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Model Validation for the FY2019 SRS Composite Analysis Monitoring Plan

B. H. Stagich

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EXECUTIVE SUMMARY

Using a projected end-state date of 2065 (SRNS 2015b), the Savannah River Site (SRS) Composite Analysis (CA) modeling for each facility and waste site began on the inventory year assigned to it so that source depletion and radionuclide transport out of the system could be appropriately captured. Some SRS waste sites that have already achieved their end states (i.e. end-state inventories and end-state configuration) are currently contributing to the potential off-site public dose through source release, groundwater transport, discharge to on-site surface streams, and stream transport to the CA point of assessments (POAs). The inventory year assigned to these waste sites is 2002 or before. This means that SRS CA results from 2002 and beyond are a reasonable representation for these waste sites that have already achieved their end states and are currently contributing to the potential off-site public dose. The SRS Annual Environmental Report (AER) monitoring can differentiate and separate liquid pathway data allowing the data representing only waste sites at their end state to be produced. Because the SRS CA has projected reasonable end-state impacts from 2002 and beyond, and the AER monitoring can differentiate and separate operating and end-state contributions to annual liquid pathway release, an opportunity exists to use the AER monitoring data to validate the SRS CA model.

The CA model validation program uses a graded and systematic approach for taking corrective action, starting with an SRS established administrative dose limit of 15 mrem/yr, below which no action is required. Based on the location of the 2010 SRS CA POAs, the only potential exposure pathway for the public is through surface water. The completion of the FY2019 CA model validation indicates that the SRS CA projected dose, while generally conservative, provides a reasonable representation of the maximum annual doses. These doses are well below the administrative limit; therefore, no additional action is required.

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LIST OF ABBREVIATIONS

AER	Annual Environmental Report
CA	Composite Analysis
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	Deactivation and decommissioning
DOE	Department of Energy
FMB	Fourmile Branch
LFRG	Low Level Waste Disposal Facility Federal Review Group
LLRWDF	Low-Level Radioactive Waste Disposal Facility
LLW	Low-Level Waste
LTR	Lower Three Runs
MEI	Maximally Exposed Individual
MWMF	Mixed Waste Management Facility
ORWBG	Old Radioactive Waste Burial Grounds
PB	Pen Branch
POA	Point of Assessment
RCRA	Resource Conservation and Recovery Act
SC	Steel Creek
SR	Savannah River
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions
SRS	Savannah River Site
UTR	Upper Three Runs
WSRC	Westinghouse or Washington Savannah River Company

1.0 Introduction

Based on the projected Savannah River Site (SRS) end-state dates presented in SRS planning documents (SRNS 2009, WSRC 2003a, WSRC 2003b, DOE 2005, WSRC 2007a, and WSRC 2007b) at the time the SRS Composite Analysis (CA) was being prepared (2009), the SRS CA end-state date was taken as 2025 [i.e., earliest time that (a) all SRS operations have been assumed to cease after all LLW disposal facilities and tanks have been closed; (b) all Resource Conservation and Recovery Act (RCRA) / Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation has been completed; (c) all site deactivation and decommissioning (D&D) has been completed; and (d) all DOE site operations, other than long-term stewardship, National Nuclear Security Administration missions, and other future missions, have ceased]. The latest SRS Ten Year Plan (SRNS 2015b) now projects this end-state date to be 2065.

The year assigned to the inventory for each facility and waste site within the CA model was generally based upon one of the following:

- a year representative of when the end-state inventory actually was placed (past);
- a year representative of the data used to develop the end-state inventory (past); or
- the year that it is anticipated that the end-state inventory will be achieved (future).

SRS CA modeling for each facility and waste site began on the inventory year assigned to it so that source depletion and radionuclide transport out of the system could be appropriately captured. This helped to ensure that an artificially high model peak would not occur at the 2025 end-state date. This means that SRS CA modeled results were obtained prior to the assumed end state date of 2025.

Some SRS waste sites that have already achieved their end states (i.e. end-state inventories and end-state configuration) are currently contributing to the potential off-site public dose through source release, groundwater transport, discharge to on-site surface streams, and stream transport to the CA point of assessments (POAs). These waste sites include Old Radioactive Waste Burial Grounds (ORWBG), Mixed Waste Management Facility (MWMF), Low-Level Radioactive Waste Disposal Facility (LLRWDF), F- and H-Area Seepage Basins, Reactor Area Seepage Basins (K-, L-, P-, and R-Areas), UTR, FMB, PB, SC, and LTR. The inventory year assigned to all of these waste sites is 2002 or before. This means that SRS CA results from 2002 and beyond are a reasonable representation for these waste sites that have already achieved their end states and are currently contributing to the potential off-site public dose.

As part of SRS Annual Environmental Report (AER) monitoring, the total radionuclide release through the liquid pathway 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.

Because the SRS CA has projected reasonable end-state impacts from 2002 and beyond, and the AER monitoring can differentiate and separate operating and end-state contributions to annual liquid pathway release, an opportunity exists to use the AER monitoring data 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.

In conformance with the DOE order/manual/guide requirements (DOE 1999a, DOE 1999b, DOE 1999c), a full revision of the SRS CA model validation plan was issued on September 19, 2011 (Crapse et al. 2011) based upon the 2010 SRS CA (SRNL 2010). SRNL used the 2010 SRS CA to determine the media, locations, and radionuclides to be considered, and designed the program to detect changing trends to allow any necessary corrective action prior to exceeding the CA performance measures. The CA model validation program can be considered performance monitoring. The program is used as an indicator of the CA model validation and as a tool to ensure that future radiological protection of the public will be maintained. 100 mrem/yr is the primary dose limit established as the CA performance measure based upon DOE Order 5400.5 (DOE 1990), which is now DOE Order 458.1 (DOE 2011). Compliance with the primary dose limit at SRS is ensured through the SRS AER monitoring conducted in compliance with DOE Order 458.1, Radiological Protection of the Public and the Environment (DOE 2011).

The CA model validation program uses a graded and systematic approach for taking corrective action, starting with an SRS established administrative limit of 15 mrem/yr, below which no action is required. Based on the location of the 2010 SRS CA POAs, the only potential exposure pathway for the public is through surface water. Consequently, a stream-monitoring-based approach that utilizes data already produced as part of the SRS AER has been designed (Phifer et al. 2011 and Crapse et al. 2011). Concurrence for implementation of this approach was received from the LFRG in May 2011. The updated Monitoring Plan was approved by DOE-Savannah River in October 2012.

Based on the adoption of the POAs identified in the 2010 SRS CA, groundwater monitoring is not required. Because all SRS groundwater discharges into site streams, monitoring of water samples collected from SRS streams at their mouths and from the SR becomes the means to evaluate SRS releases against the CA Performance Measure as outlined in the monitoring plan (Crapse et al. 2011).

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 Sections 2.1 through 2.3.

- 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.

2.0 SRS CA Model Validation Program

2.1 AER (MEI + Irrigation doses) versus SRS CA Dose

The AER MEI and irrigation doses and the corresponding CA doses are provided in Table 2-1. While the combined AER MEI and irrigation dose includes both operating (liquid effluent discharge point data) and end-state (groundwater migration pathway data) impacts and the CA dose includes only the end-state impacts, this is considered an easy comparison that demonstrates the conservative nature of the CA results. The 2018 data are in bold within the table. The trend of 2002 to 2018 AER MEI and irrigation doses versus CA doses at evaluation points in the Savannah River is presented in Figure 2-1.

As shown in this figure, the AER combined MEI and Irrigation dose (solid black markers and line) for 2018 is higher than it's been for the past several years, except for 2017. However, the SRS CA projected dose (solid blue line and markers) is very close to the AER combined MEI and Irrigation dose.

Table 2-1. 2002 to 2018 AER versus CA Doses at the Savannah River

Year	AER Liquid Pathway MEI Dose1	AER Irrigation Pathway Dose1	AER MEI plus AER Irrigation Dose	SRS CA SR Dose2,3
	All Data in mrem/yr			
2002	0.12	0.108	0.23	0.359
2003	0.12	0.084	0.20	0.346
2004	0.09	0.078	0.17	0.334
2005	0.08	0.049	0.13	0.322
2006	0.09	0.079	0.17	0.311
2007	0.05	0.054	0.11	0.300
2008	0.08	0.098	0.18	0.296
2009	0.08	0.060	0.14	0.285
2010	0.06	0.1	0.16	0.275
2011	0.08	0.09	0.18	0.266
2012[4]	0.10	0.13	0.23	0.257
2013	0.052	0.09	0.14	0.250
2014	0.041	0.074	0.12	0.240
2015	0.053	0.093	0.15	0.232
2016	0.053	0.100	0.15	0.225
2017	0.130	0.089	0.22	0.240
2018[5]	**0.092**	**0.099**	**0.19**	**0.233**

[1] AER Liquid Pathway MEI dose and AER Irrigation Pathway dose obtained from each year's respective AER (Mamatey 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011; Ackerman and Jannik 2012; SRNS 2013, 2014a, 2015a, 2016b, 2017, 2018, 2019).

[2] SRS CA SR Dose obtained from the CA Excel file, POA_Pathway_SR_FishCum, worksheet, SR_RecCum, column M (2002-2016), column L (2017), 301 Bridge Cumulative (i.e. extracted from SRNL (2010)).

[3] The dose point of assessment was the Savannah River at US 301 Bridge (river mile 118.1) for 2002-2016. In 2017, the AER dose point of assessment was moved to river mile 141.5, just below Steel Creek. Correspondingly, the CA SR dose was adjusted upward to account for reduced river flow (less dilution) at upstream locations; it was calculated using the long-term river flow for Burton's Ferry below Augusta (Jones 2009).

[4] Beginning in 2012, the Representative Person concept (gender and age averaged at the 95th percentile of usage rates) was adopted by SRS to replace the MEI for the AER. This change is allowed by DOE Order 458.1, and it was made to account for doses experienced by children, who are more sensitive than adults to radiation.

[5] 2018 AER data provided by Jannik (2019), Attachment 2.

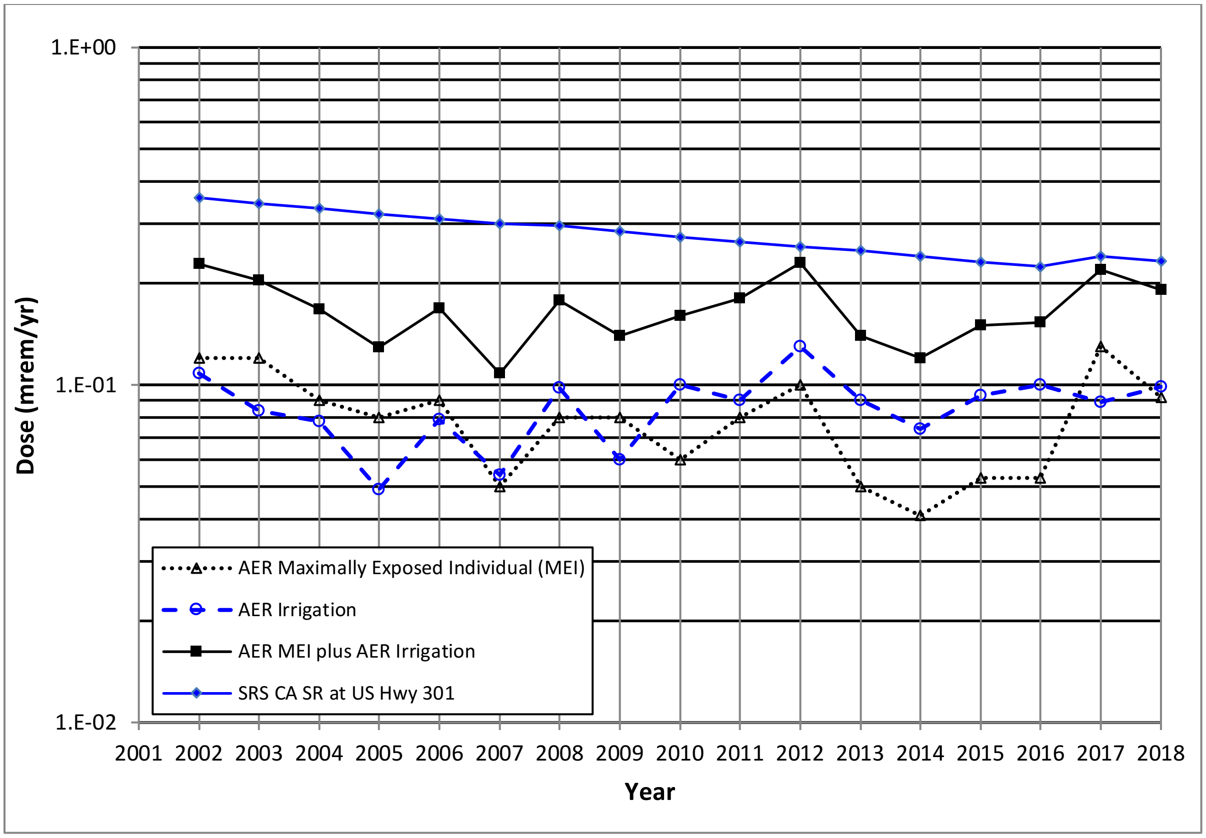

Figure 2-1. 2002 to 2018 AER versus CA Doses at the Savannah River

2.2 AER Fisherman versus SRS CA Fisherman Dose

The AER creek-mouth fisherman doses and the corresponding CA fisherman doses are presented in

Table 2-2. As discussed in Section 1.0, both the AER creek-mouth fisherman and the CA fisherman doses represent the anticipated end-state Cs-137 conditions within the site streams and SR. The 2018 data are in bold within the table. The AER versus CA creek-mouth fish pathway doses are presented in Figure 2-2 through Figure 2-6 for UTR, FMB, SC-PB, LTR, and the SR, respectively. As shown in these figures, the SRS CA projected fisherman doses trend downward over time and are usually greater than the AER fisherman doses. In 2018, the AER fisherman doses for FMB, SC-PB, LTR, and SR were lower than the stream-specific SRS CA projected fisherman doses, but the AER value for UTR was the highest it has been since 2002. 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.

Table 2-2. 2002 to 2018 AER versus CA Fish Consumption Doses at Mouths of Creeks and SR

Year	UTR		FMB		SC-PB		LTR		SR	
	AER Max Fish Dose[1]	CA Fish Dose[2]	AER Max Fish Dose[1]	CA Fish Dose[3]	AER Max Fish Dose[1]	CA Fish Dose[4]	AER Max Fish Dose[1]	CA Fish Dose[5]	AER Max Fish Dose[1]	CA Fish Dose[6]
	All Data in mrem/yr									
2002	1.10E-01	1.23E-01	1.13E-01	3.50E+00	8.35E-02	6.04E-01	3.46E-01	5.04E+00	8.68E-02	1.30E-01
2003	3.38E-02	1.20E-01	5.79E-01	3.43E+00	1.21E-01	5.87E-01	6.70E-02	4.92E+00	5.44E-02	1.27E-01
2004	7.28E-02	1.18E-01	9.65E-01	3.36E+00	1.67E-01	5.71E-01	1.30E-01	4.81E+00	6.30E-02	1.24E-01
2005	1.07E-01	1.15E-01	1.95E-01	3.29E+00	2.42E-01	5.55E-01	1.12E-01	4.69E+00	7.66E-02	1.21E-01
2006	1.02E-01	1.12E-01	1.90E-01	3.22E+00	2.44E-01	5.40E-01	1.59E-01	4.58E+00	5.88E-02	1.18E-01
2007	5.81E-02	1.10E-01	9.22E-02	3.15E+00	2.16E-01	5.25E-01	2.39E-01	4.47E+00	7.56E-02	1.16E-01
2008	1.14E-01	1.07E-01	8.24E-02	3.10E+00	9.40E-02	5.11E-01	9.25E-02	4.37E+00	4.50E-02	1.13E-01
2009	1.12E-01	1.05E-01	1.01E-01	3.03E+00	9.71E-02	4.97E-01	3.54E-01	4.26E+00	5.32E-02	1.10E-01
2010	1.45E-01	1.02E-01	8.26E-02	2.96E+00	2.20E-01	4.84E-01	2.13E-01	4.16E+00	1.25E-01	1.08E-01
2011	5.20E-02	1.00E-01	5.30E-02	2.90E+00	6.80E-02	4.71E-01	5.30E-02	4.06E+00	2.90E-02	1.05E-01
2012	1.20E-01	9.77E-02	2.20E-01	2.84E+00	5.50E-02	4.58E-01	9.40E-02	3.97E+00	1.00E-01	1.03E-01
2013	4.70E-02	9.56E-02	8.90E-02	2.78E+00	2.80E-01	4.46E-01	1.10E-01	3.87E+00	5.50E-02	1.00E-01
2014	4.30E-02	9.37E-02	9.80E-02	2.72E+00	1.60E-01	4.34E-01	2.80E-01	3.78E+00	3.10E-02	9.78E-02
2015	1.40E-02	9.27E-02	1.00E-01	2.66E+00	2.80E-01	4.23E-01	2.80E-01	3.69E+00	4.40E-02	9.56E-02
2016	1.48E-01	9.30E-02	2.15E-01	2.60E+00	1.36E-01	4.11E-01	2.10E-01	3.60E+00	5.06E-02	9.34E-02
2017	9.76E-02	9.50E-02	8.40E-02	2.54E+00	1.25E-01	4.00E-01	3.58E-01	3.52E+00	4.77E-02	9.13E-02
2018[7]	**3.43E-01**	**9.81E-02**	**8.17E-02**	**2.49E+00**	**1.59E-01**	**3.90E-01**	**3.98E-01**	**3.44E+00**	**5.68E-02**	**8.92E-02**

1 AER Liquid Pathway and Fish Pathway Dose data obtained from AER (Mamatey 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011; Ackerman and Jannik 2012; SRNS 2013b, 2014a, 2015a, 2016b, 2017, 2018).

2 UTR CA Fish Pathway Dose obtained from the CA Excel file, "POA_Pathway_SR_FishCum", worksheet, "UTR_Fish", column CE, "Total", for that respective year (i.e. extracted from SRNL (2010)).

3 FMB CA Fish Pathway Dose obtained from the CA Excel file, "POA_Pathway_SR_FishCum", worksheet, "FMB_Fish", column W, "Total", for that respective year (i.e. extracted from SRNL (2010)).

4 SC-PB CA Fish Pathway Dose obtained from the CA Excel file, "POA_Pathway_SR_FishCum", worksheet, "SC_Fish", column Y, "Total", for that respective year (i.e. extracted from SRNL (2010)).

5 LTR CA Fish Pathway Dose obtained from the CA Excel file, "POA_Pathway_SR_FishCum", worksheet, "LTR_Fish", column M, "Total", for that respective year (i.e. extracted from SRNL (2010)).

6 SR 301 CA Fish Pathway Dose obtained from the CA Excel file, "POA_Pathway_SR_FishCum", worksheet, "SR_FishCum", column H, "301 Bridge Cumulative", for that respective year (i.e. extracted from SRNL (2010)).

7 2017 AER data provided by Jannik (2019) Attachment 2.

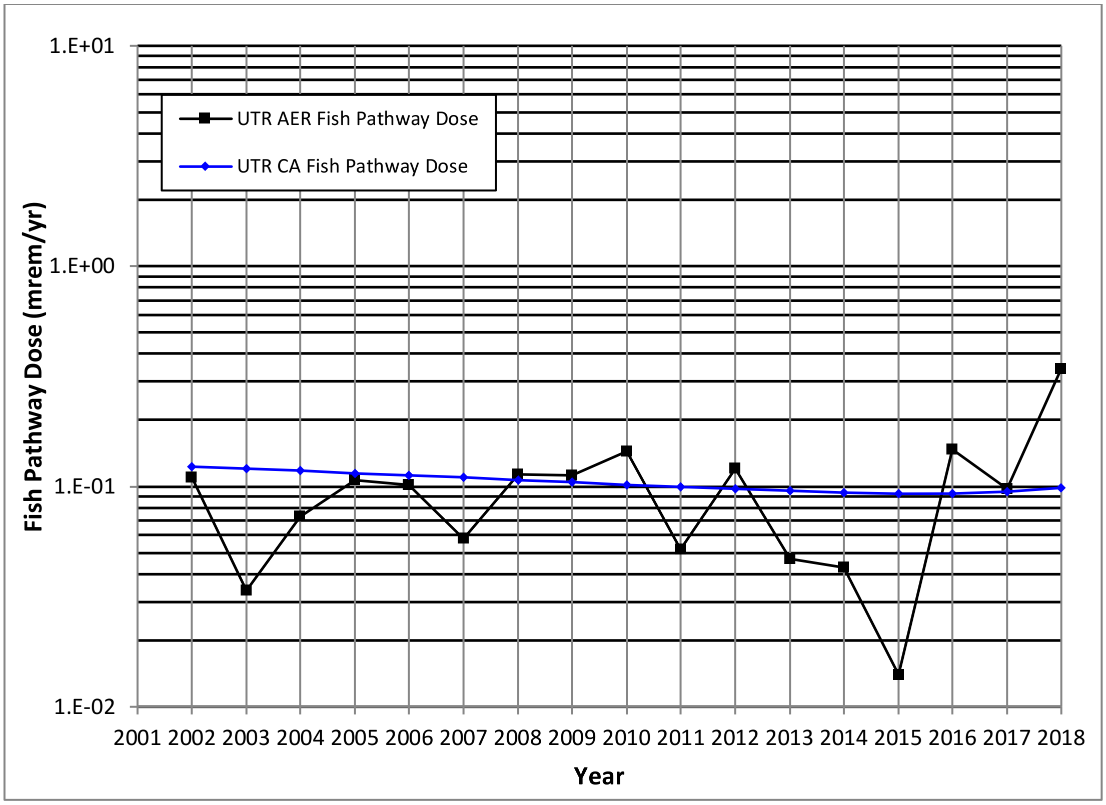

Figure 2-2. 2002 to 2018 UTR AER versus CA Creek-Mouth Fish Pathway Dose

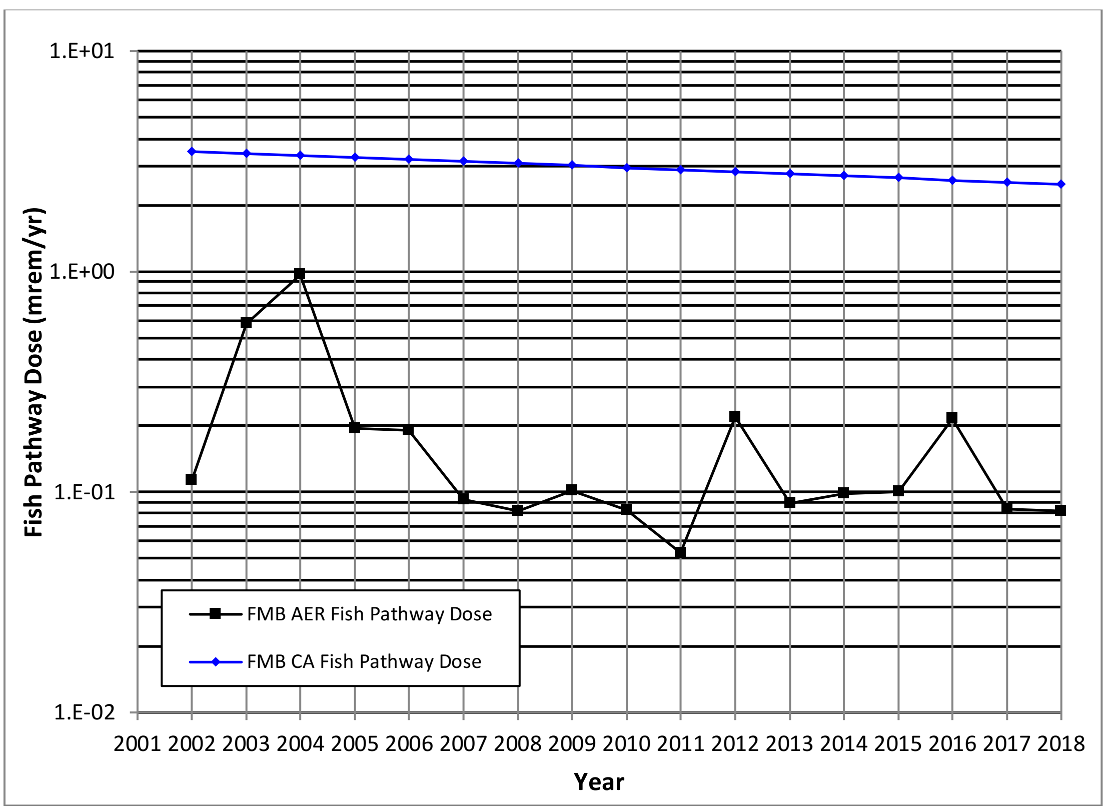

Figure 2-3. 2002 to 2018 FMB AER versus CA Creek-Mouth Fish Pathway Doses

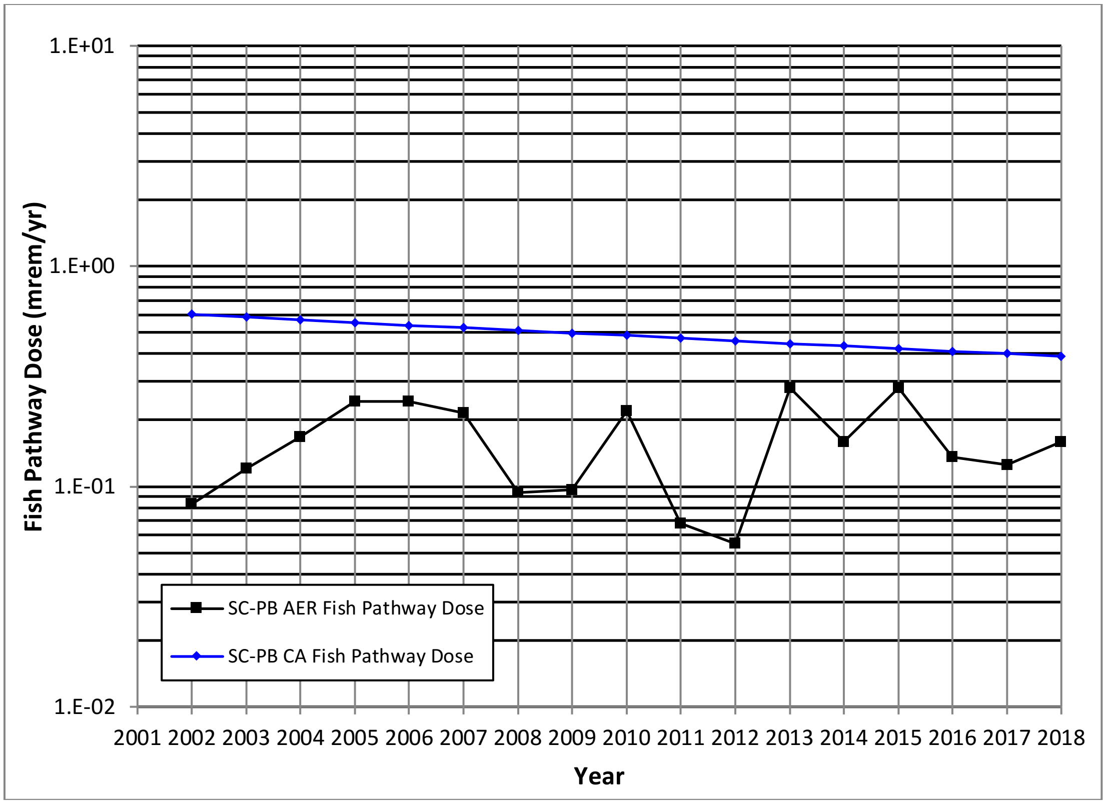

Figure 2-4. 2002 to 2018 SC-PB AER versus CA Creek-Mouth Fish Pathway Doses

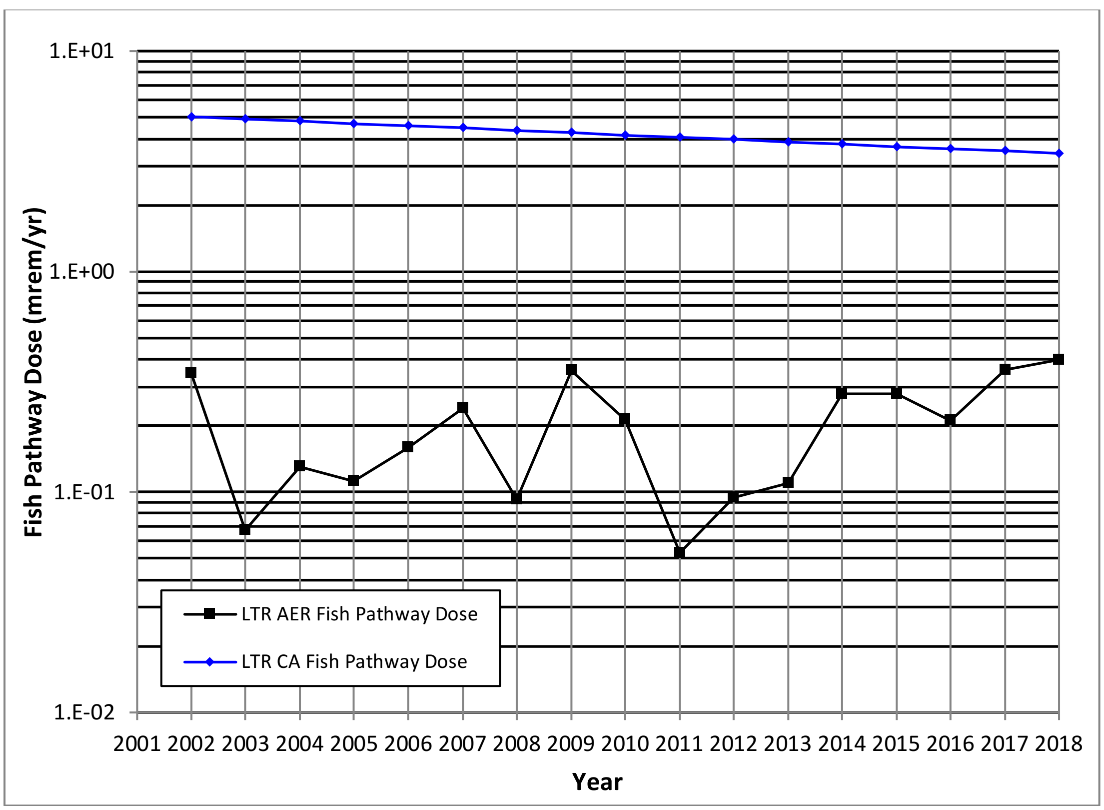

Figure 2-5. 2002 to 2018 LTR AER versus CA Creek-Mouth Fish Pathway Doses

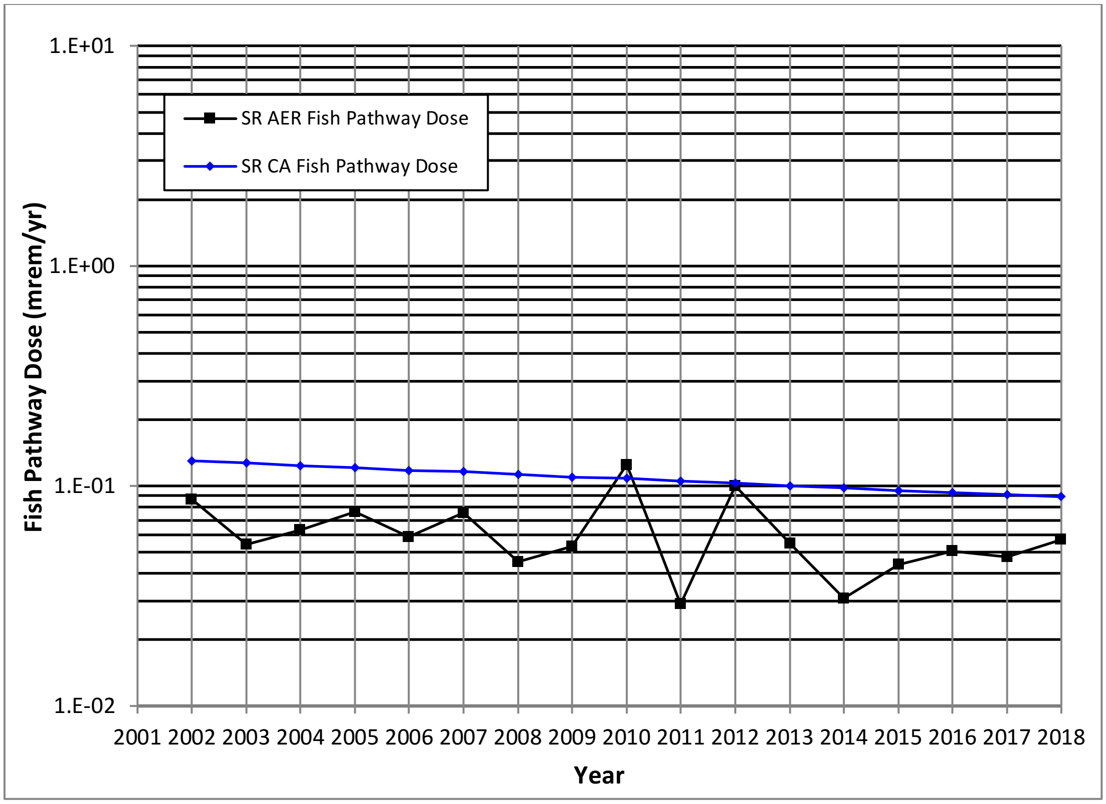

Figure 2-6. 2002 to 2018 SR AER versus CA SR 301 Bridge Fish Pathway Doses

2.3 AER End-State Equivalent Doses

Total AER releases to streams data consist of both groundwater discharges originating from closed waste sites and direct operational effluent releases to streams. CA model validation is concerned with only the end-state discharges (i.e. groundwater discharges) because operational discharges will be discontinued at the SRS end state. Therefore, SRS CA doses are compared to only "AER End-State Equivalent Doses" produced from AER groundwater discharge data and not AER operational release data as outlined in the formula developed by Phifer et al. (see Table 3 on page 11 of Phifer et al. 2011).

Table 2-3 summarizes production of the AER end-state equivalent concentrations associated with each stream and the SR. The long-term average annual flow for each site stream and the SR is provided in the top portion of the table. The middle section of the table shows total Curies by nuclide derived from the 2018 AER groundwater discharge data for each stream and the SR (i.e. AER End-State Equivalent Curies). This information was provided in Jannik (2019) Attachment 1. The AER End-State Equivalent Curies were divided by the long-term average flow to produce the AER End-State Equivalent Concentrations by nuclide for each SRS stream and the SR (see bottom section of Table 2-3). These AER End-State Equivalent Concentrations were used as input to the SRS CA dose module to produce "AER End-State Equivalent Doses" for comparison with the SRS CA dose for that respective year. The dose results are presented in Table 2-4.

Table 2-5 presents the SRS CA projected dose and the "AER End-State Equivalent Dose" for each site stream and the SR for 2009 through 2018. The data indicate that the SRS CA projected doses are generally either greater than the AER end-state equivalent doses or reasonably equivalent. These data are illustrated graphically in Figure 2-7.

Table 2-3. 2018 AER Total Curies, Stream Annual Average Flow Rates and Resulting Concentrations

Long-Term Average Annual Flow [1]					
Flow (L/yr)	**UTR**	**FMB**	**SC/PB**	**LTR**	**SR**
	2.12E+11	2.86E+10	7.95E+10	1.46E+11	9.09E+12
AER End-State Equivalent Curies [2]					
Radionuclide	**UTR**	**FMB**	**SC/PB**	**LTR**	**SR**
H-3	6.84E+01	3.70E+02	1.74E+02	7.55E-01	6.13E+02
Sr-90	0.00E+00	3.06E-02	0	0	3.06E-02
Tc-99	0	2.74E-02	0	0	2.74E-02
I-129	0	1.66E-02	0	0	1.66E-02
Cs-137	1.61E-02	1.13E-03	8.89E-04	1.90E-03	2.00E-02
AER End-State Equivalent Concentrations (Ci/L) [3]					
Radionuclide	**UTR**	**FMB**	**SC/PB**	**LTR**	**SR**
H-3	3.23E-10	1.29E-08	2.19E-09	5.16E-12	6.75E-11
Sr-90	0.00E+00	1.07E-12	0	0	3.36E-15
Tc-99	0	9.60E-13	0	0	3.02E-15
I-129	0	5.80E-13	0	0	1.82E-15
Cs-137	7.59E-14	3.96E-14	1.12E-14	1.30E-14	2.20E-15

1 Extracted from Table 3-1 of Jones (2009).

2 From Jannik (2019), Attachment 1.

3 "AER End-State Equivalent Concentration" = "AER End-State Equivalent Curies" / Long-Term Average Annual Flow.

Table 2-4. 2018 CA Dose Module Processed "AER End-State Equivalent Doses"

Radionuclide	**UTR**	**FMB**	**SC/PB**	**LTR**	**SR**
	All Data in mrem/yr				
H-3	3.56E-02	1.43E+00	2.41E-01	5.67E-04	7.43E-03
Sr-90	0.00E+00	4.57E-01	0.00E+00	0.00E+00	1.44E-03
Tc-99	0.00E+00	3.08E-03	0.00E+00	0.00E+00	9.70E-06
I-129	0.00E+00	4.47E-01	0.00E+00	0.00E+00	1.41E-03
Cs-137	1.62E-01	8.47E-02	2.39E-02	2.77E-02	4.70E-03
Total Dose [1]	**2.65E-01**	**2.50E+00**	**2.65E-01**	**2.83E-02**	**1.68E-02**

1 The total dose includes the dose from radionuclides other than the five primary radionuclides listed; therefore, the sum of the dose from the listed radionuclides does not equal the total dose.

Table 2-5. 2009 to 2018 CA Dose Module Processed "AER End-State Equivalent Doses"

Dose	UTR[1]	FMB[1]	SC/PB[1]	LTR	SR[1]
	All Data in mrem/yr				
2009 End-State Equivalent Dose[2]	6.61E-02	4.19E+00	8.29E-01	1.07E-01	2.37E-02
2009 SRS CA Projected Dose[3]	1.07E-01	3.07E+00	6.44E-01	4.46E+00	2.85E-01
2010 End-State Equivalent Dose[4]	6.88E-02	3.22E+00	7.62E-01	8.11E-02	1.97E-02
2010 SRS CA Projected Dose[3]	1.04E-01	3.00E+00	6.23E-01	4.35E+00	2.75E-01
2011 End-State Equivalent Dose[5]	2.19E-01	4.30E+00	3.20E-01	7.88E-01	3.41E-02
2011 SRS CA Projected Dose[3]	1.02E-01	2.93E+00	6.04E-01	4.24E+00	2.66E-01
2012 End-State Equivalent Dose[6]	2.47E-01	5.47E+00	3.30E-01	4.06E-02	2.65E-02
2012 SRS CA Projected Dose[3]	9.97E-02	2.87E+00	5.85E-01	4.14E+00	2.57E-01
2013 End-State Equivalent Dose[7]	2.42E-01	3.36E+00	3.53E-01	7.72E-02	2.05E-02
2013 SRS CA Projected Dose[3]	9.75E-02	2.81E+00	5.67E-01	4.04E+00	2.48E-01
2014 End-State Equivalent Dose[8]	1.76E-01	6.86E+00	3.09E-01	8.09E-02	2.97E-02
2014 SRS CA Projected Dose[3]	9.57E-02	2.75E+00	5.49E-01	3.94E+00	2.40E-01
2015 End-State Equivalent Dose[9]	2.02E-01	2.48E+00	3.51E-01	2.97E-02	1.61E-02
2015 SRS CA Projected Dose[3]	9.47E-02	2.69E+00	5.33E-01	3.84E+00	2.32E-01
2016 End-State Equivalent Dose[10]	2.06E-01	2.63E+00	3.48E-01	4.82E-02	1.69E-02
2016 SRS CA Projected Dose[3]	9.53E-02	2.63E+00	5.16E-01	3.75E+00	2.25E-01
2017 End State Equivalent Dose[11]	1.56E-01	2.41E+00	2.49E-01	2.99E-02	1.39E-02
2017 SRS CA Projected Dose[3]	9.77E-02	2.57E+00	5.01E-01	3.66E+00	2.40E-01
2018 End-State Equivalent Dose[12]	2.65E-01	2.50E+00	2.65E-01	2.83E-02	1.68E-02
2018 SRS CA Projected Dose[3]	1.01E-01	2.52E+00	4.85E-01	3.57E+00	2.10E-01

1 End-State Equivalent Dose data for 2011 through 2015 have been revised to remove dose related to direct discharges. Resulting values for UTR, FMB, SC/PB and SR are generally somewhat lower than previously reported.
2 Extracted from the Excel file Doses.xls file in the "2009" tab, row 66, columns B-F.
3 Extracted from the Excel file POA.xls in the "POA Summary" tab, columns B-E and G. Data for SR here are carried over from Table 2-1.
4 Extracted from the Excel file Doses.xls file in the "2010" tab, row 66, columns B-F.
5 Extracted from the Excel file Doses.xls file in the "2011" tab, row 85, columns B-F.
6 Extracted from the Excel file Doses.xls file in the "2012" tab, row 85, columns B-F.
7 Extracted from the Excel file Doses.xls file in the "2013" tab, row 85, columns B-F.
8 Extracted from the Excel file Doses.xls file in the "2014" tab, row 85, columns B-F.
9 Extracted from the Excel file Doses.xls file in the "2015" tab, row 85, columns B-F.
10 Extracted from the Excel file Doses.xls file in the "2016" tab, row 85, columns B-F.
11 Extracted from the Excel file Doses.xls file in the "2017" tab, row 85, columns B-F.
12 Extracted from the Excel file Doses.xls file in the "2018" tab, row 85, columns B-F.

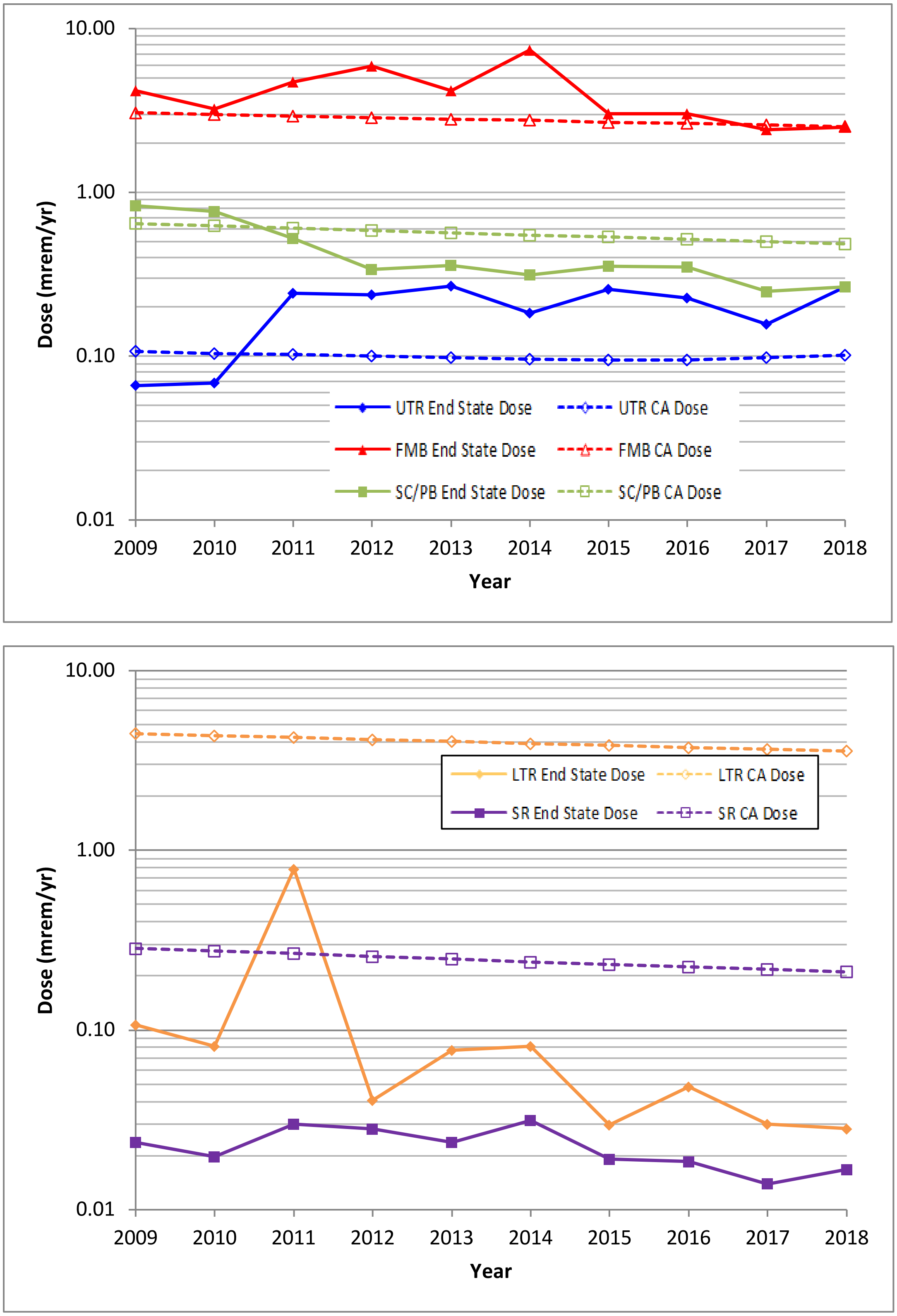

Figure 2-7. 2009 to 2018 SRS End-State Equivalent Dose versus SRS CA Dose

3.0 CA Model Validation Summary

In summary, the following observations were made regarding the CA model validation results in Sections 2.1 through 2.3:

- The SRS CA predicted 2018 dose at the Savannah River is close to the AER combined MEI and Irrigation dose. (Figure 2-1).
- The SRS CA predicted fisherman doses continue to be greater than the AER fisherman doses, aside from Upper Three Runs (Figure 2-2 through Figure 2-6).
- The SRS CA predicted doses are either greater than the AER end-state equivalent doses or are reasonably equivalent (Table 2-5 and Figure 2-7).

This indicates that the SRS CA projected dose, while generally conservative, provides a reasonable representation of the maximum annual doses. Because all doses evaluated are well below the SRS established 15 mrem/yr administrative limit (Crapse et al. 2011) no additional action is required.

4.0 References

Ackerman, J. D. and Jannik, G. T. 2012. Savannah River Site Environmental Report for 2011, SRNS–STI–2012–00200, Savannah River Nuclear Solutions, Aiken, SC.

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

DOE 1990. Radiation Protection of the Public and the Environment, DOE Order 5400.5, Change 2: 1-7-93, U.S. Department of Energy, Washington, DC. February 8, 1990.

DOE 1999a. Implementation Guide for Use with DOE M 435.1-1, Office of Environmental Management, DOE G 435.1-1, United States Department of Energy, Washington, DC. July 9, 1999.

DOE 1999b. Radioactive Waste Management Order, Office of Environmental Management, DOE O 435.1, United States Department of Energy, Washington, DC. July 9, 1999.

DOE 1999c. Radioactive Waste Management Manual, Office of Environmental Management, DOE M 435.1-1, United States Department of Energy, Washington, DC. July 9, 1999.

DOE 2005. Savannah River Site End State Vision, Savannah River Operations Office, United States Department of Energy, Aiken, SC. July 26, 2005.

DOE 2011. Radiation Protection of the Public and the Environment, DOE O 458.1, Chg 2: 06-06-2011, United States Department of Energy, Washington, DC. June 6, 2011.

Jannik, G. T. 2019. 2018 Annual Environmental Report Data to be used as Input in the FY 2019 SRS Composite Analysis Monitoring Plan, SRNL-L3200-2019-00146, Email to T. Butcher, J. Wohlwend and B. Stagich, Savannah River National Laboratory, Aiken SC. December 26, 2019.

Jones, W. E. 2009. Savannah River Site Surface Water Flow Rates for Composite Analysis Dose Calculations, SRNL-STI-2009-00077, Savannah River National Laboratory, Aiken, SC. January 2009.

Mamatey, A. R. 2003. Savannah River Site Environmental Monitoring Report for 2002, WSRC-TR-2003-00026, Rev. 0, Westinghouse Savannah River Company, Aiken, SC.

Mamatey, A. R. 2004. Savannah River Site Environmental Monitoring Report for 2003, WSRC-TR-2004-00015, Rev. 0, Westinghouse Savannah River Company, Aiken, SC.

Mamatey, A. R. 2005. Savannah River Site Environmental Monitoring Report for 2004, WSRC-TR-2005-00005, Rev. 0, Westinghouse Savannah River Company, Aiken, SC.

Mamatey, A. R. 2006. Savannah River Site Environmental Monitoring Report for 2005, WSRC-TR-2006-0007, Rev. 0, Washington Savannah River Company, Aiken, SC.

Mamatey, A. R. 2007. Savannah River Site Environmental Monitoring Report for 2006, WSRC-TR-2007-00008, Rev. 0, Washington Savannah River Company, Aiken, SC.

Mamatey, A. R. 2008. Savannah River Site Environmental Monitoring Report for 2007, WSRC-STI-2008-00057, Rev. 0, Washington Savannah River Company, Aiken, SC.

Mamatey, A. R. 2009. Savannah River Site Environmental Monitoring Report for 2008, SRNS-STI-2009-00190, Rev. 0, Savannah River Nuclear Solutions, Aiken, SC.

Mamatey, A. R. 2010. Savannah River Site Environmental Monitoring Report for 2009, SRNS-STI-2010-00175, Rev. 0, Savannah River Nuclear Solutions, Aiken, SC.

Mamatey, A. R. 2011. Savannah River Site Environmental Monitoring Report for 2010, SRNS-STI-2011-00059, Rev. 0, Savannah River Nuclear Solutions, Aiken, SC.

Phifer, M. A., Jannik, G. T., Smith, F. G., Crapse, K. P., and Millings, M. R. 2011. Input to the Savannah River Site Composite Analysis Monitoring Plan, SRNL-STI-2011-00439, Rev 0, Savannah River National Laboratory, Aiken, SC. July 25, 2011.

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

SRNS 2009. Savannah River Site Comprehensive Plan/Ten Year Site Plan FY 2010-2019, SRNS-RP-2009-00244, Savannah River Nuclear Solutions, Aiken, SC. May 2009.

SRNS 2013. Savannah River Site Environmental Report for 2012, SRNS-STI-2013-00024, Savannah River Nuclear Solutions, LLC, Aiken, SC. 2013.

SRNS 2014. Savannah River Site Environmental Report for 2013, SRNS-STI-2014-00006, Savannah River Nuclear Solutions, Aiken, SC. 2014.

SRNS 2015a. Savannah River Site Environmental Report for 2014, SRNS-RP-2015-00008, Savannah River Nuclear Solutions, Aiken, SC. 2014.

SRNS 2015b. Savannah River Site Ten Year Site Plan Limited Update FY 2016 – 2025, SRNS-RP-2015-00001, Savannah River Nuclear Solutions, Aiken, SC. June 2015.

SRNS 2016. Savannah River Site Environmental Report for 2015, SRNS-RP-2016-00089, Savannah River Nuclear Solutions, Aiken, SC. 2016.

SRNS 2017. Savannah River Site Environmental Report for 2016, SRNS-RP-2017-00174, Savannah River Nuclear Solutions, Aiken, SC. 2017.

SRNS 2018. Environmental Report for 2017, SRNS-RP-2018-00470, Savannah River Nuclear Solutions, Aiken, SC, September 2018.

SRNS 2019. Environmental Report for 2018, SRNS-RP-2019-00020, Savannah River Nuclear Solutions, Aiken, SC, November 2019.

WSRC 2003a. Remediation to Stewardship: A Strategic Plan for Accelerated Closure of SRS Inactive Waste Units, Soil and Groundwater Projects Division, Westinghouse Savannah River Company, Aiken, SC. June 2003.

WSRC 2003b. Savannah River Site Environmental Management Integrated Deactivation and Decommissioning Plan, WSRC-RP-2003-00233, Rev. 1, Westinghouse Savannah River Company, Aiken, SC. September 2003.

WSRC 2007a. Federal Facility Agreement for the Savannah River Site, WSRC-OS-94-42, Administrative Document Number 89-05-FF, Effective Date: August 16, 1993, Washington Savannah River Company, Aiken, SC. October 2, 2007 Revision.

WSRC 2007b. Life-cycle Liquid Waste Disposition System Plan, LWO-PIT-2007-00062, Rev. 14.1, Washington Savannah River Company, Aiken, SC. October 2007.

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