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FY2019 Savannah River Site Composite Analysis Annual Review

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B. T. Butcher

February 2020

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EXECUTIVE SUMMARY

This document provides the Department of Energy (DOE) Order 435.1, Radioactive Waste Management (DOE 1999c) required Annual Review for the Savannah River Site (SRS) Composite Analysis (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).

Proposed activities, discoveries, new information and changes potentially affecting the 2010 SRS CA are documented in this and earlier Annual Summary reports, and a consolidated list of changes since the 2010 CA is documented in this report. The impact to the CA of changes arising from these new PA baselines is expected to be minor for the following reasons: The primary contributors to the SRS CA dose impact at the UTR POA are the H-Canyon and Mixed Waste Management Facility (MWMF), contributing 68% and 9%, respectively, to the dose impact at that POA. The combined contribution to the UTR dose impact from all PA's (SDF, E-Area LLWF, FTF and HTF) is ~2% of this total.

The 2010 SRS CA model validation performed indicates that the CA projected dose, while generally conservative, provides a reasonable representation of the maximum annual doses. Doses evaluated are well below the SRS established 15 mrem/yr administrative limit (Crapse et al. 2011).

Based on the assessment presented within this annual review and collective engineering judgement, the conclusions of the 2010 SRS CA remain valid and there is reasonable assurance that SRS will meet the performance objectives delineated in DOE Order 435.1. 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 completed of PA revisions.

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LIST OF ABBREVIATIONS

AER	Annual Environmental Report
ASR	Annual Summary Review
CA	Composite Analysis
CLSM	Controlled Low Strength Material
DAS	Disposal Authorization Statement
D&D	Deactivation and decommissioning
DP	Distributed Processing
DOE	Department of Energy
DSS	Decontaminated Salt Solution
ELLWF	E-Area Low-Level Waste Facility
EPA	Environmental Protection Agency
ET	Engineered Trench
FMB	Fourmile Branch
FTF	F-Tank Farm
FY	Fiscal Year
GSA	General Separations Area
GW	Groundwater
HTF	H-Tank Farm
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IOU	Integrator Operable Unit
ISD	In Situ Disposal
Kd	Distribution Coefficient
LFRG	Low Level Waste Disposal Facility Federal Review Group
LLRWDF	Low-Level Radioactive Waste Disposal Facility
LLW	Low-Level Waste
LTR	Lower Three Runs
M&O	Management and Operating
MEI	Maximally Exposed Individual
MWMF	Mixed Waste Management Facility
NRC	Nuclear Regulatory Commission
NRCDA	Naval Reactor Component Disposal Area
ORWBG	Old Radioactive Waste Burial Grounds
PA	Performance Assessment

PB	Pen Branch
PEST	Parameter ESTimation Software
POA	Point of Assessment
PORFLOW	Primary flow and transport code used in SRS PA and CA modeling
R&D	Research and Development
RGFM	Regional Groundwater Flow Model
RWMB	Radioactive Waste Management Basis
SA	Special Analysis
SC	Steel Creek
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SR	Savannah River
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation
SRS	Savannah River Site
ST	Slit Trench
SZ	Saturated Zone
TCCR	Tank Closure Cesium Removal
TRU	Transuranic
UDQE	Unreviewed Disposal Question Evaluation
US	United States
UTR	Upper Three Runs
UWMQE	Unreviewed Waste Management Question Evaluation
VOC	Volatile Organic Compound
WSRC	Westinghouse or Washington Savannah River Company

1.0 SRS and the 2010 SRS Composite Analysis

1.1 SRS Background History

The Savannah River Site (SRS) is a Department of Energy (DOE) site encompassing approximately 310 square miles in South Carolina. It is bounded on the southwest by the Savannah River (SR) and is situated approximately 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia. Construction of and subsequent operations at the SRS began in 1951 under the direction of the Atomic Energy Commission. The primary mission of the SRS was to produce tritium and plutonium for the national nuclear weapons complex. Between 1953 and 1955, SRS brought five reactors and various support facilities into operation in support of its primary mission. Support facilities included two chemical separations plants, a heavy water extraction plant, a nuclear fuel and target fabrication facility, a tritium extraction facility and waste management facilities (DOE 1997; Mamatey 2007; Reed et al. 2002; SRS 2008; WSRC 2007a).

With the declining need for a large nuclear weapons stockpile since the end of the Cold War, many SRS facilities no longer produce or process nuclear materials. All reactors were shut down by 1993. However, the SRS Tritium Extraction Facility continues to supply DOE with tritium. Additionally, operations at the K-Area Complex currently provide interim safe storage for much of DOE's excess plutonium (Pu) and high enriched uranium, in a building which formerly housed K Reactor. As the SRS mission has changed, many surplus facilities are being dispositioned safely and economically. SRS has completed extensive decommissioning activities in D-Area, M-Area, P-Area, R-Area, and T-Area (Mamatey 2007; SRS 2008), with groundwater (GW) remediation ongoing. High-level waste tanks continue to be emptied and closed.

1.2 2010 SRS CA Approach

The 2010 SRS Composite Analysis (CA) (SRNL 2010) is required by DOE Order 435.1, Radioactive Waste Management (DOE 1999c), as part of the Disposal Authorization Statements (DOE 1999a, 2008a) for the E-Area Low-Level Waste Facility (ELLWF) and Saltstone Disposal Facility (SDF), and the Tier 1 Closure Authorization for the F- and H-Tank Farms (FTF, HTF).

The 2010 SRS CA is a radiological dose projection to future hypothetical members of the public, due to exposure to radioactive material originating from SRS low-level waste disposal facilities (i.e., ELLWF, SDF, FTF, and HTF), plus any other SRS sources which may comingle with material from those facilities. All pathways were considered, but screening analysis determined that at publicly accessible locations (i.e. outside the site perimeter), pathways involving surface water are more important than other pathways. Therefore, Points of Assessment (POAs) were established at the mouths of the site creeks (i.e. Upper Three Runs (UTR), Fourmile Branch (FMB), Steel Creek (SC), and Lower Three Runs (LTR)) and at a point on the Savannah River (SR), near the US Highway 301 Bridge, downstream from SRS.

The dose projection accounted for radionuclide migration from the ELLWF, SDF, FTF and HTF closures and all other known projected end-state sources of radioactive material to remain at SRS. Radiological inventories at ELLWF, SDF, and FTF were obtained from their respective Performance Assessments (PA) documents. Inventories at HTF (no PA available at the time) and other SRS facilities were obtained from other sources (see Appendix B.1). The CA model simulates transport of radioactive material by groundwater from facility to site creeks, and then as surface water from creeks to members of the public. Four different 3D groundwater flow models were used, one for A&M Area sources, one for General Separations Area (GSA) sources, one for R-Area, and a fourth for sources at C-, K-, L-, N-, P-, and T-Areas. The final output of these models is predicted surface water concentrations and doses at the POAs, at various future times, for the cumulative effect of 152 individual radiological inventory sources.

The primary dose pathways involving surface water at the POAs include residential dose and recreational dose. The residential dose is calculated by assuming that surface water at each POA is used for drinking and farming. The recreational pathway includes ingestion of fish, contact with water, and radioactive shine based on concentrations in the streams. The all-pathways dose was projected over a 1,000-year period beginning at the assumed end-state date of 2025 and was compared to the primary public dose limit of 100 mrem/yr and an administrative limit of 30 mrem/yr (CA performance measures).

The analysis resulted in a maximum projected **3 mrem/yr** dose over the 1,000-yr assessment period at the LTR POA, primarily due to Cs-137 contained within the streambed sediments. The projected dose was less at all other creek mouth POAs and at the SR POA. Also subsequent work has determined that the Cs-137 inventory in LTR streambed sediments is more accurately estimated to be 1/5 of the inventory initially utilized in the CA calculations (Hiergesell and Phifer 2012); so, in summary, the analysis provided a reasonable expectation that the CA performance measures will not be exceeded.

The 2010 CA model can be validated by comparing model results to doses calculated from measured surface water compositions at the various POAs. Section 4.0 of this report and Stagich and Jannik (2020), provide annual comparisons at each POA, modeling the dose due to SRS facilities which were in their final state as of 2002. With this report, the running comparison between modeled and observed doses at POAs is now in its 16th year. Results show that the 2010 CA is serving as a conservative estimator of dose to human receptors.

In July 2010 DOE approved the SRS CA (SRNL 2010) with the condition that the secondary issue identified by the Low-Level Waste Disposal Facility Federal Review Group (LFRG) Review Team (Carilli and Golian 2010) be resolved (Marcinowski 2010). The Review Team created one Secondary Issue through the consolidation of eighteen observations that the team concluded, when evaluated collectively, could potentially impact the integration of the CA results. Approval required that the secondary issue be tracked through the CA Maintenance Plan and progress reported in the SRS CA Annual Report (Appendix A).

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

Table 2-1 lists all the Change Control Process Evaluations (UDQE's and UWMQE's), SAs and PA's that were performed during the year. The cumulative effect of these changes is described in Section 2.1.

A consolidated list of all known CA-affecting changes that have occurred since the 2010 SRS CA is provided in Appendix B. Although CA-related work completed in FY2019 provides indications that the conclusions of the CA are still valid, the 2010 SRS CA should be updated upon revision of the SRS PA(s) to address the number of proposed changes to inventories and sources and model improvements accumulated since the 2010 CA.

Table 2-1. Potential Changes Affecting the PA, CA, DAS or RWMB

Disposal Facility/Unit	UDQE/ UWMQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts
E-Area Low-Level Waste Facility	NA	Revision of the E-Area LLWF PA	PA development ongoing	NA	CA impact TBD. Expected change in CA source terms for E-Area disposal units as a result of new PA baseline.
E-Area Low-Level Waste Facility	NA	2018 GSA flow model predicts changes in groundwater flow directions from those evaluated in 2008 PA.	New predicted GW flow directions in combination with other model updates result in lower dose impacts. Current disposal limits are acceptable.	SRNL-STI-2018-00624, Revision 0 (Hamm et al. 2018)	CA impact TBD. GW flow directions used in estimating radionuclide transport to surface water (i.e., streams and Savannah River) will need to be updated in the next CA revision.
Saltstone Disposal Facility	NA	Revision of the SDF PA.	SDF PA modeling and analyses provide a reasonable expectation that all performance objectives and required standards will be met and the operation of the SDF can continue and will be protective of human health and the environment.	SRR-CWDA-2019-00001, DRAFT, Rev. A (SRR 2019)	CA impact TBD. Expected change in CA source terms for Z-Area disposal units as a result of new PA baseline.
Saltstone Disposal Facility	SRR-UWMQE-2017-00003, Rev. 2 (SRR 2017b)	Evaluation of disposing decontaminated salt solution.	Disposal not expected to impact the cured properties of saltstone.	NA	CA impact TBD.

Disposal Facility/Unit	UDQE/ UWMQE or Change control process identification number	Change, Discovery, Proposed Action, New Information description	Evaluation Results	Special Analysis number (if applicable)	PA, CA, DAS or RWMB Impacts
F-Area Tank Farm	SRR-UWMQE-2017-00005, Rev. 1 (SRR 2017d)	Evaluation of the 2018 updated General Separations Area model.	Performance objectives still met and no operational or design changes required.	NA	CA impact TBD. GW flow directions used in estimating radionuclide transport to surface water (i.e., streams and Savannah River) will need to be updated in the next CA revision.
H-Area Tank Farm	SRR-UWMQE-2017-00006, Rev. 1 (SRR 2017e)	Evaluation of the 2018 updated General Separations Area model.	Performance objectives still met and no operational or design changes required.	NA	CA impact TBD. GW flow directions used in estimating radionuclide transport to surface water (i.e., streams and Savannah River) will need to be updated in the next CA revision.
E-Area LLWF, SDF, FTF, HTF	NA	FY2018 SRS CA Annual Review SRNS-RP-2019-00051 (Kubilius et al. 2019b)	Concluded that the 2010 SRS CA is adequate and changes/new information are not foreseen to alter CA conclusions	NA	No CA impact.

2.1 Cumulative Effect of Changes

The following is a summary of each of the changes potentially affecting the PA and CA baseline followed by a discussion of the cumulative effects of these changes.

- E-Area LLWF PA Revision

  In FY2019, work was begun to update and revise the E-Area LLWF PA. New PA models were being developed and key PA datasets updated in FY2019. The revised E-Area LLWF PA will include the following:

  - Updated GSA flow model;
  - New conceptual closure cap design;
  - New disposal unit models;
  - New GW, intruder and air pathway radionuclide screening
  - Updated infiltration estimates;
  - Updated geochemical parameters;
  - Update hydraulic parameters; and
  - New dose model based on updated radionuclide-dose parameters and dose methodology

- E-Area LLWF SA for updated GSA Model

  An SA was issued in December 2018 for the E-Area LLWF entitled *Impact of Updated GSA Flow Model on E-Area Low-Level Waste Facility Groundwater Performance* (Hamm et al. 2018). The 2018 GSA flow model had been updated using 20 years of new hydrologic field data and model calibration methods that employed mathematical optimization software. Updated flow directions in the model produced a higher degree of plume overlap for disposal units in the southeastern portion of E-Area than had been predicted in the 2008 E-Area LLWF Performance Assessment. The approach taken in this analysis was to assess unquantified conservatism in disposal unit inventory limits by accounting for plume interaction based on projected radionuclide closure inventories (source term) and a predetermined sequencing of trench operations (timing). Based on deterministic and stochastic analyses, SRNL results from the SA show that the likelihood of exceeding an absolute Sum-of-Fractions greater than one, while operating E-Area under its current Waste Information and Tracking System inventory limits, is exceedingly small. New information from this SA is being incorporated into ongoing PA revision.

- SDF PA Revision

  In FY2018, work was begun to update and revise the SDF PA. A draft was issued for DOE review in FY2019 (SRR-CWDA-2019-00001, DRAFT, Rev. A) and issuance of the approved SDF PA revision is scheduled for FY2020. The revised SDF PA includes the following:

  - Analyses and results contained in all SAs that have been completed to date;
  - Analyses and results of all UWMQEs completed to date;
  - Consideration of new information generated through applied research, including updated information about the material properties of saltstone and the transport behavior of I-129 and Tc-99 (from Dynamic Leaching Method testing);
  - Updates to disposal unit design, including an update to the Closure Cap design;
  - Revised infiltration rates based on updated closure cap modeling from expert elicitation;
  - Revised cementitious degradation rates based on updated material properties and recommended approaches informed by expert elicitation;
  - Incorporation of an updated General Separations Area Flow Model using calibration targets from wells in Z Area;

  - Changes in site future land use plans or closure plans; and
  - Changes to PA guidance documents requirements.

- SDF UWMQE for Disposal of TCCR DSS at SDF

  One UWMQE was completed in FY2019 for the SDF. The UWMQE was entitled *Disposal of Tank Closure Cesium Removal DSS at Saltstone Disposal Facility* (SRR 2017b) and was issued in March 2019. This UWMQE was updated to document the evaluation of disposing decontaminated salt solution (DSS) resulting from Tank Closure Cesium Removal (TCCR) operations at the SDF containing zirconium and titanium leached from the ion exchange media. SRNL 2018, referenced by SRR 2017b, provides an evaluation of the TCCR DSS waste stream and proposed SDF disposal and concludes that disposing of TCCR DSS containing zirconium and titanium leached from the ion exchange media at the SDF are not expected to have an impact on the cured properties of saltstone. The UWMQE states that the proposed activity does not impact the conclusion of the SDF PA, the associated SDF SAs, the CA, or the Waste Determination. The changes evaluated by the UWMQE indicate that the conclusions in the PA remain valid.

- FTF UWMQE for updated GSA Model inputs

  A UWMQE entitled *UWMQE to Evaluate Impacts to FTF PA Doses Due to the Update of the GSA Model* (SRR 2017d) was issued in FY2019. This UWMQE presented an evaluation of the 2018 update of the groundwater model known as the GSA Database (Flach 2019). The UWMQE states that the 2018 changes made to the GSA Model result in different flow fields relative to those used as inputs to the PA and SA modeling. The modeling performed to support this UWMQE (SRR 2017c) demonstrates that performance objectives are still met, requiring no operational or design changes. The GSA Model changes will be incorporated into a future revision to the FTF PA.

- HTF UWMQE for updated GSA Model inputs

  A UWMQE entitled *UWMQE to Evaluate Impacts to HTF PA Doses Due to the Update of the GSA Model* (SRR 2017e) was issued in FY2019. This UWMQE presented an evaluation of the 2018 update of the groundwater model known as the GSA Database (Flach 2019). The UWMQE states that changes made to the GSA Model result in different flow fields relative to those used as inputs to the PA and SA modeling. The modeling performed to support this UWMQE (SRR 2017c) demonstrates that performance objectives are still met, requiring no operational or design changes. The GSA Model changes will be incorporated into a future revision to the HTF PA.

- FY2018 SRS CA Annual Review:

  The FY2018 CA Annual Review (Kubilius et al. 2019b) concluded that the 2010 SRS CA is adequate and, specifically, that: 1) changes identified from completed maintenance items are not expected to alter CA conclusions; 2) no research and development (R&D) activity impacting the CA conclusions was performed; 3) changes identified from resolution of the LFRG Secondary Issue are not foreseen to alter CA conclusions; 4) changes identified to CA inputs and assumptions are not foreseen to alter CA conclusions; 5) POAs remain valid; and 6) CA model validation indicates the CA is a reasonable representation of the maximum annual dose. The FY2018 Annual Review of the 2010 SRS CA was approved by DOE-Headquarters in September 2019 (Tonkay and Suttora 2019).

The upcoming revisions to the SDF and E-Area LLWF performance assessments will produce a new PA baseline for each facility and are the result of accumulated changes (see above) since the last PA revision (SRR 2009 and WSRC 2008a). The other UWMQE's and SA's described above are being incorporated into the two PA revisions or in a future revision to the HTF and FTF PA's. The DAS and RWMB for each facility will be revised upon approval of each PA. Other documents, such as the facility closure plans, will also need to be revised to align with the updated closure cap concept evaluated in each PA.

The impact to the CA of changes arising from these new PA baselines is expected to be minor for the following reasons: The primary contributors to the SRS CA dose impact at the UTR POA are the H-Canyon and Mixed Waste Management Facility (MWMF), contributing 68% and 9%, respectively, to the dose impact at that POA. The combined contribution to the UTR dose impact from all PA's (SDF, E-Area LLWF, FTF and HTF) is ~2% of this total. Dose impacts attributed to UTR POA do not represent the maximum impacts from SRS. Rather, sources contributing to the LTR POA, primarily Cs-137 contained within the sediment of the LTR streambed, produce the maximum dose impact for SRS. This maximum dose impact is 2.99 mrem/yr as compared to the dose constraint of 30 mrem/yr and dose limit of 100 mrem/yr.

3.0 Waste Receipts

Waste receipts from each SRS LLW disposal and tank closure facility (E-Area LLWF and SDF) are shown and discussed in the respective FY2019 PA Annual Summary Review reports (Wohlwend et al. 2020 and SRR 2020) and will not be repeated here. As projected closure inventories for each facility were used in developing source terms for the CA, it would follow that inventory additions/changes in any particular year that do not exceed these future closure estimates would be within CA modeling envelope. Final closure inventory estimates are reviewed and generally updated prior to PA revisions to reflect the current projected closure estimate of total inventory and inventory distributions based on an accumulation of historical disposal receipts and improved projections. Because SRS LLW disposal and tank closure source terms are only minor contributors to the SRS CA maximum projected dose, a significant inventory multiplier to LLW disposal and tank closure facilities would be required to reach the dose constraint of 30 mrem/yr. All waste receipts met the WAC for the respective facilities; therefore, those facilities are still in compliance with the PAs, and the PAs are in line with the CA as modeled (excluding those baseline analyses performed subsequent to the PA revision evaluated by the 2010 CA).

4.0 Monitoring

Table 4-1 summarizes the FY2019 CA monitoring evaluation. SRS Annual Environmental Report (AER) monitoring data is used to validate the SRS CA model. CA model validation, based upon AER monitoring data, is a tool to improve future CA predictions, inform the CA maintenance plan relative to work required to make such improvements, and inform future AER monitoring. Additionally, it can be a tool to indicate that actions may need to be taken to provide continued reasonable assurance that future doses will be within the limit. The monitoring evaluation method is described in the CA monitoring plan (Crapse et al. 2011) and this year's evaluation is documented in Stagich and Jannik (2020).

Table 4-1. Performance Monitoring

Monitoring Purpose	AER Monitoring Results & Trends		CA Expected Behavior	Action Taken	PA/CA Impacts
	mrem/yr				
AER (MEI[1] + Irrigation Doses) versus SRS CA Dose	MEI + Irrigation Dose	0.191	0.233	None	None
AER Fisherman Dose versus SRS CA Fisherman Dose	Fisherman Dose (UTR)[2]	0.343	0.0981	None	None
	Fisherman Dose (FMB)	0.0817	2.49	None	None
	Fisherman Dose (SC/PB)	0.159	0.390	None	None
	Fisherman Dose (LTR)	0.398	3.44	None	None
	Fisherman Dose (SR)	0.0568	0.0892	None	None
AER End-State Equivalent Doses	End State Equivalent Dose (UTR)[2]	0.265	0.101	None	None
	End State Equivalent Dose (FMB)	2.50	2.52	None	None
	End State Equivalent Dose (SC/PB)	0.265	0.485	None	None
	End State Equivalent Dose (LTR)	0.0283	3.57	None	None
	End State Equivalent Dose (SR)	0.0168	0.210	None	None

[1] Maximally Exposed Individual (MEI)

[2] AER value is higher than the expected value due to variability in sample measurements, with further explanation in Stagich and Jannik (2020)

Based upon the structure of and the results from the CA model, the CA annual monitoring is able to utilize existing SRS site monitoring programs as reported in each year's SRS Annual Environmental Report to trend appropriate dose scenarios for comparison with the results calculated in the CA and also results in terms of dose calculated using the CA dose module and annual estimated concentrations at the POAs. The AER data used as input in this year's CA monitoring evaluation was reported by Jannik (2019).

As part of AER monitoring, the total radionuclide release through the liquid pathway (i.e., includes contributions from drinking water, fish, and invertebrates consumption, recreational activities, and irrigation) to the Savannah River (both in terms of curies released and concentration) is estimated using liquid effluent discharge-point data along with groundwater migration pathway data based upon concentrations and flow rates. In addition, the AER monitoring takes into account Cs-137 originating from streambeds through fish concentration monitoring (Mamatey 2010). The groundwater migration pathway data plus the Cs-137 fish data represent the contribution from waste sites that have already achieved their end states [i.e. ORWBG, MWMF, LLRWDF, F- and H-Area Seepage Basins, Reactor Area Seepage Basins (K, L, P, and R Areas), UTR, FMB, PB, SC, and LTR]. In contrast, the effluent discharge-point data represent operating, not end-state, conditions. AER monitoring is able to differentiate and separate the effluent discharge point data from the groundwater migration pathway and Cs-137 fish data so that data representing only waste sites at their end state can be produced.

In accordance with the CA model validation plan (Crapse et al. 2011, Section 4.0), the following are evaluated annually. Each is presented in more detail in Stagich and Jannik (2020).

- AER (MEI + Irrigation doses) versus SRS CA Dose: The AER Maximally Exposed Individual (MEI) plus AER irrigation doses are compared to the SRS CA projected dose for the SR POA at the US Highway 301 Bridge.
- AER Fisherman versus SRS CA Fisherman Dose: The AER creek-mouth fisherman dose for each SRS creek (i.e. UTR, FMB, SC/PB, LTR) and the SR is compared to the respective SRS CA projected creek-mouth and SR fisherman dose.
- AER End-State Equivalent Doses: The appropriate AER data for each SRS creek and the SR is used as input to the CA dose module to produce an "AER end-state equivalent dose" for comparison with the SRS CA projected dose for that respective year.

4.1 CA Model Validation Summary

In summary, the following observations were made regarding the CA model validation that is documented in Stagich and Jannik (2020) and summarized in Table 4-1:

- The SRS CA predicted 2018 dose at the Savannah River is close to the AER combined MEI and irrigation dose.
- The SRS CA predicted fisherman doses continue to be greater than the AER fisherman doses, aside from Upper Three Runs (due to variability in sample measurements). Yearly variation in the doses can be due to relatively large variability in fish radionuclide concentrations resulting from differences in the size of fish collected, time of year fish were collected, and water quality changes stemming from stream flow rates, among other factors.
- The SRS CA predicted doses are either greater than the AER end-state equivalent doses or are reasonably equivalent.

5.0 Research and Development

Table 5-1 discusses CA-specific R&D work performed in FY2019, as well as R&D work performed in FY2019 in association with the PAs for E-Area LLWF (WSRC 2008a, Hang et al. 2018), SDF (SRR 2009, SRR 2018a), FTF (SRR 2010), and HTF (SRR 2012a), that may have a bearing on the conclusions of the 2010 SRS CA (SRNL 2010).

Table 5-1. Research and Development Activities

Document Number	Results	PA/CA Impact
SRNL-STI-2018-00643, Revision 0	The groundwater flow model supporting PAs and CAs at SRS was significantly revised in 2016 and 2017 using new hydrostratigraphic surfaces, updated well water level calibration targets, and semi-automated model calibration with the Parameter ESTimation Software (PEST) optimization code. This model is referred to as "GSA_2016". This report documents further refinement of the GSA_2016 model in 2018 to incorporate updates to model calibration targets, closure of the H-Area Ash Basin, construction of E-Area Slit Trench (ST) operational covers, and plume information from the Mixed Waste Management Facility and Low-Level Radioactive Waste Disposal Facility. Another objective was to lower hydraulic head residuals by adding another calibration zone. (Flach, 2019)	Minor impact to CA. GW flow directions used in estimating radionuclide transport to surface water (i.e., streams and Savannah River) will need to be updated in the next CA revision. New flow directions from the E-Area LLWF continue to contribute to the UTR POA. Potential impacts to ELLWF, SDF, HTF and FTF PA's assessed in a SA and UWMQE's described in Table 2-1.
SRNL-STI-2018-00681, Revision 0	This limited sensitivity analysis addresses uncertainty in the conservatism of blending infiltration rates for use as input boundary conditions in PORFLOW vadose zone simulations as opposed to blending flux-to-the-water-table outputs for different subsidence infiltration scenarios, as has been done historically. Results indicate that blending infiltration rates for different subsidence infiltration scenarios is a more conservative implementation of subsidence. (Danielson, 2019)	No impact to CA. The historical method used in the 2008 PA will be implemented in the ongoing PA revision.
SRNL-STI-2019-00205, Revision 0	This technical memorandum lists the confirmed final corner coordinates of each DU footprint to be used in the next PA. (Hamm, 2019)	No impact to CA. The slight adjustments in corner coordinates are judged to be insignificant relative to the mesh size used in the 2008 PA aquifer models.
SRNL-STI-2015-00056, Revision 1	This report provides a detailed description of the methodology developed to perform dose calculations for ELLWF Facility PAs and SRS CAs. Revision 1 incorporates updated equations, parameters and references since revision 0 was issued. Changes were documented in the report and associated controlled Radionuclide-Dose database. (Smith et al., 2019)	Minor impact to CA and will be captured in the future CA revision. Changes in parameter values will either result in decreased dose impacts or negligible increases. Changes to dose equations were minor contributors to the CA projected dose impacts. Finally, a large margin exists between the maximum projected CA dose and the 30 mrem/yr dose constraint.

Document Number	Results	PA/CA Impact
SRNL-STI-2018-00633, Revision 0	This report documents SRNL's evaluation of updated Naval Reactor waste container and inventory projections and proposes a NRCDA GW pathway modeling approach for the next ELLWF PA which is scheduled to be completed in FY2021. (Wohlwend and Butcher, 2018)	Minor impact to CA. New projected inventories from Naval Reactors and changes in the modeling approach from the 2008 E-Area PA will result in an updated source term for the SRS CA. Based on the small contribution of the NRCDA's to the 2010 SRS CA result, new NRCDA PA model meeting performance objectives is expected to produce an acceptable CA result.
SRNS-RP-2018-01123 Revision 0	This report describes results of a saturated zone (SZ) characterization campaign which was conducted in 2017-2018 (Kubilius 2018). The field characterization employed direct push technology into the water table in the vicinity of Engineered Trench 1 (ET01) and ET02. Analyses indicated that the uppermost five to twelve feet of the SZ is free of significant contamination from MWMF. This is demonstrated by the lack of VOCs in that interval. Therefore, SZ monitoring wells set in the uppermost part of the aquifer could be good indicators of E-Area LLWF-sourced contamination or the lack of it. Changes are proposed to the E-Area PA monitoring approach based on this characterization work.	No impact to CA and will be captured in the future CA revision.
SRNL-STI-2018-00484, Revision 0 SRR-CWDA-2016-00086, Rev 1	Testing of a Tank 12H residual waste sample was performed in FY2018 using the same basic methodology used for Tank 18F residual waste testing, with some minor changes made to incorporate lessons learned. The test setup modifications and the Tank 12H waste release testing results have been documented (King 2018). An evaluation of the test results (SRR 2016b) was issued in FY2019 with no impact to PA conclusions.	No impact to CA and will be captured in the future CA revision.
SREL Doc.: R-19-0004	The Tank Farm PAs use a conceptual Waste Release Model to simulate stabilized contaminant release from the grouted waste tanks based on various chemical conditions in the waste tank which control solubility and thereby affect the timing and rate of release of contaminates from the residual waste layer. A waste release test plan was issued in FY2019 (Seaman and Baker 2019). Part 1 of the test plan work scope involves measuring the Eh and pH of eluate (open system, oxic conditions) and immersion (closed system, anoxic conditions) solutions associated with cementitious materials exposed to a simulant of SRS vadose zone liquid.	Minor impact to CA and will be captured in the future CA revision.
NA	Several different grout mixes have been used since 1997 as the bulk fill material for waste tank closure, with additional mixes were used for specialized purposes, such as filling cooling coils. The various grouts all have different attributes and features that make them better or worse with respect to the bulk fill grout function. Grout work was initiated in FY2019 in order to identify additional bulk fill grout alternatives for the next tank closure.	Minor impact to CA and will be captured in the future CA revision.

Document Number	Results	PA/CA Impact
SRRA099188-000010, Rev. B	Environmental Protection Agency (EPA) Method 1315 and dynamic leaching testing was continued in FY2019 and encompassed evaluation of radionuclide-spiked saltstone simulants and actual saltstone cores extracted from SDU Cell 2A. The data from these studies are provided in Seaman et al 2019.	Minor impact to CA and will be captured in the future CA revision.
SRR-CWDA-2019-00110, Rev. 0	*Determination of SDF Inventories through 9/30/2019* (SRR 2020) includes both the original inventory disposed of at the SDF and the current inventory of the SDF through FY2019. The current inventory at the SDF includes decay and ingrowth for SDF operations beginning in 1990 through FY2019. As of the end of FY2019, 738 kilocuries (kCi) have been disposed in the SDF and the current inventory in the SDF as of the end of FY2019, accounting for decay and daughter ingrowth, is 383 kCi.	No impact to CA and will be captured in the future CA revision.

6.0 Planned or Contemplated Changes

Major revisions to the SDF and E-Area LLWF PA's are currently underway to incorporate new information since the previous PA revisions. Section 2.1 lists some of the key updates to the baseline being included in each of these new PA's. Change control process evaluations and a SA have been conducted this review period that will also impact the ELLWF, SDF, HTF and FTF PA baselines (i.e., evaluated a new flow model and proposed receipt of a new SDF waste stream). Finally, optimization of the E-Area LLWF PA monitoring approach is being field tested before being formally incorporated in a new PA Monitoring Plan revision. Table 6-1 lists the planned changes and their projected PA/CA impacts.

Table 6-1. Planned or Contemplated Changes

Planned or contemplated change	Change Basis	PA/CA Impacts	Schedule
Saltstone Disposal Facility Performance Assessment revision (SRR 2019)	Will incorporate results and analyses of SAs and UWMQEs, and revisions to modeling parameters and guidance requirements. Planned updates of key aspects of the PA baselines are summarized in Section 2.1.	CA impact TBD. New PA baseline. Updated CA source terms for Z-Area disposal units to be incorporated in next CA revision.	FY2020 (LFRG approval)
E-Area Low-Level Waste Facility Performance Assessment revision (Not yet available)	Will incorporate results and analyses of SAs and UDQEs, updates to key modeling parameters, new models, improvements addressing LFRG secondary issues on the 2008 PA and latest DOE technical standard guidance. Planned updates of key aspects of the PA baselines are summarized in Section 2.1	CA impact TBD. New PA baseline. Updated CA source terms for E-Area LLWF disposal units to be incorporated in next CA revision.	FY2022 (LFRG review and approval)
Optimization of the E-Area Low-Level Waste Facility groundwater monitoring program (Kubilius 2018)	Proposed changes based on the results of a saturated zone characterization campaign as described in Table 5-1. This new PA monitoring strategy will be tested in FY2020 for potential implementation into the PA baseline.	Revision of the E-Area LLWF PA Monitoring Plan. No CA impact.	FY2021
General Separations Area (GSA) Model inclusion into future PA revisions (Wohlwend 2018, Flach 2019, Flach et al. 2017, SRR 2017b, SRR 2017d, SRR 2017e)	The GSA groundwater flow model supporting PAs and CAs at SRS has been significantly revised using new hydrostratigraphic surfaces, updated well water level calibration targets, and semi-automated model calibration with the PEST optimization code.	CA impact TBD. Updated GSA flow model is being incorporated into the E-Area and SDF PAs, and will be incorporated into future F-Area Tank Farm and H-Area Tank Farm PAs	Per approvals of SDF and E-Area PA's; TBD for FTF and HTF PA's
Disposal of Decontaminated Salt Solution (DSS) in Saltstone Disposal Facility (SRR 2017b)	Evaluation of DSS from Tank Closure Cesium Removal operations as a proposed activity	No impact to PA or CA baseline.	Evaluation issued in FY2019
Savannah River Site Composite Analysis revision (future)	Will incorporate results and analyses of approved PA revisions and SAs along with proposed activities/discoveries/ new information/changes identified and/or evaluated since the 2010 SRS CA (see Appendix B).	New CA baseline.	FY2024 (estimated)

7.0 Status of DAS Conditions, Key and Secondary Issues

The LFRG SRS CA review (Carilli and Golian 2010) consolidated eighteen observations, deemed to have a potential impact on the integration of results, into a single secondary issue. These observations were to be resolved by the performance of 17 specific work items, which the LFRG concurred would resolve the observations once completed.

Table 7-1 lists the completed work items since approval of the 2010 CA and provides a summary of the estimated impact. Secondary issue observations have been generally closed by LFRG approval of the corresponding CA Annual Summary Review (ASR) in which the associated completed work items are described. Table 7-2 shows the status of outstanding secondary issue observations. The complete list and description of secondary issue observations and associated work items are found in Appendix A.

Table 7-1. Completed Secondary Issue Observations

Secondary Issue Observation and Work Item Number	Issue description	Resolution date	Disposition Documentation	PA, CA, DAS Impact
Observation 4 Work Item 1	Re-evaluation of the SRS facility and waste site lists.	2016	Hiergesell et al. 2016	Expected minor impact to the SRS CA results/conclusions. Overlooked facilities and waste sites represent minor new contributors to the CA source term.
Observation 4 Work Item 3	Consider inventory changes due to FTF and SDF PA development.	2017	Halverson and Stagich 2017	Expected minor impact to the SRS CA results/conclusions. Updated source terms for FTF and SDF have been evaluated for inclusion in their respective PA baselines. The combined contribution to the maximum CA dose from all SRS PA's (SDF, E-Area LLWF, FTF and HTF) is ~1% of the total.
Observation 4 Work Item 5	LTR Integrator Operable Unit (IOU) inventory and distribution.	2014	Phifer et al. 2014	Expected to reduce the CA dose impact. A re-evaluation of the base case end state inventory for the LTR IOU was performed. Cs-137 is the only IOU contaminant of concern because it is the only radionuclide of any consequence in terms of delivering a dose to an offsite member of the public. Cs-137 inventory estimates for the LTR IOU were reduced based on a refined method of estimating mass of contaminated streambed sediments and previously existing sampling and analysis data.
Observation 4 Work Item 6	FMB, SC and PB inventory and uncertainty.	2015	Phifer et al. 2015	Expected to reduce the CA dose impact. Cs-137 is the only IOU contaminant of concern because it is the only radionuclide of any consequence in terms of delivering a dose to an offsite member of the public. Cs-137 inventory estimates for the FMB, PB and SC IOU's were reduced based on a refined method of estimating mass of contaminated streambed sediments and previously existing sampling and analysis data.

Secondary Issue Observation and Work Item Number	Issue description	Resolution date	Disposition Documentation	PA, CA, DAS Impact
Observation 4 Work Item 7	H-Canyon, HB-Line, and H-Canyon Outside Facilities inventory and uncertainty.	2015	Phifer et al. 2015	Expected to reduce the CA dose impact. A re-evaluation was conducted of the base case end state inventory for the H-Canyon and HB-Line with a focus on Np-237, because it was the primary dose driver. More realistic de-inventorying assumptions were made reducing the original CA estimated residual inventory for Np-237 and other key nuclides.
Observation 2 Work Item 8	F&H Seepage Basin Groundwater Plume inventories and distributions.	2017	Halverson and Stagich 2017	Expected to reduce the CA dose impact. A refinement of the method for estimating plume inventories reduced the original CA estimated radionuclide inventory.
Observation 13 Work Item 12	Develop an SRS regional groundwater flow model (RFGM) encompassing the entire SRS.	2018	Ross and Marble 2018	LFRG approved removal of this work item based on a review of an SRNL position paper demonstrating that AM, CKLP, GSA, and R Flow Models provide an adequate representation of flow paths for use within the CA.
Observation 21 Work Item 15	Procure 36 Processor Windows Cluster and GoldSim DP-Plus Module.	2013	Phifer et al. 2013	Procured Windows cluster in 2010 and used in enhanced CA uncertainty analysis in 2011.

Table 7-2. Status of Outstanding DAS Conditions and Secondary Issue Observations

Secondary Issue Observation and Work Item Number	Issue description	Projected Resolution schedule date [1]	Disposition Documentation & Date Completed	PA, CA, DAS Impact
Observation 4 Work Item 2	Revise CA inventory report with corrections made during CA development.	2021 (Not started)	-	Expected minor impact to the SRS CA results/conclusions.
Observation 4, 21 Work Item 4	Develop and implement methodologies to estimate inventory uncertainty associated with significant radionuclide source locations.	2022 (Started in 2012)	-	Inventory distributions have been developed for the LTR IOU (Hiergesell and Phifer 2012), FMB-PB-SC IOU's (Hiergesell and Phifer 2014a, 2014b) and H-Canyon and HB-Line (Phifer and Dixon 2014)
Observation 4 Work Item 9	Revise inventory estimation ratio based on final data from facilities demolished since publication of the 2010 SRS CA.	2021 (Not started)	-	Expected minor impact to the SRS CA results/conclusions.
Observation 4 Work item 10	Revise the CA radionuclide screening by using the CA base case model and by considering radionuclides associated with the SDF PA.	2022 (Not started)	-	Expected minor impact to the SRS CA results/conclusions.
Observation 5 PA Maintenance	Update the geochemical and material property data packages.	2020 (Started in 2016)	-	The geochemical data package was updated in 2016 (Kaplan 2016a, 2016b). The material property data package is being updated in 2020.
Observation 13 Work Item 11	Perform a water balance study to provide estimates of natural streamflow for UTR, FMB, SC/PB and LTR.	2022 (Not started)	-	Expected minor impact to the SRS CA results/conclusions.
Observation 14 Work Item 13	Perform field characterization study of UTR, FMB, SC/PB and LTR streambeds to reduce uncertainty with release of radionuclides from streambed sediments.	2022 (Not started)	-	Expected minor impact to the SRS CA results/conclusions.
Observation 16 Work Item 14	Investigate the distribution of uranium within Tims Branch between that dissolved in water, that bound to streambed sediment, and that bound to particulates in transit.	2020 (Started in 2019)	-	The Tims Branch study is expected to be completed in 2020.
Observation 21 Work Item 16	Perform a systematic sensitivity analysis to identify model parameters that have greatest impact on CA results.	To be completed as part of next CA revision (Not started)	-	Expected minor impact to the SRS CA results/conclusions.

Secondary Issue Observation and Work Item Number	Issue description	Projected Resolution schedule date [1]	Disposition Documentation & Date Completed	PA, CA, DAS Impact
Observation 21 Work Item 17	Perform a more structured uncertainty analysis to identify those stochastic variables that have the greatest/least impact on model results) that have been initiated.	To be completed as part of next CA revision (Started in 2011)	-	The 2010 SRS CA uncertainty analysis considered 17 sources over 2,000 years using 400 realizations. The uncertainty was expanded to 39 sources over 10,000 years using 1,000 realizations (Smith and Phifer 2011). Further work on this item deferred until work on the next CA revision.

[1] Projected resolution dates for outstanding secondary issue observations assume availability of funding and resources to complete work items.

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

Based on all the information presented in this annual review, it is SRS's engineering judgement that the continued adequacy of the 2010 SRS CA is confirmed.

- Changes identified from completed maintenance items are not expected to alter CA conclusions.
- No R&D activity impacting the CA conclusions was performed.
- Changes identified from resolution of the LFRG Secondary Issue are not foreseen to alter CA conclusions.
- Changes identified to CA inputs and assumptions implemented into respective PA baselines through the UDQE, UMWQE and SA processes are not foreseen to alter CA conclusions.
- Because any potential lease or transfer of SRS land would have to comply with DOE Orders 458.1 and 435.1, it is anticipated that the current 2010 SRS CA POAs at the mouths of site streams to the SR and the SR itself would remain valid.
- CA model validation indicates the CA is a reasonable representation of the maximum annual dose.

Based on the assessment presented within this annual review and collective engineering judgement, the conclusions of the 2010 SRS CA remain valid and there is reasonable assurance that SRS will meet the performance objectives delineated in DOE Order 435.1. Although CA-related work completed in FY19 provides indications that the conclusions of the CA are still valid, the 2010 SRS CA should be updated upon revision of the SRS PA(s) to incorporate PA changes and to address the number of proposed changes to inventories and sources and model improvements accumulated since the 2010 CA (see Appendix B).

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Appendix A. Status of Secondary Issue from LFRG Review of the 2010 SRS CA

The SRS CA Review Report (Carilli and Golian 2010) documented the results of the LFRG Review Team's review of the 2010 SRS CA (SRNL 2010). The Review Team created one Secondary Issue through the consolidation of eighteen observations that the team concluded, when evaluated collectively, could potentially impact the integration of the CA results based on the following Results Integration review criterion in the Low-Level Waste Disposal Facility Federal Review Group Manual (DOE 2008b):

3.3.10.1 The results of the analysis for the source terms and transport of radionuclides, dose analysis, available site monitoring data, supporting field investigations, sensitivity or uncertainty analysis, and options analysis are reasonable representations of the existing knowledge of the site, disposal facility, and contributing sources.

According to Carilli and Golian (2010) the secondary issue must be addressed as indicated below.

Secondary Issue: Eighteen observations, when viewed collectively, were deemed to have a potential impact on the integration of results presented in the CA and were consolidated under a single Secondary Issue to be resolved.

- Nine observations involved missing data or a clarification of the information provided in the CA to ensure the document is complete. (Observations 1, 3, 9, 11, 12, 18, 19, 20, and 23 from Carilli and Golian 2010).
- Nine observations were related to ensuring specific future work items listed in Chapter 11 of the SRS CA Review Report are included in the CA maintenance plan. (Observations 2, 4, 5, 6, 7, 13, 14, 16, and 21 from Carilli and Golian (2010)).

<u>Recommendation:</u> Revise the CA to include/clarify the information and revise the maintenance plan to include specific items identified in the above observations. Further, SR must report on the progress of this secondary issue in its annual summary to the LFRG until closed (Carilli and Golian 2010).

The following outlines the status of SRNS progress in addressing the Secondary Issue:

- The LFRG approved resolution for the nine Secondary Issue observations that involved missing data or a clarification of the information was to incorporate that data or information into the 2010 SRS CA prior to its approval (Marcinowski 2010). Therefore, these nine observations were closed with DOE approval of the 2010 SRS CA. Additionally, the LFRG Observation and Recommendation (Carilli and Golian 2010) and the resolution (SRNL 2010) to these nine observations were documented within Appendix A of the FY2012 SRS CA Annual Review (Phifer et al. 2013) and will not be reproduced herein because these nine observations have been officially closed.

Table A-1 provides the LFRG Observation and Recommendation (Carilli and Golian 2010), the LFRG approved resolution (SRNL 2010), and the status for the nine secondary issue observations related to ensuring specific future work items are included in the CA maintenance plan. These nine observations are to be resolved by the performance of 17 specific work items.

Table A-1. Secondary Issue Observations Related to Future Work

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
3.3.2.2	Observation 2: The inventory of radionuclides other than Tritium (H-3) in GSA groundwater plumes has not been estimated and evaluated. Yet site monitoring data indicates that other radionuclides of concern [e.g., Strontium 90 (Sr-90), Technetium 99 (Tc-99), Cesium 137 (Cs-137), Iodine 129 (I-129)] are present in GSA groundwater and being released to Four Mile Branch. Recommendation: The maintenance program should address the neglected inventory of detected radionuclides in GSA groundwater plumes and their impacts assessed through CA screening or dose assessment, as appropriate.	Work Item 8 (SRNL 2010 Table 11-2): The inventory and inventory distribution for radionuclides within the F and H-Area Seepage Basins groundwater plumes, such as Strontium 90, Technetium 99, Cesium 137, Iodine 129, should be developed in addition to that for tritium. This inventory and its distribution should be evaluated within the SRS CA through screening or an actual dose assessment, as appropriate.	**Completed**	Groundwater sample analyses obtained from the wells that monitor groundwater contamination emanating from the F- and H-Area Seepage Basins were evaluated. Generalized groundwater plume maps for the radionuclides that occur in elevated concentrations (Am-241, Cm-243/244, Cs-137, I-129, Ni-63, Ra-226/228, Sr-90, Tc-99, U-233/234, U-235 and U-238) were generated and utilized to calculate both the inventory of radionuclides dissolved in groundwater, and their spatial distribution. (Hiergesell and Kubilius 2016).	FY2016 CA Annual Review [9]
	Observation 4: Limitations of the current CA inventory and its uncertainty are well recognized by SRS. Section 11.1 of the CA discusses CA related maintenance items, which include the maintenance of the SRS CA Inventory Database. Future work items of Table 11-2 also include items related to inventory updates and uncertainty assessments (Items 1, 3, 7, 13, 14, 15, 16, 17, and 21). Recommendation: If not already initiated, these items should be given top priority in the maintenance plan. *(CA Table 11-2 Items 1, 3, 7, 13, 14, 15, 16, 17, and 21 have been renumbered as Items 5, 1, 6, 3, 2, 9, 7, 4 and 10,*	Work Item 1 (SRNL 2010 Table 11-2): A re-evaluation of SRS facility and waste site lists will be conducted to identify any facilities or waste sites, which were overlooked in the 2009 CA inventory (i.e., SRS facilities and waste sites anticipated to have an “End-State” radionuclide inventory that were not included in the 2009 CA inventory). This item was specifically added to the 2010 SRNS PA/CA Maintenance Plan, and work on this item has been initiated.	**Completed**	• Other Industrial Facility Screening – Screened 523 facilities from CA (Phifer and Smith 2011). • Waste Site Screening – Conducted screening of 585 waste sites and identified five with inventories to include in the CA and 32 to evaluate once characterization completed (Hiergesell and Schiefer 2012, Hiergesell and Schiefer 2013). • Total Facilities Screening – Conducted screening of 1141 SRS facilities and identified 61 that require further consideration within the CA (Phifer and Swingle 2013). • Management and Operating (M&O) Contractor Overlooked Facilities and Waste Sites Evaluation and	**Closed** FY2015 CA Annual Review.[4]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
	respectively, within the approved 2010 SRS CA (SRNL 2010))			Inventory Development – Conducted screening of 27 facilities and developed inventories for 16 facilities (Hiergesell and Phifer 2014b). • Liquid Waste Contractor Overlooked Facilities and Waste Sites Evaluation and Inventory Development - Conducted screening of 35 facilities and developed inventories for 17, none of the other facilities found to require an inventory (Watkins 2015)	
		<u>Work Item 2 (SRNL 2010 Table 11-2):</u> The CA inventory report (Hiergesell et al. 2008) should be revised with corrections made during CA development (e.g., see Tables A-17, A-46, A-61, A-73, A-74, A-75, and A-78 in Volume II) and other appropriate changes (Smith et al. 2009).	Not Started	None	See Note 1

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		Work Item 3 (SRNL 2010 Table 11-2): FTF and SDF PAs are currently under review by the LFRG and/or Nuclear Regulatory Commission (NRC). Results of those reviews could impact the inventories or base case flux to the water table for both PAs. In fact, revision 1 of the FTF PA is under development to incorporate comments from the NRC, Environmental Protection Agency (EPA), and South Carolina Department of Health and Environmental Control, and it was issued in FY 2010. The CA will consider any such future changes to these PAs.	**Completed** After the HTF, FTF and SDF PAs were prepared, work was conducted through the Liquid Waste PA Maintenance Program to update certain tank and disposal unit design features and inventories and to evaluate the associated fluxes to the water table.	Inventories for FTF Tanks 5 and 6 were updated in a Special Analysis (SA) (SRR 2013b); HTF inventories for Tanks 12 and 16 in were updated in SAs (SRR 2015a, and 2015d); all Saltstone Disposal Unit (SDU) inventories, some of which are the result of a new SDU design feature, were updated in an SA (SRR 2014); and Tank inventories for Tanks 9, 10, 11, 13, 14 and 15 and tank annulus inventories for Tanks 9, 10 and 14 were updated (Dixon and Layton 2016).	FY2016 CA Annual Review [9]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		Work Item 4 (SRNL 2010 Table 11-2): Methodologies to estimate the inventory uncertainty associated with significant radionuclide source locations should be developed and implemented. The effort should focus on the most significant sources first, with significance defined in terms of the maximum dose from Table 9-26 through Table 9-30. The initial effort will focus on the Lower Three Runs (LTR) Integrator Operable Unit (IOU) as outlined in Item 5 below. Work on other significant sources should follow, such as the FMB and SC/PB IOUs (Item 6 below) and the H-Canyon (Item 7 below). Additionally, defensible criteria to categorize whether sources require a distribution or not should be established.	Initiated	Completed: • LTR IOU radionuclide inventory and distribution – Characterized horizontal and vertical distributions of radionuclides in P and R-Reactor canal systems, Par Pond and LTR streambed sediments for improved inventory and uncertainty estimates (Hiergesell and Phifer 2012). • FMB, PB and SC IOU's radionuclide inventory and distribution – Characterized horizontal and vertical distributions of radionuclides in FMB, PB and SC IOU streambed sediments for improved inventory and uncertainty estimates (Hiergesell and Phifer 2014a, 2014b). • H-Canyon, HB-Line radionuclide inventory and distribution – Evaluated the base case end state inventory for the H-Canyon and HB-Line using more realistic de-inventorying assumptions and documented uncertainty associated with nondestructive gamma-ray assay measurements (Phifer and Dixon 2014).	See Note 1
		Work Item 5 (SRNL 2010 Table 11-2): As summarized in Section 10.0, Cs-137 in the LTR IOU (i.e., streambed and floodplain) is the primary CA dose driver. Therefore, the uncertainty associated with the LTR IOU	**Completed**	Lower Three Runs (LTR) Inventory and Uncertainty – Developed inventory estimates and uncertainty for Cs-137, Co-60, Sr-90, Pu-239, Pu-238, Cm-244, Np-237, and Am-241 within LTR	**Closed** FY2013 CA Annual Review.[5]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		inventory (i.e., inventory distribution) will be developed along with a re-evaluation of the base case inventory. While Cs-137 is the most significant and abundant radionuclide associated with the LTR IOU, it is not the only radionuclide. Therefore, streambed inventories and distributions for other radionuclides will also be developed. This effort will initially focus on existing sampling and analysis data. However, this effort may require additional streambed and floodplain sampling and analysis that may include horizontal and vertical distributions of the radionuclides and correlation with water concentrations including Cs-137. This item was specifically added to the 2010 SRNS PA/CA maintenance plan, and work on this item has been initiated.		based upon existing sampling and analysis data (Hiergesell and Phifer 2012).	
		Work Item 6 (SRNL 2010 Table 11-2): As summarized in Section 10.0, Cs-137 from the FMB and SC/PB IOUs (i.e., streambed and floodplain) is the primary dose driver for those respective Points of Assessment (POA). Therefore, the uncertainty associated with the FMB and SC/PB IOU inventories (i.e., inventory distribution) should be developed along with a re-evaluation of the base case inventories. While Cs-137 is the most significant and abundant radionuclide associated with the FMB and SC/PB IOUs, it is not the only radionuclide. Therefore, streambed inventories and distributions for other significant radionuclides should also be developed. This effort should initially focus on existing sampling and analysis data. However, this effort may require additional streambed and floodplain sampling and analysis	**Completed**	Fourmile Branch (FMB), Steel Creek (SC), and Pen Branch (PB) Inventory and Uncertainty – Developed inventory estimates and uncertainty for Cs-137 and seventeen other radionuclides within FMB, SC, and PB based upon existing sampling and analysis data (Hiergesell and Phifer 2014a).	**Closed** FY2014 CA Annual Review.[6]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		that may include horizontal and vertical distributions of the radionuclides and correlation with water concentrations including Cs-137.			
		Work Item 7 (SRNL 2010 Table 11-2): As summarized in Section 10.0, H-Canyon and its associated Np-237 inventory is the primary dose driver for the UTR POA. Therefore, the uncertainty associated with the H-Canyon inventory (i.e., inventory distribution) should be developed along with a re-evaluation of the base case inventory. Additionally, an investigation of H-Canyon Np-237 should be conducted to determine how and in what form the Np-237 is distributed, and whether or not the large end-state inventory calculated from the Safety Analysis Report (SAR) information is credible.	**Completed**	H-Canyon, HB-Line, and H-Canyon Outside Facilities Inventory and Uncertainty – Developed inventory estimates and uncertainty for Np-237 and other radionuclides within H-Canyon, HB-Line, and H-Canyon Outside Facilities based upon inventory data produced after bulk flushing facility vessels (Phifer and Dixon 2014).	**Closed** FY2014 CA Annual Review.[6]
		Work Item 9 (SRNL 2010 Table 11-2): A method has been developed to estimate the residual inventory for operational facilities and future facilities whose end states are slated to be in-situ disposal (ISD) or demolish to slab. The method consists of using facilities for which safety documentation, both during operation and following deactivation, exists. The ratio of inventories provides an estimate of the factor by which the operational inventory might be reduced prior to reaching the End State. At this time, the reduction factors are based upon two facilities, the F Canyon complex and the 321-M building. As more facilities are deinventoried and either closed by in-situ disposal or demolish to slab, the inventory estimation ratio should be revised based on the new final data from those facilities.	Not Started	None	See Note 1

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		Work Item 10 (SRNL 2010 Table 11-2): The CA radionuclide screening (Taylor et al. 2008) should be revised by using the CA base case model (transport plus dose modules) and also by considering key radionuclides associated with the SDF PA. Key radionuclides from the ELLWF and FTF PAs were considered during the CA radionuclide screening, but the SDF PA had not been performed at the time of the screening.	Not Started	None	See Note 1
3.3.2.3	Observation 5: The CA recognizes the limitations of the characterization data currently in the CA, as evidenced by the CA Maintenance Items listed and summarized in Section 11.1, as well as the future work items listed in Table 11-2. These include revisions of the properties and geochemical data packages, sorption behavior of key PA radionuclides, fate of Carbon 14 (C-14) and I-129 at the seeplines. Recommendation: Add the above items to the CA maintenance plan.	As outlined in Section 11.1 of the CA, material properties data package revision, geochemical data package revision, sorption behavior of key PA radionuclides, fate of C-14, and phenomenon of I-129 at the seepline were all incorporated within the 2009 SRNS PA/CA maintenance plan (SRNS 2009a) within Sections 5.1.1, 5.1.2, 5.1.9, 5.2.1, and 5.2.3 of that plan, respectively. Investigation of the geochemistry and environmental fate of C-14 in the SRS environment has been completed with issuance of the following two reports: • Carbon-14 Geochemistry at Savannah River Site (Roberts and Kaplan 2008), and • Systems Model of Carbon Dynamics in Four Mile Branch on the Savannah River Site (Hinton et al. 2009)	Initiated	Completed: • C-14 Geochemistry – C-14 K_ds developed for clayey sediment, sandy sediment, concrete, and reducing grout (Roberts and Kaplan 2008). • Carbon Dynamics in Fourmile Branch – Developed a C-14 specific bioaccumulation factor (Hinton et al. 2009). • I-129 Geochemistry in SRS Wetland Environment – R&D conducted to explain the accumulation of I-129 in high organic carbon environments (Schwehr et al. 2009, 2014; Kaplan et al. 2010, 2014a, 2014b; Powell et al. 2010; Xu et al. 2011a, 2011b, 2012, 2013; Zhang et al. 2011, 2013; Chang et al. 2014; Emerson et al. 2014; Li et al. 2014; Kaplan 2016a). • Sorption Behavior of Key PA Radionuclides – Updated the Radionuclide Data Package for PA's and CA's (Kaplan 2016a and 2016b)	FY2016 PA Annual Review[7] for the Radionuclide data package and See Note 1.

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
				Remaining Work: • The update of the material properties of the ELLWF disposal system will be addressed as item 3.14 under PA maintenance (Butcher 2016), with expected completion of FY20.	
	Observation 6: Radionuclide streambed inventories are minimally described. Recommendation: Radionuclide inventory of the streambed sediments should be better quantified as described in Table 11-2, Item 7 and added to the CA maintenance plan. *(CA Table 11-2 Item 7 has been renumbered as Item 6 within the approved 2010 SRS CA (SRNL 2010))*	Work Item 6 (SRNL 2010 Table 11-2): See Observation 4 for Work Item 6 LFRG approved resolution.	**Completed**	See Observation 4 for Work Item 6 documentation.	**Closed** FY2014 CA Annual Review.[6]
	Observation 7: No discussion is provided in the CA regarding the streambed sediment scour, deposition, and transport characteristics. Recommendation: Item 8 of Table 11-2 should be expanded to include these streambed transport characteristics and added to the CA maintenance plan. *(CA Table 11-2 Item 8 has been renumbered as Item 13 within the approved 2010 SRS CA (SRNL 2010))*	Work Item 13 (SRNL 2010 Table 11-2): The following field characterization associated with the UTR, FMB, SC/PB, and LTR streambeds should be performed: • Streambed vertical gradients, sediment types, and saturated hydraulic conductivities (groundwater-surface water interactions) • Streambed sediment scour, deposition, and transport • Streambed K_ds for the predominant radionuclides. This item along with Items 5, 6, 11, and 14 will help validate the CA streambed release modeling and further reduce the uncertainty	Not started	None	See Note 1

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		associated with the release of radionuclides from streambed sediments.			
3.3.6.1	Observation 13: The SRS CA acknowledges the limitations of the current CA methodology: (1) the lack of SRS-wide watershed model and groundwater flow and transport model; (2) the need to reduce uncertainty of the abstractions from the existing groundwater flow and transport models into the GoldSim CA model, (3) the limitations of the version of the GoldSim code used in the CA, and (4) limited capability built into the current GoldSim CA model to perform probabilistic analysis. Development of an SRS-wide watershed model and a groundwater model are proposed in items 5 and 18 of Table 11-2. Recommendation: Add the above specified items to the CA maintenance plan. *(CA Table 11-2 Items 5 and 18 have been renumbered as Items 11 and 12, respectively, within the approved 2010 SRS CA (SRNL 2010))*	Work Item 11 (SRNL 2010 Table 11-2): A water balance study to provide estimates of natural stream flow for Upper Three Runs (UTR), Fourmile Branch (FMB), Steel Creek/Pen Branch (SC/PB), and Lower Three Runs (LTR) should be performed. Such a study could also potentially correlate real-time precipitation with stream flow variations and assist in better quantification of deep infiltration, runoff, evapotranspiration, and groundwater-surface water interactions. Years wherein reactor cooling water discharges, the largest anthropogenic contributor to on-site stream flow, occurred have not been included in the stream flow estimates used in the CA. However, other, much smaller and often intermittent industrial National Pollutant Discharge Elimination System discharges to streams have not been subtracted from the United States Geologic Survey (USGS) stream flow measurements used. The current SRS Land Use Plan states that the entire site will be owned, controlled, and maintained by the federal government, most likely by the DOE, in perpetuity, as established by Congress. Site boundaries will remain unchanged and the Site will be used for industrial purposes for future DOE and non-DOE missions. Based upon these SRS land-use plans, the current stream flow estimates provide a reasonable estimate into the future, but the determination of natural stream flows would provide a basis for a low-flow sensitivity other than the 7Q10 low-flow values used by the CA.	Not started	None	See Note 1

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		Work Item 12 (SRNL 2010 Table 11-2): An SRS regional groundwater model, encompassing the entire SRS, should be developed as outlined in Table 11-1. This regional groundwater model should be used to establish boundary controls for smaller SRS groundwater models with greater grid resolution and to evaluate the impacts of transient drought and wet conditions on contaminant transport. As part of the evaluation of the impacts of transient drought and wet conditions, the model should include low, average, and high potentiometric surfaces of the water table and underlying aquifers, so that distributions about the aquifer flow path parameters can be developed.	**Completed**	A position paper to request removal of the SRS RGFM from the LFRG Secondary Issue was prepared in FY15 and submitted to LFRG in 2015 (Phifer 2015). The position paper provides justification for the removal, including an assessment of the cost-benefit of an SRS RGFM from a dose significance basis. LFRG agreed to waive Work Item 12 in FY18 (Ross & Marble 2018).	**Closed** Per Ross & Marble 2018
3.3.6.3	Observation 14: To reduce uncertainty, the GoldSim CA model should be improved, by better abstractions of groundwater flow paths, flow rates, and discharges to the streams. Water balance and SRS-wide groundwater models, (proposed in Table 11-2), and studies of streambed sediment characterizations and groundwater-surface water interactions should be completed to provide the basis for these improvements. Recommendation: Add the above specified items to the CA maintenance plan.	Work Item 11 (SRNL 2010 Table 11-2): See Observation 13 for Work Item 11 LFRG approved resolution.	Not started	None	See Note 1
		Work Item 12 (SRNL 2010 Table 11-2): See Observation 13 for Work Item 12 LFRG approved resolution.	**Completed**	See Observation 13 for Work Item 12 documentation.	**Closed**
		Work Item 13 (SRNL 2010 Table 11-2): See Observation 7 for Work Item 13 LFRG approved resolution.	Not started	None	See Note 1
3.3.6.5	Observation 16: The CA acknowledges the uncertainty of the radionuclide releases from streambed sediments. Items 1, 5, 7, 8, and 9 (Chapter 11) in table 11-2 address work proposed to	Work Item 5 (SRNL 2010 Table 11-2): See Observation 4 for Work Item 5 LFRG approved resolution.	**Completed**	See Observation 4 for Work Item 5 documentation.	**Closed** FY2013 CA Annual Review.[5]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
	further investigate releases of radionuclides from streambed sediments. Observations of LFRG M Review Criterion 3.3.2.3 should be considered to address this uncertainty. Recommendation: Add the above specified items to the CA maintenance plan. *(CA Table 11-2 Items 1, 5, 7, 8, and 9 have been renumbered as Items 5, 11, 6, 13, and 14, respectively, within the approved 2010 SRS CA (SRNL 2010))*	Work Item 6 (SRNL 2010 Table 11-2): See Observation 4 for Work Item 6 LFRG approved resolution.	**Completed**	See Observation 4 for Work Item 6 documentation.	**Closed** FY2014 CA Annual Review.[6]
		Work Item 11 (SRNL 2010 Table 11-2): See Observation 13 for Work Item 11 LFRG approved resolution.	Not started	None	See Note 1
		Work Item 13 (SRNL 2010 Table 11-2): See Observation 7 for Work Item 13 LFRG approved resolution.	Not started	None	See Note 1
		Work Item 14 (SRNL 2010 Table 11-2): The distribution of uranium within Tims Branch between that dissolved in the water, that bound to the streambed sediment, and that bound to particulates in transit should be investigated. The implications of this distribution on uranium mobilization and the rate of uranium transport to the CA point of assessment (mouth of UTR) should be determined. Finally, the resulting dose implications of such uranium distributions, mobilization, and transport should be determined. Such an effort may require additional streambed sampling and analysis.	Streambed uranium characterization work started in FY2019	None	See Note1
3.3.8.1	Observation 21: There is agreement with previous comments (Appendix G) identifying the incompleteness of the sensitivity and uncertainty analysis. In particular, the omission of inventory uncertainty in the uncertainty analysis needs to be remedied. However, because all dose results are well below levels of concern, qualitative arguments used to address these limitations provide enough confidence to accept the primary conclusions of the sensitivity and uncertainty analysis. Furthermore, the	Work Item 4 (SRNL 2010 Table 11-2): See Observation 4 for Work Item 4 LFRG approved resolution.	Initiated	See Observation 4 for Work Item 4 documentation	See Note 1
		Work Item 15 (SRNL 2010 Table 11-2): GoldSim™ has a Distributed Processing (DP) capability that can be used when performing probabilistic calculations. Using this feature, individual realizations can be run on as many processors as the master GoldSim™ simulation can be linked to. The basic GoldSim™ software is limited to using four processors one of which is reserved for the master simulation that farms out realizations to the connected processors.	**Completed**	Procured 36 Processor Windows Cluster and Goldsim DP-Plus Module to reduce probabilistic simulation run times and to increase the number of sources included and number of realizations run (Smith and Phifer 2011).	**Closed** FY2012 CA Annual Review.[8]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
	future CA maintenance activities (particularly items 17, 27, and 28 in Table 11-2) identify these limitations and the need to address them. Given improved input data distributions and an improved GoldSim model, additive and multiplicative effects of factors affecting the CA results could be better assessed through a global sensitivity analysis. This effort would also better streamline future maintenance task priorities. *(CA Table 11-2 Items 2, 17, 27, and 28 have been renumbered as Items 15, 4, 16, and 17, respectively, within the approved 2010 SRS CA (SRNL 2010))*	This capability was utilized in performing the CA uncertainty calculations which reduced the simulation run time by a factor of three. However, by adding the GoldSim™ DP module, available from GoldSim™ Technology Group at a nominal cost, a probabilistic GoldSim™ simulation can be connected to as many processors as are available. This offers the possibility of dramatically decreasing probabilistic simulation run times and increasing the capability of performing uncertainty calculations including more sources with more realizations. Utilizing this approach is currently limited by our inability to access other computers through the SRS network primarily from computer security concerns. If a large cluster of Windows machines could be assembled off the SRS network, all of the processors could be accessed by GoldSim™ for probabilistic calculations. This item was specifically added to the 2010 SRNS PA/CA maintenance plan, and work on this item has been initiated.			
		Work Item 16 (SRNL 2010 Table 11-2): A systematic sensitivity analysis should be performed to identify the model parameters that have the greatest impact on CA results. This analysis should investigate the additive and multiplicative effects of parameters on the CA results. This analysis should investigate parameters in the transport model and in the dose model separately. This systematic sensitivity analysis along with a more structured uncertainty analysis (Item 17) will assist in future work prioritization. Expertise in the SRNL statistical group should be utilized to help	Initiated	Enhanced Sensitivity and Uncertainty Analysis – The 2010 SRS CA uncertainty analysis considered 17 sources over 2,000 years using 400 realizations. Using the 36 Processor Windows Cluster and Goldsim DP-Plus Module, the uncertainty was expanded to 39 sources over 10,000 years using 1,000 realizations (Smith and Phifer 2011).	Further work on this item deferred until work on the next CA revision is initiated per DOE approval of the FY2012 CA Annual Review.[8]

LFRG CA Criteria [1]	LFRG Observation and Recommendation [2]	LFRG Approved Resolution [3]	Status	Documentation	Closure Method
		structure this investigation and interpret the results.			
		Work Item 17 (SRNL 2010 Table 11-2): A more structured uncertainty analysis should be performed to identify both those stochastic variables that have the greatest impact on model results and stochastic variables that have an insignificant impact on model results and can be eliminated from the uncertainty analysis. In particular inventory uncertainty distributions developed from Items 4, 5, 6, and 7 should be included in the uncertainty analysis. This structured uncertainty analysis along with a more systematic sensitivity analysis (Item 16) will assist in future work prioritization. Expertise in the SRNL statistical group should be utilized to help structure this investigation and interpret the results.	Initiated	Enhanced Sensitivity and Uncertainty Analysis – The 2010 SRS CA uncertainty analysis considered 17 sources over 2,000 years using 400 realizations. Using the 36 Processor Windows Cluster and Goldsim DP-Plus Module, the uncertainty was expanded to 39 sources over 10,000 years using 1,000 realizations (Smith and Phifer 2011).	Further work on this item deferred until work on the next CA revision is initiated per DOE approval of the FY2012 CA Annual Review.[8]

1 DOE (2008b)
2 Carilli and Golian (2010)
3 SRNL (2010) Appendix H and Table 11-2
4 Hiergesell et al. (2016)
5 Phifer et al. (2014)
6 Phifer et al. (2015)
7 Crapse et al. (2017)
8 Phifer et al. (2013)
9 Halverson and Stagich (2017)

Notes for Table A-1:

1. To be closed upon future DOE approval of the respective CA (or PA) Annual Review within which completion of the item has been documented.

Appendix B. List of Proposed Activities/Discoveries/New Information/Changes to the 2010 SRS CA through FY2019

The following is a list of proposed activities/discoveries/new information/changes that have occurred since the 2010 SRS CA that are pertinent to the modeled dose to the public. This list may not be comprehensive because it may not have identified all SRS facility-specific proposed activities/discoveries/new information/changes to the 2010 SRS CA. Annual Reports and the sections documenting the changes are provided in parentheses after each item.

B.1. Revised inventories for existing 2010 SRS CA sources (the revised inventory data can be run in the SRS CA GoldSim model without developing any other new input data):

- A revised inventory for the 235-F facility was developed as documented within Phifer and Swingle (2013) Table I-1. *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1).*
- A revised inventory for the H-Area Sand Filter System (294-H, 294-1H, and 291-H) was developed as documented within Phifer and Swingle (2013) Table I-2 *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1).*
- A revised inventory and distribution for LTR were developed as documented within Hiergesell and Phifer (2012) Table 3-4 with a uniform distribution of ±10% about the nominal values *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1.).*
- Revised inventories and distributions for FMB, PB, and SC were developed as documented within Hiergesell and Phifer (2014a) Table 3-4 (nominal values) and Table 3-8 (upper and lower bounds) *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.1).*
- Revised inventories and distributions for H-Canyon and HB-line were developed as documented within Phifer and Dixon (2014) Table 2-12 and Table 2-13, respectively *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.1).*
- Revisions to the SDF inventory and flux to the water table were made as shown below. The original SDF inventory used within the 2010 SRS CA was based upon the inventory provided within Revision B of the SDF PA (LWO 2009). Additionally, the 2010 SRS CA used the flux to the water table from the base case SDF PA modeling that had been performed as a model input for Disposal Unit 2 and all future disposal cells.
  - Revision 0 of the SDF PA (SRR 2009) included updated inventories (Tables 3.3-1, 3.3-3, and 3.3-5) and an updated base case flux to the water table for Disposal Unit 2 and all future disposal cells *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
  - A SDF Special Analysis (SRR 2013a) was completed to incorporate Tc-99 release using new solubility limits and incorporate cementitious material degradation rates calculated with the Cementitious Barriers Partnership Toolbox, resulting in new flux to the water table estimates *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
  - A SDF Special Analysis (SRR 2014) was prepared, submitted and approved in FY2014 for a new larger disposal unit design that will result in a new footprint and new flux to the water table estimates *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.2).*
- Revisions to the FTF inventory were made as shown below. The original FTF inventory used within the 2010 SRS CA was based upon the inventory provided within Revision 0 of the FTF PA (WSRC 2008b).
  - Revision 1 of the FTF PA (SRR 2010) included updated inventories (Tables 3.3-2, 3.3-13, 3.3-16, and 3.3-20) *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
  - Revision 0 of the Tanks 18 and 19 Special Analysis (SRR 2012b) contained updated Tank 18 and 19 closure inventories *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
  - Revision 1 of the Tanks 5 and 6 Special Analysis (SRR 2013b) contained updated Tank 5 and 6 closure inventories (*FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*

- Revisions to the HTF inventory have been made as shown below. The original HTF inventory used within the 2010 SRS CA was based upon the HTF PA while it was under development.
  - Revision 1 of the HTF PA, dated November 2012 (SRR 2012a), which includes updated inventories (Tables 3.4-9, 3.4-11, 3.4-13, and 3.4-15), was issued in November 2012 (*FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
  - Tank 12 Special Analysis (SRR 2015b) contained an updated estimate of the residual radionuclide inventory expected to remain in H-Area Tank 12 upon closure (SRR 2015a) *(FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.1).*
  - Tank 16 Special Analysis (SRR 2015d) contained an updated estimate of the residual radionuclide inventory expected to remain in H-Area Tank 16 upon closure (SRR 2015c) *(FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.1).*
  - Updates to the radionuclide and chemical inventories in Tanks 9, 10, 11, 13, 14 and 15 assigned primary tank inventory values for the HTF Type I and II tanks (Tanks 9, 10, 11, 13, 14 and 15) and annulus inventory values for Tanks 9, 10 and 14 *(FY2016 CA Annual Review (Halverson and Stagich 2017) Section 3.6.2).*
- The actual disposed inventory for some radionuclides disposed in the ELLWF exceeded the estimated radionuclide inventory analyzed within the 2010 SRS CA (WSRC 2008a, SRNL 2010). A new end-state inventory needs to be developed based upon the actual disposal history to date and more up-to-date waste forecasts *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.2).*
- Inventories for C, K, and L-Reactors were assigned the same values used for the P-Reactor Building, because the inventories for these reactors had not been developed at the time the 2010 SRS CA was prepared. Subsequent to approval of the 2010 SRS CA the inventories associated with the C, K, and L reactor vessels and surrounding shielding were developed (Vinson and Webb 2010) *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.2).*
- The inventory for the C-Area Disassembly Basin was assigned the same values used for the P-Area Disassembly Basin, because the inventory for the C-Area Disassembly Basin had not been developed at the time the 2010 SRS CA was prepared. Subsequent to approval of the 2010 SRS CA the inventory associated with the C-Area Disassembly Basin were developed (SRNS 2013a) *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.2).*
- Transuranic (TRU) Pad #1 was cleared of all waste and the pad was declared clean with no contamination; therefore, this facility can be removed as a source from the SRS CA (Sink 2014) *(FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.2).*
- Radionuclide inventories for the F- and H-Area seepage basin groundwater plumes were quantified in Hiergesell and Kubilius (2016). Radionuclides that occur in elevated concentrations include Am-241, Cm-243/244, Cs-137, I-129, Ni-63, Ra-226/228, Sr-90, Tc-99, U-233/234, U-235 and U-238. Results were used to calculate the volume of contaminated groundwater and the representative concentration and range of uncertainty of each radionuclide associated with different plume concentration zones (*FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.2).*
- Projected radionuclide inventories for 643-26E Naval Reactor Component Disposal Area at closure were revised (Sink 2016a). In 2016, Bettis and KAPL provided new radionuclide inventories of planned components to be sent for disposal to 643-26E between FY2015 and FY2025. The updated forecast information was used along with radionuclide inventories disposed to date to generate a forecast for both FY2025 and FY2040 (*FY2017 SRS CA Annual Review (Halverson and Jannik 2018) Section 3.6.2*).
- ELLWF radionuclide inventories were projected out to the closure of each active and future ELLWF disposal unit, using a combination of current historical data and process knowledge (Sink 2016b). The expected closure date used for the first 100 acres of the ELLWF was FY2040, compared to the FY2025 date used in the PA. These inventories should be used in development of the new ELLWF PA (*FY2017 SRS CA Annual Review (Halverson and Jannik 2018) Section 3.6.2*).

- Revised Radionuclide Inventories for SDUs: *Determination of SDF Inventories through 9/30/2018* (SRR 2018b) includes both the original inventory disposed of at the SDF and the current inventory of the SDF through FY2018. The current inventory at the SDF includes decay and ingrowth for SDF operations beginning in 1990 through FY2018. As of the end of FY2018, 734 kilocuries (kCi) have been disposed in the SDF and the current inventory in the SDF as of the end of FY2018, accounting for decay and daughter ingrowth, is 388 kCi (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section 3.6.2*).
- Revised Radionuclide Inventories for SDUs: *Determination of SDF Inventories through 9/30/2019* (SRR 2020) includes both the original inventory disposed of at the SDF and the current inventory of the SDF through FY2019. The current inventory at the SDF includes decay and ingrowth for SDF operations beginning in 1990 through FY2019. As of the end of FY2019, 738 kilocuries (kCi) have been disposed in the SDF and the current inventory in the SDF as of the end of FY2018, accounting for decay and daughter ingrowth, is 383 kCi (*FY2019 SRS CA Annual Review (this report) Section* 2.5.2).

B.2. New sources not included in the 2010 SRS CA (the aquifer flow path data will need to be developed for these sources to run them in the SRS CA GoldSim model):

- Changing the D&D option to ISD is being considered. While the 607-33H, 607-34H, 607-35H, and 607-36H Solvent Tanks have been screened out based on regulatory commitments within Phifer and Swingle (2013), consideration is being given to changing the D&D option to ISD, which would involve grouting the tanks in place with the current inventory left in place. Phifer and Swingle (2013) Table I-3 provides the inventory associated with the ISD option of these tanks. *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1).*
- New inventories provided in Phifer and Swingle (2013) included the following facilities and waste sites, which were not previously considered within the 2010 SRS CA *(FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1)*:
  - Building 294-2F Sand Filter (associated with 235-F) (Table I-6), and
  - 242-18H Concentrate Transfer System (Table I-7).
- Inventory and distribution the for H-Canyon Outside Facilities (211-H) were provided in Phifer and Dixon (2014), which were not previously considered separately from the H-Canyon inventory within the 2010 SRS CA (*FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.1*).
- New inventories provided in Hiergesell and Phifer (2014b) included the following M&O Contractor (SRNS) facilities and waste sites, which were not previously considered within the 2010 SRS CA (*FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.1*):
  - 794-A Sand Filter and Supply Tunnel and 791-A Pollution Control Stack - representing two facilities (Table A-1),
  - Spill on 12/01/71 of 1000 Gal of Rad Water from 773-A (Unit Index 387) (Table A-2),
  - Mixed Waste Management Facility Groundwater (Unit 103) (Table A-3),
  - 643-7E Lysimeters (Not the active E-Area Lysimeter network) (Table A-4),
  - E-Area Solvent Storage Tanks (650-23E through 650-30E and 650-32E, which are also referred to as tanks 23-30 and 32) - represent 9 facilities (Table A-5),
  - 294-2F Sand Filter for 235-F (Table A-6), and
  - R-Area Bingham Pump Outage Pits (643-8G, 643-9G and 643-10G) (Unit 113, 114 and 115) (Table A-7).
- TRU Pad #16 residual isotopes were determined in Sink (2017). TRU Pad #16 was cleared of all waste, but the slab will not be left clean. This pad had a spill several years ago. A radiological characterization (G-CLE-E-00331, Burns 2015) was performed and verified. The composite contamination isotopic characterization is presented in Table 8 of this calculation. The pad has been entombed with a concrete slab over the top of the existing pad *(FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.6.2).*

- Radionuclide inventories were developed for 17 facilities associated with Effluent Treatment Facility as part of the SRS CA source completeness evaluation. A total of 35 facilities were evaluated (Watkins 2015) by the Liquid Waste Contractor (SRR). The remaining 18 facilities will not require an inventory to be developed for incorporation into the SRS CA *(FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.1).*

B.3. Potential new sources that require screening and/or inventory development:

- 32 waste sites for which characterization work is scheduled in the future are identified in Hiergesell and Schiefer (2013) Appendix D. It is not known whether they will contain radionuclides requiring inclusion in the CA at their end state (*FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.1).*
- TRU Pad 2 is scheduled to undergo characterization work in the future; at this time characterization is expected to occur at the time of closure.
- Contamination was released to Outfall Z-01 in early 2011. The SDU 4 gutter system was tied into the storm water collection system leading to Z-Area Sedimentation Basin number 4. Concurrent with the initiation of rainfall diversion to the basin in 2011, Tc-99 and Cs-137 concentrations in the basin water began to increase. In 2012, a significant rainfall event resulted in Sedimentation Basin 4 overflowing to Outfall Z-01. A characterization plan was put in place to evaluate the extent of the release. Sampling of the soil and water within Sedimentation Basin 4, at Outfall Z-01, and within McQueens Branch was performed in 2012. Those results were reported in Eddy (2012).
- A 1997 release of radioactive contamination from Vault 4 Cell G to the ground surface nearby has been seen in the groundwater at well ZBG 2 (Layton 2016). Based on the 2014 data from well ZBG 2, additional characterization for nonvolatile beta, Tc-99 and nitrates in the groundwater in Z-Area was initiated in 2014, implemented in July 2015 and reported in FY2016 (SRNS 2016b) *(FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.2).*

B.4. Revised input data from that utilized within the 2010 SRS CA:

- A new ELLWF PA-SRS CA geochemical data package was issued. Kaplan (2007) was the site-specific geochemical data package that was the primary source for the K_ds utilized within the 2010 SRS CA. The document was updated in Kaplan (2010). Another updated PA-CA Geochemical data package was issued (Kaplan 2016a), which provided updated information from more than 70 new studies for four general environments of interest to SRS PAs and CAs: sandy sediment, clayey sediment, oxidizing cementitious, and reducing cementitious environments. Data included best estimates and their uncertainties for K_d values, apparent solubility values, and cementitious leachate impact factors (*FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.3).*
- An updated radionuclide screening list was prepared. Because a wider set of elements are needed in the radionuclide screening process, a supplemental report was prepared containing geochemical values for an additional 33 elements (Kaplan 2016b). The values for this wider set of elements were based on assumed speciation and chemical analogs to elements for which site-specific experimental data are available (*FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.3).*
- A new ELLWF PA-SRS CA radionuclide data package was issued (Smith et al. 2015) which updated dose calculation methodology as well as data inputs (i.e., dose coefficients, radionuclide decay data, and transfer factors as described in the following three bullets) *(FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.6.3).*
  - The ingestion and inhalation dose coefficients utilized within the 2010 SRS CA were obtained from the International Commission on Radiological Protection (ICRP) publication 72 (ICRP 1995). Subsequently DOE published a new Derived Concentration Technical Standard, DOE-STD-1196-2011 (DOE 2011a), which provided dose coefficients for use within PAs and CAs (*FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.3).*

   - The radionuclide decay data utilized within the 2010 SRS CA were obtained from the 2005 Nuclear Wallet Cards (Tuli 2005). Subsequently DOE published a new Derived Concentration Technical Standard, DOE-STD-1196-2011 (DOE 2011a), which was based on radionuclide decay data from the ICRP publication 107 (ICRP 2008). For consistency with use of the DOE 2011a dose coefficients, the underlying radionuclide decay from ICRP 2008 will be utilized within the CA in the future (*FY2013 SRS CA Annual Review (Phifer et al. 2014) Section 3.6.3).*
   - The transfer factors utilized within the 2010 SRS CA were obtained from Lee and Coffield (2008). Subsequently new transfer factors were published and utilized in other SRS PAs (Taylor et al. 2008; IAEA 2010; Jannik et al. 2010; and SRR 2012a) (*FY2014 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.3*).
- A 2013 Unreviewed Disposal Question Evaluation (UDQE) (Flach 2013) and subsequent update (Flach et al. 2014) considered numerous changes in the PA baseline since the 2008 ELLWF PA including revised input parameters, revised facility design, evolving facility operations, and changed design, operation and physical phenomena assumptions. Several of these changes were identified elsewhere in Appendix B (e.g., updated K_d values). However, these two UDQE's should be reviewed for potential impacts to the CA baseline (*FY2015 SRS CA Annual Review (Phifer et al. 2015) Section 3.6.3).*
- New atmospheric-pathway dose-release factors were calculated for potential atmospheric releases of C-14 and H-3 from the ELLWF (Dixon and Moore 2016). These factors represent the maximum dose a receptor would receive if standing at either 100 m or 11,410 m (Site Boundary) from the edge of an ELLWF disposal unit, which are the points of assessment for DOE Order 435.1 PAs. These dose-release factors can be refined to take into consideration disposal unit size, proximity and timing of peak dose to establish less conservative radionuclide specific disposal limits *(FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.3)*.
- A new GoldSim Model to calculate doses and limits to a member of the public and corresponding waste disposal limits has been developed (Smith 2016) for use in the next E-Area PA and SRS CA. The model was developed using the latest radionuclide and geochemical data (Smith et al. 2015 and Kaplan 2016a, respectively). Calculations of water pathway doses, groundwater protection concentrations, and intruder doses, along with the resulting radionuclide screening and disposal limits are provided in one software package *(FY2016 SRS CA Annual Review (Halverson and Stagich 2017) Section 3.6.4).*
- Parameters for SRS Dosimetry Models were updated based on detailed surveys of local land-use and water-use (characteristics of meat, milk, and vegetable production/consumption; river recreational activities; and other human usage parameters). The preferred elemental bioaccumulation factors and transfer factors were also documented (Jannik and Stagich 2017) *(FY2017 SRS CA Annual Review (Halverson and Jannik 2018) Section 3.6.3).*
- Testing of a Tank 12H residual waste sample was performed in FY2018 using the same basic methodology used for Tank 18F residual waste testing, with some minor changes made to incorporate lessons learned. The test setup modifications and the Tank 12H waste release testing results are documented in *Determining the Release of Radionuclides from Tank 12H Waste Residual Solids Following Tank Closure* (King 2018). An evaluation of the test results (SRR 2016b) was issued in FY2019 with no impact to PA conclusions. (*FY2019 SRS CA Annual Review (this report)* Table 5-1*).*
- Three field lysimeter reports were issued in FY2018. The first report summarized findings regarding sorption/desorption of Np, Pu, Cs, Co, and other elements (Kaplan et al, 2018). The second report documented concentrations measured in field lysimeter effluents from the fourth quarter of FY2017 and the second quarter of FY2018 (Powell 2018a). The third report documented the detailed solid phase analysis of a field lysimeter (lysimeter 41) with an emplaced Pu(V)NH4(CO3)(s) source (Powell 2018b) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.4).
- An SDU concrete degradation document (*Predicting the Hydraulic Conductivity Over Time for Degrading Saltstone Vault Concrete – Task 5*, SRRA110110-000004) was issued in FY2018. This report included an examination of relevant literature and determined that for layered systems, the geometric mean is typically used to represent hydraulic conductivity. To further justify the use of a

geometric degradation rate, a quantitative evaluation of the approach determined that the geometric mean provides estimated hydraulic performance with a potential departure of 10% to 25% whereas the linear degradation rates shows potential departures of 60% to 140% relative to typically expected variability. The recommended degradation rates from SRRA110110-000004 will be incorporated into the SDF PA modeling for the FY2019 revision to SDF PA (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).

- B-25 Box and SeaLand Container Corrosion Coupon Field Resistivity Measurements. SRNL E-Area LLWF B-25 Box Corrosion Coupon Test Site was established in 2005 to evaluate the corrosion of LLW metal containers. Buried coupons included both painted and unpainted material cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing steel. Solid copper wires were attached to a subset of the buried coupons for electrical resistance measurement above ground as a means to monitor in-situ coupon corrosion over time with increasing resistance readings. The objective of this long-term field experiment was to determine the optimum time to conduct buried-waste stabilization measures (ex. dynamic compaction) prior to installing the final closure cap over the site. Resistance measurements were obtained in March 2017 for buried corrosion coupons at the E-Area Corrosion Monitoring Test Site. The latest resistance measurements are similar to previous readings and do not indicate significant corrosion. This memorandum documents the periodic evaluation of the E-Area Corrosion Monitoring Test Site and presents the resistance measurements obtained from corrosion coupons for the previous twelve years (Dixon 2018a) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- B-25 Box and SeaLand Corrosion Coupon Laboratory Testing. Corrosion coupons were recovered from the E-Area B-25 Box Corrosion Coupon Test Site. Recovered coupons included both painted and unpainted material cut from a B-25 box, a SeaLand container, and SeaLand container reinforcing steel. The coupons were evaluated following 12 years of exposure to natural subsurface conditions at SRS. Painted coupons of each material type remained intact and showed general corrosion and pitting at calculated average corrosion rates based on total coupon mass loss ranging from 0.14 to 0.42 mils per year (mpy) with a mean of 0.33 mpy. Conversely, unpainted coupons of all material types experienced more substantial corrosion as evidenced by mass loss and physical deformation. Calculated average corrosion rates based on total coupon mass loss for unpainted coupons of all material types ranged from 0.78 to 1.17 mpy with a mean of 1.04 mpy. The corrosion rates calculated in this analysis support earlier conclusions that the corrosion rate of carbon steel containers will not exceed 2 mpy for the majority of the 100-year period following burial. As expected, insufficient time has elapsed since corrosion coupons were buried to ascertain long term corrosion rates for painted steel containers. This determination cannot be made until painted surfaces become sufficiently delaminated. Additional coupon recovery and evaluation on the pre-established schedule is therefore essential to obtaining long term corrosion rates and reaching conclusions about the timing and effectiveness of future waste stabilization measures (Dixon 2018b) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- A new version of the Geochemical database, v3.1, was produced implementing previous decisions on use of equilibrium versus transient Kd values and precision of Kd values (Butcher 2018) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- A Special Analysis on the impact of the new 2018 General Separations Area (GSA) flow model (Hamm et al. 2018) on the groundwater disposal limits for the E-Area Low-Level Waste Facility (LLWF) was performed and issued in FY2019. The results of this analysis (Hamm et al. 2018) determined that there was no impact on the current inventory limits and the performance objectives would not be exceeded. (*FY2019 SRS CA Annual Review (this report) Section* 2.1*).*
- The Tank Farm PAs use a conceptual Waste Release Model to simulate stabilized contaminant release from the grouted waste tanks based on various chemical conditions in the waste tank which control solubility and thereby affect the timing and rate of release of contaminates from the residual waste layer. A waste release test plan was issued in FY2019. Part 1 of the test plan work scope involves

measuring the Eh and pH of eluate (open system, oxic conditions) and immersion (closed system, anoxic conditions) solutions associated with cementitious materials exposed to a simulant of SRS vadose zone liquid. This testing is intended to reduce uncertainty in the ranges of Eh and pH controlling radionuclide solubility. The cementitious materials selected for testing are candidates for waste tank bulk fill materials. The three grout formulations that will be used in batch and column tests completed a 90-day cure in 2019. Batch tests using open and closed containers to create oxic and anoxic exposure conditions were initiated. Column tests using both oxic and anoxic infiltrates were started in October 2019, and pH and Eh will be monitored in the batch and column tests for at least 20 weeks. Following Eh/pH testing, Part 2 of the Scope of Work includes characterization of the solid phase composition of the cementitious materials using applicable analytical techniques (e.g., X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) spectroscopy). This will guide validation and/or refinement of the geochemical modeling underlying PA radionuclide solubility assumptions. (*FY2019 SRS CA Annual Review (this report)* Table 5-1*).*

- Several different grout mixes have been used since 1997 as the bulk fill material for waste tank closure, with additional mixes were used for specialized purposes, such as filling cooling coils. The various grouts all have different attributes and features that make them better or worse with respect to the bulk fill grout function. Grout work was initiated in FY2019 in order to: 1) Identify the grout attributes affecting performance as a liquid waste tank bulk fill material, 2) Define performance metrics and associated requirements and goals, 3) Identify additional CLSM characterization needed to support a DOE Order 435.1 Performance Assessment (PA) of the next tank closure, 4) Assemble existing material characterization data on the last used grout and two candidate CLSM mixes, 5) Identify key data gaps and acquire new CLSM material property measurements, 6) Assess the pros and cons of the reference LP#8-16 and candidate CLSM mixes on an attribute-by-attribute basis, and 7) Recommend next steps toward selecting an additional bulk fill grout alternative for the next tank closure. (*FY2019 SRS CA Annual Review (this report)* Table 5-1*).*

B.5. Other updated considerations since the 2010 SRS CA:

- <u>Revisions to the SRS site planning documents</u> have been issued, opening the possibility of public or private ownership of selected tracts of land in the future, but to-date no actual changes in land use have been proposed or made (*FY2015 SRS CA Annual Review (Hiergesell et al. 2016) Section 3.6.1*):
  - The SRS Land Use Plan (SRNS 2014b) states the following: “SRS will maintain its current physical boundary under the ownership of the federal government in perpetuity, except where lease or transfer to the private or public entities in accordance with applicable laws and regulations aligns with DOE objectives and enhances economic development in the surrounding region.”
  - The latest SRS Ten Year Site Plan (SRNS 2015b) states the following: “The current EM Program Management Plan…indicates the SRS cleanup program will continue for another 50 years to Fiscal Year (FY) 2065. Work will continue for several decades to complete environmental remediation and legacy materials disposition from the heavy nuclear materials production activities of the past” and, “The Site anticipates future interest by both governmental and private entities in new uses of its land and is studying which, if any, tracts of land may be excess to our EM missions in support of new headquarters’ initiative to eliminate under-utilized federal property.”
  - The Environmental Management Program Management Plan (DOE 2017b) states the following: “The future use for the SRS is non-residential and will be maintained as such using institutional controls.”
- <u>A new ELLWF conceptual closure cap design</u> has been produced to address as-built trench unit layouts and implement best-practice multi-layer closure cap design (SRNS 2016a). The new features include a reorientation of the cap producing longer slope lengths and incorporation of a high-density polyethylene geomembrane above the geosynthetic clay liner.
- <u>A UDQE was approved for placing ET 3 in the footprint designated for ST 12 and to operate it using ST 12 disposal limits</u>. The evaluation concluded that the proposed operations result in an acceptably

small risk of exceeding a Sum-of-Fractions of 1.0 (Hamm et al. 2013) *(FY2017 SRS CA Annual Review Section 3.6.3).*

- A change in the layout of SDUs 6, 7, 8, and 9 was assessed by SA (SRR 2016, SRR 2018a). The SA also updated the model to incorporate observed field conditions and lessons learned, and to provide additional design margins. Results indicated a reduction in peak dose *(FY2017 SRS CA Annual Review Section 3.6.3).*
- Saltstone Disposal Unit 6 as-built conditions were evaluated in a UWMQE against the assumptions used in 2009 SDF PA (SRR 2009), the CA (SRNL 2010), and other documents.
- The 2004 GSA/PORFLOW groundwater flow was updated and recalibrated using the PEST optimization code. The model, "GSA2016," uses field data current through at least 2015. The update addressed issues raised by the LFRG in a 2008 review of the E-Area Performance Assessment, and by the Nuclear Regulatory Commission in its reviews of tank closure and Saltstone Disposal Facility Performance Assessments. The GSA2016 model exhibits good agreement with well water level, stream baseflow and seepline data (Flach et al. 2017).
- Disposal Authorization Statement and Tank Closure Document was issued by DOE. This Standard provides a consistent approach for Federal and contractor personnel responsible for developing and/or reviewing documents that support the issuance of a Disposal Authorization Statement and Tier 1 Closure Plan authorizing radioactive waste disposal. The Standard will help assure that the technical basis for radioactive waste management disposal authorization is complete and sufficient to protect the public and the environment. The technical basis includes site characterization, facility design, laboratory and field studies, mathematical modeling, technical analyses, and commitments to continuous improvement to demonstrate that a facility should be authorized to dispose of LLW (DOE 2017a).
- Proposed new SDF conceptual closure cap design. A Closure Cap document (*Predicting Long-Term Percolation from the SDF Closure Cap*, Benson et al 2018) was issued in FY2018. This report updated the inputs and assumptions from the 2008 estimates (WSRC-STI-2008-00244) and developed a revised model using WinUNSAT-H (a variably saturated flow code that has been used extensively over the past two decades for predicting the hydrology of covers for waste containment systems). During report development, it was determined that a number of assumptions used to develop the 2008 estimates had no supporting bases. These assumptions were re-evaluated, and more realistic assumptions were developed based on field observations, recent laboratory analyses, and subject matter expertise. Justifications for the revised assumptions, and the updated modeling inputs were documented in the 2018 Closure Cap document (SRRA107772-000009). The resulting infiltration (or percolation) estimates will be used in the SDF PA modeling for the FY2019 SDF PA revision. Updating the inputs and assumptions from the 2008 estimates provides lower infiltration rates for use in the FY2019 SDF PA revision (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- SDF UWMQE for updated GSA Model inputs. A UWMQE entitled *UWMQE to Evaluate Impacts to SDF PA Doses Due to the Update of the GSA Model* (SRR-UWMQE-2017-00004) was issued in FY2018. This UWMQE was generated to document the evaluation of the proposed activity for use of updated GSA Model inputs in PA modeling. The UWMQE states that changes made to the GSA Model result in different flow fields relative to those used as inputs to the PA and SA modeling. The modeling performed to support this UWMQE (SRR-CWDA-2017-00065) does demonstrates that performance objectives are still met, requiring no operational or design changes. The GSA Model changes will be incorporated into the SDF PA modeling for the FY2019 revision to SDF PA (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- SRNL Bamboo Plot Field Evaluation. The use of an invasive species such as Phyllostachys-species Bamboo for long-term planting over closed radioactive waste disposal sites has been studied extensively on the Savannah River Site. Based on this and previous assessments of the performance of the SRNL's bamboo test plots over 26 years, and conservative projections of long term (1000-year) performance, bamboo is considered a viable final vegetative cover over SRS closure caps.

Recommendations are provided on timing and rate of pine tree encroachment/succession into an SRS Bamboo cover stand and other pertinent considerations over the post closure period for use in estimating infiltration in performance assessment models (Skibo 2018) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).

- Rainfall infiltration modeling approach at ELLWF. Work was conducted on updating the treatment of rainfall infiltration for the ELLWF PA. A conceptual model was presented for the proposed E-Area closure cap design (Dyer 2017a). A mass balance model was developed in Microsoft Excel to confirm correct implementation of intact- and subsided-area infiltration profiles for the proposed closure cap in the PORFLOW vadose-zone model (Dyer 2017b). A method was developed to generate uncertainty distributions for intact- and subsided-area infiltration rates for the GoldSim probabilistic system model. This effort builds upon earlier reports whose purpose is to lay the foundation for the infiltration data package that will be assembled during the next revision of the ELLWF PA (Dyer 2018a). A probabilistic model employing a Monte Carlo sampling technique was developed in Python to generate statistical distributions of the upslope-intact-area to subsided-area ratio ($Area_{UAi}/Area_{SAi}$) for closure cap subsidence scenarios that differ in assumed percent subsidence and the total number of intact plus subsided compartments (Dyer and Flach 2017). To support future UDQEs, SAs and PAs for ELLWF, the HELP model and a newly developed, Python-based, probabilistic model employing a Monte Carlo sampling technique were used together to generate infiltration degradation curves for a 10,000-year simulation period for both intact and low-percent-subsidence closure-cap scenarios. The infiltration data will be used in PORFLOW transport model simulations of the ELLWF trench units (Dyer & Flach 2018). Finally, the impact of different vegetative cover scenarios on infiltration rates in E-Area was studied (Dyer 2018b). (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3. *See also Kubilius et al 2019a).*
- A probabilistic aquifer model was developed and calibrated, using GoldSim® Monte Carlo simulation software, to evaluate transport of a tracer species as it travels from the water table below the disposal unit footprint, through the aquifer, to the Point of Assessment at the 100-meter boundary. This model is a key component of the effort to include uncertainty quantification and sensitivity analysis in the next revision of the E-Area PA. The Aquifer Model and associated optimized geometric parameters will be implemented in the future GoldSim® system model that will simulate subsurface flow and radionuclide transport from the ground surface to the 100-meter POA. (Wohlwend & Flach 2018) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.3).
- Updated the 2016 GSA/PORFLOW groundwater flow model to "GSA 2018". The 2016 GSA/PORFLOW flow model was refined in 2018 to incorporate updates to model calibration targets, closure of the H-Area Ash Basin, construction of E-Area Slit Trench operational covers, and plume information from the Mixed Waste Management Facility and Low-Level Radioactive Waste Disposal Facility. Another objective was to reduce hydraulic head residuals by adding another calibration zone. The resulting model is referred to as "GSA_2018" (Wohlwend 2018, Flach 2019) (*FY2018 SRS CA Annual Review (Kubilius et al. 2019b) Section* 3.6.4).
- FTF UWMQE for updated GSA Model Inputs. A UWMQE entitled *UWMQE to Evaluate Impacts to FTF PA Doses Due to the Update of the GSA Model* (SRR 2017d) was issued in FY2019. This UWMQE presented an evaluation of the 2018 update of the groundwater model known as the GSA Database (SRNL-STI-2018-00643). The UWMQE states that the 2018 changes made to the GSA Model result in different flow fields relative to those used as inputs to the PA and SA modeling. The modeling performed to support this UWMQE (SRR 2017c) demonstrates that performance objectives are still met, requiring no operational or design changes. The GSA Model changes will be incorporated into a future revision to the FTF PA. (*FY2019 SRS CA Annual Review (this report)* Table 2-1 *and Section 2.1).*
- HTF UWMQE for updated GSA Model Inputs. A UWMQE entitled *UWMQE to Evaluate Impacts to HTF PA Doses Due to the Update of the GSA Model* (SRR 2017e) was issued in FY2019. This UWMQE presented an evaluation of the 2018 update of the groundwater model known as the GSA

Database (SRNL-STI-2018-00643). The UWMQE states that changes made to the GSA Model result in different flow fields relative to those used as inputs to the PA and SA modeling. The modeling performed to support this UWMQE (SRR 2017c) demonstrates that performance objectives are still met, requiring no operational or design changes. The GSA Model changes will be incorporated into a future revision to the HTF PA. (*FY2019 SRS CA Annual Review (this report)* Table 2-1 *and Section 2.1).*

- SDF UWMQE for Disposal of TCCR DSS at SDF. One UWMQE was completed in FY2019 for the SDF. The UWMQE was entitled Disposal of Tank Closure Cesium Removal DSS at Saltstone Disposal Facility (SRR 2017b) and was issued in March 2019. This UWMQE was updated to document the evaluation of disposing decontaminated salt solution (DSS) resulting from Tank Closure Cesium Removal (TCCR) operations at the SDF containing zirconium and titanium leached from the ion exchange media. SRNL 2018, referenced by SRR 2017b, provides an evaluation of the TCCR DSS waste stream and proposed SDF disposal and concludes that disposing of TCCR DSS containing zirconium and titanium leached from the ion exchange media at the SDF are not expected to have an impact on the cured properties of saltstone. The UWMQE states that the proposed activity does not impact the conclusion of the SDF PA, the associated SDF SAs, the Composite Analysis (CA), or the Waste Determination (WD). The changes evaluated by the UWMQE indicate that the conclusions in the PA remain valid. (*FY2019 SRS CA Annual Review (this report)* Table 2-1 *and Section 2.1).*

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