Enclosure 2

SRR-CWDA-2012-00103
Revision 1

Sensitivity Analysis for Disposal Operations into Saltstone Disposal Facility Vault 1, Vault 4, and SDUs 2, 3 and 5

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ACRONYMS/ABBREVIATIONS

CFR	Code of Federal Regulations
DAS	Disposal Authorization Statement
MOP	Member of the Public
NRC	Nuclear Regulatory Commission
PA	Performance Assessment
RAI	Request for Additional Information
SDF	Saltstone Disposal Facility
SDU	Saltstone Disposal Unit
SRS	Savannah River Site
TER	Technical Evaluation Report

EXECUTIVE SUMMARY

As directed in the Disposal Authorization Statement (DAS) transmittal letter for the Savannah River Site (SRS) Saltstone Disposal Facility (SDF), dated May 22, 2012 (WDPD-12-49), a sensitivity analysis has been conducted to provide additional information on potential doses to a future member of the public (MOP) living near (i.e., 100 meters from) the closed SDF. This sensitivity analysis evaluates near-term disposal actions for SDF Vaults 1 and 4 and Saltstone Disposal Units (SDUs) 2, 3 and 5.

As specified in the subject transmittal letter this sensitivity analysis was based on:

1. The Case K model parameters presented in the response to the U.S. Nuclear Regulatory Commission (NRC) Request for Addition Information (RAI) PA-8 provided in SRR-CWDA-2011-00044, Rev. 1, and
2. The Tc-99 inventory in SDUs 2, 3 and 5 that reflects the expected Tc-99 concentration in salt solution to be processed during the filling of these six disposal cells. [SRR-CWDA-2012-00095]

Two sensitivity cases were evaluated. The first sensitivity case (SC-1) used the model parameters for Case K, except for inventory, presented in the response to RAI PA-8 provided in SRR-CWDA-2011-00044, Rev. 1. The inventories in this analysis for Vaults 1 and 4 were based on the current inventories, as provided in SRR-CWDA-2012-00002 (for Vault 1) and in SRR-CWDA-2012-00067 (for Vault 4), decayed to October 1, 2030. The inventories used for SDUs 2, 3, and 5 were consistent with the projected inventories described in the response to RAI PA-8, with the exception of Tc-99. For Tc-99, the projected inventories in each of the six disposal cells was 119 curies (22% of the 540 curies projected for each of these SDUs for Case K). These Tc-99 inventories for SDUs 2, 3 and 5 are conservative based on the information presented in SRR-CWDA-2012-00095. For this sensitivity case, the technetium distribution coefficient (K_d) values for cementitious materials were, as discussed in the response to RAI PA-8, 1,000 mL/g for saltstone and concrete in Reducing Region II, 10 mL/g for saltstone in Oxidizing Region II, and 0.8 mL/g for concrete in Oxidizing Region II.

The second sensitivity case (SC-2) used the same model parameters and inventory projections used in SC-1, except that the K_d values for technetium reflected the assumed values for Case K1 presented in the response to RAI SP-19, as provided in SRR-CWDA-2011-00044, Rev. 1. That is, 500 mL/g in Reducing Region II and 0.8 mL/g in Oxidizing Region II for both saltstone and concrete.

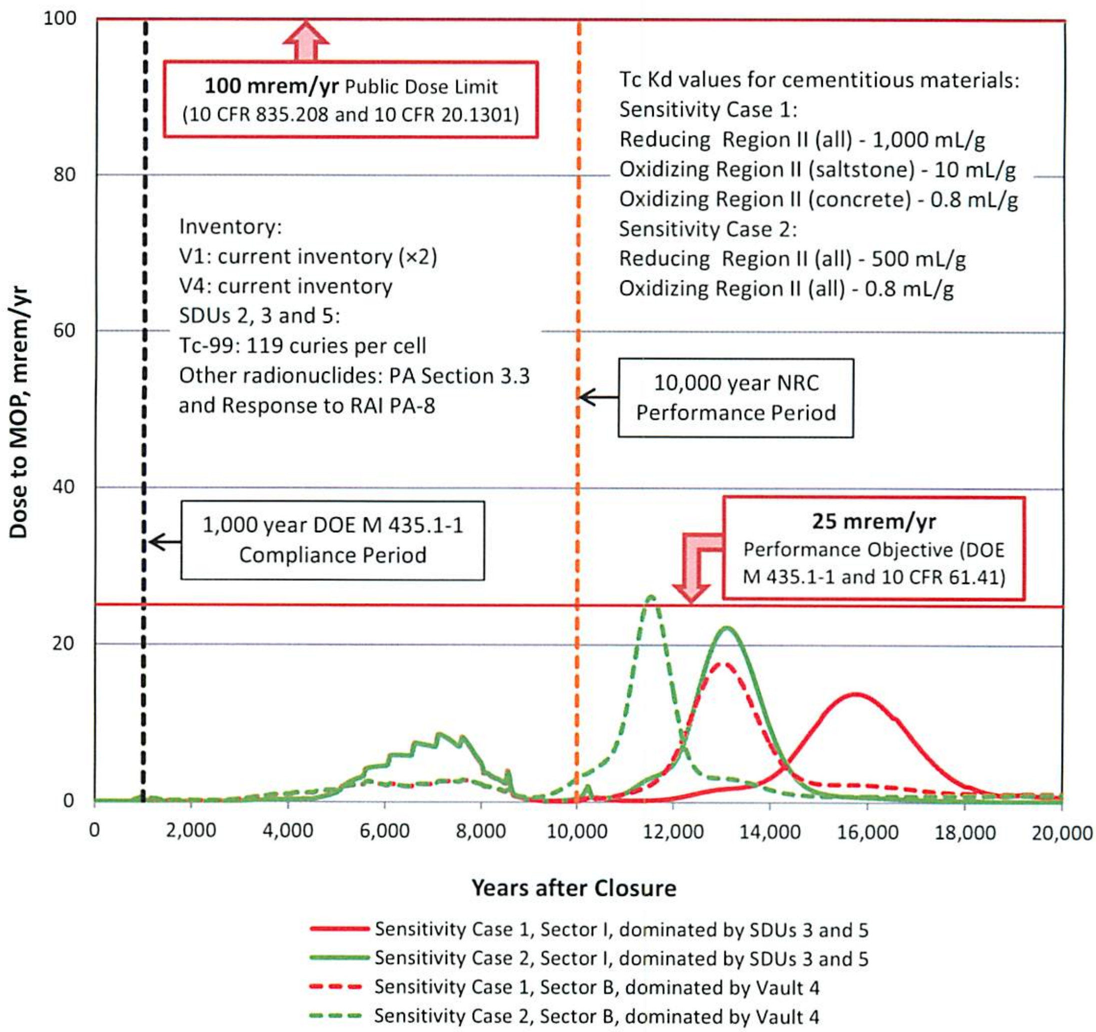
These sensitivity cases were evaluated using the SDF Stochastic Fate and Transport Model (version 3.002) developed for Case K, as described in SRR-CWDA-2011-00178. This GoldSim model tends to over-predict the peak calculated dose; thus reported peak dose results are expected to be lower if the aquifer concentrations are computed using PORFLOW (ACRi-2008). In addition, although the NRC has questions about modeling parameters for Case K and Case K1 in their Technical Evaluation Report (TER) specifically related to the treatment of technetium retention in the disposal cell floors (ML121020140), any changes that lead to an earlier peak dose timing from technetium would tend to decrease the magnitude of such peak.

Table ES-1 presents the peak dose to the MOP for both SC-1 and SC-2 within 1,000 years, 10,000 years, and 100,000 years after SDF closure. Figure ES-1 illustrates the dose profile to the MOP for SC-1 and SC-2 out to 20,000 years after SDF closure, for SDF Vaults 1 and 4 and SDUs 2, 3 and 5.

Table ES-1: Peak Dose to the MOP Using GoldSim Model v3.002

Time Period after Closure	Sensitivity Case 1	Sensitivity Case 2
0 - 1,000 Years	0.55 mrem/year (at 990 years)	0.57 mrem/year (at 1,000 years)
0 - 10,000 Years	8.7 mrem/year (at 7,120 years)	8.6 mrem/year (at 7,140 years)
0 - 100,000 Years	17 mrem/year (at 13,020 years)	26 mrem/year (at 11,540 years)

Figure ES-1: Dose to the MOP from Vaults 1 and 4 and SDUs 2, 3 and 5 Using GoldSim Model v3.002



1.0 INTRODUCTION

As directed in the DAS transmittal letter for the SRS SDF, dated May 22, 2012 (WDPD-12-49), a sensitivity analysis has been conducted to provide additional information on potential doses to a future MOP living near (i.e., 100 meters from) the closed SDF. This sensitivity analysis evaluates near-term disposal actions for SDF Vaults 1 and 4 and SDUs 2, 3 and 5.

As specified in the subject transmittal letter this sensitivity analysis was based on:

1. The Case K model parameters presented in the response to the U.S. Nuclear Regulatory Commission (NRC) Request for Addition Information (RAI) PA-8 provided in SRR-CWDA-2011-00044, Rev. 1, and
2. The Tc-99 inventory in SDUs 2, 3 and 5 that reflects the expected Tc-99 concentration in salt solution to be processed during the filling of these six disposal cells. [SRR-CWDA-2012-00095]

As described in more detail in the response to RAI PA-8, Case K was developed to provide additional information regarding the release of radionuclides when select barriers of concern were degraded simultaneously. In summary, the hydraulic properties of all cementitious material (saltstone and concrete) are degraded within 10,000 years after closure to reflect hydraulic properties associated with soil. The release of Tc-99 is based on an "average K_d" model that considers the growth of fractures within saltstone and concrete such that within 10,000 years after closure the spacing between fractures is ten centimeters. In this technetium release model the diffusion of oxygen starting at the surface of each fracture causes oxidation within the intact saltstone or concrete matrix and a time-dependent average K_d value is developed for saltstone and the concrete. This fracturing model was developed to address questions raised by the NRC regarding potential cracking in the saltstone and concrete. These are a few of the key parameters of Case K with all of the parameters described in detail in the response to RAI PA-8. [SRR-CWDA-2011-00044, Rev. 1]

In addition:

1. The dose pathway calculations have been updated to reflect an NRC TER comment on the leaching factor that impacts the uptake of radionuclides in vegetation. In the response to RAI B-3, provided in SRR-CWDA-2011-00044, Rev. 1, a soil buildup factor to account for the buildup of radionuclides in the soil from irrigation was developed that included a leaching factor. A comment by the NRC in the TER (ML121020140), Section 2.10.3.2 (page 145), was investigated. The investigation of the dose model verified that the fraction of time for irrigation (0.2 on an annual basis) was not included in the leaching factor. Not including this annual fraction for irrigation could dilute the buildup of radionuclides in the soil. This sensitivity analysis applies the fraction of time for irrigation to the soil buildup factor.

2. Two sensitivity cases were conducted to evaluate the impact of different distribution coefficients (K_d values) for technetium. The first sensitivity case, SC-1, used the K_d values presented in the Case K analysis presented in the response to RAI PA-8. The second sensitivity case, SC-2, used the K_d values associated with the evaluation identified as Case K1 in the response to RAI SP-19.

This sensitivity analysis was conducted using the updated SDF Stochastic Fate and Transport Model, version 3.002, described in SRR-CWDA-2011-00178, but modified to include a revised soil buildup factor used in the dose pathway calculations described above.

2.0 DESCRIPTION OF THE SENSITIVITY ANALYSIS

This sensitivity analysis utilizes the Case K model parameters presented in the response to RAI PA-8 as a starting point. The details of Case K were presented in the response to RAI PA-8 provided in SRR-CWDA-2011-00044, Rev. 1. Below is a brief summary of the pertinent assumptions of the Case K model modified for this sensitivity analysis, namely the inventory and the use of the SDF Stochastic Fate and Transport Model version 3.002.

2.1 Inventory

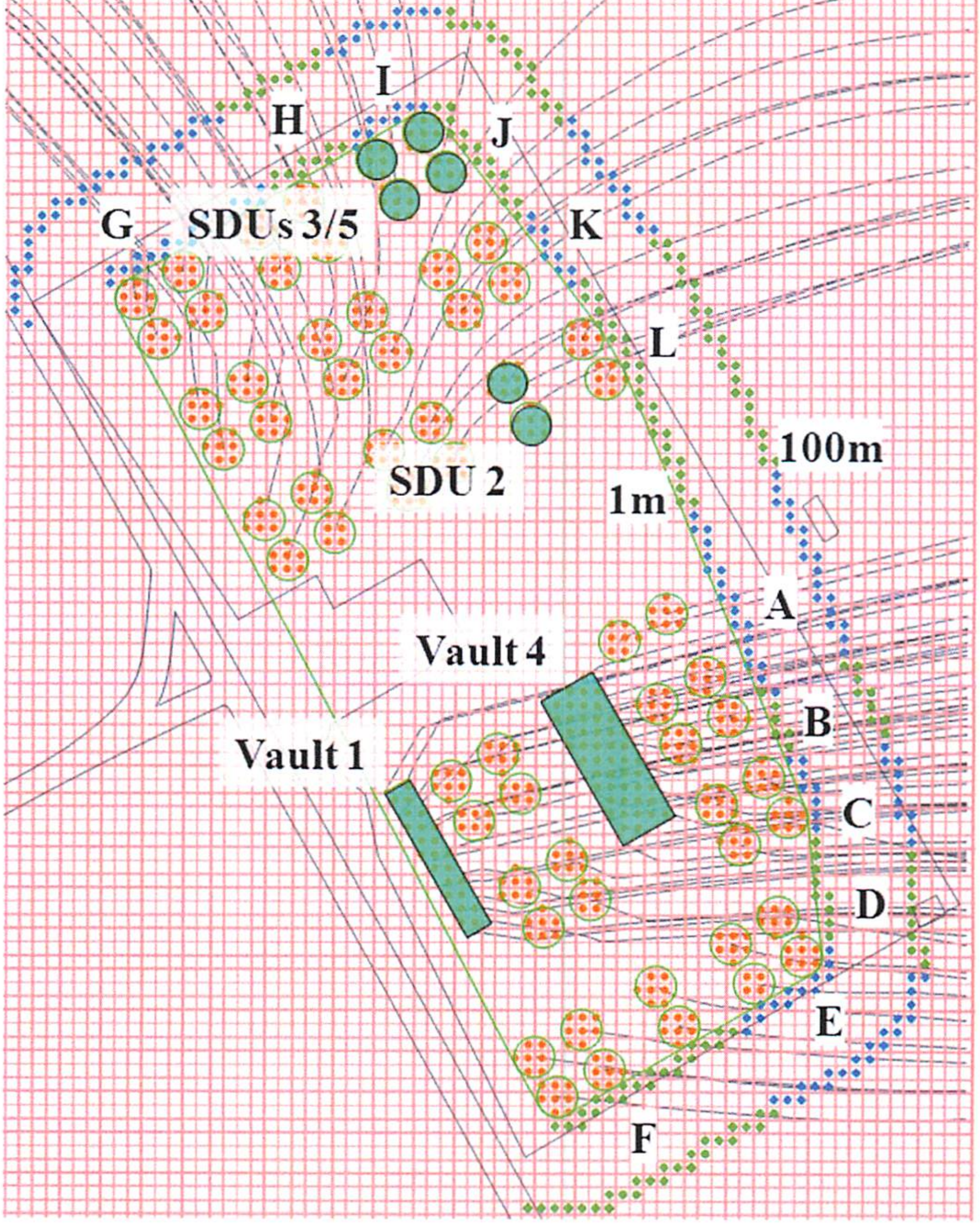
The radionuclide inventory reported in the SDF Performance Assessment (PA) (SRR-CWDA-2009-00017), and modified for Case K, as described in the response to RAI PA-8, was revised for this sensitivity analysis.

For Vaults 1 and 4 the current inventories, decayed to October 2030, were used rather than the projected inventories reported in SDF PA Tables 3.3-1 and 3.3-3. Note that for Vault 4 the inventories projected in SDF PA Table 3.3-3 was modified in Case K for Ra-226, Th-230, U-234, and Pu-238. The Vault 1 inventories, as of September 30, 2011, reported in SRR-CWDA-2012-00002, was increased by a factor of two to account for potential future additions. The Vault 4 inventories, as of March 31, 2012, was reported in SRR-CWDA-2012-00067.

For the SDUs, the projected inventories presented in SDF PA Table 3.3-5 and modified in Case K (1.3E-4 curie for Th-230 and 1.3E-5 curie for Ra-226) have not been changed except for the inventories of Tc-99. For Tc-99, an analysis was conducted to estimate the amount of Tc-99 that would be disposed in disposal cells 2A/B, 3A/B, and 5A/B, given the current salt waste batching strategy. [SRR-CWDA-2012-00095] Based on this analysis, the average Tc-99 inventory in the six disposal cells was estimated to be between 18% and 22% of the projected individual cell Tc-99 inventory of 540 curies reported in SDF PA Table 3.3-5. For this sensitivity analysis, each of the six disposal cells was assumed to contain 22% of the projected Tc-99 inventory reported in SDF PA Table 3.3-5 (540 curies), or 119 curies per disposal cell.

Figure 2.2-1 shows the location of Vaults 1 and 4, and SDUs 2, 3 and 5 with respect to the modeled sectors. The figure illustrates why Sector B is dominated by releases from Vault 4 and Sector I is dominated by releases from SDUs 3 and 5.

Figure 2.2-1: Location of SDF Disposal Units Evaluated in this Sensitivity Analysis



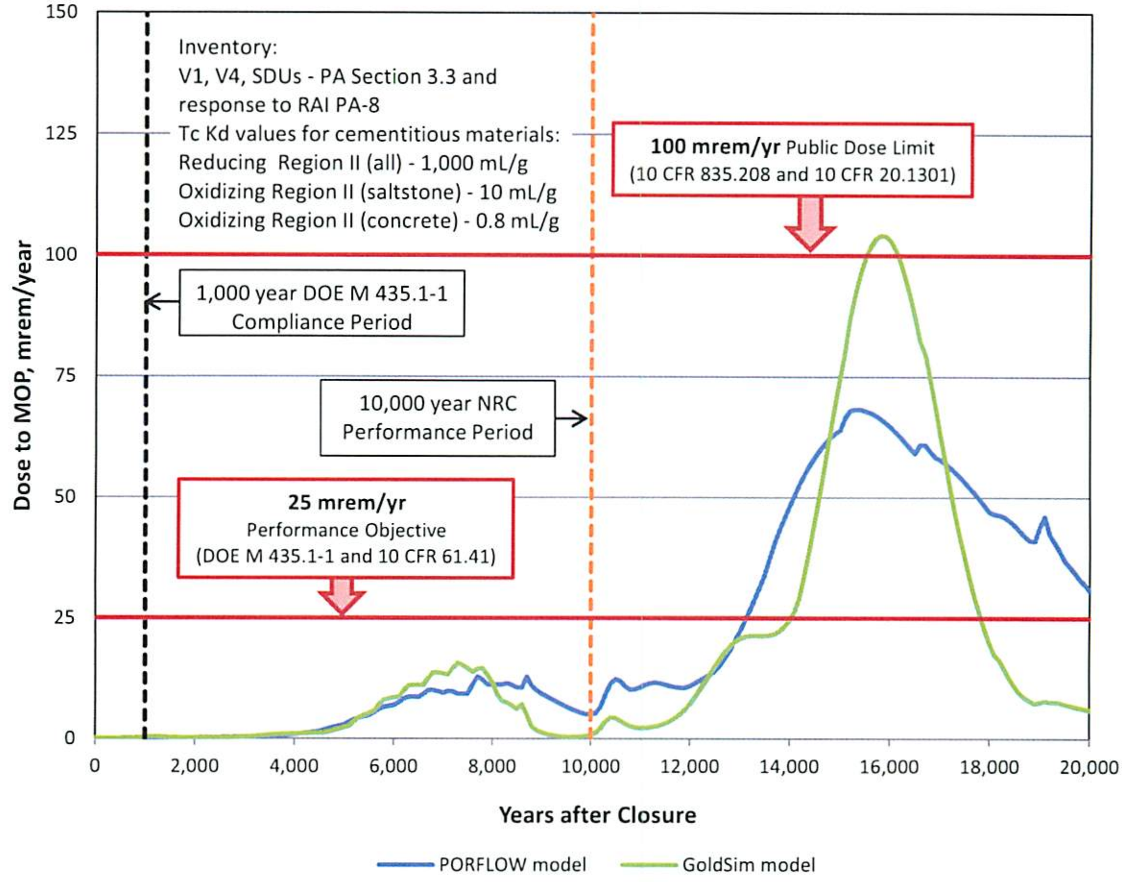
2.2 Use of SDF Stochastic Fate and Transport Model v3.002

To establish a baseline for SC-1, the Case K analysis results presented in the response to RAI PA-8, using the inventory discussed in the response to RAI PA-8, were updated using the GoldSim dose calculator (from the SDF Stochastic Fate and Transport Model v3.002) with the Case K aquifer concentrations computed using PORFLOW incorporating the soil buildup factor modification described in Section 1.0. The SDF Stochastic Fate and Transport Model v3.002 was also run with the inventory discussed in the response to RAI PA-8. These model runs provide a comparison between the two Case K models (PORFLOW versus GoldSim) for all disposal units. Table 2.2-1 presents the results from these two model runs. Figure 2.2-2 illustrates that the dose peaks are greater from the GoldSim model than from the PORFLOW model for a 20,000-year, post-closure period. Thus, the GoldSim transport model tends to over-predict the estimated peak dose to the MOP for SC-1.

Table 2.2-1: Peak Dose to MOP for Updated Case K

Model Used	Peak Dose in 1,000 Years	Peak Dose in 10,000 Years
PORFLOW	0.2 mrem/year @ Year 1,000	13 mrem/year @ Year 7,700
GoldSim	0.3 mrem/year @ Year 1,000	16 mrem/year @ Year 7,300

Figure 2.2-2: Comparison of the Case K Dose Results (PORFLOW versus GoldSim) Using Updated Dose Methodology

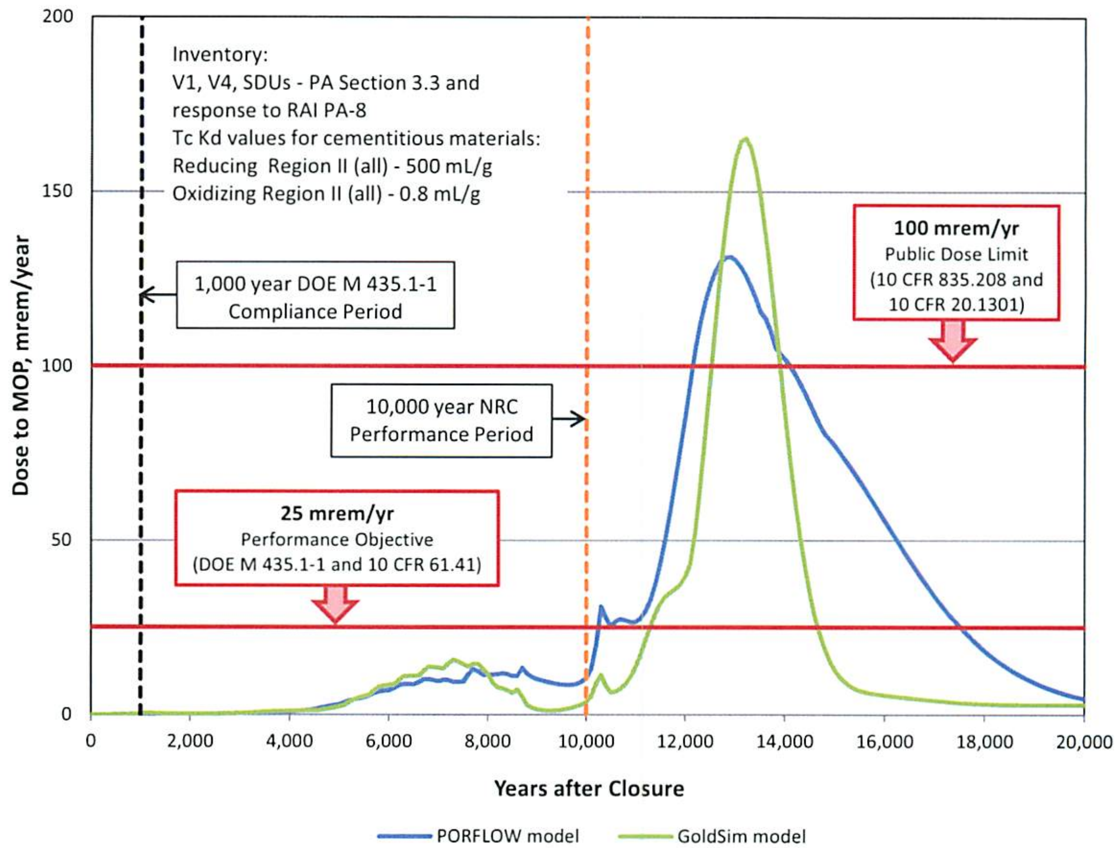


Similarly, to establish a baseline for SC-2, the Case K1 analysis results presented in the response to RAI SP-19, using the inventory discussed in the response to RAI PA-8, were updated using the GoldSim dose calculator (from the SDF Stochastic Fate and Transport Model v3.002) with Case K1 aquifer concentrations computed using PORFLOW. The SDF Stochastic Fate and Transport Model v3.002 was also run with the inventory discussed in the response to RAI PA-8. These model runs provide a comparison between the two Case K1 models (PORFLOW versus GoldSim). Table 2.2-2 presents the results from these two model runs. Figure 2.2-3 illustrates the differences between the two models. The dose peaks are greater from the GoldSim model than from the PORFLOW model for a 20,000-year, post-closure period. Thus, the GoldSim transport model would tend to over-predict the estimated peak dose to the MOP for SC-2.

Table 2.2-2: Peak Dose to MOP for Updated Case K1

Model Used	Peak Dose in 1,000 Years	Peak Dose in 10,000 Years
PORFLOW	0.2 mrem/year @ Year 1,000	14 mrem/year @ Year 8,700
GoldSim	0.3 mrem/year @ Year 1,000	16 mrem/year @ Year 7,300

Figure 2.2-3: Comparison of the Case K1 Dose Results (PORFLOW versus GoldSim) Using Updated Dose Methodology



3.0 SENSITIVITY ANALYSIS RESULTS

The SDF Stochastic Fate and Transport Model v3.002 (developed with GoldSim) is used to assess the impact to the MOP dose for sensitivity cases, SC-1 and SC-2. As discussed in Section 1.0, the use of the GoldSim model and treatment of technetium retention in the disposal cell floor tend to increase the modeled peak dose.

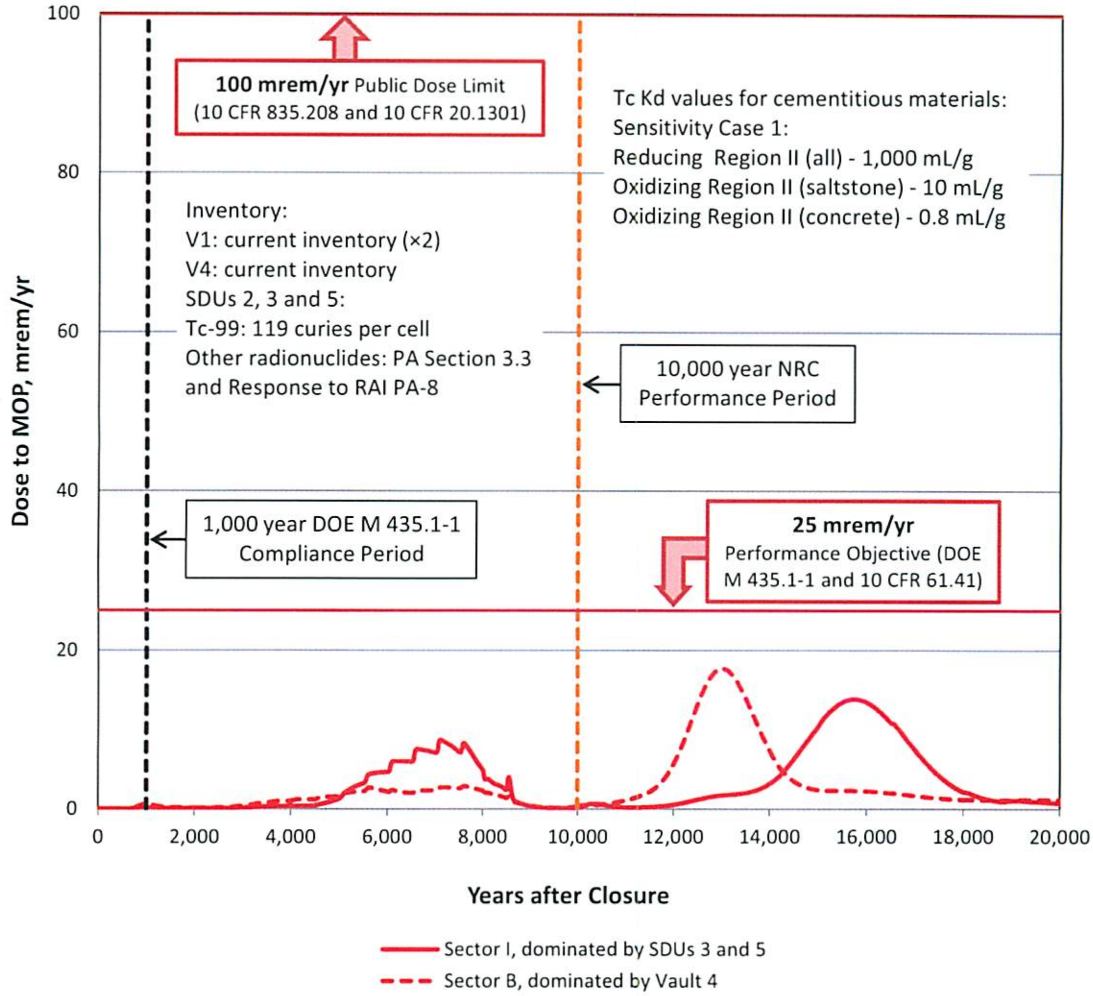
3.1 Sensitivity Case 1

Table 3.1-1 presents the peak dose to the MOP within a 1,000-year,10,000-year, and 100,000-year period after SDF closure for SC-1. As presented in Table 3.1-1, the estimated dose to the MOP does not exceed the performance objective. Figure 3.1-1 illustrates the dose to the MOP, for SC-1, in Sector B (dominated by the release from Vault 4) and Sector I (dominated by the release from SDUs 3 and 5). As indicated in Figure 3.1-1, the peak dose to the MOP based on the current inventory in Vaults 1 and 4 and the revised projected inventory in SDUs 2, 3 and 5 is less than the 25 mrem/year performance objective.

Table 3.1-1: Peak Dose to MOP for SC-1 (Vaults 1 and 4 and SDUs 2, 3 and 5 Only)

Time Period after Closure	Sensitivity Case 1
0 - 1,000 Years	0.55 mrem/year (at 990 years)
0 - 10,000 Years	8.7 mrem/year (at 7,120 years)
0 - 100,000 Years	17 mrem/year (at 13,020 years)

Figure 3.1-1: Dose to MOP for SC-1 Using GoldSim Model v3.002 (Vaults 1 and 4 and SDUs 2, 3 and 5 Only)



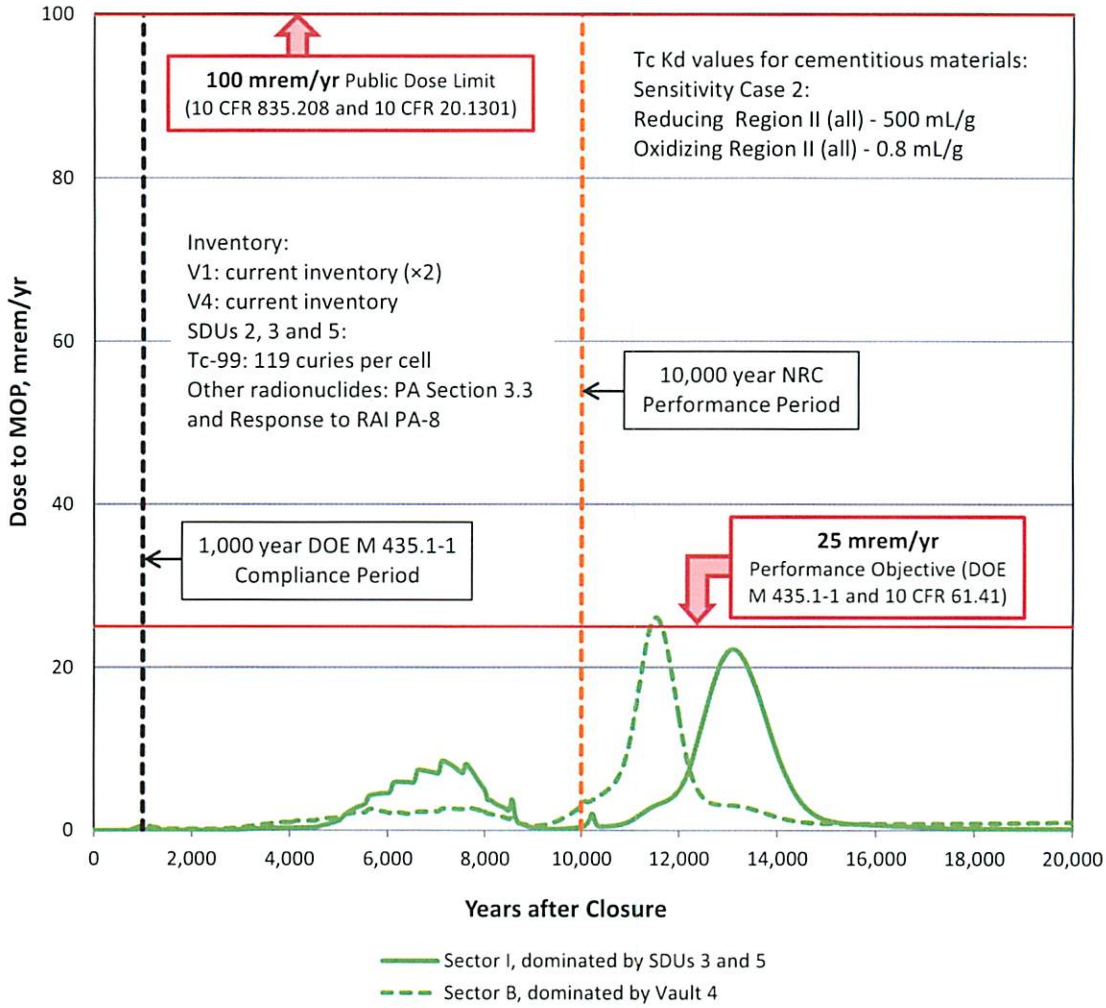
3.2 Sensitivity Case 2

Table 3.2-1 presents the peak dose to the MOP within a 1,000-year, 10,000-year, and 100,000-year period after SDF closure for SC-2. As presented in Table 3.2-1, the estimated dose to the MOP does not exceed the performance objective. Figure 3.2-1 illustrates the dose to the MOP, for SC-2, in Sector B (dominated by the release from Vault 4) and Sector I (dominated by the release from SDUs 3 and 5).

Table 3.2-1: Peak Dose to MOP for SC-2 (Vaults 1 and 4 and SDUs 2, 3 and 5 Only)

Time Period after Closure	Sensitivity Case 2
0 - 1,000 Years	0.57 mrem/year (at 1,000 years)
0 - 10,000 Years	8.6 mrem/year (at 7,140 years)
0 - 100,000 Years	26 mrem/year (at 11,540 years)

Figure 3.2-1: Dose to MOP for SC-2 Using GoldSim Model v3.002 (Vaults 1 and 4 and SDUs 2, 3 and 5 Only)



4.0 CONCLUSIONS

This sensitivity analysis illustrates that near-term disposal operations into SDF Vaults 1 and 4 and SDUs 2, 3 and 5 can be accomplished with reasonable assurance that the performance objective of 25 mrem/year to a MOP, from DOE M 435.1-1 and 10 CFR 61, will be met even with the conservative peak doses calculated using the GoldSim model and the treatment of technetium retention in the disposal cell floor. Subsequent research and development and modeling is expected to verify that the SDF, with all disposal units filled, will continue to meet the performance objectives.

5.0 REFERENCES

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