238)	47	24
Slit Trench 9 (Administrative Limit = 46.9 pCi/mL)		
ST9-VL-1 (239)	2	3
ST9-VL-2 (229)	3	3
ST9-VL-3 (240)	5	5
Slit Trench 14 (Administrative Limit = 63.8 pCi/mL)		
ST14-VL-1 (240)	4	4
ST14-VL-2 (239)	13	10
ST14-VL-3 (237)	189	175

\+ All data in pCi/mL
* No sample collected
Pink shading = Exceeds Adminstrative Limit

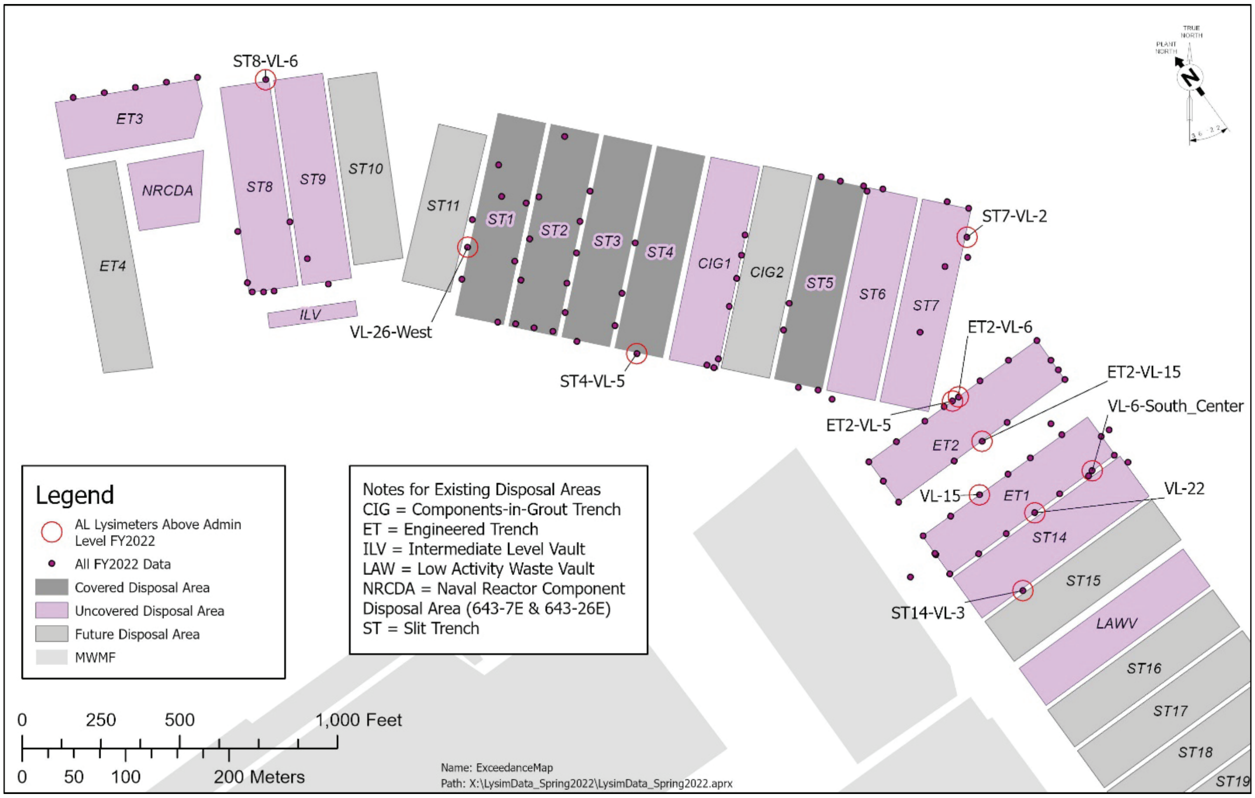

Figure 5-2. Layout showing action-level lysimeters with administrative limit exceedances.

However, the tritium concentration spiked in FY2020 to a peak of 786 pCi/mL. In FY2021, the concentration decreased to 500 pCi/mL. This trend continued in FY2022 as the tritium concentration decreased to 175 pCi/mL. The tritium concentration in the shallow lysimeter has been decreasing since reaching a peak in FY2019 (1026 pCi/mL). This suggests the tritium concentration in the AL lysimeter may decrease in the future. Concentrations in adjacent lysimeters remain below the action level (VL-7 and VL-23). ST14-VL-2 is the closest lysimeter station to VL-6-SC (less than 10 ft). After trending upwards for several sampling events, the tritium concentration in the AL lysimeter at ST14-VL-2 is trending downwards (10.3 pCi/mL) and is below the action-level for both ET 1 (101.3 pCi/mL) and ST 14 (63.8 pCi/mL).

VL-15. Tritium concentrations in this AL lysimeter have been increasing since FY2008 with the first exceedance of the administrative limit occurring in FY2012. It has exceeded the administrative limit in every successful sampling event since FY2012. The increasing trend continued in FY2022 as the concentration reached 1320 pCi/mL, which is the highest concentration measured to date in this AL lysimeter. An increasing trend was also observed for the shallow lysimeter. It appears that tritium concentrations in the AL lysimeter follow the same pattern as the shallower lysimeter but are lagged and slightly reduced. Therefore, concentrations are expected to continue increasing in the AL lysimeter. Concentrations in adjacent lysimeters VL-14 (3.29 pCi/mL) and VL-16 (25.3 pCi/mL) are well below the administrative limit (101.3 pCi/mL).

VL-17. The AL lysimeter exceeded the action level for the first time in the fall sampling event for FY2020 when the tritium concentration peaked at 199 pCi/mL. For the spring FY2020 sampling event, the concentration had declined to 60 pCi/mL. For FY2022, the concentration was 69 pCi/mL, which is below the administrative limit (101.3 pCi/mL). Recent concentrations in this lysimeter have been trending slightly upward. Concentrations in the upper lysimeter peaked in 2014 and declined through 2017 when they began to increase again. This suggests the AL lysimeter may continue to increase in the future.

VL-22. The tritium concentration measured in the AL lysimeter was 230 pCi/mL compared to 238 pCi/mL in FY2021. Shallow lysimeters at VL-22 are elevated and have increased compared to recent sampling events. This suggest that the tritium concentration in the AL lysimeter may increase in the future.

As a result of the exceedances noted for the ET1 sampling locations, a study was undertaken to assess whether the elevated concentrations challenged the PA conclusions (Flach and Whiteside, 2016). Because ET1 and ET2 were analyzed together in the 2008 PA, they were evaluated together in this study. The 2008 PA model conservatively assumed hypothetical waste disposal timing and distribution based on both trenches opening and being filled simultaneously. However, the average disposal dates for ET1 and ET2 differ by more than eight years, which will result in some plume separation. Because the as-disposed-of waste conditions for ET1 and ET2 were different than assumed in the PA, the model was revised to reflect the actual disposal conditions. The results of the study showed that simulated and vadose zone plume concentrations are reasonably consistent and that the phased operation of ET1 and ET2 is likely to ensure that performance objectives are met. This conclusion was later confirmed by the SA of the impact of the updated GSA flow model on E-Area groundwater performance (Hamm et al. 2018).

5.1.2 Engineered Trench 2

There are 15 AL lysimeters associated with Engineered Trench 2 and all were successfully sampled in FY2022. Three of the 15 AL lysimeters, ET2-VL-5, ET2-VL-6, and ET2-VL-15, exceeded the tritium concentration administrative limit of 101 pCi/mL. These same three lysimeters exceeded the limit in FY2021.

ET2-VL-5. This AL lysimeter first exceeded the tritium administrative limit in spring 2017, with a result of 178 pCi/mL. It increased again in both fall 2017 and spring 2018. The spring 2018 concentration of 2822 pCi/mL is the highest level of any AL lysimeter at ELLWF to date. The FY2022 concentration was 1410 pCi/mL which is generally consistent with recent sampling events. After decreasing from the high of 2822 pCi/mL, the tritium concentration in the AL lysimeter appears to have stabilized. The tritium concentration in the shallow lysimeter at ET2-VL-5 has been declining since fall 2020. As part of normal operations, the operational soil cover over the waste was extended beyond ET2-VL-5 in FY2019. This action will reduce infiltration and funneling of water in the vicinity of ET2-VL-5.

ET2-VL-6. This lysimeter exceeded the administrative limit for the first time in fall 2020. The concentration in this lysimeter has been increasing since fall 2018 and spiked to a concentration of 924 pCi/mL in spring 2021. In fall 2021, the concentration declined to 149 pCi/mL. In spring 2022, the concentration declined again to 26.9 pCi/mL, which is below the administrative limit. ET2-VL-6 is the closest lysimeter to ET2-VL-5 (7 meters), which is also elevated as previously discussed. The shallow lysimeters at this location remain at or near background. As with ET2-VL-5, the expansion of the operational soil cover beyond this location should reduce infiltration and funneling of water. This location will be monitored closely in the future.

ET2-VL-15. Tritium concentrations at this AL lysimeter began increasing in 2015 and reached a peak of 231 pCi/mL in the fall 2019 sampling event. Since fall 2019, the tritium concentration has been generally declining. The tritium concentration in this lysimeter was 168 pCi/mL in fall 2021 and 162 pCi/mL in spring 2021. The shallow lysimeters in this cluster are elevated but have generally been declining since 2016. This suggests the concentration in the AL lysimeter may continue to decrease. As with ET2-VL-5, the operational soil cover was extended beyond this lysimeter location during FY2019.

5.1.3 Slit Trench 1

In FY2022, one of the eight AL lysimeters in Slit Trench 1, VL-26-West, exceeded the tritium concentration administrative limit of 61 pCi/mL. AT-6 exceeded the limit in FY2021 but was slightly below the limit in FY2022.

AT-6. The tritium concentration in the AL lysimeter at AT-6 rose gradually from about 2011, and it exceeded the administrative limit in fall 2016 with a concentration of 76 pCi/mL. Since then, tritium concentrations have hovered around the administrative limit of 61 pCi/mL but had not exceeded the limit again until spring 2021 with a concentration of 62.1 pCi/mL. For FY2022, the tritium concentration was 60.9 pCi/mL, which is slightly below the administrative limit. The tritium concentration in this lysimeter appears to have plateaued and is hovering around the administrative limit. The tritium concentrations in the shallow lysimeters at AT-6 are generally trending downward but have stabilized in recent sampling events. This suggests the tritium concentration in the AL lysimeter is likely to continue to hover around the administrative limit.

VL-26-West. This AL lysimeter was the first at ELLWF to exceed its administrative limit. This lysimeter was installed in 2003 and the first action level exceedance was in spring 2008 with a result of 67 pCi/mL. The tritium concentration increased gradually through 2017 reaching 515 pCi/mL. Since 2017, the concentration has been on a slight downward trend. The FY2022 concentration (437 pCi/mL) is below the peak measured in fall 2017. The lysimeter above the AL lysimeter is also elevated, but tritium concentrations there have been declining since 2013. The decreasing trend in the shallower lysimeter suggests that concentrations in the AL lysimeter have plateaued and may decrease in the future. Previous investigations into VL-26-West have included additional sampling events, reviews of geology and disposal history (Millings, 2009), modeling (Smith, 2010), and a field study (Millings et al., 2010). Data from these studies indicate that the tritium emanating from ST1 near VL-26-West is localized and should have minimal effect on groundwater near the trench.

5.1.4 Slit Trench 4

ST4-VL-5. One of the two AL lysimeters in Slit Trench 4, ST4-VL-5, exceeded its tritium concentration administrative limit (61 pCi/mL) in FY2022. It also exceeded the limit in FY2021. This AL lysimeter had elevated tritium levels when installed in 2008, and concentrations have increased since then. It has exceeded the administrative limit continuously since fall 2011. In FY2022, the concentration was 134 pCi/mL. Concentrations in the shallower lysimeters within the cluster are elevated but have been generally trending upward since fall 2020. This suggests the tritium concentration in the AL lysimeter may continue to slowly increase.

5.1.5 Slit Trench 7

ST7-VL-2. One of the six AL lysimeters in Slit Trench 7, ST7-VL-2, exceeded its tritium concentration administrative limit (61 pCi/mL) in FY2022. This AL lysimeter slightly exceeded the administrative limit in FY2010 and FY2011, then was below it for several years. Beginning in FY2017, it has been above the administrative limit for each subsequent sampling event. Concentrations in the AL lysimeter reached a maximum in fall 2021 of 706 pCi/mL before declining slightly to 692 pCi/mL in spring 2022. Shallow lysimeters in the cluster are at background levels (~5-10 pCi/mL).

5.1.6 Slit Trench 8

ST8-VL-6. One of the five AL lysimeters in Slit Trench 8, ST8-VL-6, exceeded its tritium concentration administrative limit (46.9 pCi/mL) in FY2022, with a concentration of 47.1 pCi/mL (fall 2021). The concentration in spring 2022 decreased to 24.3 pCi/mL, which is below the administrative limit. This lysimeter first exceeded the administrative limit in FY2018. The shallow lysimeter at this cluster is elevated but the tritium concentration is decreasing. Based on the trend in the shallow lysimeter and the results from the spring 2022 sampling event, the concentration in the AL lysimeter is expected to be below the administrative limit in the future.

5.1.7 Slit Trench 14

ST14-VL-3. One of the three AL lysimeters in Slit Trench 14, ST14-VL-3, exceeded its tritium concentration administrative limit (64 pCi/mL) in FY2022 with a concentration of 189 pCi/mL (fall 2021). In spring 2022, the tritium concentration decreased slightly (175 pCi/mL). This lysimeter was installed in 2016, and it has exceeded the limit since 2017. The tritium concentration has been decreasing since fall 2020. The lysimeter immediately above the AL lysimeter is near background but the shallowest lysimeter in the cluster has been trending upwards.

5.2 Saturated Zone Monitoring

Since 1999, the vadose zone monitoring system (VZMS) has been used to successfully demonstrate that the ELLWF performance meets the requirements and predictions of the approved PA. However, AL lysimeters at the ELLWF are experiencing an increasing number of administrative limit exceedances for tritium concentrations in vadose zone groundwater. Therefore, saturated zone (SZ) monitoring will be included in the PA monitoring plan revision planned for FY2023.

The ELLWF is down gradient from the Mixed Waste Management Facility (MWMF) and, contaminants (including tritium) migrating from MWMF have impacted the water table aquifer beneath a portion of ELLWF. For a SZ monitoring program to be effective, it is necessary to distinguish tritium originating from the MWMF from that of the ELLWF. Extensive characterization work in previous years has identified volatile organic compounds (VOCs) and refrigerants as marker compounds associated with the MWMF contaminant plume (Kubilius, 2019). Therefore, the presence or absence of these compounds in the aquifer can be used to distinguish between ELLWF and MWMF contamination.

In FY2021, eight water table monitoring wells were installed at various locations around ELLWF (Figure 5-3). Four wells were installed in the area down gradient of ET1 and ET2 where 8 of 11 administrative limit exceedances for AL lysimeters occurred in FY2022. These wells were all screened within the uppermost portion of the water table aquifer which is presumed free of MWMF contamination based on the absence of MWMF marker compounds (Kubilius and Joyce, 2018). Contamination detected in these wells is presumed to be from ELLWF.

Water table wells were also installed near ST1 in response to administrative limit exceedances in this area of the facility. The groundwater in this portion of ELLWF is impacted by MWMF contamination. Consequently, wells were placed both upgradient (two wells) and downgradient (two wells) of the disposal area as shown in Figure 5-3. Due to MWMF contamination in this area, tritium concentrations in these wells are expected to be above the maximum contaminant level (MCL). Therefore, interpretation of the analytical data will rely on time trending and will require several years of monitoring before ELLWF contamination, if any, will be apparent.

Although saturated zone monitoring has not been formally implemented in the PA monitoring plan, in FY2022 SRS initiated sampling of the wells shown in Figure 5-3. Six of the eight wells were sampled in FY2022. Two of the wells were not sampled as they were awaiting final construction of above ground components. Performance objectives for these wells have not been established and will be addressed with the revision to the performance monitoring plan anticipated in FY2023. However, the results of the FY2022 sampling are presented in Table 5 4. For the group of wells situated downgradient of ET1/ET2, all tritium results were below the MCL (20 pCi/ml). No VOCs or refrigerant compounds were detected in any of the samples. For the wells down gradient of ST1 (ELF005 and ELF006), tritium concentrations were above the MCL as expected. VOCs were detected in these wells which indicates the presence of MWMF contamination. As mentioned previously, the distinction between MWMF-derived tritium and ELLWF-derived material will be made by comparing concentration time trends. Several years of data will be required for this analysis.

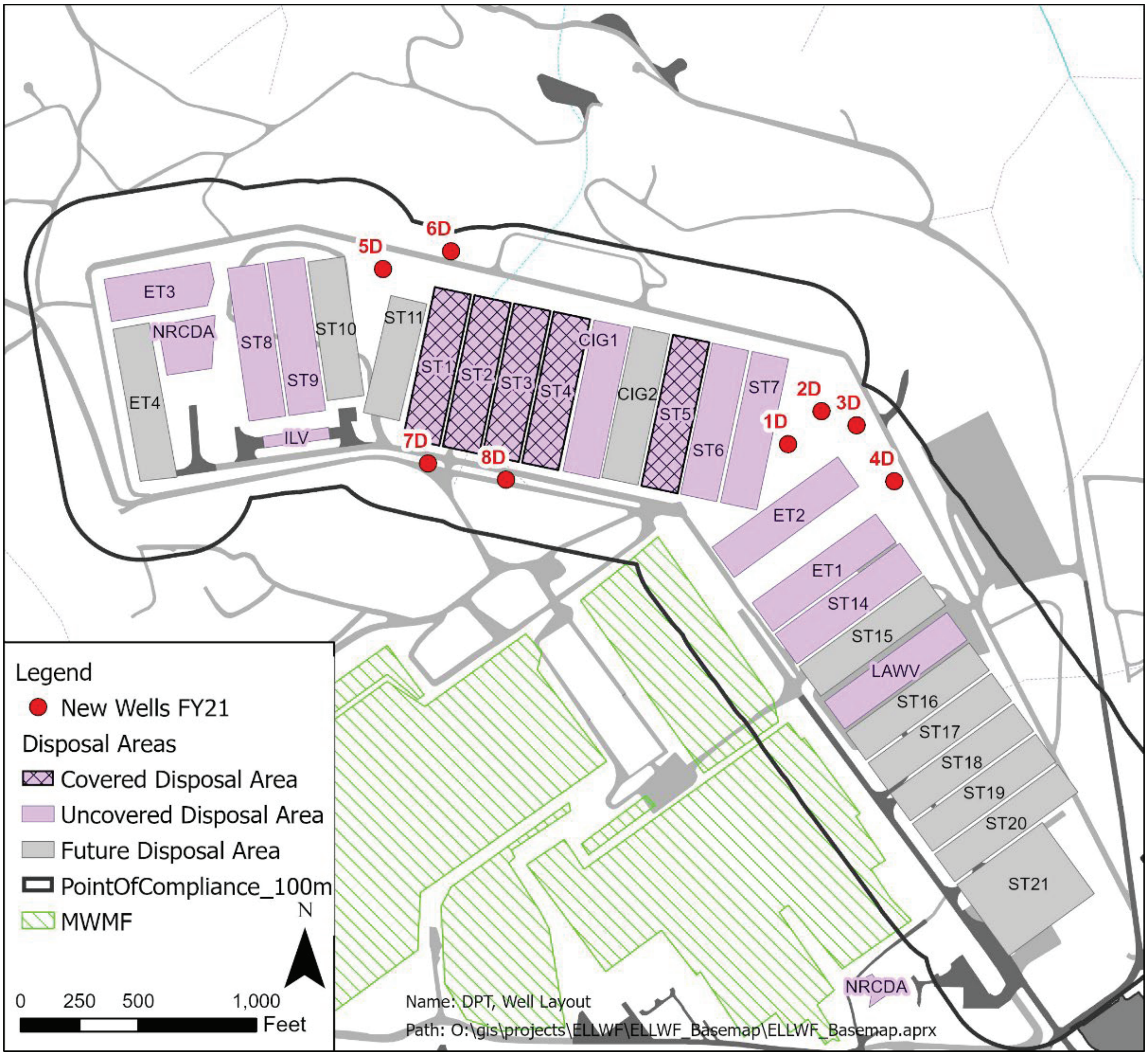

Figure 5-3. New ELLF Water Table Wells (red symbols)

5.3 Trench Cover Monitoring

Inspections of the soil cover over filled sections of operating STs and ETs are conducted on a quarterly basis per procedure SW15.6-INP-SWF-03 (SWMa, 2022). A few localized depressions and erosion areas were noted in these inspections. SWM addressed each area of concern with grading equipment and soil fill.

Inspections of the CIG storm water runoff cover are performed on a quarterly basis (SWMa, 2022). Four inspections were conducted in FY2022. In August 2022, during the quarterly inspection, a tear was found at a seam that had been previously repaired. The cover will be repaired once resolution has been made with the vendor in FY2023.

Table 5-4 Summary FY2022 Tritium Data (pCi/mL) for ELLWF Monitoring Wells.

Well	Tritium (pCi/mL)	TCE (ug/L)	PCE (ug/L)	1,1-DCA (ug/L)	I-129 (pCi/L)	Tc-99 (pCi/L)
ELF001D	3.29	ND	ND	ND	ND	ND
ELF002D	3.51	ND	ND	ND	ND	ND
ELF003D	3.74	ND	ND	ND	ND	ND
ELF004D	5.01	ND	ND	ND	ND	ND
ELF005D	36.6	1.38	ND	ND	ND	ND
ELF006D	1410	1.85	ND	5.07	ND	ND

Inspections of the Slit Trench water barriers are performed quarterly (SWMa, 2022). Ongoing maintenance issues were addressed with concrete fasteners. A few concrete fasteners for the stainless-steel anchor strips had been found to be broken off at the head of the fasteners. These fasteners were replaced with more durable concrete anchors. In addition, SWM has continued to monitor two depressions that had formed underneath the covers due to subsidence of the waste in FY2012. One depression is approximately ten feet in diameter and the other depression is approximately five feet in diameter. Both are up to approximately eighteen inches deep. The FY2022 inspections determined that these two depressions had not changed in size or in depth. The covers were still intact with no fatigue issues above these two depression areas. SWM will continue to monitor these depressions for changes in conditions.

5.4 Vault Concrete Monitoring

Inspection of the LAWV walls was last performed in October 2020 (FY2021) by procedure 724-EAV-50 (SWMa, 2020) which showed no significant cracking or degradation beyond what was assumed for the PA. This inspection is performed every two years.

5.5 Sump Water Monitoring

Water samples are taken from the vault (LAWV and ILV) and engineered trench sumps. SWM monitors the vault sump through procedure SW15.1-SOP-LLS-01 (SWMb, 2022) and the ET2 sump through procedure SW15.1-SOP-ESUMP-02 (SWM, 2017). These procedures provide instructions for sampling and pumping the vaults and ET 2 sumps. The sumps are checked for liquid levels and if liquid level thresholds are exceeded, then the contents are sampled for evaluation against the administrative limits (SWM, 2017, SWMb, 2022) and dispositioned accordingly. All FY2022 samples were below administrative limits.

5.6 Surface Water Compliance Monitoring

SRS conducts scheduled compliance monitoring of surface water at several locations downstream of ELLWF, per DOE Order 458.1 (DOE, 2020) and the CA monitoring plan (Crapse et al., 2011). Results and projected radiation doses to the public are published in the SRS Annual Environmental Report and are compared to CA predictions in the CA annual reviews (Stagich and Mayer, 2022). The most recent predicted maximum dose to a member of the public, via the liquid pathways (includes doses from drinking water, fish and invertebrate consumption, recreational activities, and irrigation) at locations below ELLWF, is published in the 2021 Annual Environmental Report (SRNS, 2022) and shown in Table 5-5. This value is 0.28 mrem/yr, which is far below the DOE 458.1 dose limit of 100 mrem/yr.

Table 5-5. Compliance Monitoring.

Disposal Facility/Unit	Monitoring Type	Monitoring Results & Trends	Performance Objective Measure or other Regulatory Limit	Action Level	Action Taken	PA/CA Impacts
ELLWF	Surface Water	0.28 mrem	<100 mrem	NA	None	None

5.7 Monitoring Conclusions

The majority of AL lysimeter locations, approximately 88%, remained below administrative limits in FY2022. A majority of the AL lysimeters would need to reach, with some exceeding, their administrative limit in order to exceed a groundwater PO or measure. Because administrative limits are set at 1/4th the concentration predicted to result in an exceedance in the groundwater, the remaining 12% of the AL lysimeters spread over 7 trenches are not expected to result in an exceedance at the 100-m POA. The source of these exceedances in the overlying waste zone and potential impacts have been previously evaluated (Halverson and Millings, 2017; Hang et al., 2018; Kubilius et al., 2019) and trends in these lysimeters continue to be monitored.

Trench cover inspections during FY2022 revealed a tear in the CIG storm water runoff cover that had been previously repaired. The cover will be repaired once resolution has been made with the vendor in FY2023. Other observed defects were minor (i.e., cover depressions, erosion areas, broken fasteners) and not expected to affect performance of these barriers. In some cases, repairs were made (i.e., trench cover concrete fasteners). In other cases, conditions will continue to be monitored for progression of existing defects or new defects.

Finally, sump water samples were all found to be below administrative limits before being discharged. Impacts from surface waters downstream from the E-Area LLWF (Upper Three Runs, Savannah River) continue to fall well below DOE public dose limits based on annual compliance monitoring.

6.0 Research and Development

In FY2022, SRNL produced a number of technical reports and memoranda supporting ELLWF annual PA maintenance, SWM Operations & Engineering, PA Test & Research, and PA Revision Development. Table 6-1 lists a summary of this work.

7.0 Planned or Contemplated Changes

A PA revision is currently ongoing to update the ELLWF PA technical baseline and is scheduled to be submitted to LFRG in FY2023. This comprehensive update is warranted by the cumulative number of changes to the existing PA technical baseline as contained in 15 UDQE's and 10 SA's approved since the 2008 PA. A 2016 PA strategic planning document set out recommendations and a roadmap for the current revision. Numerous updates to models, assumptions, approaches and key PA datasets are being evaluated as part of this new baseline. SA SRNL-STI-2018-00624 (Hamm et. al., 2018) employed a version of these improvements existent at that time and demonstrated a sizeable amount of operating margin with respect to POs. This provides increased confidence that the ongoing PA revision will produce acceptable GW limits.

Table 6-1. Research and Development Activities.

Document Number	Results	PA/CA Impact
Q-SQP-A-00021, Revision 0	**Software Quality Assurance Plan for The SRNL Dose Toolkit - Classified as Level C** At SRNL, the Dose Toolkit (DTK) plays an important role in the calculation of groundwater and inadvertent human intruder pathways inventory limits and dose factors for the E-Area Low-Level Waste Facility performance assessment. The software classification for DTK is Level "C." DTK was developed by SRNL and came into existence outside of the Software Quality Assurance procedures; therefore, it is considered "existing" software. This Software Quality Assurance Plan addresses verification techniques and the required life cycle components for Level "C" existing software (i.e., "Evaluation," "Configuration Control," and "Cyber Security Analysis") with other elements optionally applied using a graded approach.	None
SRNL-TR-2019-00337, Revision 1	**Savannah River National Laboratory Dose Toolkit** The SRNL Dose Toolkit was developed to automate the calculation of inventory limits and dose factors for PAs, CAs, UDQEs, UCAQEs and SAs by incorporating the "Dose Calculation Methodology and Data for Solid Waste Performance Assessment and Composite Analysis at the Savannah River Site". The dose calculational methodology includes human receptors for the PA/CA all-pathways (resident farmer scenario), CA (recreational scenario), PA acute and chronic inadvertent human intruder, and EPA groundwater protection standards for drinking water. It also plays an important role in the calculation of groundwater and inadvertent human intruder pathways inventory limits and dose factors for the E-Area Low-Level Waste Facility PA. Lastly, the SRNL Dose Toolkit is used to compute radionuclide screening factors and multi-element dose factors for PA Closure Analyses.	None
SRNL-L3200-2022-00058, Revision 0	**Technical Memorandum, "Re: Fall 2021 Lysimeter Tritium Data"** The purpose of this memo was to provide the Fall 2021 tritium data for the E-Area Vadose Zone Monitoring System and to summarize the tritium concentrations and trends in the Action Level lysimeters. Analytical results in Fall 2021 were at or below the administrative limits at 78 out of 88 sampled locations. There were 10 AL lysimeters above the administrative limits. There were 5 dry AL lysimeters in Fall 2021.	None
SRNL-L3200-2022-00066, Revision 0	**Technical Memorandum, "Re: Spring 2022 Lysimeter Tritium Data"** The purpose of this memo was to provide the Spring 2022 tritium data for the E-Area Vadose Zone Monitoring System and to summarize the tritium concentrations and trends in the Action Level lysimeters. Analytical results in Spring 2022 were at or below the administrative limits at 83 out of 92	None

Document Number	Results	PA/CA Impact
	sampled locations. There were 9 AL lysimeters above the administrative limits. There was 1 dry AL lysimeter in Spring 2022.	
SRNL-L3200-2022-00034, Revision 0	**Examination of Component-In-Grout Test Trench for Cracking** In January of 2007, several trenches were created at the E-Area Low-Level Waste Facility (LLWF) to test various concretes and grouts for potential use in Component-In-Grout (CIG) waste disposals. Results from this testing were used to select the grout for CIG disposals. At the conclusion of testing, the trench containing the CIG grout was backfilled with native soil. This test trench is periodically unearthed, and the surface of the grout is examined for cracks. An inspection was conducted in FY2022, and no cracks were observed in the surface of the grout.	None
SRNL-STI-2018-00038, Revision 1	**E-Area Corrosion Coupon Recovery and Evaluation** The recovery and evaluation of selected E-Area corrosion coupons were completed in FY2022. This is the second time coupons have been recovered from the E-Area Corrosion Monitoring Test Site, with the first recovery effort occurring in FY2017. Coupons recovered during the FY2022 extraction have now been exposed to the subsurface for approximately 17 years. This effort is part of an ongoing study where a subset of coupons is recovered at each determined time interval over a 100-year period. Results from this effort, as well as updates to the schedule for future recovery and evaluation efforts, are included in this report revision.	None
SRNL-TR-2020-00298, Revision 1	**Updated Estimate of Tritium Permeation from TPBAR Disposal Containers in ILV (U)** A tritium source term analysis was performed for Tritium-producing burnable absorber rod (TPBAR) disposal in the E-Area Intermediate Level Vaults for the E-Area Low-Level Waste Facility Performance Assessment (PA). This analysis is based on an earlier source term analysis which treated the bulk of the tritium residual as tightly bound by the TPBAR getter material, with only a small fraction existing as tritiated moisture in the lithium aluminate ceramic pellets. Results were obtained for four different combinations of internal and container wall temperatures, established in an earlier thermal analysis that considered two different vault loadings and two different TPBAR activity levels. An additional calculation was performed to look at the possibility of other volatile radionuclides escaping confinement due to the leak allowance. In particular, release of Ar-39, a nuclide known to be present in small quantities in spent TPBARs, was considered. Using the molar balance for the void volume constructed for the tritium source term calculations, and assuming all of the argon would immediately enter the void volume at container closure, it was shown that less than 20% of the Ar-39 could escape the container in the first 50 years of disposal under worst-case conditions.	None

Document Number	Results	PA/CA Impact
Q-SQP-A-00020, Revision 0	**Software Quality Assurance Plan for PlotFlow3dS, Ver. 1.0** PlotFlow3dS is a Fortran 90 program designed to extract information from a 3D structured grid, flow simulation, PORFLOW archive file and create a Tecplot data file to support Performance Assessment and Special Analysis related work. PlotFlow3dS has been classified as Level "D" software and is considered "Developed" because the code was developed for post-processing PORFLOW archive data. This Software Quality Assurance Plan identifies the lifecycle quality requirements for PlotFlow3dS.	None
SRNL-STI-2022-00323, Revision 0	**Radiological Impact of 2021 Operations at the Savannah River Site** This report presents the environmental dose assessment methods and the estimated potential doses to the public from 2021 SRS air and liquid radioactive releases. Also documented are potential doses from special-case exposure scenarios, such as the consumption of wildlife or goat milk. The 2021 dose to the offsite representative person from SRS liquid releases was 0.28 mrem and from SRS air releases it was 0.017 mrem. To show compliance with the DOE all - pathway dose standard of 100 mrem/yr, SRS conservatively adds these two doses for a total representative person dose of 0.30 mrem which is 0.30% of the DOE standard. The estimated dose from consuming hunter harvested deer or wild pig meat is determined for every onsite hunter. Due to pandemic restrictions, there were no annual hunts held in 2021. SRS estimated the maximum potential dose from fish consumption at 0.426 mrem from bass collected at the mouth of Steel Creek. This dose is 0.426% of the DOE standard. SRS bases this hypothetical dose on the low probability scenario that, during 2021, a fisherman consumed 24 kg (53 lbs) of bass caught exclusively from the mouth of Steel Creek. SRS conducts screening evaluations of plant and animal doses for aquatic and terrestrial ecosystems. For 2021, all SRS aquatic system locations passed the initial (Level 1) screening and no further assessments were required at those locations. For the land-based systems evaluation, SRS performed initial screenings using concentration data from the five onsite radiological soil sampling locations. Typically, SRS collects and analyzes only one soil sample per year from each location. For 2021, all land-based locations passed their initial (Level 1) pathway screenings.	None
SRNL-STI-2022-00018, Revision 0	**FY2021 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility** This annual review for the E-Area Low-Level Waste Facility (ELLWF) affirms that the disposal facility continued to operate within the bounds of the current PA and Composite Analysis (CA) baseline and the subsequent SA's and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS, RWMB, and ELLWF Low-Level Waste Acceptance Criteria. This report affirms that the supporting studies performed in FY2021 do not alter the conclusions of the 2008	None

Document Number	Results	PA/CA Impact
	ELLWF PA and that there is a reasonable expectation that the ELLWF will meet the performance objectives delineated in DOE Manual 435.1-1.	
SRNL-STI-2020-00410, Revision 1	**PORFLOW Modeling of Vadose Zone Flow and Transport for the E-Area Intermediate Level Vault** In support of the E-Area Performance Assessment, a two-dimensional model of water flow and radionuclide transport through the E-Area Intermediate Level Vault (ILV) and local vadose zone has been developed using the PORFLOWTM software. The purpose of the model is to calculate flux to the water table for radionuclides eluted from the ILV during its operational life, the period of institutional control, and times following site closure. Results of model calculations will be used by a three-dimensional PORFLOW model of transport through the aquifer to determine radionuclide concentrations at a hypothetical 100 meter well and at the site boundary where contaminated groundwater is accessible to members of the public following site closure.	None
SRNL-STI-2022-00049, Revision 0	**Model Validation for the FY2021 SRS Composite Analysis Monitoring Plan** Using a projected end-state date of 2065, the Savannah River Site (SRS) Composite Analysis (CA) modeling for each facility and waste site began on the inventory year assigned to it so that source depletion and radionuclide transport out of the system could be appropriately captured. The CA model validation program uses a graded and systematic approach for taking corrective action, starting with an SRS established administrative dose limit of 15 mrem/yr, below which no action is required. Based on the location of the 2010 SRS CA POAs, the only potential exposure pathway for the public is through surface water. The completion of the FY2021 CA model validation indicates that the SRS CA projected dose, while generally conservative, provides a reasonable representation of the maximum annual doses. These doses are well below the administrative limit; therefore, no additional action is required.	None
SRNL-STI-2022-00048, Revision 0	**FY2021 Savannah River Site Composite Analysis Annual Summary Review** This document provides DOE Order 435.1 and its manual, Radioactive Waste Management required Annual Review for the SRS CA. Progress made to-date toward addressing the secondary issue from the LFRG review of the 2010 SRS CA has focused primarily upon inventory estimate improvements. Inventory impacts dose in a linear fashion and reduces the uncertainty with the CA conclusions. Maintenance items are addressed, as funding allows, based on the relative risk associated with meeting the performance objectives. Currently, there is minimal risk in exceeding the DOE 100 mrem/yr CA primary dose limit or the DOE 30 mrem/yr dose constraint (administrative limit). Based on the assessment presented within this annual review and collective engineering judgement, the conclusions	None

Document Number	Results	PA/CA Impact
	of the 2010 SRS CA remain valid and there is reasonable assurance that SRS will meet the performance objectives delineated in DOE Manual 435.1-1. The 2010 SRS CA should be updated to incorporate PA changes, proposed changes to inventories and sources and model improvements accumulated since the 2010 CA. The timing will be dependent on the completion of the ongoing E-Area PA revision.	
SRNL-STI-2019-00357, Revision 1	**PORFLOW Implementation of Vadose Zone Conceptual Model for Naval Reactor Component Disposal Area in the E-Area Low Level Waste Facility Performance Assessment** PORFLOW models have been developed to implement the proposed conceptual models for the two Naval Reactor Component Disposal Areas, 643-7E and 643-26E, for the purpose of evaluating dose impacts and producing disposal limits for the E-Area Low-Level Facility. Separate three-dimensional models have been developed for each naval reactor pad to capture the unique geometry/features of the waste zone and subsurface hydrostratigraphic units, and chronology of facility events for each disposal unit. Radionuclide, chemical and material properties, as well as subsurface features represented in the models, were obtained from data packages containing key performance assessment data. Four modeling cases have been proposed to capture the uncertainty in the waste release characteristics of the two types of waste forms. Results from modeling two of the four cases described above are presented in this report for a limited set of isotopes representing a range of radionuclide decay and elemental chemical properties.	None
SRNL-STI-2021-00276, Revision 0	**E-Area Low Level Waste Generator Inventory Uncertainty Estimation** This report describes the method used to estimate the uncertainty and bias in the low-level waste inventory, as reported by Waste Generators, for waste disposed in the E-Area Low-Level Waste Facility at SRS. The waste cut uncertainty and bias is summed to calculate the current total uncertainty and bias in each disposal unit in the E-Area Low-Level Waste Facility. This information is used to estimate the future uncertainty and bias when all disposal units are closed. This report details the method, data sources, and calculation techniques used to calculate these values. It also presents some of the difficulties in working with the reported data and gives examples of the calculations and analysis. The software used to carry out the analysis is included and the location of the complete individual analyses is given.	None
SRNL-L4120-2021-00003, Revision 0	**"Uncertainty and Bias Calculation Check (Memorandum: T. S. Whiteside to J. J. Mayer dated October 25, 2021)."** This document describes the test cases used to prove the correctness of the uncertainty and bias calculation code. The overall purpose of this code and calculation method is described. The description	None

Document Number	Results	PA/CA Impact
	of the test cases and "hand-calculation" of the results is found in the z_analysis_qa.xlsx. That document describes the test case number, the characterization the waste cut or container, the number of outer containers, the number and nesting of inner containers, the number of cuts, and the measurement and characterization activity bias and uncertainty factors.	

A revision to the monitoring plan in FY23 will implement a change to the PA groundwater monitoring program that adds a saturated zone component to the existing vadose zone monitoring system. The details of these changes were documented in the FY2021 ASR (Labone, et al., 2022). Also, in FY2023, up to nine new lysimeter stations will be installed on the perimeter of ET3, ST8, and ST9 (Figure 7-1). Each station will consist of two lysimeters with the deeper lysimeter at each station being designated as the AL lysimeter. Prior to installing lysimeters, a cone penotrometer (CPT) lithology push will be conducted at each station to a depth of approximately 90 ft. The CPT lithologic logs will be used to guide lysimeter placement. If CPT is not practical (e.g., due to field conditions), gamma-ray logging and core obtained during the sonic drilling process will be used to guide lysimeter placement. Lysimeter placement will be based on stratigraphy with lysimeters typically located in sandy zones above silt/clay layers. This strategy takes advantage of the possibility of perched water at this interface to improve the odds of collecting water samples. The action level lysimeter will be located such that it is outside the influence of the water table and capillary fringe.

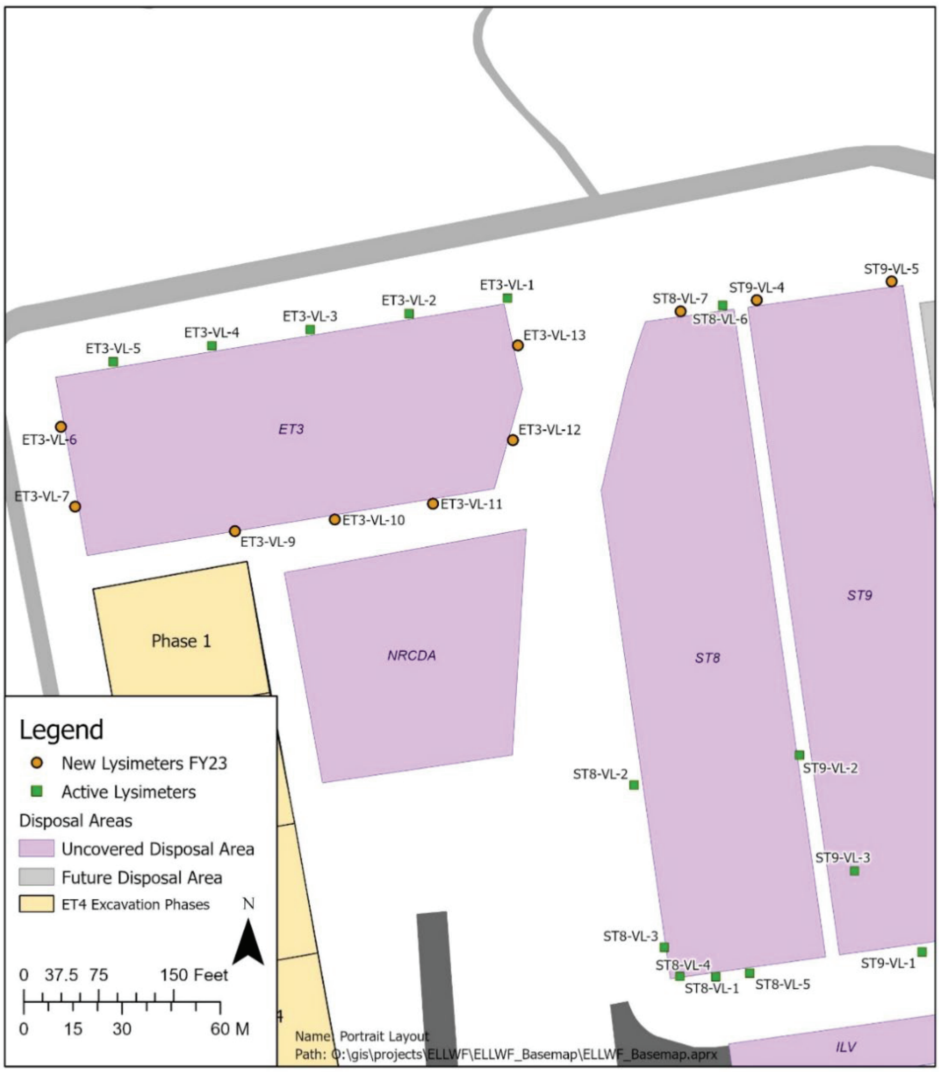

Figure 7-1. Layout of New Lysimeter Stations at ET3, ST8, and ST9.

The revision to the PA will lead to a revision of the ELLWF PA monitoring plan in FY2024. As part of the revised PA monitoring plan, tritium administrative limits for the AL lysimeters that comprise the VZMS will be re-calculated. The administrative limits for tritium are calculated using the inventory limit for each disposal unit, the peak activity concentration to the groundwater determined by PA modeling, disposal unit geometry, and estimated infiltration rates (Millings, 2012).

A summary of these planned changes is provided in Table 7-1.

One of the planned changes identified in the FY2020 PA ASR was the implementation of Consolidated Waste Tracking System (CWTS) (LaBone et al. 2021). Beginning in 2021, SRS migrated to CWTS from the legacy Waste Inventory Tracking System (WITS) database. The final implementation of CWTS was completed in FY2022. This will have no impact on the PA.

Table 7-1. Planned or Contemplated Changes.

Planned or contemplated change	Change Basis	PA/CA Impact	Schedule
Update of ELLWF PA technical baseline	A FY2016 PA planning document surveyed the 2008 PA as well as PA's across the DOE Complex, reviewed ELLWF operational plans and history, evaluated changes in the ongoing DOE O 435.1 update, and identified new PA data and model simulation techniques to develop a strategy and lay out recommendations for the PA revision currently underway. Based on this roadmap, the E-Area PA revision is being developed to employ the following new models and updated key PA datasets in a new technical baseline: updated GSA flow model; new conceptual closure cap design; updated infiltration estimates; new trench, NRCDA, ILV and LAWV models; latest geochemical parameters; updated hydraulic parameters; new comprehensive radionuclide screening model, safety functions and relevant features-events-processes screening, and exposure pathway screening; and a new dose model based on updated radionuclide-dose parameters and dose methodology. (Butcher and Phifer, 2016)	New radionuclide disposal limits and operational constraints, and update to estimated dose impacts at facility closure	FY23
Revision to Administrative Limits for Action Level Lysimeters	Administrative limits are calculated based on PA modeling. Specifically, these conservative limits are based on disposal unit inventory limits, peak activity concentrations to groundwater for tritium, disposal unit geometry, and estimated infiltration rates. These input parameters will change with the PA revision. Therefore, new administrative limits will be calculated based on the revised PA due to be completed in FY2023.	New administrative limits for AL lysimeters.	FY23 or later

Planned or contemplated change	Change Basis	PA/CA Impact	Schedule
Optimization of Groundwater Monitoring Program at the E-Area Low-Level Waste Facility	A FY2019 report describes results of a SZ characterization campaign which was conducted in 2017, and proposes changes to the ELLWF PA Monitoring Plan, including: 1) reducing the frequency of vadose zone lysimeter sampling from semi-annually to annually; 2) omitting sampling of about 40 (of 300) lysimeters that are deemed unnecessary due to either being historically dry or because they are one of several lysimeters at a station; 3) installing up to eight new performance monitoring wells in the saturated zone downgradient of ET 1 and 2 and ST 1; and 4) considering future compliance monitoring at surface water stations in Upper Three Runs or Crouch Branch. (Kubilius and Joyce, 2018)	Update to the monitoring plan	FY23 or later

8.0 Status of DAS Conditions, Key and Secondary Issues

All key and secondary issues from the LFRG review of the 2008 ELLWF PA have been resolved and are understood to be closed with final DOE-HQ approval of the FY2014 Annual Review. Three issues were closed by committing to address the issues in the next PA and are listed in Table 8-1. This annual review affirms that the ELLWF has satisfied all the requirements, conditions and limitations identified in the DAS and that a revision to the DAS is not needed at this time.

9.0 Certification of the Continued Adequacy of the PA, CA, DAS and RWMB

This annual review affirms that the disposal facility continued to operate within the bounds of the current PA and CA baselines and satisfied all the requirements, conditions, and limitations identified in the 2008 DAS (DOE 2008a), RWMB (McGill, 2022), and ELLWF Waste Acceptance Criteria (SRS-1S, 2021). This annual review affirms that the supporting studies performed in FY2022 do not alter the conclusions of the 2008 ELLWF PA (WSRC, 2008) and that there is a reasonable expectation that the ELLWF will meet the POs delineated in DOE Order 435.1. The number of proposed changes to data, models and operational plans for the ELLWF since the 2008 ELLWF PA were deemed sufficient to warrant a revision. A revised PA is in preparation and anticipated review and approval is scheduled to occur in FY2023.

Table 8-1 Status of DAS Conditions, Key and Secondary Issues

Disposal Facility/ Unit	Key/ Secondary Issue or DAS Condition number	Issue Description	Issue Closure Method	Disposition Documentation & Date Completed	PA, CA, DAS Impact or Status
ELLWF	7.2.3.2	Insufficient documentation of all components of the site model for the vadose and saturated zone (five specific items to be addressed)	Closed per DOE approval of FY2011 Annual Review	Items 1, 3, 4 and 5: *PORFLOW Qualification for use in E-Area Low-Level Waste Facility Performance Assessment*, (McDowell-Boyer and Flach, 2011)*, July 2011; Item 2: Information was included in App. G of the PA *GSA Model Improvements will be incorporated into the next revision of the PA.	Complete Pending PA Revision
ELLWF	7.2.4	Greater consistency is needed in the level of detail of technical approaches and results for each facility in Ch. 1-5 (recommend including figures and diagrams of the general technical approaches and calculational steps that led to performance measures and disposal limits). Evaluate information within App. A of Part B for relevance.	Closed per DOE approval of the FY2014 Annual Review.	All figures in the Appendices underwent a general review before the final PA was issued. The labeling on the specific figures referenced in the last paragraph of this issue was corrected in the final PA. These actions addressed the concerns about mislabeling. For the remaining details of this issue, re-examining and rewriting Chapters 1 through 5 of the PA in order to achieve greater consistency for all disposal units represent significant revision. As such, improvements will be incorporated into the next revision of the PA.	Complete Pending PA Revision
ELLWF	7.1.1	Additional sensitivity and uncertainty work required to increase confidence in the waste concentration limits and SOFs (through deterministic or probabilistic sensitivity and uncertainty analysis). In the near term, focus should be on components most likely to compromise Performance Objectives (the non-sorbing radionuclides disposed in STs and ETs).	Closed per DOE approval of FY2014 Annual Review.	This item was downgraded from a key issue to a secondary issue based on additional sensitivity analyses performed and documented in the final PA during the factual accuracy review. Additional work to improve the 1-D GoldSim ELLWF trench models, benchmark to PORFLOW, and update the S/U analysis was completed in 2010 with subcontractor support. The initial benchmarking report was updated in FY2013, *Benchmarking Exercises to Validate the Updated ELLWF GoldSim Trench Models*, SRNL-STI-2010-0737, Rev. 1, November 2013. (Taylor and Hiergesell, 2013) In 2014 SRNL prepared a report that compiles and summarizes the collective GoldSim trench model improvements, benchmarking work, and S/U analysis update, *Update to the Uncertainty Analysis for the E-Area Low-Level Waste Facility Trenches*, SRNL-STI-2013-00660, Rev. 0, May 2014. (Hiergesell and Taylor, 2014) These improvements will be incorporated into the next revision of the PA.	Complete Pending PA Revision

10.0 References

Aleman, S. E. 2022. "Software Quality Assurance Plan for The SRNL Dose Toolkit - Classified as Level C" Q-SQP-A-00021, Rev. 0. Savannah River National Laboratory, Aiken, SC. September 2022.

Aleman, S. E. 2022. Savannah River National Laboratory Dose Toolkit, SRNL-TR-2019-00337, Revision 1, September 2022.

Butcher, 2017. B. T. Butcher, *Revision of the ELLWF Disposal Limits Database Evaluating Use of Slit Trench 13 Limits for Engineered Trench #4 (Revision 2017-1)*, SRNL-L3200-2017-00154, Savannah River National Laboratory, Aiken SC, January 2018.

Butcher and Phifer, 2016. B. T. Butcher and M. A. Phifer, *Strategic Plan for Next E-Area Low-Level Waste Facility Performance Assessment*, SRNL-STI-2015-00620, Revision 0, Savannah River National Laboratory, Aiken, SC, February 2016.

Crapse et al., 2011. K.P. Crapse, M.A. Phifer, F.G. Smith, G.T. Jannik, and M.R. Millings, *Savannah River Site DOE 435.1 Composite Analysis Monitoring Plan,* SRNL-STI-2011-00458, Revision 0, Savannah River National Laboratory, Aiken SC, September 2011.

Crapse et al., 2017. K. P. Crapse, N. V. Halverson, D. F. Sink and G. K. Humphries, *FY2016 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNL-STI-2016-00722, Revision 0, Savannah River National Laboratory, Aiken, SC, March 2017.

Dixon and Vermeulen, 2022. K. L. Dixon and H. H. Vermeulen, E-Area Corrosion Coupon Recovery and Evaluation. SRNL-STI-2018-00038, Revision 1. Savannah River National Laboratory, Aiken, SC. 2020a.

Dixon to Rigsby 2022a. Technical Memorandum, “Re: Examination of Component-In-Grout Test Trench for Cracking”, SRNL-L3220-2022-00034, Revision 0, June 14, 2022.

Dixon to Rigsby 2022b. Technical Memorandum, “Re: Fall 2021 Lysimeter Tritium Data”, SRNL-L3220-2022-00058, Revision 0, June 21, 2022.

Dixon to Rigsby 2022c. Technical Memorandum, “Re: Spring 2022 Lysimeter Tritium Data”, SRNL-L3220-2022-00066, Revision 0, September 15, 2022.

DOE, 1999. *Disposal Authorization Statement for the DOE Savannah River Site E-Area Vaults and Saltstone Disposal Facilities,* U.S. Department of Energy, Washington D.C., September 28, 1999.

DOE, 2008a. *Disposal Authorization Statement for the Savannah River Site E-Area Low-Level Waste Facility*, Revision 1, U. S. Department of Energy, Washington D.C., July 15, 2008.

DOE, 2008b. DOE Low-Level Waste Disposal Facility Federal Review Group Review Team, *Review Team Report for the E-Area Low-Level Waste Facility DOE 435.1 Performance Assessment at the Savannah River Site*, February 4, 2008.

DOE, 2021. *Radioactive Waste Management Manual*, DOE M 435.1-1, Chg 3: 1-11-2021. U. S. Department of Energy, Washington, DC. January 11, 2021.

Flach and Whiteside, 2016. G. P. Flach and T. S. Whiteside, *Interpretation of Vadose Zone Monitoring System Data near Engineered Trench 1*, SRNL-STI-2016-00546, Revision 0, Savannah River National Laboratory, Aiken SC, December 2016.

Gorensek, M. B. 2021. "Updated Estimate of Tritium Permeation from TPBAR Disposal Containers in ILV (U)." SRNL-TR-2020-00298, Rev. 1. Savannah River National Laboratory, Aiken, SC. December 7, 2021.

Halverson and Millings, 2017. N. V. Halverson and M. R. Millings, *Vadose Zone Monitoring Report for the E-Area Low Level Waste Facility*, SRNS-TR-2016-00137, Revision 0, Savannah River National Laboratory, Aiken, SC, August 2017.

Hamm et al., 2013. L. L. Hamm, F. G. Smith, III, G. P. Flach, R.A. Hiergesell, B.T. Butcher, *Unreviewed Disposal Question Evaluation: Waste Disposal in Engineered Trench #3*, SRNL-STI-2013-00393, Revision 0, Savannah River National Laboratory, Aiken, SC, July 2013.

Hamm et al., 2018. L. L. Hamm, S. E. Aleman, T. L. Danielson, B. T. Butcher, *Special Analysis: Impact of Updated GSA Flow Model on E-Area Low-Level Waste Facility Groundwater Performance*, SRNL-STI-2018-00624, Revision 0, Savannah River National Laboratory, Aiken, SC, December 2018.

Hang, T. 2021. Software Quality Assurance Plan for PlotFlow3dS, Ver. 1.0, Q-SQP-A-00020, Revision 0, December 2021.

Hang et al., 2018. T. Hang, N.V. Halverson, I.J. Stewart, and G.K. Humphries, *FY2017 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNL-STI-2017-00761, Revision 0, Savannah River National Laboratory, Aiken, SC, March 2018.

Hang, T., and L. L. Hamm. 2022. PORFLOW Implementation of Vadose Zone Conceptual Model for Naval Reactor Component Disposal Area in the E-Area Low Level Waste Facility Performance Assessment, SRNL-STI-2019-00357, Revision 1, January 2022

Hiergesell and Taylor, 2014. R. A. Hiergesell and G. A. Taylor, Update to the Sensitivity/Uncertainty Analysis for the E-Area Low-Level Waste Facility Trenches, SRNL-STI-2013-00660, Revision 0, Savannah River National Laboratory, Aiken, SC, May 2014.

Hiergesell et al., 2016. R. A. Hiergesell, M. R. Millings, G. K. Humphries and D. F. Sink, FY2015 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility, SRNL-STI-2015-00691, Revision 0, January 2016.

Kubilius 2019. W. P. Kubilius, Updated Approach to Performance Monitoring at the E-Area Low Level Waste Facility. SRNL-RP-2019-00682, Revision 0, Savannah River National Laboratory, Aiken, SC. 2019.

Kubilius and Joyce, 2018. W.P. Kubilius and W.D. Joyce, *Optimization of the Groundwater Monitoring Program at the E-Area Low-Level Waste Facility (ELLWF)*, SRNS-RP-2018-01123, Revision 0, December 2018.

Kubilius et al., 2019. W. P. Kubilius, B. T. Butcher and I. J. Stewart, *FY2018 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNS-RP-2019-00002, Revision 0, February 2019.

LaBone et al. 2021. E. D. LaBone, B. T. Butcher, K. L. Dixon and I. J. Stewart. *FY2020 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNL-STI-2020-00588, Revision 0, February 2021.

LaBone et al. 2022. E. D. LaBone, J. J. Mayer, K. L. Dixon and I. J. Stewart. *FY2021 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNL-STI-2022-00018, Revision 0, March 2022.

McDowell-Boyer and Flach, 2011. L. McDowell-Boyer and G. P. Flach, *PORFLOW Qualification for Use in E-Area Low-Level Waste Facility Performance Assessment,* SRNL-STI-2010-00732, Revision 0, Savannah River National Laboratory, Aiken, SC, September 2011.

McGill 2022. S. McGill, *Savannah River Nuclear Solutions (SRNS) Solid Waste Management (SWM) Radioactive Waste Management Basis (RWMB) (U)*, Q-RWM-E-00001, Revision 10, January 2022.

Millings, 2009. M.R. Millings, *Review of Lysimeter Cluster VL-26 at Slit Trench 1*, SRNL-L6200-2009-00038, Revision 0, Savannah River National Laboratory, Aiken, SC, November 2009.

Millings, 2012. M. R. Millings, *Performance Assessment Monitoring Plan for the E-Area Low Level Waste Facility*, SRNL-RP-2009-00534, Revision 1, Savannah River National Laboratory, Aiken, SC, August 2012.

Millings et al., 2010. M. R. Millings, L. A. Bagwell, J. V. Noonkester and K. A. Roberts, *Summary Report for the VL-26 Lysimeter Field Characterization*, SRNL-STI-2010-00436, Revision 0, Savannah River National Laboratory, Aiken, SC, July 2010.

Millings et al. to Fox and Gilmour, 2014. Technical Memorandum, "Review of Lysimeter Cluster "VL-6-South Center" at Engineered Trench 1", SRNL-L3200-2014-00004, Savannah River National Laboratory, Aiken, SC, July 24, 2014.

SCDHEC, 2014. *South Carolina Department of Health and Environmental Control Hazardous and Mixed Waste Permit, Permit Number SCI 890 008 989*, 2014 RCRA Permit Renewal for the Savannah River Site, issued on February 11, 2014, South Carolina Department of Health and Environmental Control, Office of Environmental Quality Control, Bureau of Land and Waste Management, Columbia, SC.

Simmons, 2020. J. O. Simmons, *UDQE to Determine Significance of TPBAR Disposal Container #4 Weld Leak Rate*, SRNS-TR-2020-00005, Revision 0, August 2020.

Smith, 2010. F. G. Smith III, *GoldSim Analysis of Slit Trench 1*, SRNL-L5200-2009-00085, Revision 1, Savannah River National Laboratory, Aiken, SC, June 2010.

Smith, F. G. III. 2021. PORFLOW Modeling of Vadose Zone Flow and Transport for the E-Area Intermediate Level Vault, SRNL-STI-2020-00410, Revision 1, December 2021.

SRNS, 2022. *Savannah River Site Environmental Report 2021*, SRNS-RP-2022-00001, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC 29808.

SRS-1S, 2021. SRS Radioactive Waste Requirements Manual, Chapter 5, *Low Level Waste*, Revision 2, Savannah River Nuclear Solutions, Aiken, SC, February 11, 2021.

Stagich, B. H. 2022. Model Validation for the FY2021 SRS Composite Analysis Monitoring Plan, SRNL-STI-2022-00049, Revision 0, March 2022.

Stagich, B. H., and J. J. Mayer. 2022. FY2021 Savannah River Site Composite Analysis Annual Summary Review, SRNL-STI-2022-00048, Revision 0, March 2022.

Stagich et al. 2022. B. H. Stagich, K. L. Dixon, and E. D. LaBone "*Radiological Impact of 2021 Operations at the Savannah River Site*." SRNL-STI-2022-00323, Rev. 0, Savannah River National Laboratory, Aiken, SC. July 2022.

SWM, 2017. *Engineered Trench #2 Sump Sampling and Pumping (U)*, SW15.1-SOP-ESUMP-02, Revision 9, Savannah River Nuclear Solutions, Aiken SC, June 19, 2017.

SWM, 2020. *E-Area Vaults Subsidence and Low Activity Waste Vault Concrete Degradation Inspection (U),* 724-EAV-50, Revision 8, Savannah River Nuclear Solutions, Aiken SC, June 17, 2020.

SWM, 2022a. *SWMF E-Area Inspections (U)*, SW15.6-INP-SWF-03, Revision 40, Savannah River Nuclear Solutions, Aiken SC, March 16, 2022.

SWM, 2022b. *E-Area Low Level Sump Sampling and Pumping (U)*, SW15.1-SOP-LLS-01, Revision 17 IPC01, Savannah River Nuclear Solutions, Aiken SC, May 4, 2022.

Taylor and Hiergesell, 2013. G. A. Taylor and R. A. Hiergesell, *Benchmarking Exercises to Validate the Updated ELLWF GoldSim Trench Models*, SRNL-STI-2010-0737, Revision 1, November 2013.

Taylor, S. B., and T. S. Whiteside. 2022. E-Area Low Level Waste Generator Inventory Uncertainty Estimation, SRNL-STI-2021-00276, Revision 0, January 2022.

Whiteside, T. S. 2021. "Uncertainty and Bias Calculation Check (Memorandum: T. S. Whiteside to J. J. Mayer dated October 25, 2021)." SRNL-L4120-2021-00003. Savannah River National Laboratory, Aiken, SC.

Wohlwend et al. 2020. J. L. Wohlwend, *FY2019 Performance Assessment Annual Review for the E-Area Low-Level Waste Facility*, SRNL-STI-2019-00748, Revision 1, March 2020.

WSRC, 2008. *E-Area Low-Level Waste Facility DOE 435.1 Performance Assessment,* WSRC-STI-2007-00306, Revision 0, Washington Savannah River Company, Aiken, SC, July 2008.