AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been divided into sections.

EDMC#: 0073120
SECTION: 2 OF 2

DOCUMENT #: EDF-NSNF-072

TITLE: Hanford Cs-Sr Repository Disposal Performance Analysis Using TSPA-FEIS Model

4.5.2 Radionuclide Inventory Effects

This section considers the transport of materials through the repository for the cases shown in Table 22. In all cases, the graphs shown in this section show mean value results for the simulation and the output variable considered is dose (see Nomenclature for a description of dose calculations). Appendix B displays graphs showing the full statistical plots for all cases.

The Base Case, shown in Figure 31, is the TSPA-FEIS Base Case (See Table 22 for case details) modified to run with GoldSim 7.51.200 (as described in Section 4.1). This models the full repository inventory including commercial waste packages and DOE waste packages under the nominal scenario (see Nomenclature). The statistical curves for this case are contained in Appendix B as Figure B-1.

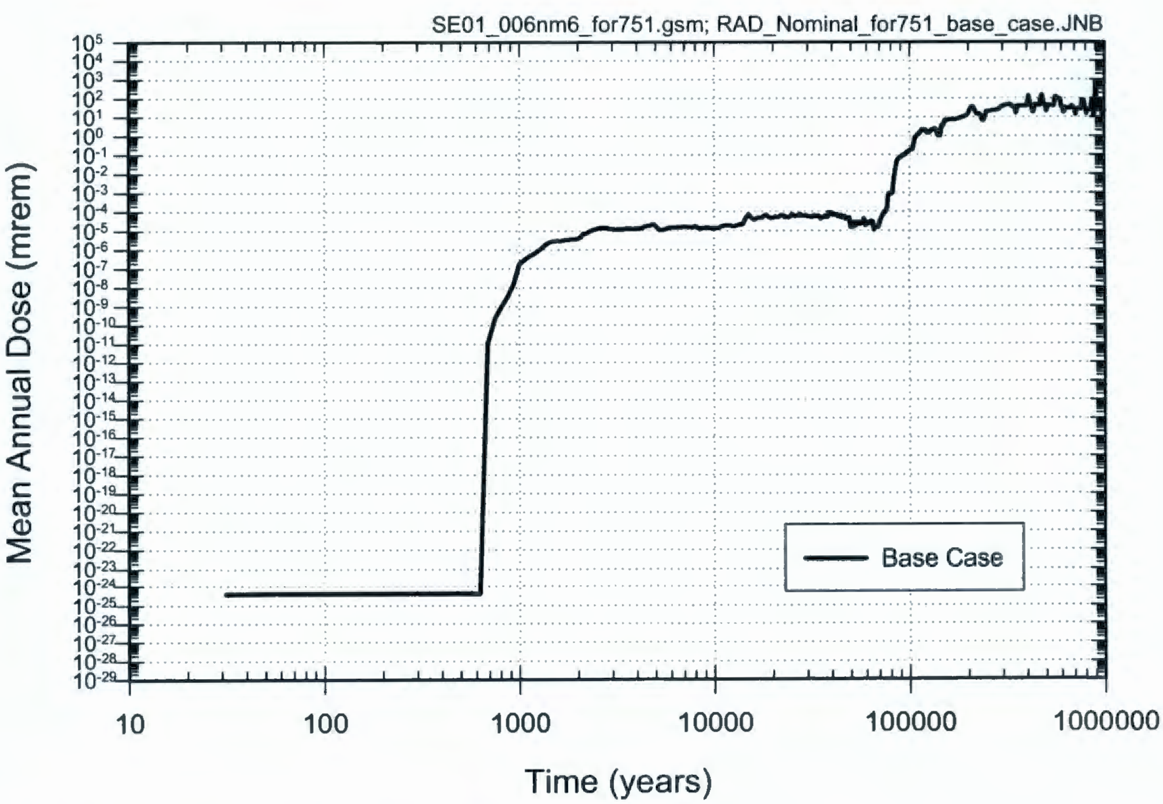

Figure 31. Radionuclide nominal scenario Base Case.

Figure 32 displays the results for the Base Case (see Table 22 for case definition) compared to the Cesium 1 case and the Strontium 1 case. The Base Case models the full repository inventory including commercial spent nuclear fuel and DOE waste packages. The Cesium 1 case modifies the Base Case by preventing release from commercial SNF waste packages and modifying the number of codisposal packages to 84 to match the projected number of cesium waste packages. The Strontium 1 case modifies the Base Case by setting the release from the commercial waste packages to zero and modifying the number of codisposal packages to 38 to match the projected number of strontium waste packages. As expected when reducing the available inventory, the mean annual dose for the Cesium 1 case is lower than the Base Case and the mean annual dose for the Strontium 1 case is lower than for the Cesium 1 case. The statistical plots for these cases are shown in Appendix B, Figures B-1, B-2, and B-3.

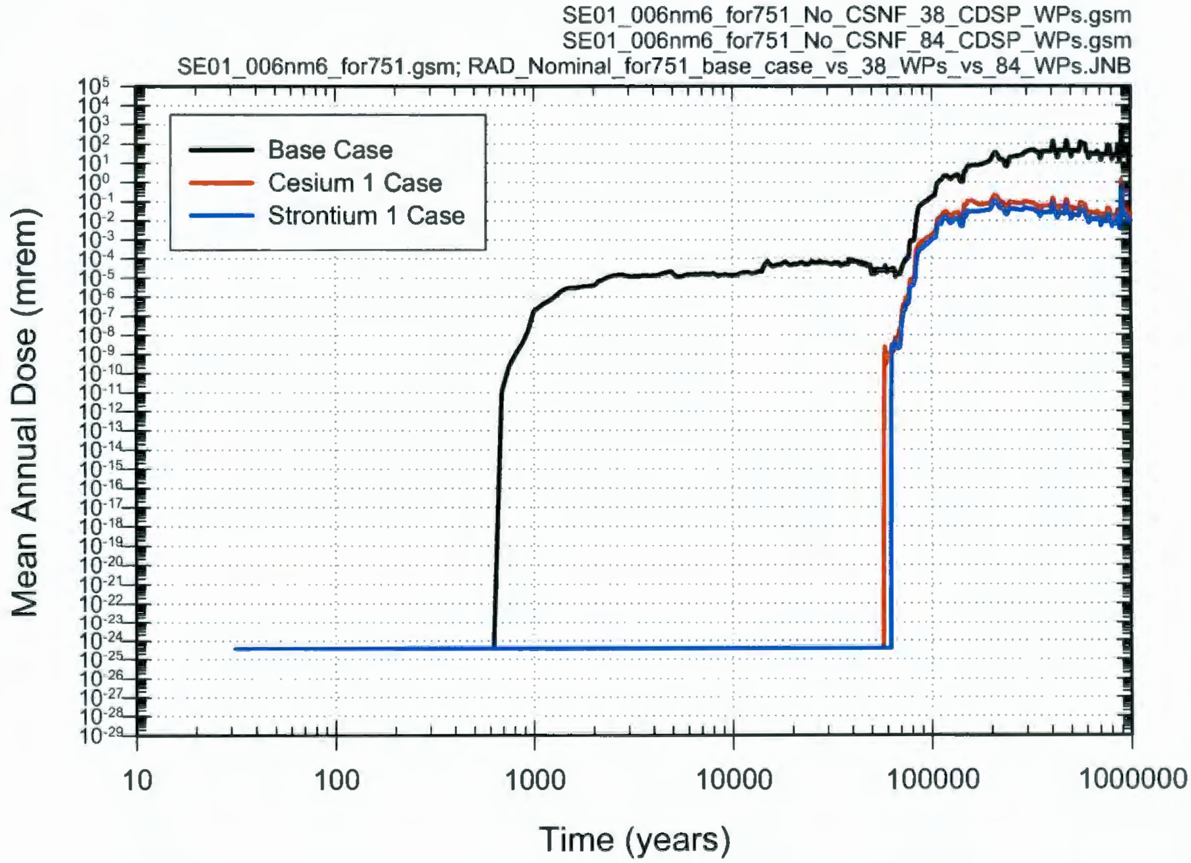

Figure 32. Comparison of mean annual dose for the Base Case, Cesium 1, and Strontium 1 cases.

Figure 33 displays the results for the Cesium 1 case (see Table 22 for case definition) compared to the Cesium 2 case. The Cesium 1 case modifies the Base Case by setting the release from the commercial waste packages to zero and modifying the number of codisposal packages to 84 to match the number of projected cesium waste packages. The Cesium 2 case modifies the Cesium 1 case to replace each DOE standardized canister containing DOE SNF with a DOE standardized canister containing the maximum inventory of cesium-137 chloride. The mean annual dose for the Cesium 2 case has a lower value. The statistical plots for these cases are shown in Appendix B, Figures B-2 and B-4.

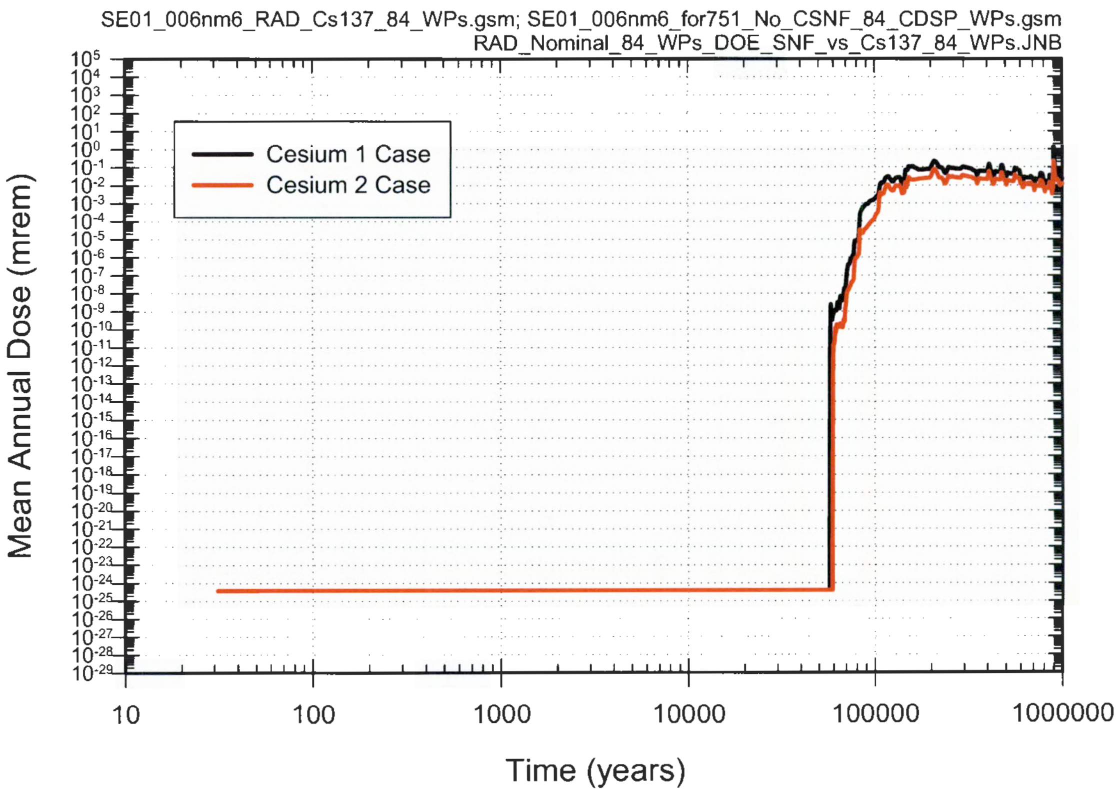

Figure 33. Comparison of mean annual dose for the Cesium 1 and Cesium 2 cases.

Figure 34 displays the results for the Cesium 1 case (see Table 22 for case definition) compared to the Cesium 3 case. The Cesium 1 case modifies the Base Case by setting the release from the commercial waste packages to zero and modifying the number of codisposal packages to 84 to match the number of projected cesium waste packages. The Cesium 3 case modifies the Cesium 1 case by replacing each DOE standardized canister containing DOE-SNF with a DOE standardized canister containing the maximum inventory of cesium-135 chloride. The mean annual dose for the Cesium 3 case has a lower value. The statistical plots for these cases are shown in Appendix B, Figures B-2 and B-5

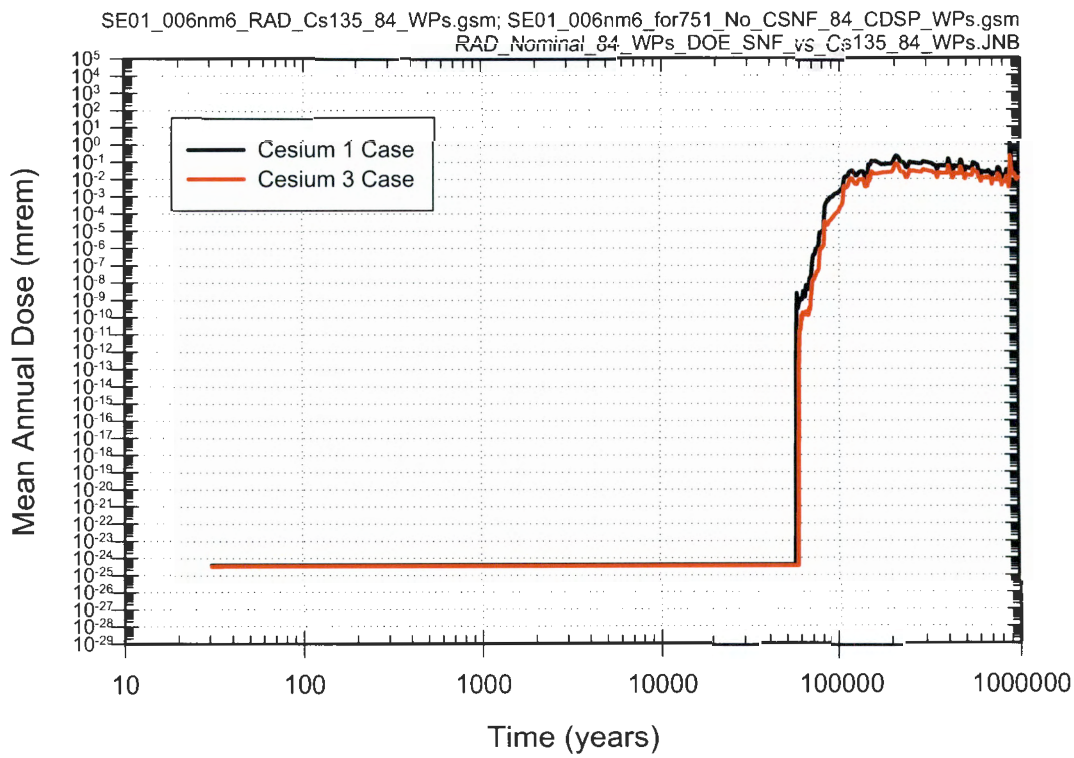

Figure 34. Comparison of mean annual dose for the Cesium 1 and Cesium 3 cases.

Figure 35 displays the results for the Strontium 1 case (see Table 22 for case definition) compared to the Strontium 2 case. The Strontium 1 case modifies the Base Case by setting the release from the commercial waste packages to zero and modifying the number of codisposal packages to 38 to match the number of projected strontium waste packages. The Strontium 2 case modifies the Strontium 1 case by replacing each DOE standardized canister containing DOE-SNF with a DOE standardized canister containing the maximum inventory of strontium-90 fluoride. The mean annual dose for the Strontium 2 case has a lower value. The statistical plots for these cases are shown in Appendix B, Figures B-3 and B-6.

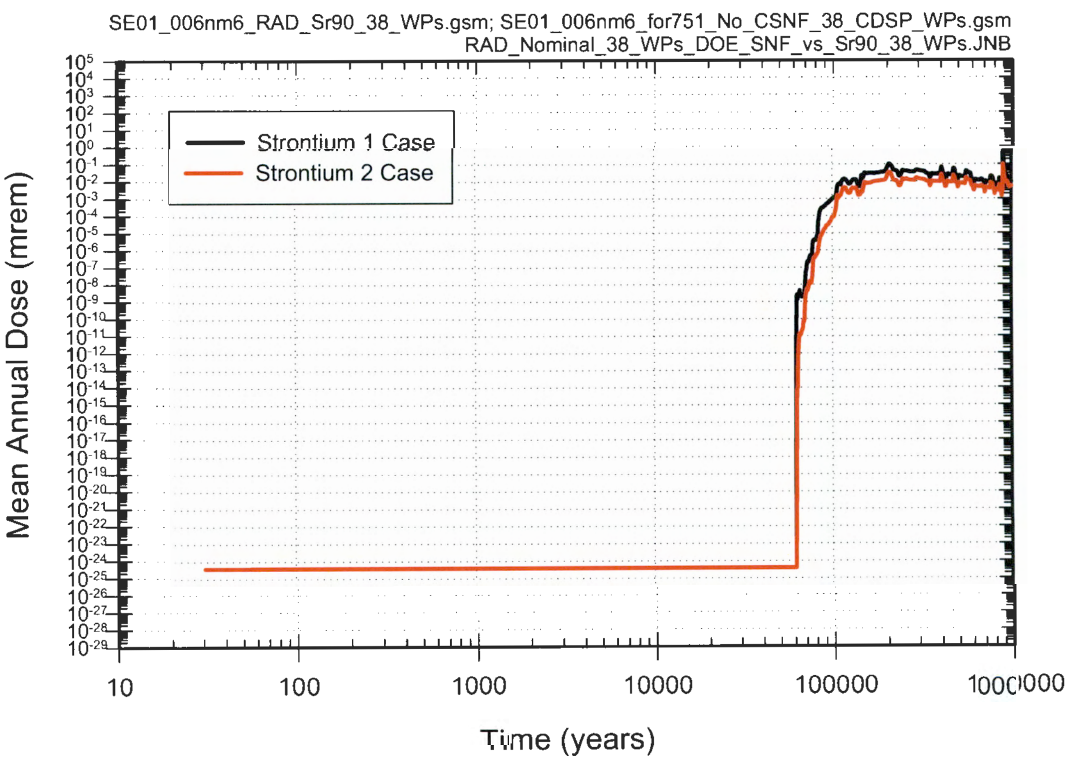

Figure 35. Comparison of mean annual dose for the Strontium 1 and Strontium 2 cases.

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Figure 36 displays the results for the Base Case (see Table 22 for case definition) compared to the Cesium Strontium 1 case. The Base Case models the full repository inventory including commercial spent nuclear fuel and DOE waste packages. The Cesium Strontium 1 case modifies the Base Case by adding the maximum inventories of cesium-137 chloride and strontium-90 fluoride to each DOE waste package. This simulates more capsule material than is physically available to place in the repository, which provides a high estimate of dose change from these sources. The mean annual dose shows no change between the cases. The statistical curves for these case are contained in Appendix B as Figures B-1 and B-7.

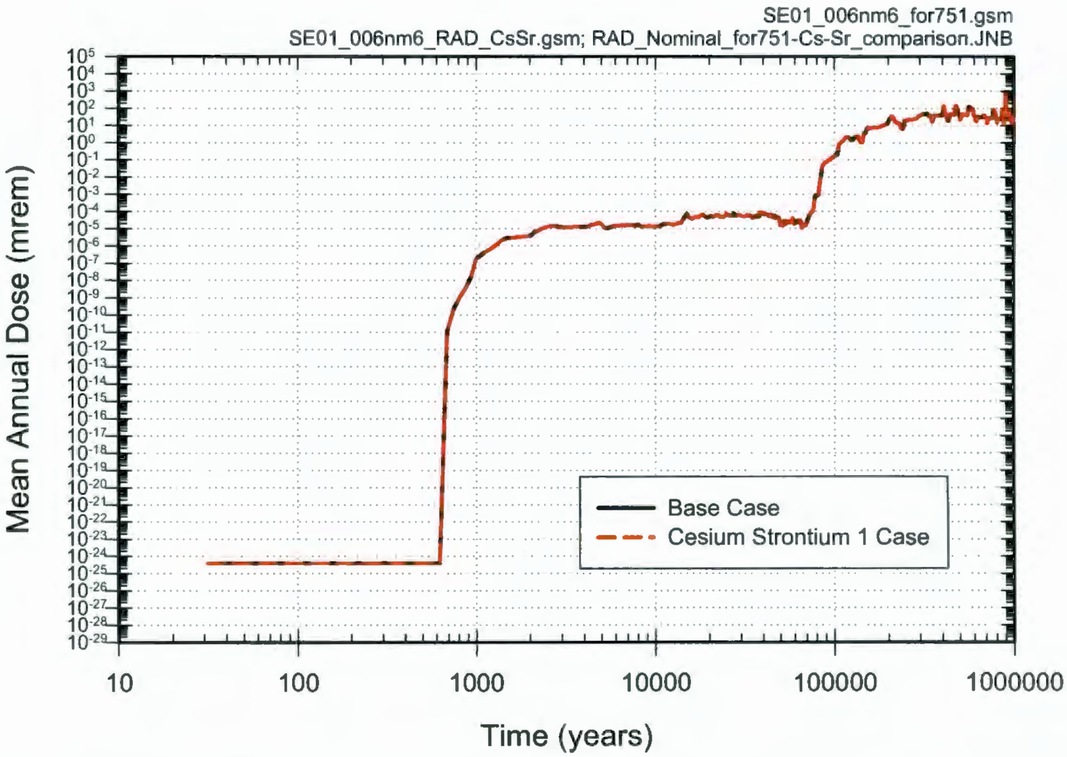

Figure 36. Comparison of mean annual dose for the Base Case and Cesium Strontium 1 cases.

Figure 37 displays the results for the Base Case (see Table 22 for case definition) compared to the Cesium 4 case. The Base Case models the full repository inventory including commercial spent nuclear fuel and DOE waste packages. The Cesium 4 case modifies the Base Case by adding the maximum inventory of cesium-135 chloride to each DOE waste package. This simulates more capsule material than is physically available to place in the repository, which provides a high estimate of dose change from this source. The mean annual dose shows no change between the cases. The statistical curves for these case are contained in Appendix B as Figures B-1 and B-8.

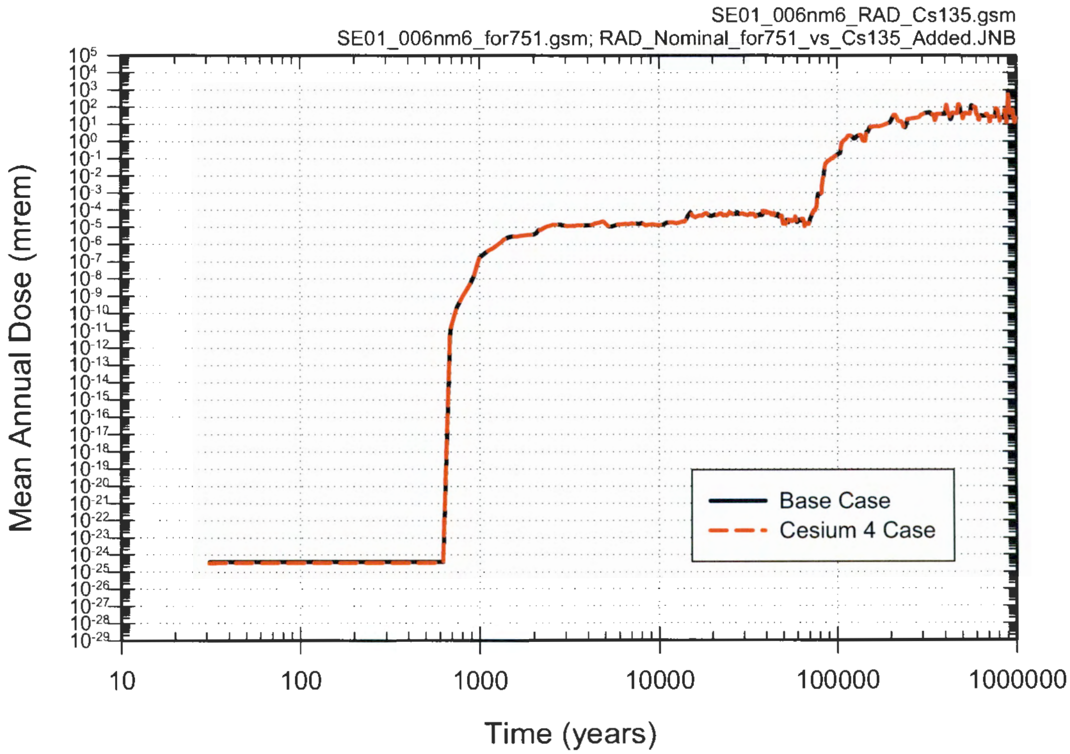

Figure 37. Comparison of mean annual dose for the Base Case and Cesium 4 cases.

Figure 38 displays the results of Base Case 1 (See Table 22 for case definition). Base Case 1 models the full repository inventory including commercial spent nuclear fuel and DOE waste packages during an igneous event (see Section 4.1) on the Base Case analysis. The line labeled Igneous–Ash Dose represents the portion of the dose that would become airborne and transported in the ash plume resulting from the eruptive event. It is calculated based on the ash hypothetically collecting at a point 18 kilometers from the repository (the same distance as the hypothetical well used for groundwater dose calculation). The line labeled Igneous–Groundwater Dose represents the portion of the dose that would be transported by the groundwater resulting from the intrusive event. The line labeled Igneous–Total Dose represents the sum of the ash and groundwater doses from the event. The statistical curves (total dose and groundwater dose) for this case are contained in Appendix B as Figures B-9 and B-10.

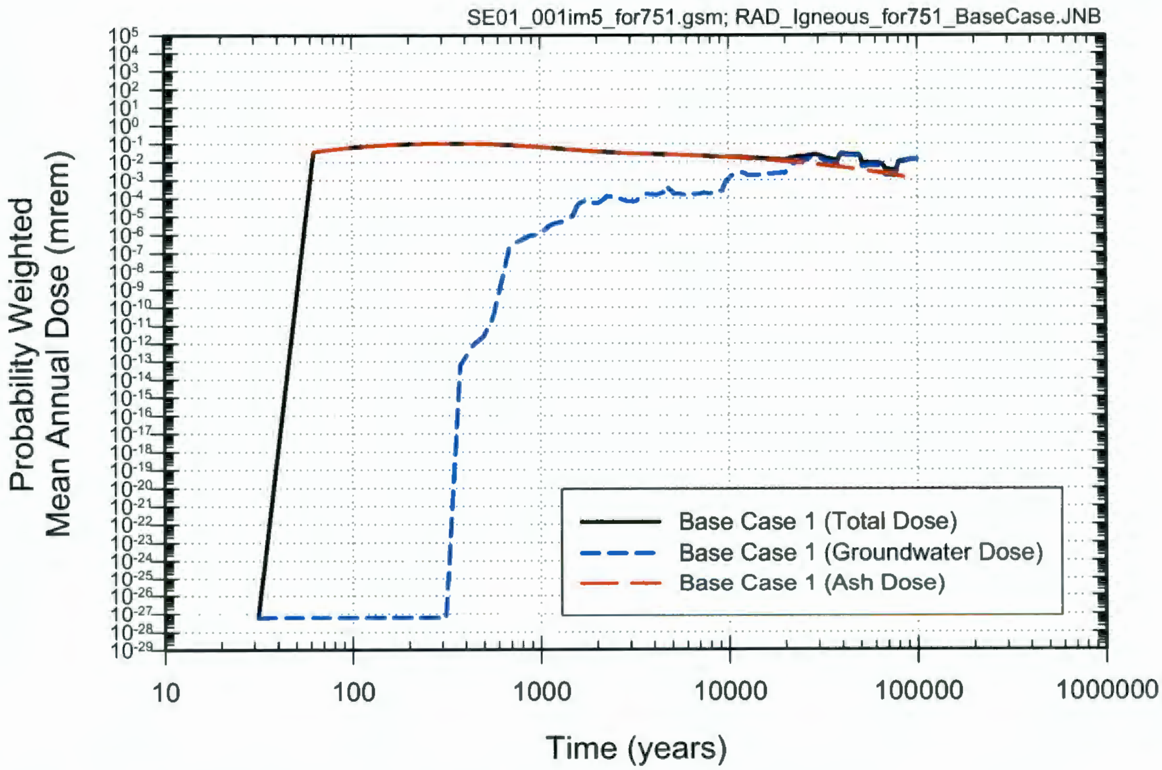

Figure 38. Comparison of mean annual dose for the Base Case 1 case.

Figure 39 displays groundwater dose results for Base Case 1 (see Table 22 for case definitions) and Cesium Strontium 2 case. Base Case 1 simulates an igneous event (see Section 4.1) on the Base Case analysis. Base Case 1 models the full repository inventory including commercial spent nuclear fuel and DOE waste packages. The Cesium Strontium 2 case modifies Base Case by adding the maximum inventories of cesium-137 chloride and strontium-90 fluoride to each DOE waste package in the Base Case, thus simulating more capsule material than is physically available to place in the repository. This provides a high estimate of change to the repository dose from this source. The Groundwater Dose represents the portion of the dose that would be transported by the groundwater resulting from the intrusive event. The ash (airborne) dose for this case is shown in Figure 40. The mean annual dose shows no change between the cases. The statistical curves for these cases are contained in Appendix B as Figures B-10 (Base Case 1 groundwater dose) and B-11 (Cesium Strontium 2 case total dose).

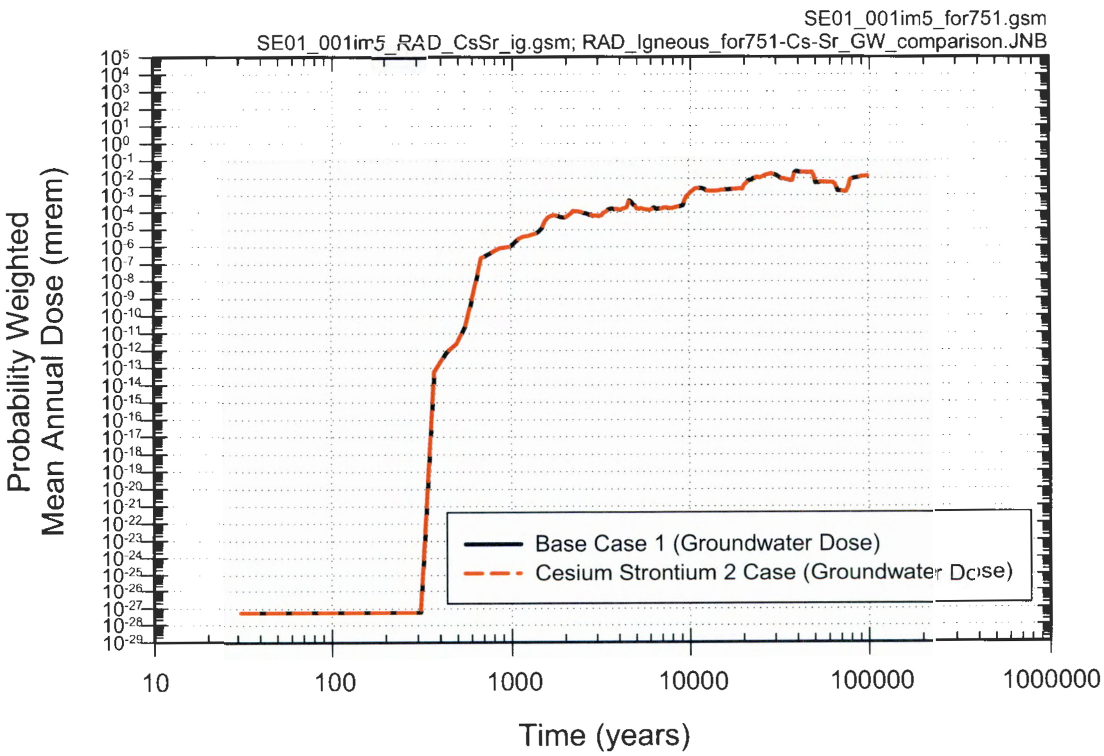

Figure 39. Comparison of groundwater mean annual dose for the Base Case 1 and Cesium Strontium 2 cases.

Figure 40 displays the ash dose results for Base Case 1 (see Table 22 for case definitions) and Cesium Strontium 2 case. Base Case 1 simulates an igneous event (see Section 4.1) on the Base Case analysis. Base Case 1 models the full repository inventory including commercial spent nuclear fuel and DOE waste packages. The Cesium Strontium 2 case modifies Base Case 1 by adding the maximum inventories of cesium-137 chloride and strontium-90 fluoride to each DOE waste package in Base Case 1, thus simulating more capsule material than is physically available to place in the repository. This provides a high estimate of change to the repository dose from this source. The Ash Dose represents the portion of the dose that would become airborne and transported in the ash plume resulting from the eruptive event. The groundwater dose for this case is shown in Figure 39. The mean annual dose shows no change between the cases. The total dose statistical curves for these cases are contained in Appendix B as Figures B-9 and B-11.

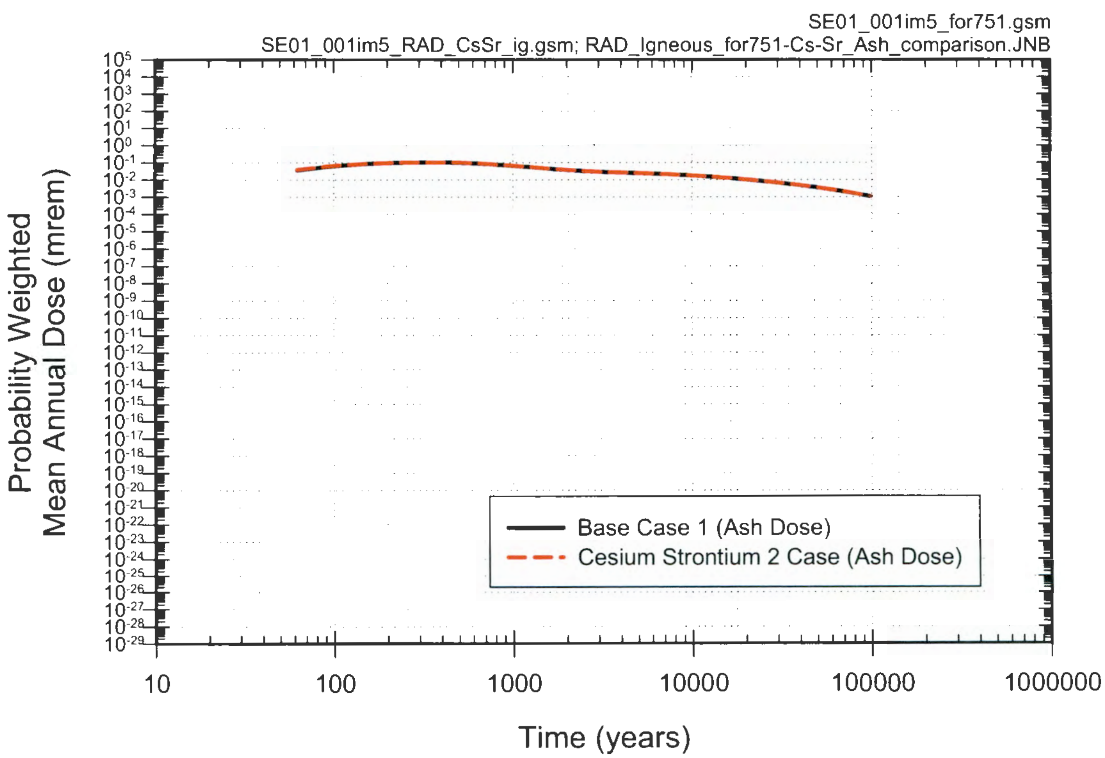

Figure 40. Comparison of ash mean annual dose for the Base Case 1 and Cesium Strontium 2 cases.

4.6 Contaminant Metal Modeling

4.6.1 Metal Contaminant Modeling Approach

In order to model the migration of contaminant metals through the repository system, each contaminant inventory was inserted one at a time into the specie technetium-99 slot in the DOE SNF codisposal package. This specie was chosen as a surrogate because it does not have parent or daughter decay products that are tracked in the TSPA, thus it eliminates the changes in quantities over time. Also, technetium-99 does not sorb and the transport processes are appropriate for the material as being substituted. Radioactive decay calculations were turned off for technetium-99, and its properties of molecular weight, inventory, and solubility were changed for each run to match the appropriate metal being modeled. The remaining species in the DOE SNF were zeroed. All the species of the DOE HLW waste glass were also zeroed except for a very small amount (1E-12 g) that was left in the carbon-14 specie to avoid a divide by zero error in the model. The colloid specie was left as is. A setting was also made to prevent the commercial SNF waste packages from failing, defining the dose from this source as zero. These model settings were made in order to sharpen focus on the migration of each contaminant metal.

A triangular (see Nomenclature) distribution with the minimum, maximum, and the most likely values was applied to the inventory of each metal for the nominal, nominal without engineered barrier system, and igneous scenarios. The dissolution rate for the surrogate was set to instantaneous, thus allowing all of the contaminant metal to be available for transport when the waste package failed. For each individual metal analysis, the metal data was inserted by placing the waste package metal inventory in the surrogate slot and defining the solubility limit for the metal as the maximum metal solubility from the geochemistry calculations into the surrogate slot. The number of codisposal waste packages was set to 84 when analyzing the cesium chloride capsules and to 38 when analyzing the strontium fluoride capsules (see Section 2.4.1.4).

The TSPA-FEIS model was run several times in order to analyze the effects of contaminant metal transport in the repository. The results for contaminant metal transport were extracted from the model's groundwater concentration (mg/L). This evaluation is based on concentration of the material at the point of analysis on the site boundary which is located 18 kilometers from the repository. These concentrations are evaluated against EPA's 40 CFR 141 National Primary Drinking Water Regulation, 141.62 Maximum Contaminant levels for inorganic contaminants (Barium, Cadmium and Chromium), Subpart I Control of Lead and Copper, 141.80, (c),(1) (lead) and 40 CFR 143, National Secondary Drinking Water Regulation, 143.3 (silver) limits that were provided by the study requestor. The concentration limits used are shown on each result graph for the contaminant metals.

4.6.2 Solubilities

The solubility limits used in the TSPA modeling for each selected metal are shown in Table 23. These limits are the 20,000-year maximum concentrations in the groundwater calculated by the geochemical analysis. The 20,000-year maximum concentration was used to provide a maximum credible limit on metal transport from the waste package. A discussion of these results from the geochemical analysis was presented previously in Section 3.

Table 23. Solubility limits used for TSPA analysis.

Metal	Maximum Solubility in Cesium Chloride Capsules (mg/L)	Maximum Solubility in Strontium Fluoride Capsules (mg/L)
Barium	5.18E+03	2.90E+02
Cadmium	4.31E+00	1.63E+01
Chromium	3.17E+02	1.86E-04
Lead	1.70E+02	1.47E-01
Silver	1.10E+00	2.81E-01

4.6.3 Contaminant Metal Inventories

The inventories used in the TSPA modeling for each selected metal are taken from Tables 2, 3, 4, and 5 with the exception of barium. The amount of barium used in the TSPA modeling of the cesium chloride capsules was increased by the amounts of cesium-137 and cesium-135 that would decay into barium over the time span of the TSPA (1 million years). This was done since, as previously discussed, the TSPA does not calculate concentration of these daughter products. Correcting the barium in this manner provides a conservatively high value of barium available for transport at the beginning of the simulation, but the amount becomes closer to the real situation at the end of the simulation. Table 24 indicates the minimum, average, and maximum values of barium used for the cesium chloride capsules.

Table 24. Barium amounts used in the TSPA analysis.

Capsule Type	Minimum (g)	Average (g)	Maximum (g)
Cesium Chloride	1,189.5	9,956.3	12,827.7

4.6.4 Cesium Chloride Capsule Contaminant Metal TSPA Details and Results

For the simulation of contaminant metal transport, the TSPA-FEIS model was run one time for each case. Simulation details for each case are shown in Table 25. For all metals except barium, the Year 2006 inventory was used for initial quantity values. For barium, the Year 2275 inventory was used for initial quantity values to account for the generation of barium by nuclear decay of cesium. As discussed previously, the TSPA does not track the generation of this daughter product internally, so the inclusion of the Year 2275 inventory assures calculation of the conservative case barium release.

Table 25. Cesium capsule contaminant metal simulation case details.

Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
Cesium Contaminant 1	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range barium inventory.	Nominal	1,000,000	300
Cesium Contaminant 2	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the maximum barium inventory.	Nominal	1,000,000	300
Cesium Contaminant 3	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range barium inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Cesium Contaminant 4	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range barium inventory.	Igneous	100,000	5,000
Cesium Contaminant 5	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range cadmium inventory.	Nominal	1,000,000	300
Cesium Contaminant 6	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the maximum cadmium inventory.	Nominal	1,000,000	300
Cesium Contaminant 7	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range cadmium inventory. The repository Engineered	Nominal	1,000,000	300

Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
	Barrier System is removed.			
Cesium Contaminant 8	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range cadmium inventory.	Igneous	100,000	5,000
Cesium Contaminant 9	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range chromium inventory.	Nominal	1,000,000	300
Cesium Contaminant 10	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the maximum chromium inventory.	Nominal	1,000,000	300
Cesium Contaminant 11	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range chromium inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Cesium Contaminant 12	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range chromium inventory.	Igneous	100,000	5,000
Cesium Contaminant 13	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range lead inventory.	Nominal	1,000,000	300
Cesium Contaminant 14	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the	Nominal	1,000,000	300

Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
	maximum lead inventory.			
Cesium Contaminant 15	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range lead inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Cesium Contaminant 16	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range lead inventory.	Igneous	100,000	5,000
Cesium Contaminant 17	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range silver inventory.	Nominal	1,000,000	300
Cesium Contaminant 18	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the maximum silver inventory.	Nominal	1,000,000	300
Cesium Contaminant 19	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range silver inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Cesium Contaminant 20	Repository inventory reduced to 84 codisposal waste packages. Each waste package contains the full range silver inventory.	Igneous	100,000	5,000

Figure 41 displays the statistical mean groundwater concentration of barium for the Cesium Contaminant 1 (full-range barium inventory) (See Table 25 for full case descriptions), Cesium Contaminant 2 (maximum barium inventory), Cesium Contaminant 3 (full-range barium inventory with no engineered barrier system), and Cesium Contaminant 4 (full range barium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 41 is contained in Appendix B as Figures B-12, B-13, B-14, and B-15. The concentration limit line represents the requestor-defined groundwater concentration limit for barium.

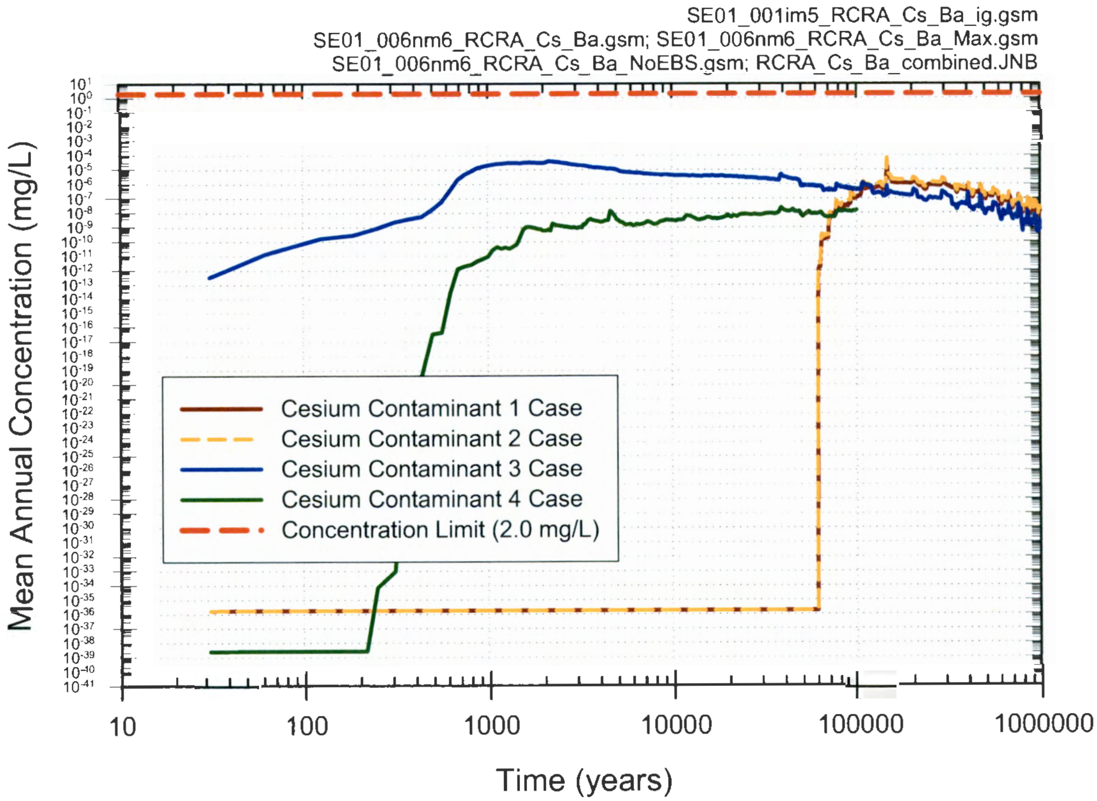

Figure 41. Mean annual concentration of barium for selected cesium contaminant analysis cases.

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Figure 42 displays the statistical mean groundwater concentration of cadmium for the Cesium Contaminant 5 (full-range cadmium inventory) (See Table 25 for full case descriptions), Cesium Contaminant 6 (maximum cadmium inventory), Cesium Contaminant 7 (full-range cadmium inventory with no engineered barrier system), and Cesium Contaminant 8 (full range cadmium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 42 is contained in Appendix B as Figures B-16, B-17, B-18, and B-19. The concentration limit line represents the requestor-defined groundwater concentration limit for cadmium.

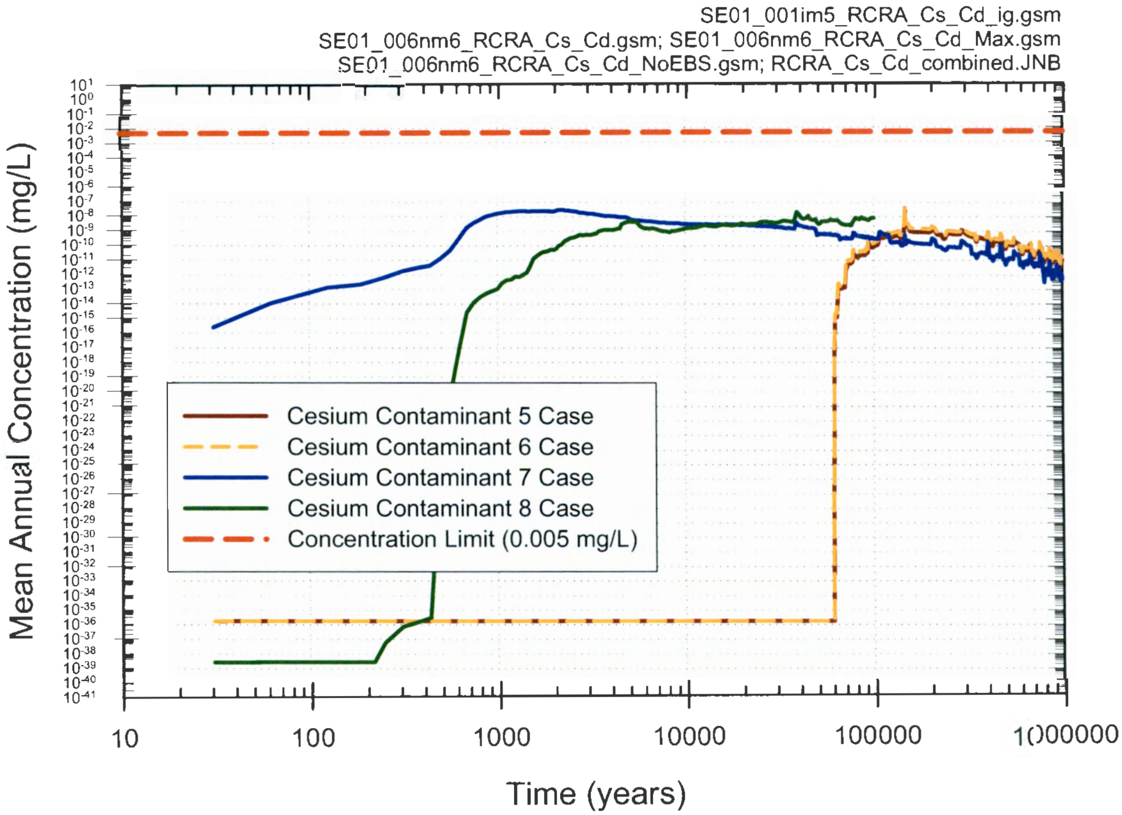

Figure 42. Mean annual concentration of cadmium for selected cesium contaminant analysis cases.

Figure 43 displays the statistical mean groundwater concentration of chromium for the Cesium Contaminant 9 (full-range chromium inventory) (See Table 25 for full case descriptions), Cesium Contaminant 10 (maximum chromium inventory), Cesium Contaminant 11 (full-range chromium inventory with no engineered barrier system), and Cesium Contaminant 12 (full range chromium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 43 is contained in Appendix B as Figures B-20, B-21, B-22, and B-23. The concentration limit line represents the requestor-defined groundwater concentration limit for chromium.

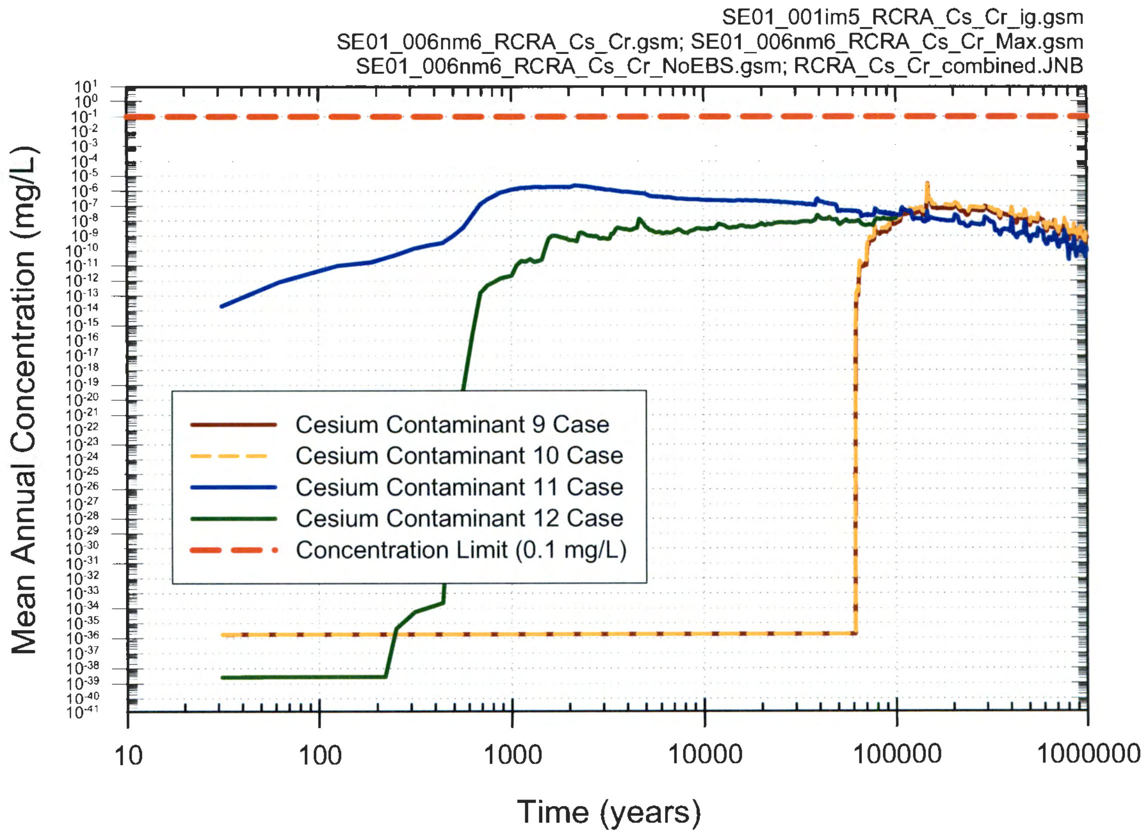

Figure 43. Mean annual concentration of chromium for selected cesium contaminant analysis cases.

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Figure 44 displays the statistical mean groundwater concentration of lead for the Cesium Contaminant 13 (full-range lead inventory) (See Table 25 for full case descriptions), Cesium Contaminant 14 (maximum lead inventory), Cesium Contaminant 15 (full-range lead inventory with no engineered barrier system), and Cesium Contaminant 16 (full range lead inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 44 is contained in Appendix B as Figures B-24, B-25, B-26, and B-27. The concentration limit line represents the requestor-defined groundwater concentration limit for lead.

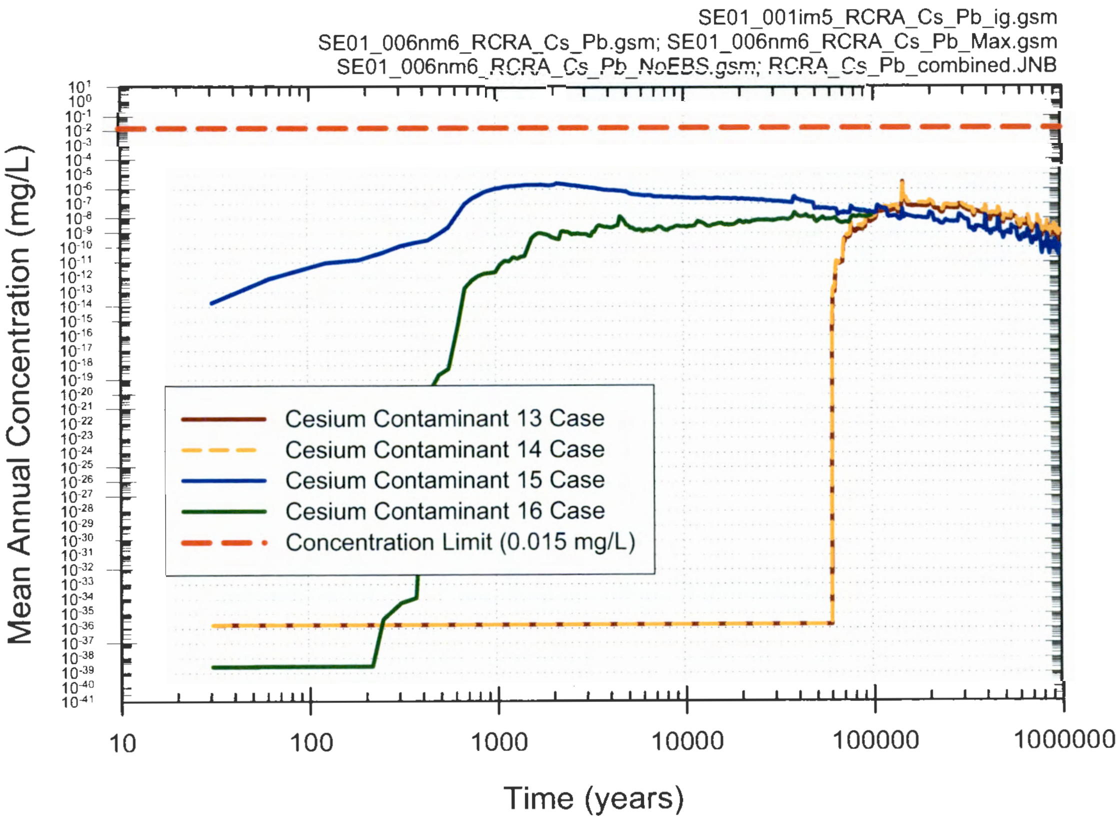

Figure 44. Mean annual concentration of lead for selected cesium contaminant analysis cases.

Figure 45 displays the statistical mean groundwater concentration of silver for the Cesium Contaminant 17 (full-range silver inventory) (See Table 25 for full case descriptions), Cesium Contaminant 18 (maximum silver inventory), Cesium Contaminant 19 (full-range silver inventory with no engineered barrier system), and Cesium Contaminant 20 (full range silver inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 45 is contained in Appendix B as Figures B-28, B-29, B-30, and B-31. The concentration limit line represents the requestor-defined groundwater concentration limit for silver.

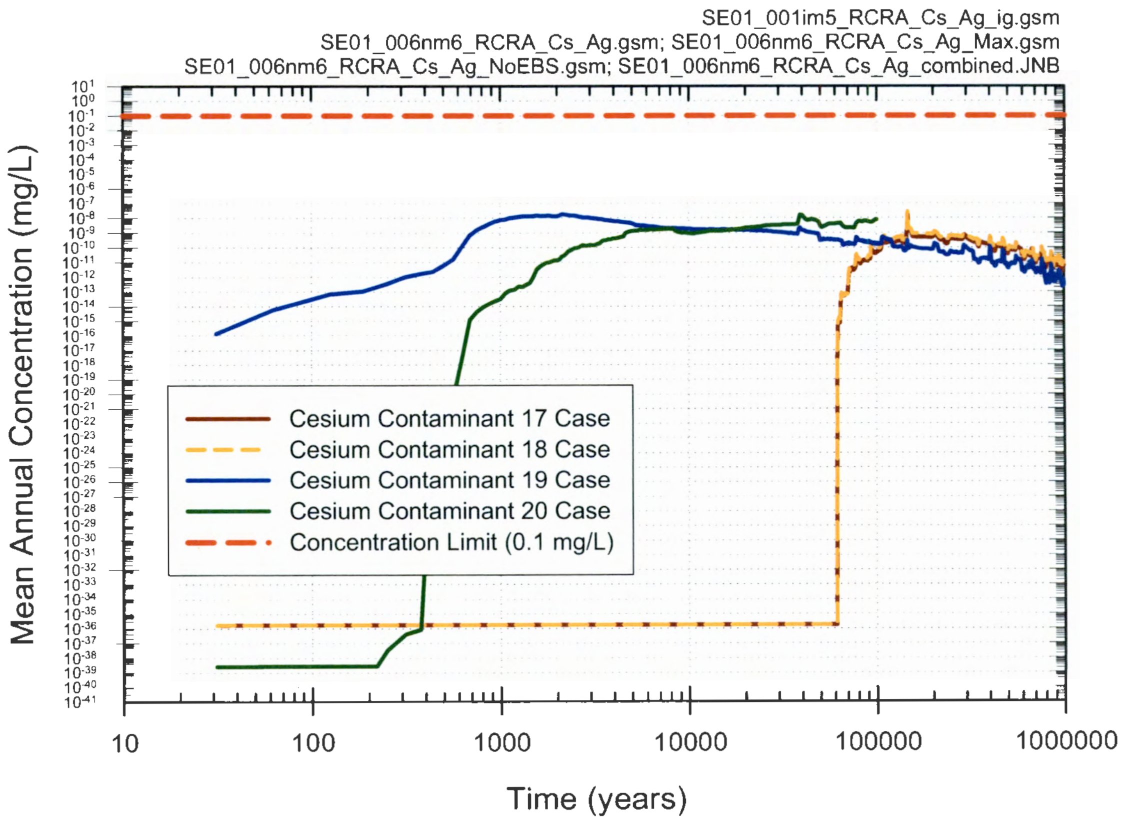

Figure 45. Mean annual concentration of silver for selected cesium contaminant analysis cases.

4.6.5 Strontium Fluoride Capsule Contaminant Metal TSPA Results

For the simulation of contaminant metal transport, the TSPA-FEIS model was run one time for each case. Simulation details for each of the cases are shown in Table 26. In all cases, the Year 2006 inventory was used for initial metal quantity values since nuclear decay does not change the metal inventory in this case.

Table 26. Strontium capsule contaminant metal simulation case details.

Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
Strontium Contaminant 1	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range barium inventory.	Nominal	1,000,000	300
Strontium Contaminant 2	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the maximum barium inventory.	Nominal	1,000,000	300
Strontium Contaminant 3	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range barium inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Strontium Contaminant 4	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range barium inventory.	Igneous	100,000	5,000
Strontium Contaminant 5	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range cadmium inventory.	Nominal	1,000,000	300
Strontium Contaminant 6	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the maximum cadmium inventory.	Nominal	1,000,000	300

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Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
Strontium Contaminant 7	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range cadmium inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Strontium Contaminant 8	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range cadmium inventory.	Igneous	100,000	5,000
Strontium Contaminant 9	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range chromium inventory.	Nominal	1,000,000	300
Strontium Contaminant 10	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the maximum chromium inventory.	Nominal	1,000,000	300
Strontium Contaminant 11	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range chromium inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Strontium Contaminant 12	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range chromium inventory.	Igneous	100,000	5,000
Strontium Contaminant 13	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range lead inventory.	Nominal	1,000,000	300

Case Name	Case Description (See Nomenclature)	Scenario (See Nomenclature)	Simulation Period (years)	Number of Realizations
Strontium Contaminant 14	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the maximum lead inventory.	Nominal	1,000,000	300
Strontium Contaminant 15	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range lead inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Strontium Contaminant 16	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range lead inventory.	Igneous	100,000	5,000
Strontium Contaminant 17	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range silver inventory.	Nominal	1,000,000	300
Strontium Contaminant 18	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the maximum silver inventory.	Nominal	1,000,000	300
Strontium Contaminant 19	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range silver inventory. The repository Engineered Barrier System is removed.	Nominal	1,000,000	300
Strontium Contaminant 20	Repository inventory reduced to 38 codisposal waste packages. Each waste package contains the full range silver inventory.	Igneous	100,000	5,000

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Figure 46 displays the statistical mean groundwater concentration of barium for the Strontium Contaminant 1 (full-range barium inventory) (See Table 26 for full case descriptions), Strontium Contaminant 2 (maximum barium inventory), Strontium Contaminant-3 (full-range barium inventory with no engineered barrier system), and Strontium Contaminant 4 (full-range barium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 46 is contained in Appendix B as Figures B-32, B-33, B-34, and B-35. The concentration limit line represents the requestor-defined groundwater concentration limit for barium.

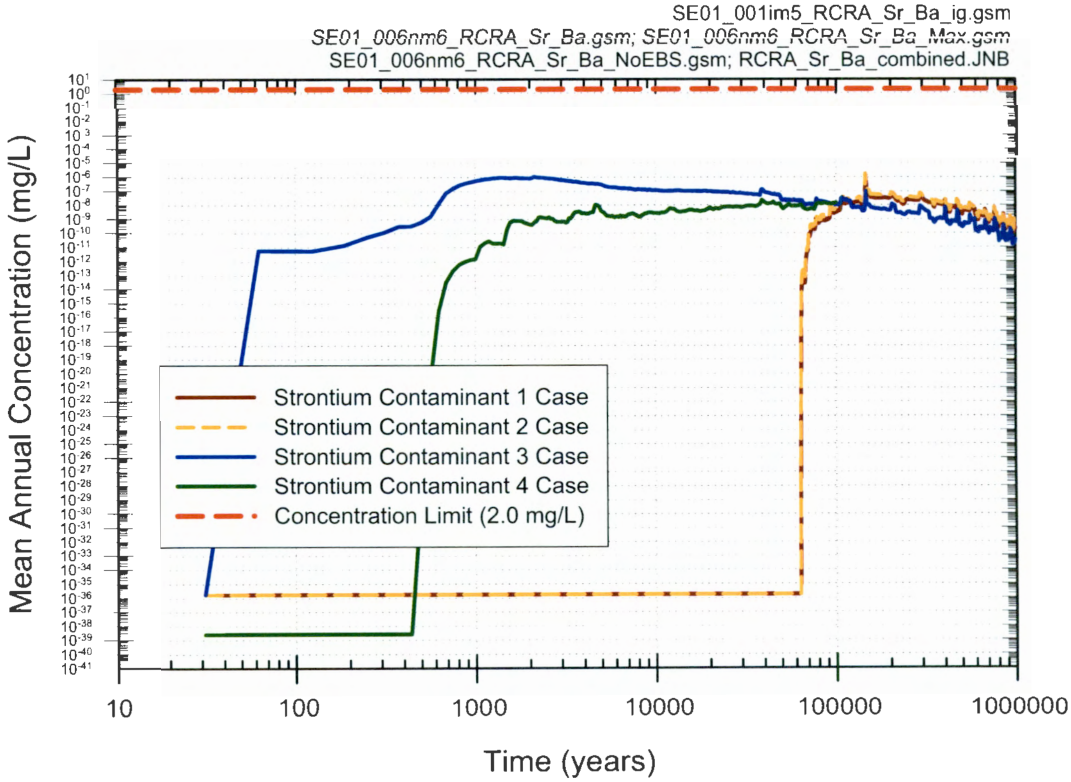

Figure 46. Mean annual concentration of barium for selected strontium contaminant analysis cases.

Figure 47 displays the statistical mean groundwater concentration of cadmium for the Strontium Contaminant 5 (full-range cadmium inventory) (See Table 26 for full case descriptions), Strontium Contaminant 6 (maximum cadmium inventory), Strontium Contaminant 7 (full-range cadmium inventory with no engineered barrier system), and Strontium Contaminant 8 (full-range cadmium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 47 is contained in Appendix B as Figures B-36, B-37, B-38, and B-39. The concentration limit line represents the requestor-defined groundwater concentration limit for cadmium.

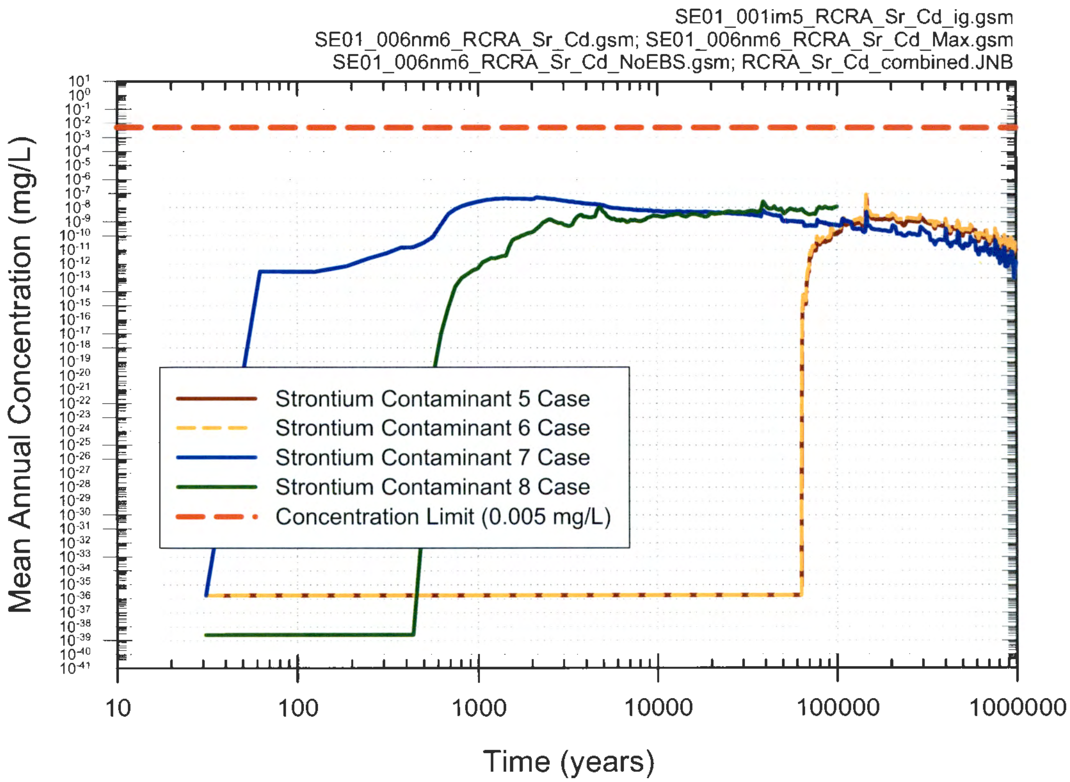

Figure 47. Mean annual concentration of cadmium for selected strontium contaminant analysis cases.

Figure 48 displays the statistical mean groundwater concentration of chromium for the Strontium Contaminant 9 (full-range chromium inventory) (See Table 26 for full case descriptions), Strontium Contaminant 10 (maximum chromium inventory), Strontium Contaminant 11 (full-range chromium inventory with no engineered barrier system), and Strontium Contaminant 12 (full-range chromium inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 48 is contained in Appendix B as Figures B-40, B-41, B-42, and B-43. The concentration limit line represents the requestor-defined groundwater concentration limit for chromium.

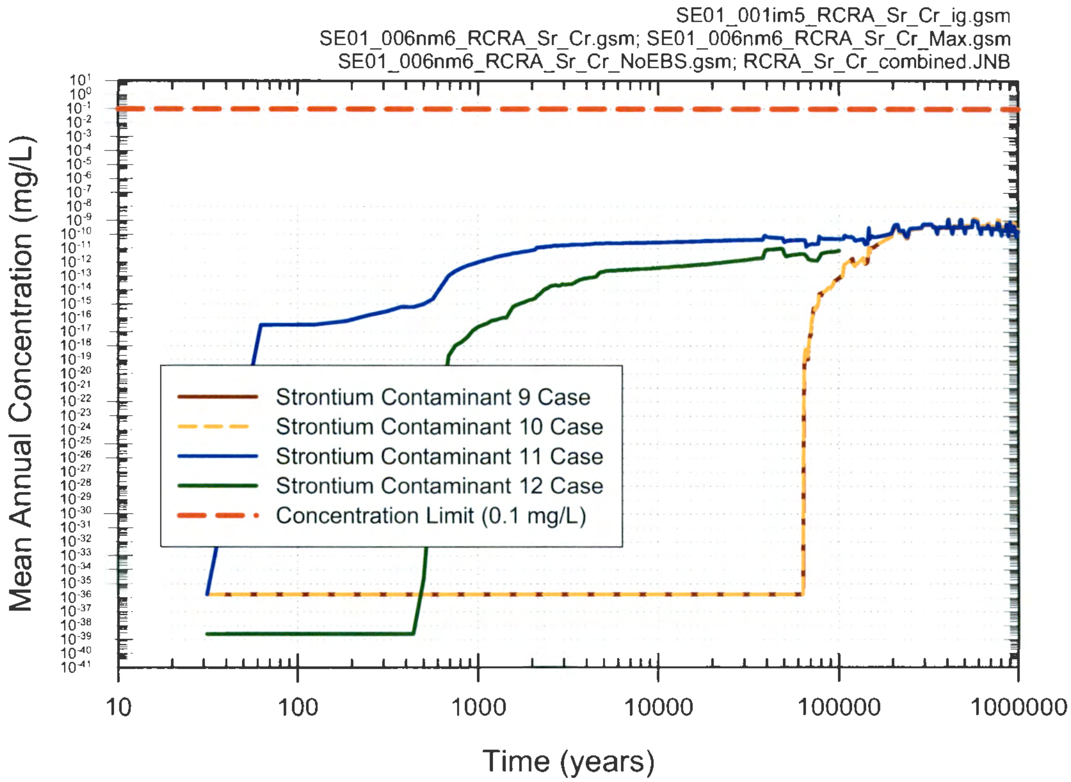

Figure 48. Mean annual concentration of chromium for selected strontium contaminant analysis cases.

Figure 49 displays the statistical mean groundwater concentration of lead for the Strontium Contaminant 13 (full-range lead inventory) (See Table 26 for full case descriptions), Strontium Contaminant 14 (maximum lead inventory), Strontium Contaminant 15 (full-range lead inventory with no engineered barrier system), and Strontium Contaminant 16 (full-range lead inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 49 is contained in Appendix B as Figures B-44, B-45, B-46, and B-47. The concentration limit line represents the requestor-defined groundwater concentration limit for lead.

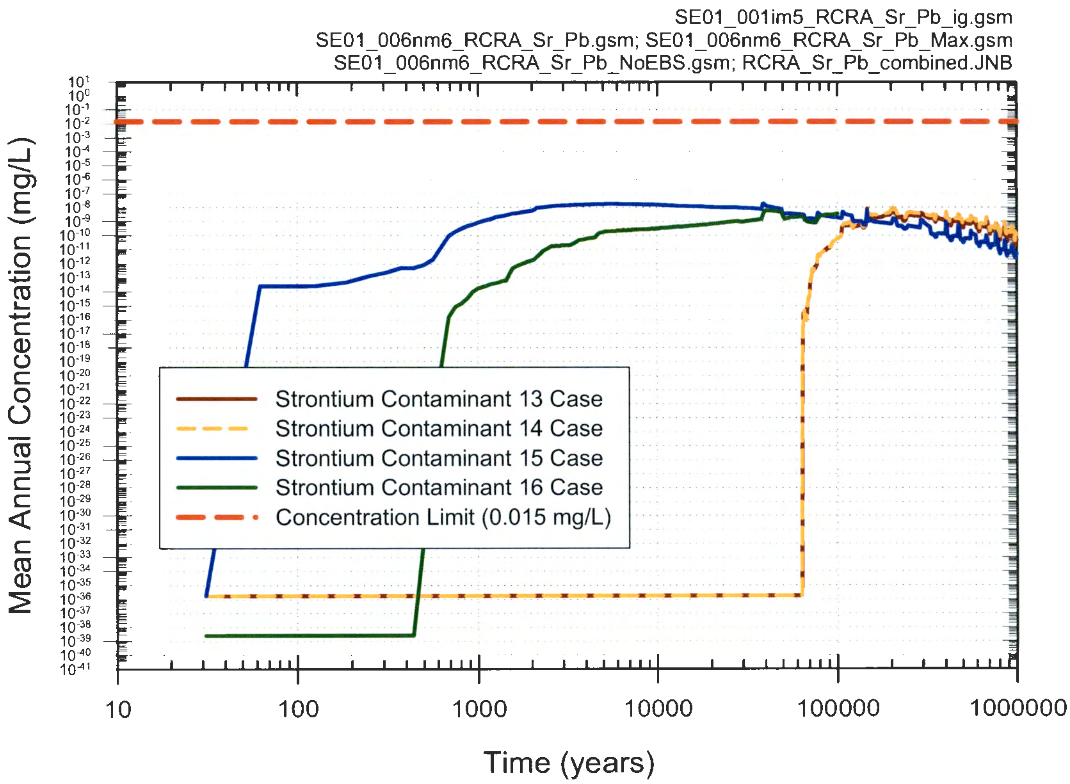

Figure 49. Mean annual concentration of lead for selected strontium contaminant analysis cases.

Figure 50 displays the statistical mean groundwater concentration of silver for the Strontium Contaminant 17 (full-range silver inventory) (See Table 26 for full case descriptions), Strontium Contaminant 18 (maximum silver inventory), Strontium Contaminant 19 (full-range silver inventory with no engineered barrier system), and Strontium Contaminant 20 (full-range silver inventory in the igneous scenario) cases. The full statistical curve set for each case shown in Figure 50 is contained in Appendix B as Figures B-48, B-49, B-50, and B-51. The concentration limit line represents the requestor-defined groundwater concentration limit for silver.

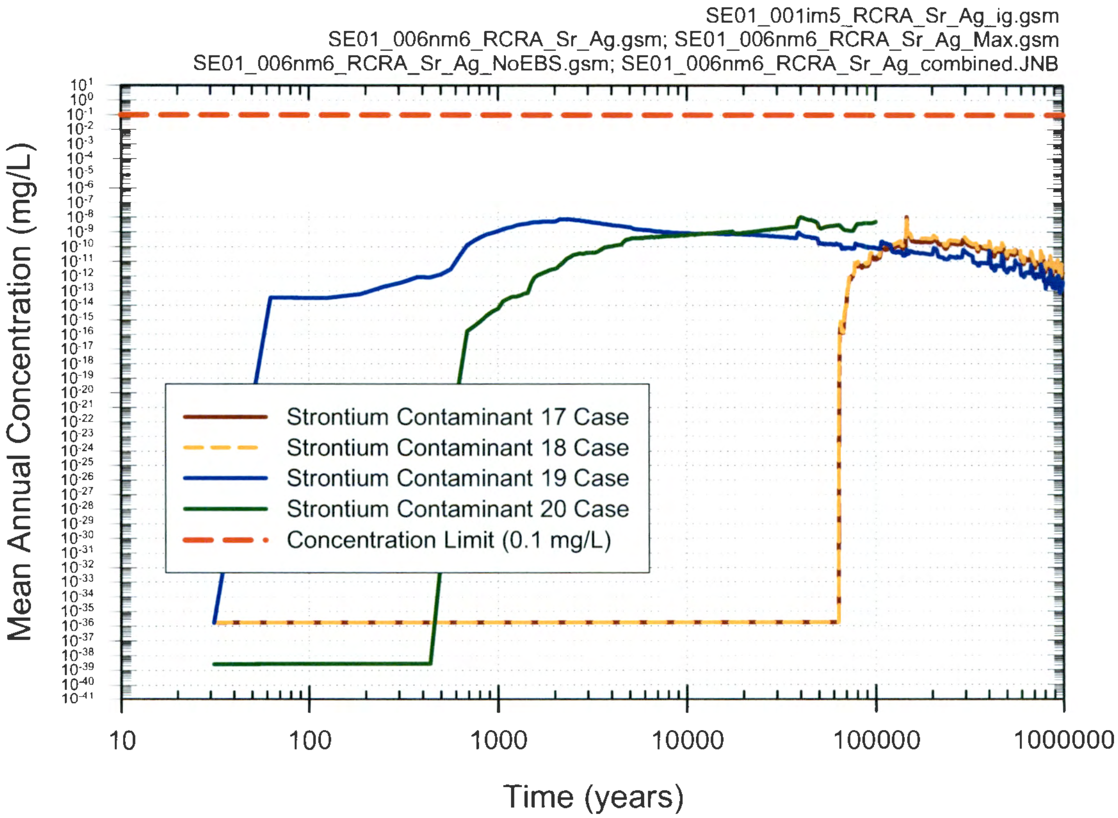

Figure 50. Mean annual concentration of silver for selected strontium contaminant analysis cases.

5. STUDY CONCLUSIONS

The study indicates that there is no significant affect of the low pH during the early phase of waste package failure on the overall corrosion product formation from the long-term degradation of the waste package. In other words, the corrosion products from a package containing cesium or strontium capsules are not significantly different than those from a codisposal package containing DOE SNF.

The TSPA analysis results for the maximum value of radionuclides contained in the capsules shows the increased dose from the radionuclide inventory in the capsules is very low compared to existing baseline models, which contain commercial SNF, DOE SNF, and DOE HLW. As shown by the TSPA model results, inclusion of the capsules has a negligible effect on the overall dose.

The TSPA analysis results for the contaminant metals of concern, using a triangular distribution of inventory values in the waste packages, indicates that calculated releases from the repository for the scenarios studies here are below the EPA's 40 CFR 141 National Primary Drinking Water Regulation, 141.62 Maximum Contaminant levels for inorganic contaminants (Barium, Cadmium and Chromium), Subpart I Control of Lead and Copper, 141.80, (c),(1) lead and 40 CFR 143, National Secondary Drinking Water Regulation, 143.3 (silver) limits, as interpreted by the DOE Richland Operations Office, for the nominal case analysis for all metals. This statement is also true for igneous scenarios and for the very conservative "no engineered barrier system" scenario.

This study is not a final determination of acceptability of the capsule materials in the proposed repository, but is rather a feasibility study indicating how the materials would transport through the repository after the breach of waste package(s) containing the materials. This study does not address other issues related to the direct disposal of the capsules to the repository, but rather only analyzes the chemical and transport effects of the capsule material after assumed placement in the proposed repository. Issues that need to be addressed for a full evaluation of the direct disposal of the capsules include transportation studies, studies of container handling at the repository, packaging studies, and others.

Since this study was conducted with a previous version of all software and models, further information is needed before any final decisions are made on direct disposal of the capsules. Some this information, related solely to repository transport analysis, are:

- This analysis evaluates an assumed scenario rather than a design. A detailed disposition design, specifying the canister design containing the capsules, the canister capsule loading, and verifying proposed materials of construction for the canister is needed to better define the as-packaged characteristics of the capsules.
- More refined data on the capsule contents to feed the analysis is desirable. Also, an evaluation of the data defining the capsule contents relative to repository quality requirements should be performed.
- As license application analyses at Yucca Mountain proceed, design changes are being made to the commercial SNF waste package and the DOE-SNF/HLW codisposal waste package. The final designs of these waste packages should be incorporated into the geochemical evaluations to determine if there is any impact to these results from those changes.

- Due to the many model enhancements currently underway for the repository license application calculations, repetition of this analysis at a future date with the both an updated EQ3/6 program and the final license application version of the TSPA is warranted to assure that conclusions from this study are not invalidated by model changes.

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Appendix A

Geochemical Analysis Assumptions And Rationales

Geochemical calculations for this study are performed using conceptual and computational methods consistent with previous waste package analyses.[1] To aid interpretation, assumptions relevant to both previous and current analyses are listed and include assumptions specific to the replacement of spent nuclear fuel with cesium chloride or strontium fluoride capsules in those previous waste package analyses. The assumptions are listed here with the same section headings as the main body of the report to facilitate cross-referencing.

Assumption 3.4.1 - Water Flux and Circulation

Assumption. The waste package configuration is discussed in Section 2.4.1. Based on this configuration, the geochemical calculations assume: (1) the corrosion-resistant shell remains intact except for openings near the upper surface that allow dripping ground water to enter and exit the waste package via these openings; (2) the rate of water ingress and egress (i.e., flux) are consistent and equivalent to the rate at which infiltrating ground water drips onto the waste package; and (3) the water circulates freely enough within the partially filled waste package that all the waste package components and degradation products may react with each other through the aqueous solution.

Rationale. (1) The first assumption is reasonable because the slow rate of corrosion of Alloy 22,[2] as compared to internal components of the waste package (i.e., steels), could allow water to pool inside the waste package. If the Alloy 22 were allowed to react, there would be no reservoir to contain the water and the chemical reaction of the water with the waste package materials, and the components would be minimized. (2) For most of the period of interest (i.e., after the waste package barriers becomes largely degraded), it is more reasonable to assume that all water dripping onto the degraded waste package will enter the waste package rather than to presume that a significant portion will be diverted around the remains of the waste package. This assumption yields the greatest release of dissolved waste constituents from the breached (failed) waste package and is reasonably conservative. (3) The third assumption is based on the convective circulation and mixing of water inside the waste package that is expected due to residual radioactive decay heat within the waste package.[3] Free circulation of water within the waste package is reasonably conservative, because it yields a greater opportunity for dissolution and removal of dissolved waste constituents from the waste package.

Assumption 3.4.2 - Insoluble Metals

Assumption. The waste package drip shield (Titanium Grade 7) and the outer corrosion-resistant shell (Alloy 22) will have a negligible effect on the in-package chemistry. Thus, these materials are neglected in geochemical calculations.

Rationale. These alloys corrode very slowly compared to other waste package materials as well as the rate at which soluble corrosion products will be flushed from the waste package. Therefore, they would have a negligible effect on the chemistry (see also Reference 2).[4]

Assumption 3.4.3 - Waste Package Component Properties

Assumption. The component properties (i.e., composition, mass, surface area, volume, and degradation rates) of the waste package used in these calculations are represented to a degree that closely approximates their true properties.

Rationale. Waste package component (i.e., inner liner, basket, HLW glass, and HLW glass canisters) mass, surface area, and volume are based on previous geochemical analyses. Likewise, the waste package void volume is based on those previous geochemical analyses. Component compositions and degradation rates are based on the latest version of the *In-Package Chemistry Abstraction* (see Reference 1). These previous analyses were intended to obtain the greatest accuracy in the representation of waste package materials and contents. The use of waste package material and content (i.e., HLW glass) data from the previous analyses is a reasonable approach for comparison of previous analyses to these that consider the replacement of spent nuclear fuel with Hanford capsules using an identical DOE waste package.

Assumption 3.4.4 - Capsule Properties

Assumption. Based on the capsule descriptions in Section 2, the geochemical calculations assume: (1) The chemical and physical properties (e.g., composition, mass, surface area, and volume) of capsules used in these calculations are represented to a degree that closely approximates their true properties, (2) the cesium chloride capsules degrade and dissolve into waste package solution very quickly, within the first few days of EQ6 simulations, (3) impurities in the cesium chloride capsules (e.g., $PbCl_2$) and strontium fluoride capsules (e.g., PbF_2) will dissolve at rates consistent with those prescribed for the bulk capsules, and (4) the inner strontium fluoride canister material, Hastelloy C-276, will have a negligible effect on the in-package chemistry and may be substituted with 316L stainless steel in these calculations.

Rationale. (1) The first assumption is based on the fact that the availability of technical data regarding chemical and physical properties of both cesium chloride and strontium fluoride capsule is limited. Calculations requiring knowledge of these properties rely exclusively upon the properties report generated for this study.[5] Uncertainties regarding capsule compositions and material characteristics result in the use of average capsule compositions, which include the method detection limits (MDLs) for some capsule constituent quantities (e.g., silver) and the exclusion of the capsule's sintered stainless steel discs in these calculations. Use of MDLs for capsule constituent quantities is justified in that it leads to conservatively high estimations of constituent concentrations in solution. Exclusion of the sintered discs is assumed inconsequential because the amount of stainless steel (316L) in the discs (approximately <0.001% of total 316L) is insignificant relative to the amount of 316L in other waste package components. (2) The basis for the second assumption is the lack of cesium chloride capsule dissolution data. However, cesium chloride is a chloride salt and as such will be expected to readily dissolve in aqueous solutions. A high cesium chloride degradation rate was arbitrarily selected to affect rapid dissolution. (3) The third assumption is based on increased conservatism with respect to capsule impurities (i.e., metals). Homogeneity of capsule degradation allows all constituents to be equally available to participate in precipitation reactions and/or release to the environment. (4) The fourth assumption is base on uncertainty regarding the use of Hastelloy C-276 canisters for the strontium fluoride capsules. The strontium fluoride capsules were intended to be placed into inner canisters made of Hastelloy and outer canisters made of 316L stainless steel. However, there are indications that Hastelloy may have been inadvertently used for some of the outer strontium fluoride canisters (see Reference 5). Uncertainty regarding both the amount of Hastelloy and its degradation characteristic under conditions simulated affects the exclusion of Hastelloy and use of the 316L stainless steel composition for inner and outer strontium fluoride canisters in these calculations. This substitution is a reasonable approach based on the general composition, similar of Hastelloy and 316L stainless steel, and use of 316L stainless steel degradation rates that have been established for the conditions simulated.

Assumption 3.4.5 - Cesium and Strontium Isotopes

Assumption. The initial cesium and strontium isotopic mass ratios may be used for post EQ6 determination of individual isotope in-package solution concentrations.

Rationale. This assumption is based on the need to differentiate multiple isotopes during geochemical simulations and the inability of EQ6 to differentiate and track multiple isotopes of an individual element. These analyses include calculations for in-package solution concentrations of cesium and strontium isotopes over a 20,000-year period for maximum and minimum capsule mass loading of two capsule composition scenarios (cases): (1) early (i.e., current year, 2006) waste package breach (failure) occurring before significant isotopic decay occurs, and (2) late (i.e., 10 half-life decay or Year 2275) waste package failure occurring after relatively short lived isotopes have completely decayed to their progeny. The Year 2006 failure cases are intended to represent the potential maximum concentration of cesium or strontium isotopes. Neglecting radioactive decay and determining isotope concentration based on the initial isotope mass is justified in that it leads to conservatively high estimations of isotopes in solution.

The late time (Year 2275) failure cases are intended to represent the most likely or probable concentration of cesium and strontium isotopes. Year 2275 failure is defined as occurring after the relatively short lived cesium-137 and strontium-90 isotopes have completely decayed to their respective progeny barium and zirconium (i.e., after 10 half-lives or ~300 years). For these cases, the capsule compositions are modified to account for changes in these masses while the mass of other capsule impurities are identical for all cases. Year 2275 strontium fluoride waste package simulations include the only remaining strontium isotope, strontium-87, which is radioactively stable. However, Year 2275 cesium chloride waste package cases contain both cesium-133 (stable) and cesium-135 (radioactive). Given the cesium-135 half-life of 2.3 million years, the initial mass of cesium-135 would in actuality be reduced by ~0.6 wt% over the 20,000 year simulation. Determination of the cesium isotope concentration based on the initial cesium-133/cesium-135 mass ratio is justified in that it leads to conservatively high estimations of cesium-135 in solution.

Assumption 3.4.6 - Mineral Phase Suppression

Assumption. This study assumes goethite may be suppressed in favor of hematite formation.

Rationale. Individual minerals may be manually suppressed based on knowledge of that mineral's means of formation. Otherwise, the choice of which minerals precipitate is determined automatically within EQ6 with consideration of the system's chemical thermodynamics. Which ferric (hydr)oxide phase will form in a degrading waste package is uncertain. There is information suggesting a time dependency where poorly crystalline ferrihydrite may initially dominate with a slow transformation, depending on the system chemistry, to goethite and hematite (see Reference 1, Section 6.3.2). In actuality, a mixture of these three phases in varying proportions is likely to occur. Ferrihydrite formation does not occur in these simulations because of limited thermodynamic data. Formation of goethite is kinetically favored over hematite; however, hematite is the more thermodynamically stable mineral. From a modeling stand point, suppression of goethite with formation of hematite as the primary ferric iron phase is consistent with use of the EQ6 thermodynamic equilibrium code. Therefore, suppression of goethite is justified based on use of a thermodynamic database. Additional discussion of mineral suppression is found in the document associated with the input file adopted for this investigation (see Reference 1, Section 6.3.1.3.5).

Assumption 3.4.7 - Capsule and HLW Glass Exposure

Assumption. The cesium chloride, strontium fluoride capsule, and HLW glass canisters are initially completely breached (allowing 100% of the surface areas to be exposed to degradation) to allow for damage that may occur due to future events and processes.

Rationale. This is conservative in that it allows maximum dissolution of capsules and glass with maximum availability of capsule impurities for aqueous transport from the waste package.

Assumption 3.4.8 - In-Package Water Content and Composition

Assumption. Based on the overall system configuration and the baseline analysis comparison, the geochemical calculations assume: (1) The volume of an aqueous solution in the waste package is maintained at one-half of the total in-package void volume. (2) The solid volume initially occupied by the 16 capsules can be added to the total initial waste package void volume (i.e., mass of water). (3) The solutions that drip into the waste packages will have the major ion composition of J-13 well water as given in DTN: MO0006J13WTRCM.000 for at least 20,000 years. (4) And the addition of small amounts (1.0E-16 molal) of trace elements present in the waste package to the EQ3NR input file used to calculate initial in-package solution composition will not affect the nature or extent of subsequent EQ6 geochemical calculations.

Rationale. (1) The basis for the first part of this assumption is to maintain consistency with the baseline analysis (see Reference 1, Section 6.3.1.1, p. 6-6). The baseline considers the waste package void space to be half-filled with water. The other half of the void space is filled with air in equilibrium with the drift atmosphere. This approach may be considered to approximate the effects of capillary forces distribute water to the tight spaces in the waste package allowing all reactants to react with in-package solution though the waste package is not completely filled with water. The first assumption is reasonable for comparing current waste package analyses to the baseline analysis. (2) The basis for the second assumption is that the capsules are expected to dissolve quickly (on the order of days to months) relative to the 20,000-year geochemical simulations. Addition of the volume briefly occupied by the capsules into the total in-package void volume allows the volume (i.e., mass) of in-package solution reacting with waste package materials to be more closely represented during the greater portion of EQ6 simulations. (3) The basis for the third assumption is that the groundwater composition is controlled largely by transport through the host rock, over pathways of hundreds of meters, and the host rock composition is not expected to change substantially over one million years. (4) The basis for the fourth assumption is that EQ6 requires that a tangible amount (e.g., 1.0E-16 molal) of each element in a reaction path calculation be present in the aqueous phase at the start of calculations.

Assumption 3.4.9 - Thermodynamic Equilibrium

Assumption. All reactions between the in-package solution and precipitating solids are in equilibrium. In addition, all gas-solution reactions are reversible and are at equilibrium with the ambient atmosphere outside the waste package, and the latter will be characterized by specific partial pressures (fugacities) of carbon dioxide and oxygen, respectively, of $10^{-3.0}$ and $10^{-0.7}$ atm.[6]

Rationale. (1) The first assumption is based on the fact that thermodynamic equilibrium is implicit in the EQ3/6 reaction and reaction path codes. In these models, kinetic factors do not control reactions between solution and precipitating solids, even though it is unlikely all reactions will actually reach equilibrium even over the 10,000-year regulatory period. Therefore, exceptions to the equilibrium assumption are made based on knowledge of a reaction product's means of formation and/or the kinetics of formation. Exceptions include the suppression of mineral phases known to form only at high temperatures. An example of mineral suppression based on temperature of formation is quartz. At low temperatures quartz is less soluble than amorphous silica, thus quartz reaches saturation before amorphous silica. However, quartz is not observed to form in low temperature aqueous systems. Therefore, quartz formation is suppressed in these low-temperature EQ6 runs. (2) The second assumption is justified because the O_2 partial pressure at the repository horizon is equivalent to that in the atmosphere. The CO_2 pressure is somewhat higher than atmospheric and was chosen to reflect the observation that J-13 well water (i.e., the waste package displaced solution) appears to be in equilibrium with higher than atmospheric CO_2 levels.[7]

Assumption 3.4.10 - Thermodynamic Database

Assumption. The thermodynamic database, data0.ymp.R4, used for the previous base case analysis (see Reference 1), is sufficiently accurate for these geochemical calculations. The additions and changes made to the database for previous base case analyses will not compromise the results of the geochemical calculations.

Rationale. (1) The basis for the first assumption is the use of a database, which is qualified for temperatures up to 200°C when excessive temperatures may exist especially for the scenario involving waste package breach occurring immediately after waste package emplacement in Year 2006. Use of the database is justified in that it is the only database qualified for EQ3/6 calculations relative to the Yucca Mountain Performance Assessment. Further, only cursory consideration is given to geochemical calculations involving the Year 2006 "worse-case" scenario and results are evaluated as extreme inputs to the TSPA. Consideration is given to results of geochemical calculations involving cases for which short-lived cesium and strontium isotopes have been decayed to their progeny in Year 2275. Consistent with the previous base case, geochemical calculations for the Year 2275 "most likely" scenario begin 10,000 years after waste package emplacement when the thermal pulse will have passed and waste package temperatures will be at or below 100°C. (2) The base for the second assumption is the addition of vitrified Savannah River HLW (HLW Glass) and limitation of the chromium oxidation state in the database. HLW glass was entered to the database as the "mineral" GlassSRL to facilitate the use of pH-dependent kinetic rate laws (i.e. a range of degradation rates based on pH can be specified only for waste package components [reactants] entered as minerals in the database). (Reactants entered via EQ6 input files as "Special" reactants must be assigned a constant or fixed degradation rate). The GlassSRL reactant was assigned infinite solubility to prevent its formation via precipitation reactions. This addition to the database is justified because it will allow more realistic degradation and lead to more logical results from the EQ6 calculations regarding this HLW form. The element chromium is a major constituent of HLW capsules and several of the stainless steels and alloys used in the construction of the HLW canisters and co-disposal waste package materials. Allowing chromium to oxidize to chromium (VI) has been shown to leads to artificially high ionic strengths and low pH of in-package solutions (see Reference 1, Section 6.3.1). The reason for this in-package condition is the chromium that comes out of the stainless steels drives up the ionic strength and lowers the pH through chromic acid (H_2CrO_4) formation. Therefore, consistent with the previous base case analysis, the oxidation state of chromium is limited to chromium (III) rather than chromium (VI) in EQ3/6 calculations. Justification for selection of the chromium (III) oxidation state (kinetically determined in reality) is stated in Reference 1 (Section 6.6.3).

Selection of chromium (III) over that of the more soluble chromium (VI) species is based on experimentally observed corrosion products, and on the kinetics and conditions required to obtain the fully oxidized chromium (VI) state.[8] Smith and Purdy's examination (see Reference 8) of the actual chromium speciation as a result of corrosion of 316L stainless steel demonstrated a predominance of the less soluble chromium (III) species, except under the conditions of hot concentrated nitric acid (111°C and >7 molal nitric acid), (see Reference 8, Figure 6). Therefore, explicitly excluding chromium (VI) solids in the database in favor of chromium (III) phases is justified because it will lead to more logical results from the EQ6 calculations.

As in the previous base case analysis, the oxidation state of chromium is modeled as chromium (III) by removing aqueous and solid phase chromium (VI) from the database. However, the chromium (VI) species, $CrO4^{-}$, is a basis species in the database and as such cannot be removed. Therefore, chromium (VI) is effectively excluded from EQ3/6 calculations by swapping Cr^{+++} for $CrO4^{-}$, in the *master species list*, and suppressing $CrO4^{-}_{(aq)}$, in the *suppressed species* block, of EQ3/6 input files. Removal of solid phase chromium (VI) from the database eliminates minerals functioning as a sink for chromium. The elimination of chromium minerals is not practical because it would allow the solution to becoming unrealistically concentrated with respect to aqueous chromium as chromium-rich materials dissolve. To prevent this condition, two chromium (III) minerals: $Cr(OH)_3$ and eskolaite (Cr_2O_3), taken from a report by Ball and Nordstrom,[9] were added to the database. Thus, the amount of chromium remaining in solution is determined by the system's chemical thermodynamics as it relates to precipitate of these chromium (III) minerals.

Assumption 3.4.11 - Changes to the Capsule Composition

Assumption. Highly reactive chemical species of barium and zirconium produced by radioactive decay will react with capsule impurities, forming metals of those materials and stable species of those decay products prior to waste package failure. Using chloride or fluoride to balance the electrochemical charge of the capsule's molar composition will have a negligible effect on in-package chemistry.

Rationale. (1) The first assumption is based on results of a study for dry corrosion of cesium chloride and strontium fluoride capsule containers by highly reactive decay products (Reference 2). Simply put, the radioactive decay of one CsCl molecule produces one Cl and one Ba atom, which form the very unstable BaCl molecule. The BaCl molecule quickly acquires an additional Cl atom to form a stable $BaCl_2$ molecule. Because two Cl atoms are needed to form each $BaCl_2$ and only one is acquired from the decay of CsCl, a second Cl atom is acquired from less stable metal salts present in the capsule as impurities. The metal cations remaining after reduction of the salts are subsequently converted to their stable metallic form.[10] A similar reaction is expected for the radioactive decay of SrF_2 to one Zr atom and two F atoms (Reference 10, Section 4.2.3). In this case, formation of two fluorides of Zr with similar stability is possible (i.e., ZrF_2 and ZrF_4). Given uncertainties of impurity mass determinations and speciation, F is expected to be present in molar quantities sufficient to maintain electrochemical neutrality regardless of Zr-fluoride speciation. The impurities expected in CsCl and SrF_2 capsule and their weight percentages are given in Reference 4 (Tables 3.5, p. 3-9 and 3.7, p. 3-15, respectively). (2) The basis for the second assumption is that electrical charge balance is explicit to geochemical calculations. However, capsule compositions used in the geochemical model were originally given in terms of metal/cation mass (e.g., grams of Cs, Sr, Fe, Mg, etc), primarily in the form of stable chlorides or fluorides. Uncertainty regarding mass determinations and speciation of CsCl and SrF_2 capsule impurities results in electrical charge imbalances of molar compositions initially calculated for input to the geochemical model. Therefore, the molar compositions of CsCl and SrF_2 capsules were respectively charge balanced using Cl^- and F^- prior to EQ6 calculations. Electrical charge was not balanced on oxygen because the capsules were processed in a helium environment and oxides are largely absent from capsule compositions. The addition of oxygen would also lead to artificially high precipitation of ferric hydroxides. The addition of Cl^- and F^- to balance change is justified because it improves the electrochemical representation of capsule compositions used in EQ6 calculations.

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Appendix B

Cesium-Strontium Capsule TSPA Full Statistical Plots

Figure B-1 shows the statistical plots of the annual dose for the Base Case (see Table 22 for specific case detail), which simulates the base repository inventory of 7,860 commercial SNF waste packages and 3,910 DOE waste packages which contain DOE SNF and HLW glass. The plot displays separate curves for various statistical values of the set of realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

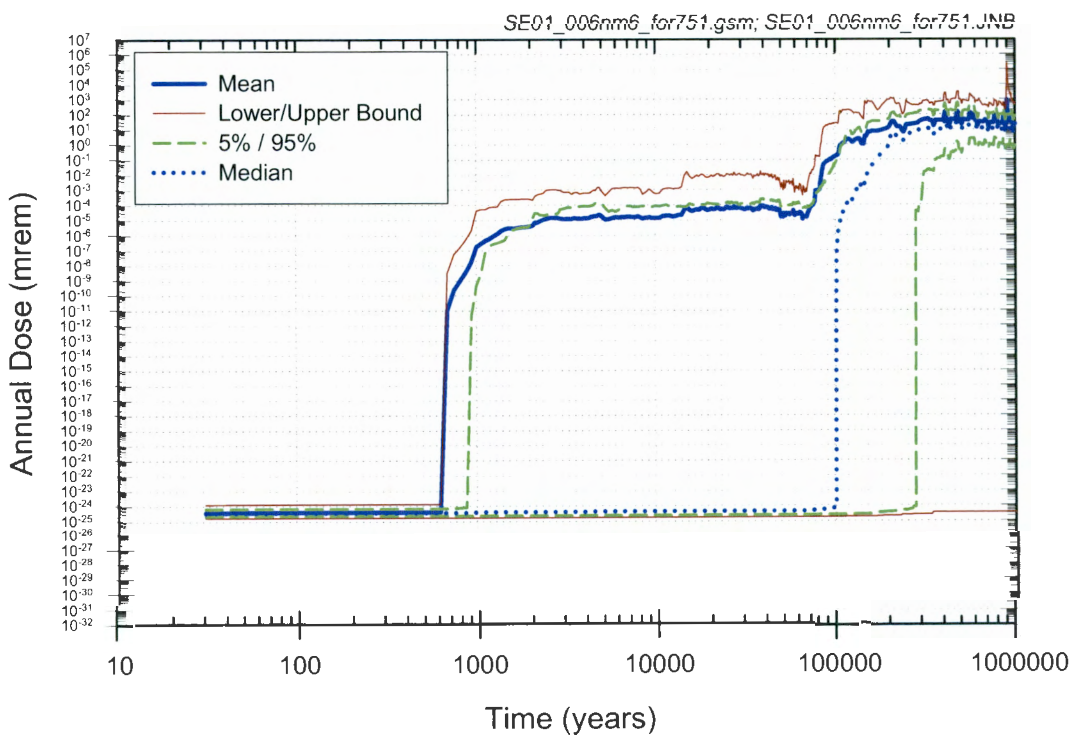

Figure B-1. Statistical curve set for the Base Case analysis.

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Figure B-2 shows the statistical plots of the annual dose for the Cesium 1 case (see Table 22 for specific case detail), which prevents release from commercial SNF waste packages, thereby defining the dose from this source as zero and modifying the number of codisposal packages to 84 to match the projected number of cesium waste packages. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

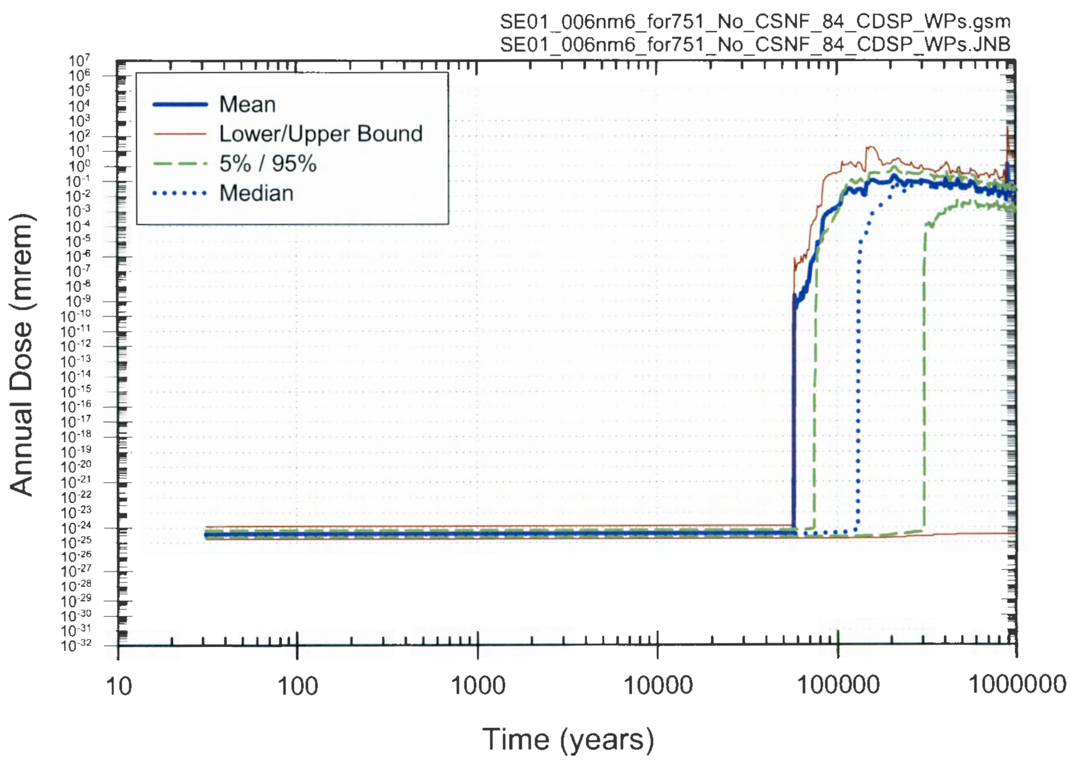

Figure B-2. Statistical curve set for the Cesium 1 case analysis.

Figure B-3 shows the statistical plots of the annual dose for the Strontium 1 case (see Table 22 for specific case detail), which prevents release from commercial SNF waste packages, thereby defining the dose from this source as zero and modifying the number of codisposal packages to 38 to match the projected number of strontium waste packages. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

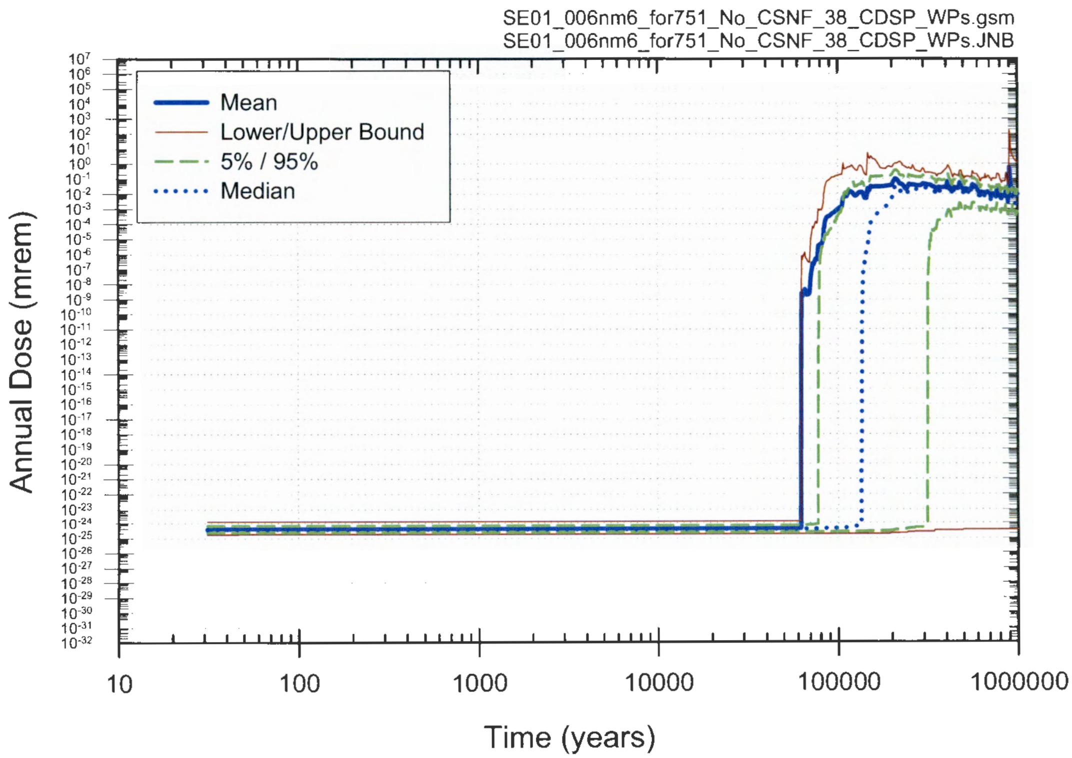

Figure B-3. Statistical curve set for the Strontium 1 case analysis.

Title: Hanford Cs-Sr Repository Disposal Performance Analysis Using the TSPA-FEIS Model

Figure B-4 shows the statistical plots of the annual dose for the Cesium 2 case (see Table 22 for specific case detail), which prevents release from commercial SNF waste packages, thereby defining the dose from this source as zero and modifying the number of codisposal packages to 84 to match the projected number of cesium waste packages. In addition, the Cesium 2 case replaces each DOE standardized canister containing DOE SNF with a DOE standardized canister containing the maximum inventory of Cesium-137 chloride. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

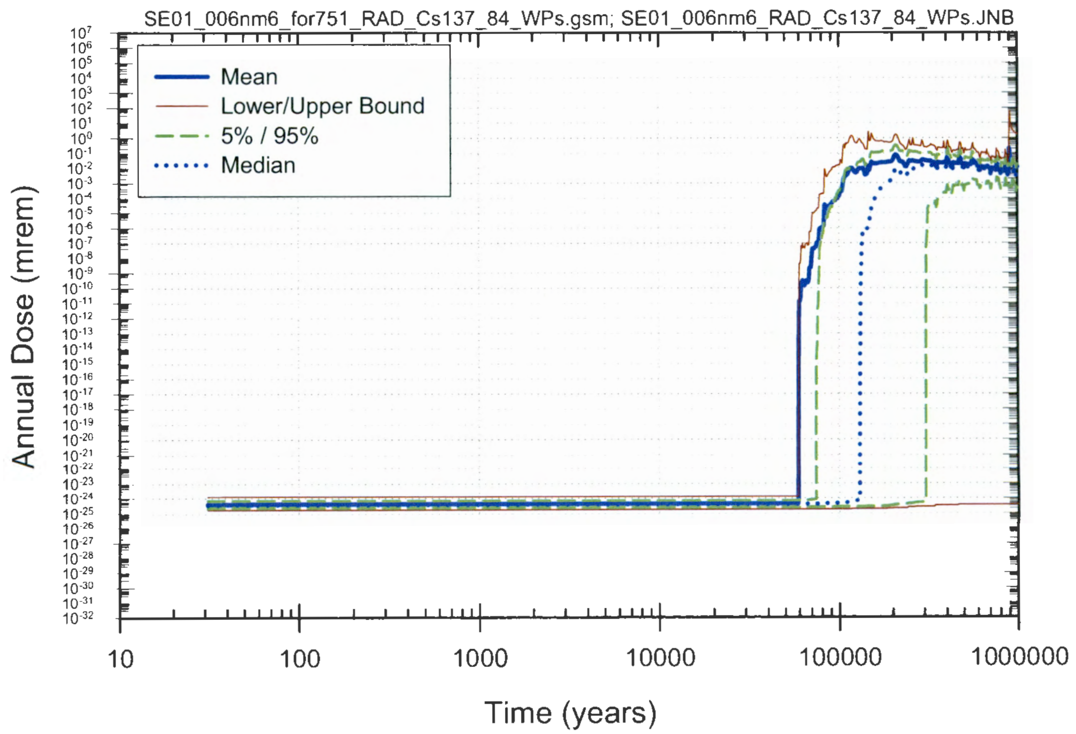

Figure B-4. Statistical curve set for the Cesium 2 case analysis.

Figure B-5 shows the statistical plots of the annual dose for the Cesium 3 case (see Table 22 for specific case detail), which prevents release from commercial SNF waste packages, thereby defining the dose from this source as zero and modifying the number of codisposal packages to 84 to match the projected number of cesium waste packages. In addition, the Cesium 3 case replaces each DOE standardized canister containing DOE SNF with a DOE standardized canister containing the maximum inventory of Cesium-135 chloride. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. As discussed in the main body of the report, the dose calculations for this case are based on Cesium-135 properties and are included only for indication. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

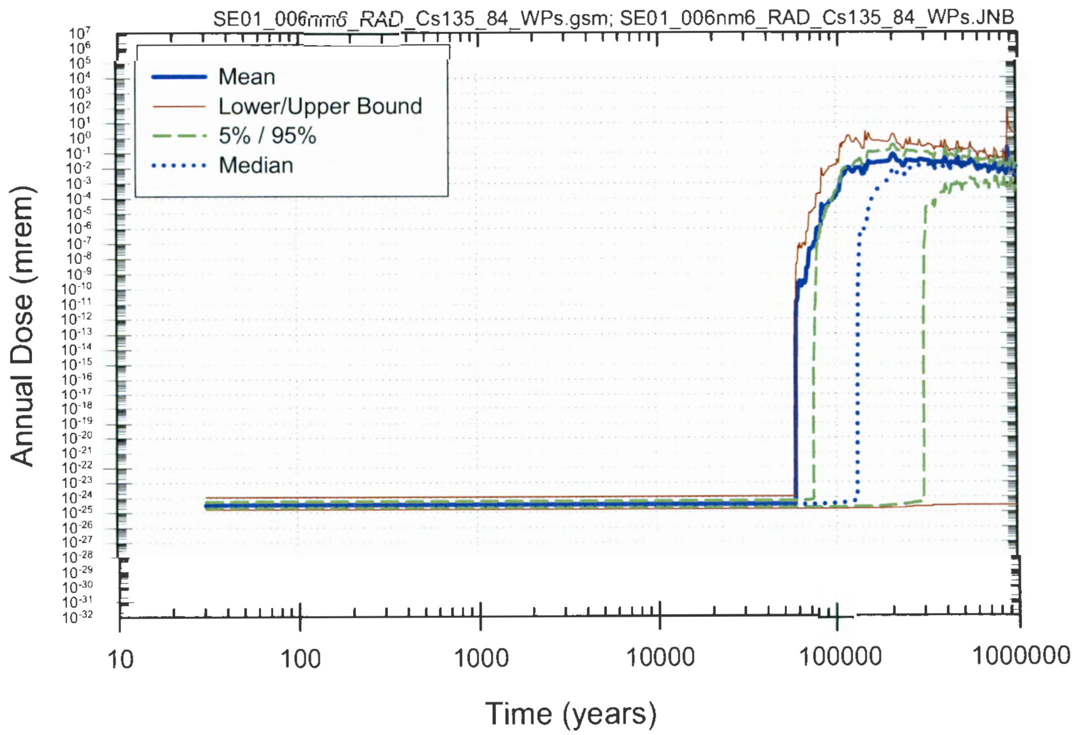

Figure B-5. Statistical curve set for the Cesium 3 case analysis.

Figure B-6 shows the statistical plots of the annual dose for the Strontium 2 case (see Table 22 for specific case detail), which prevents release from commercial SNF waste packages, thereby defining the dose from this source as zero and modifying the number of codisposal packages to 38 to match the projected number of strontium waste packages. In addition, the Strontium 2 case replaces each DOE standardized canister containing DOE SNF with a DOE standardized canister containing the maximum inventory of strontium-90 fluoride. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

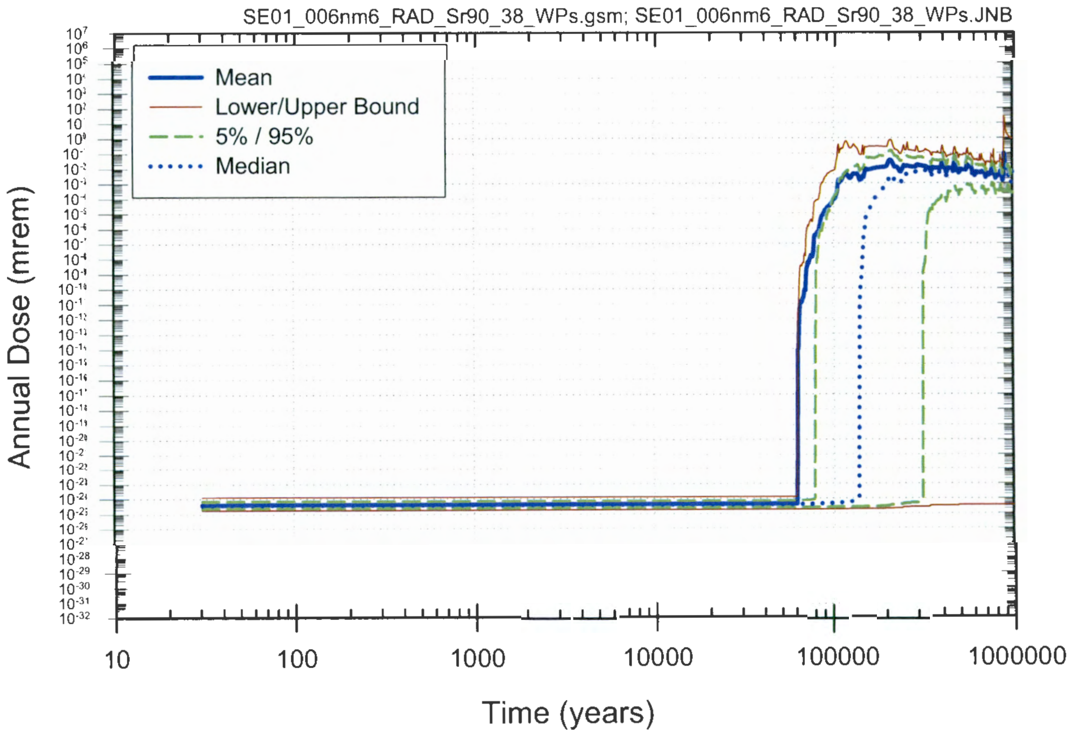

Figure B-6. Statistical curve set for the Strontium 2 case analysis.

Figure B-7 shows the statistical plots of the annual dose for the Cesium Strontium 1 case (see Table 22 for specific case detail), which adds the maximum inventories of cesium-137 chloride and strontium-90 fluoride to each DOE waste package in the Base Case. This simulates more capsule material than is physically available to place in the repository, which provides a high estimate of dose change from these sources. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to transport of the radionuclides in the groundwater. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

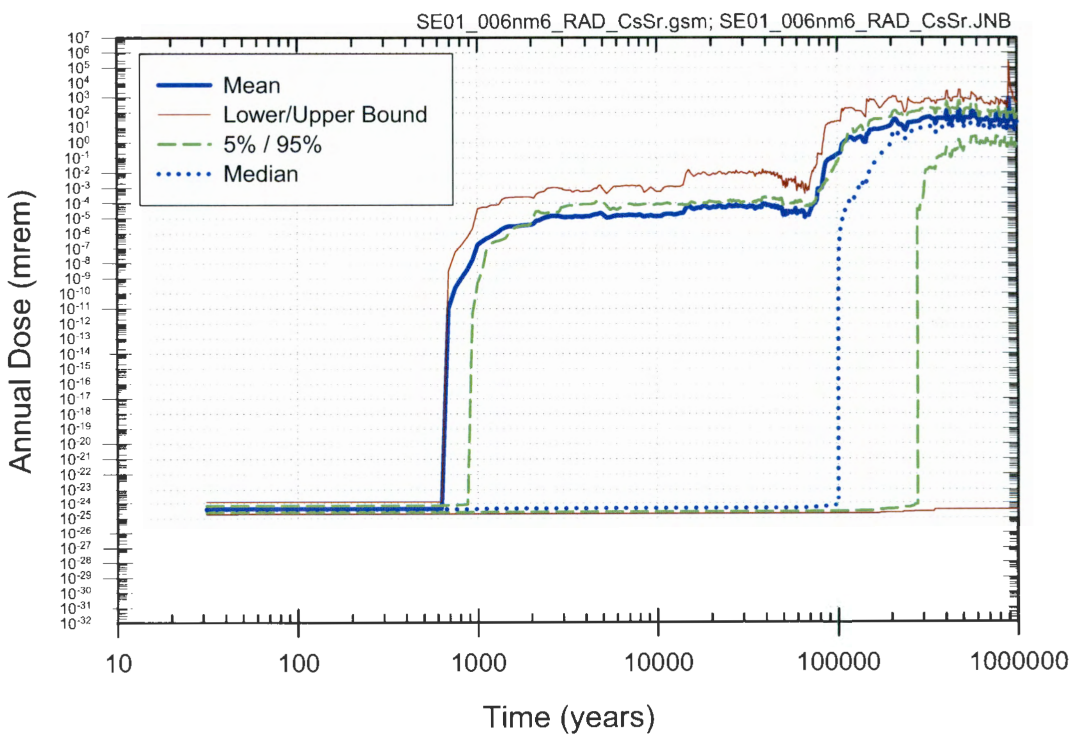

Figure B-7. Statistical curve set for the Cesium Strontium 1 case analysis.

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Figure B-8 shows the statistical plots of the annual dose for the Cesium 4 case (see Table 22 for specific case detail), which adds the maximum inventory of cesium-135 chloride to each DOE waste package in the Base Case. This simulates more capsule material than is physically available to place in the repository, which provides a high estimate of dose change from these sources. The plot displays separate curves for various statistical values of the set of 300 realizations. The mean line displays the expected value of the annual dose due to groundwater transport of the radionuclides. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

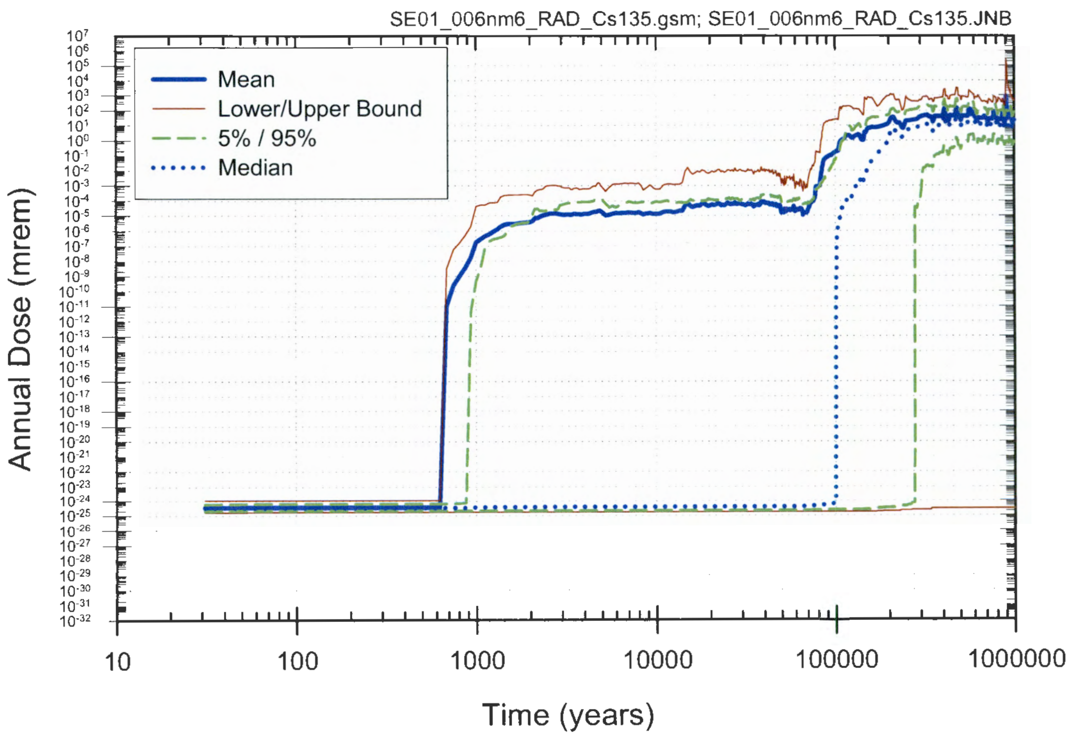

Figure B-8. Statistical curve set for the Cesium 4 case analysis.

Figure B-9 shows the statistical plots of the annual dose for the Base Case 1 (see Table 22 for specific case detail), which models the full repository inventory including commercial waste packages and DOE waste packages during an igneous event (see Section 4.1) on the Base Case analysis. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The mean line displays the expected value of the annual dose due to ash and groundwater transport of the radionuclides. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

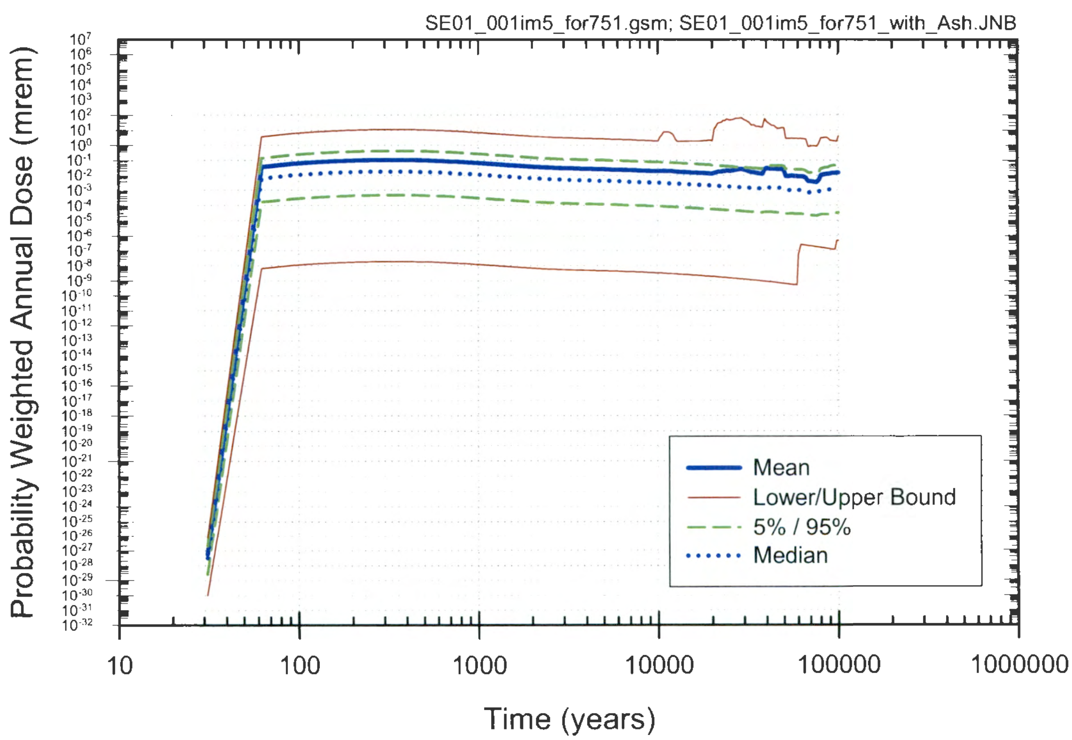

Figure B-9. Statistical curve set for the Base Case 1 analysis.

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Figure B-10 shows the statistical plots of the annual dose for the Base Case 1 (see Table 22 for specific case detail), which models the full repository inventory including commercial waste packages and DOE waste packages during an igneous event (see Section 4.1) on the Base Case analysis. This figure displays only the dose in the groundwater from this case. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The mean line displays the expected value of the annual dose due to groundwater transport of the radionuclides. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

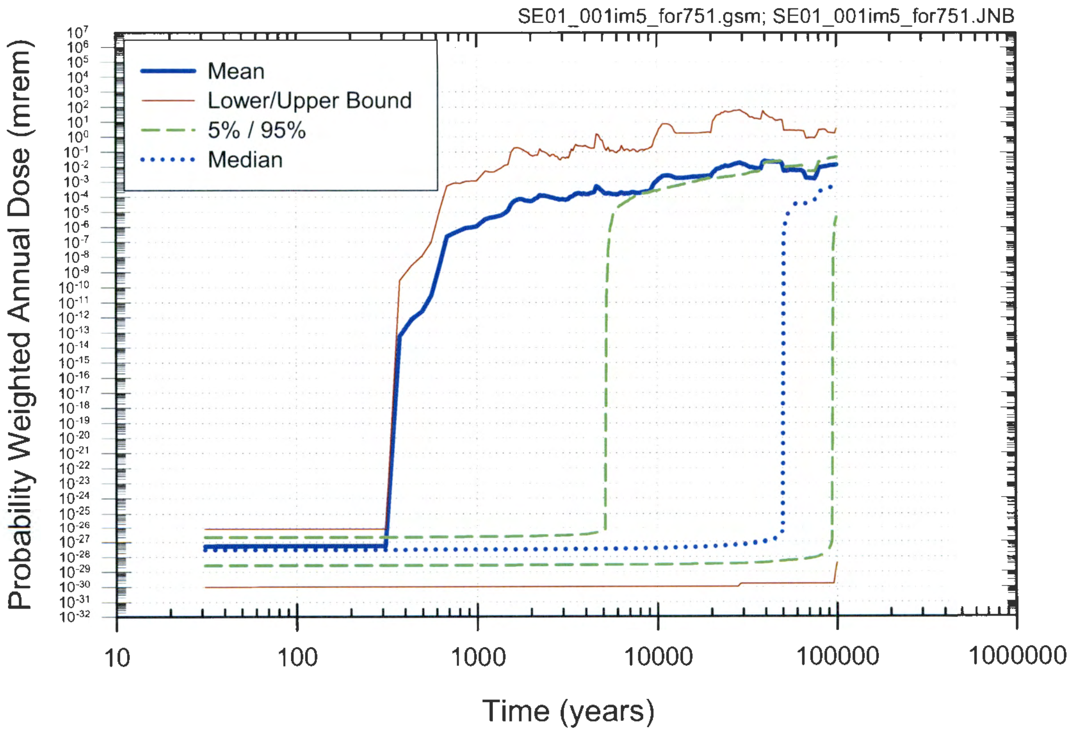

Figure B-10. Statistical curve set for groundwater dose the Base Case 1 analysis.

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Figure B-11 shows the statistical plots of the annual dose for the Cesium Strontium 2 case (see Table 22 for specific case detail), which modifies the Base Case by adding the maximum inventories of Cesium-137 chloride and strontium-90 fluoride to each DOE waste package in the Base Case, thus simulating more capsule material than is physically available to place in the repository. This provides a high estimate of change to the repository dose from this source. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The mean line displays the expected value of the annual dose due to ash and groundwater transport of the radionuclides. The most significant item for this data is the mean since the mean is the most likely value of the dose. Also shown on the plot are the upper and lower bounds for the range of the calculated dose. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

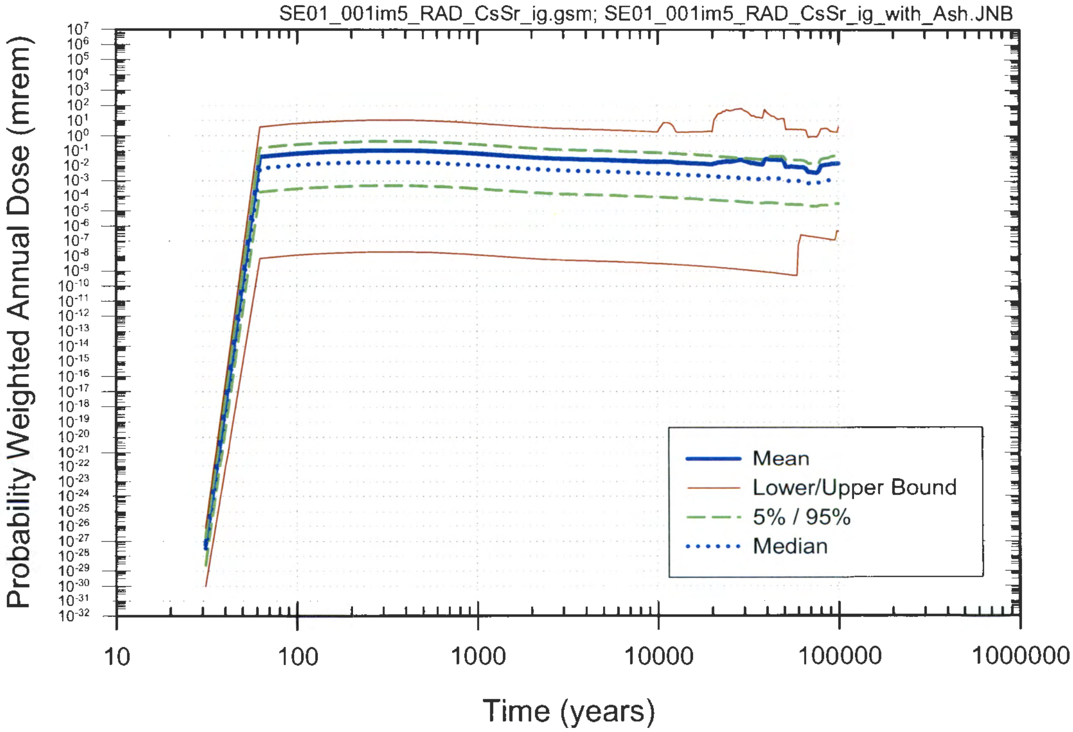

Figure B-11. Statistical curve set for the Cesium Strontium 2 case analysis.

Figure B-12 shows the statistical plots of the annual barium release for the Cesium Contaminant 1 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

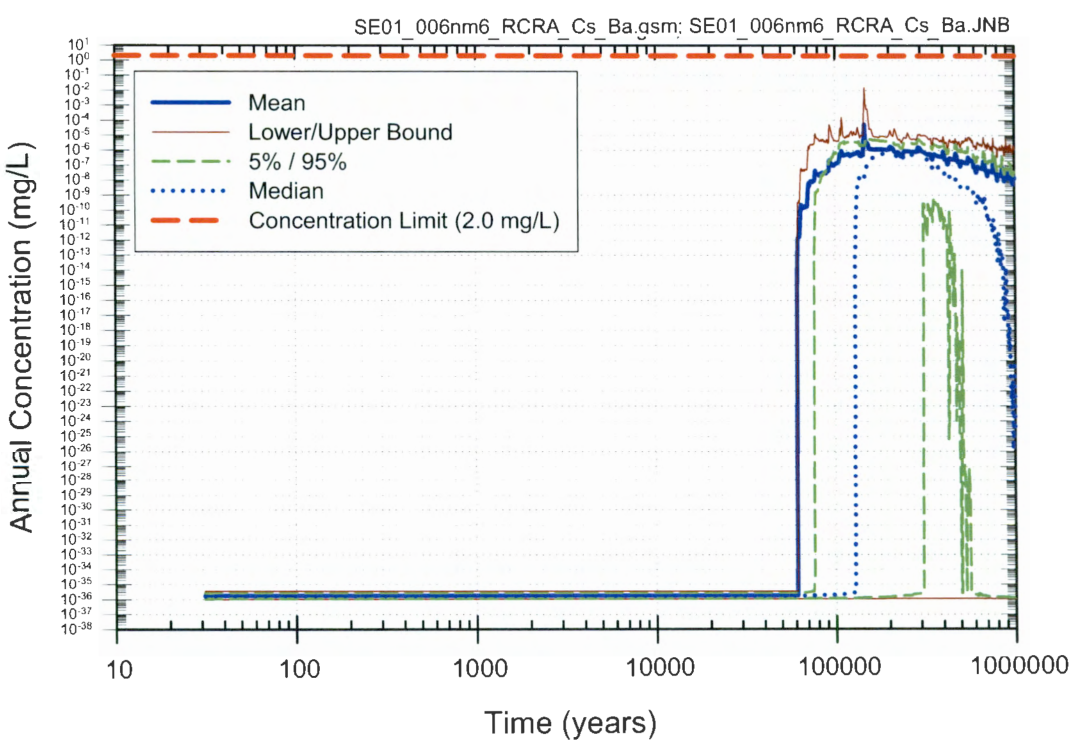

Figure B-12. Statistical curve set for the Cesium Contaminant 1 case analysis.

Figure B-13 shows the statistical plots of the annual barium release for the Cesium Contaminant 2 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

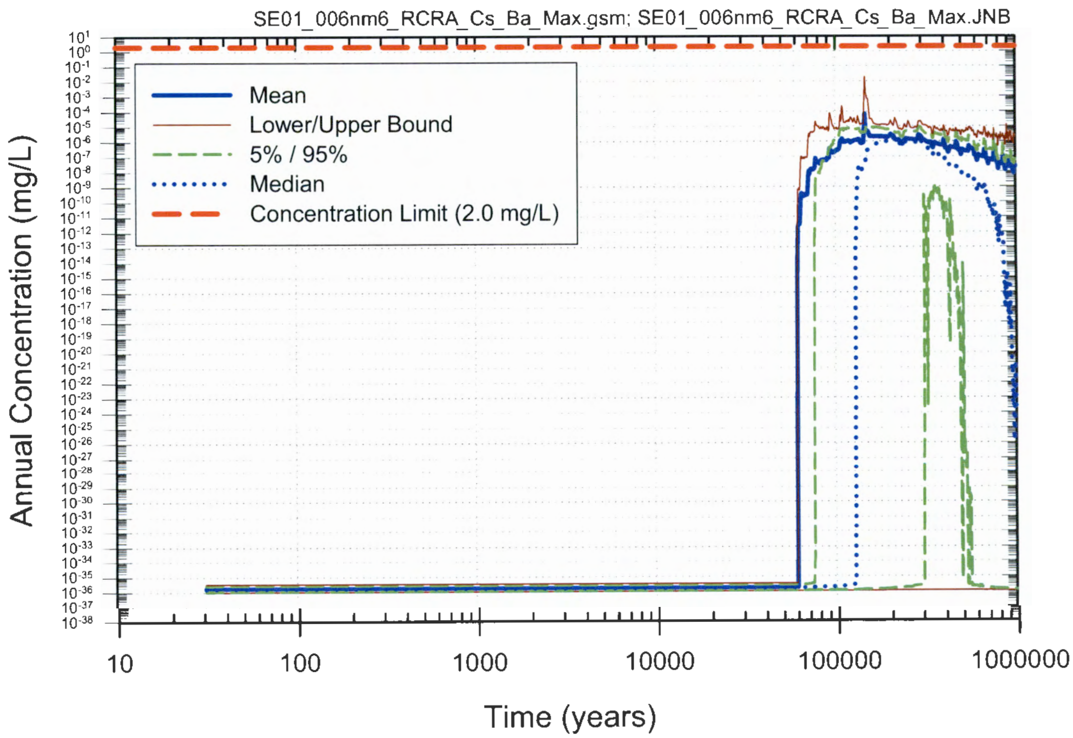

Figure B-13. Statistical curve set for the Cesium Contaminant 2 case analysis.

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Figure B-14 shows the statistical plots of the annual barium release for the Cesium Contaminant 3 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

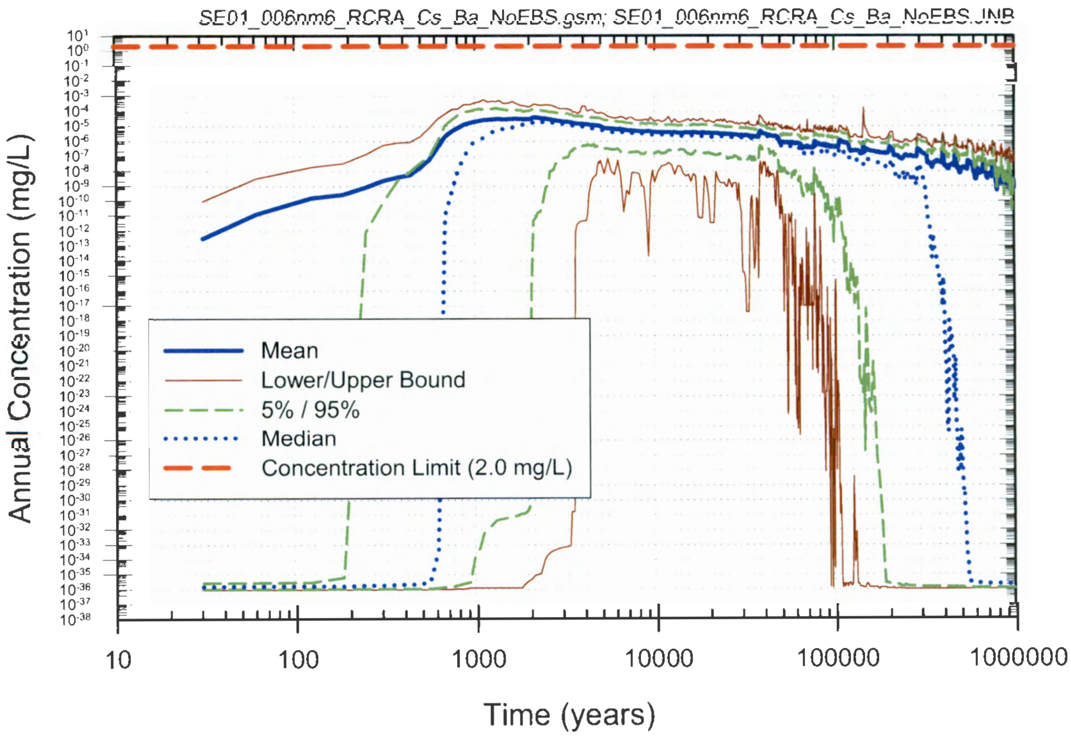

Figure B-14. Statistical curve set for the Cesium Contaminant 3 case analysis.

Figure B-15 shows the statistical plots of the annual barium release for the Cesium Contaminant 4 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each cesium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 5,000 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

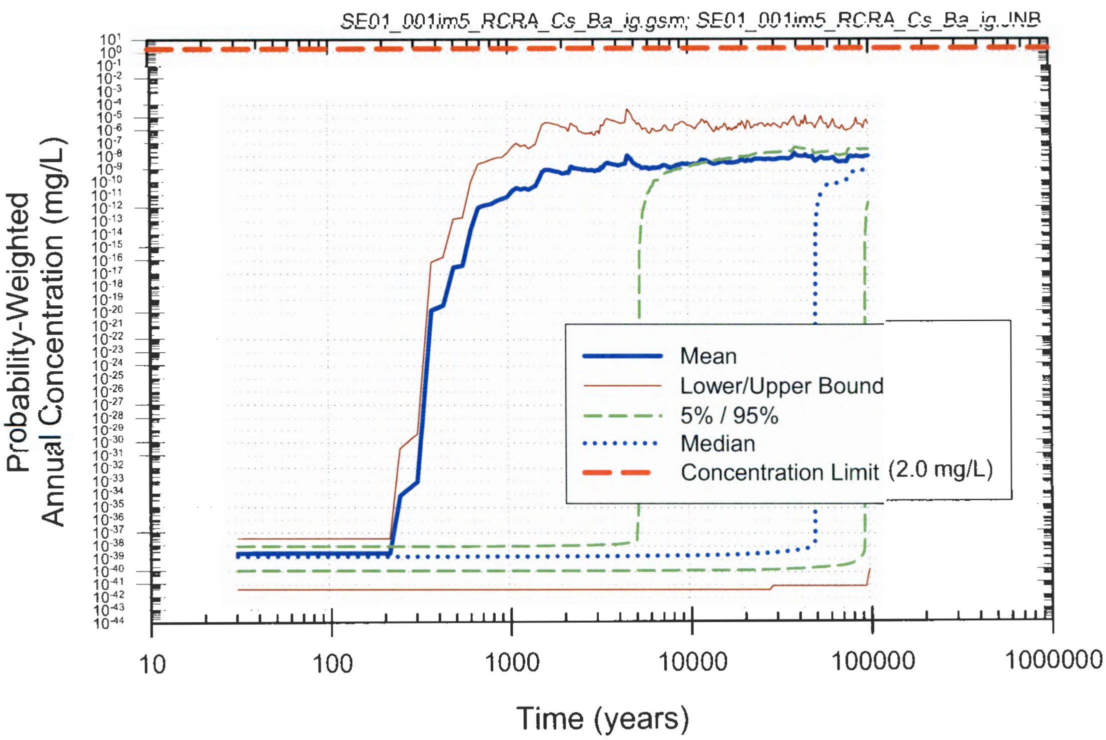

Figure B-15. Statistical curve set for the Cesium Contaminant 4 case analysis.

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Figure B-16 shows the statistical plots of the annual cadmium release for the Cesium Contaminant 5 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

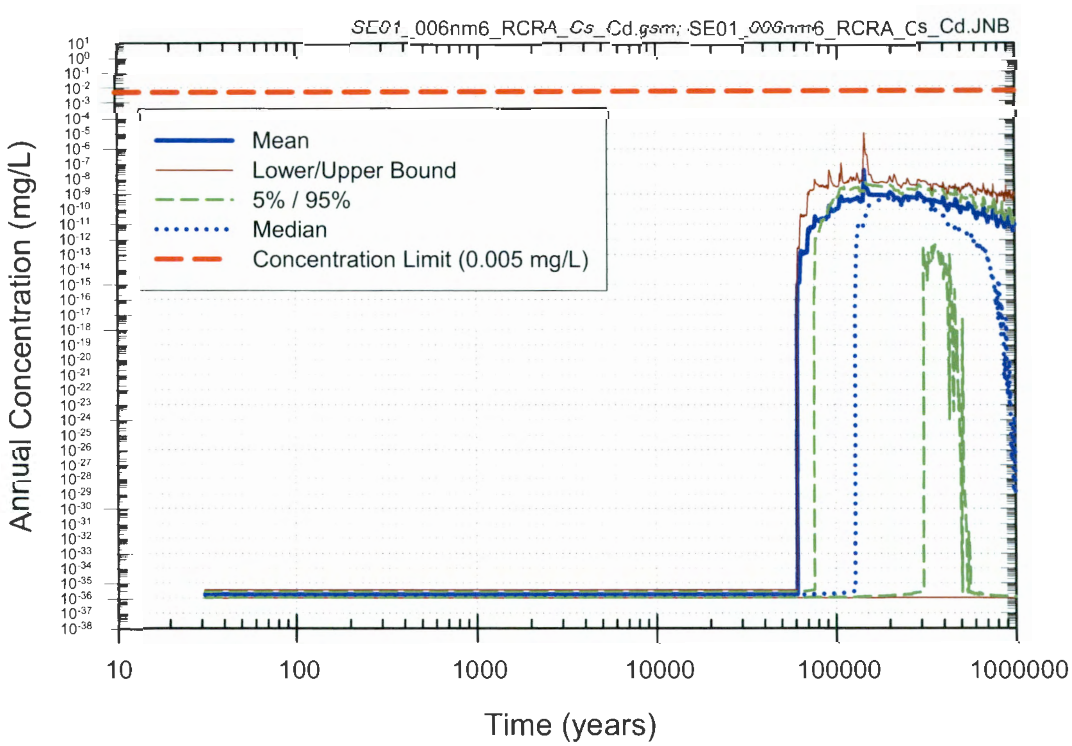

Figure B-16. Statistical curve set for the Cesium Contaminant 5 case analysis.

Title: Hanford Cs-Sr Repository Disposal Performance Analysis Using the TSPA-FEIS Model

Figure B-17 shows the statistical plots of the annual cadmium release for the Cesium Contaminant 6 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

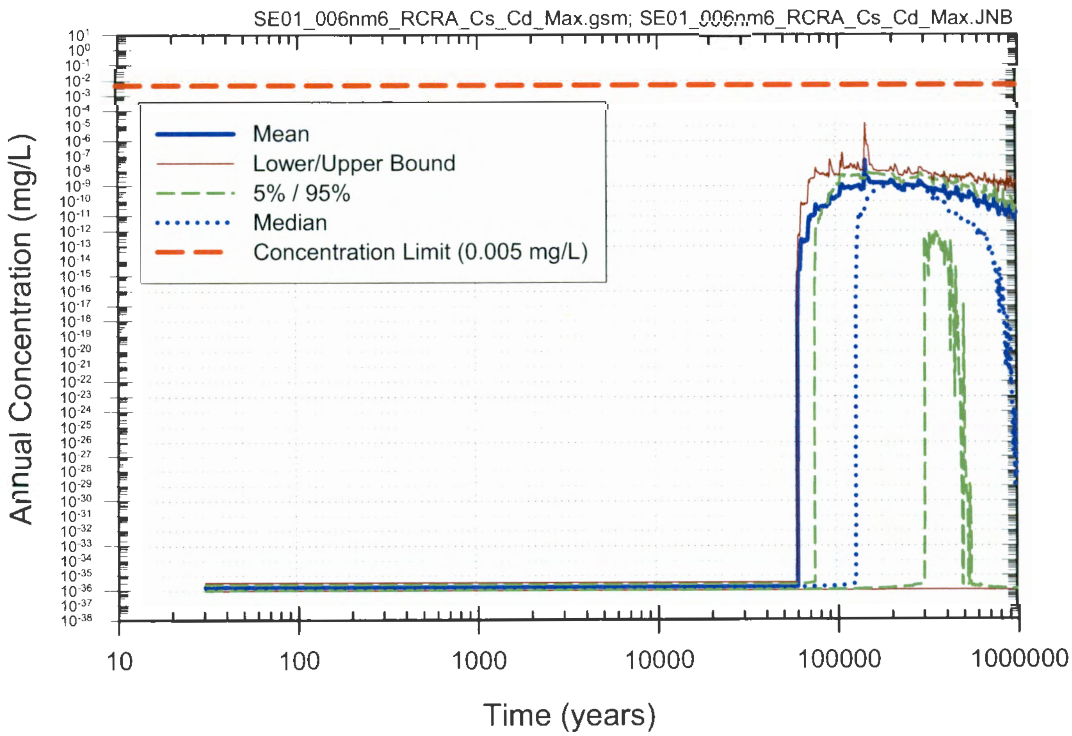

Figure B-17. Statistical curve set for the Cesium Contaminant 6 case analysis.

Figure B-18 shows the statistical plots of the annual cadmium release for the Cesium Contaminant 7 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

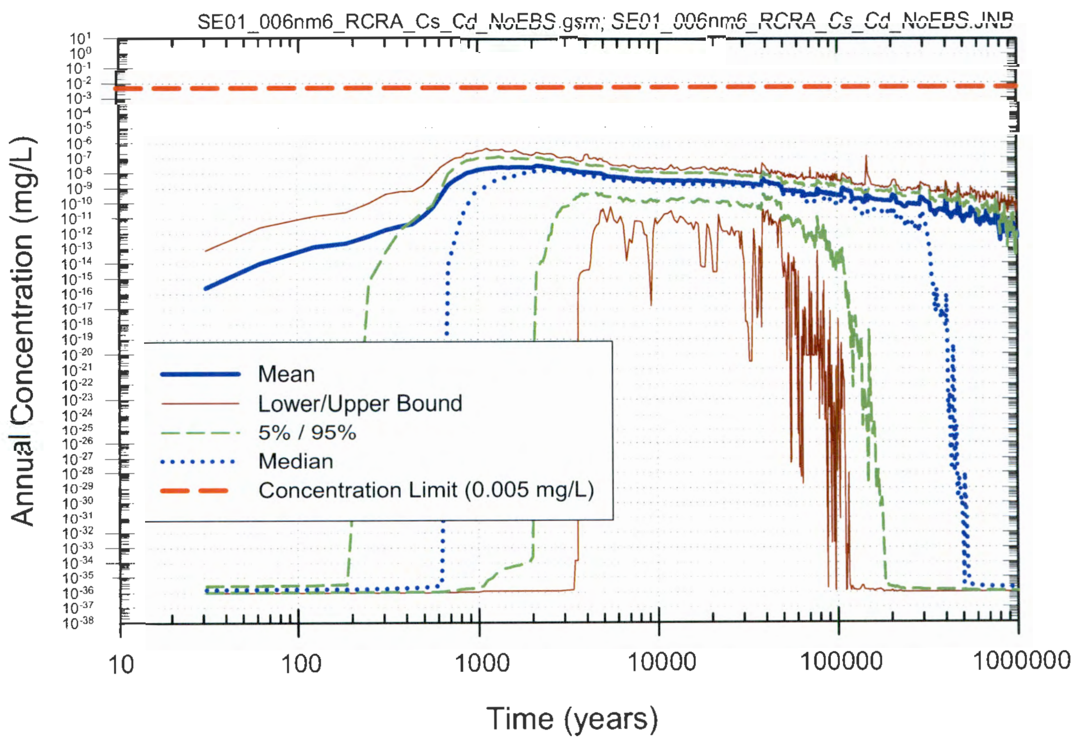

Figure B-18. Statistical curve set for the Cesium Contaminant 7 case analysis.

Figure B-19 shows the statistical plots of the annual cadmium release for the Cesium Contaminant 8 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each cesium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 5,000 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

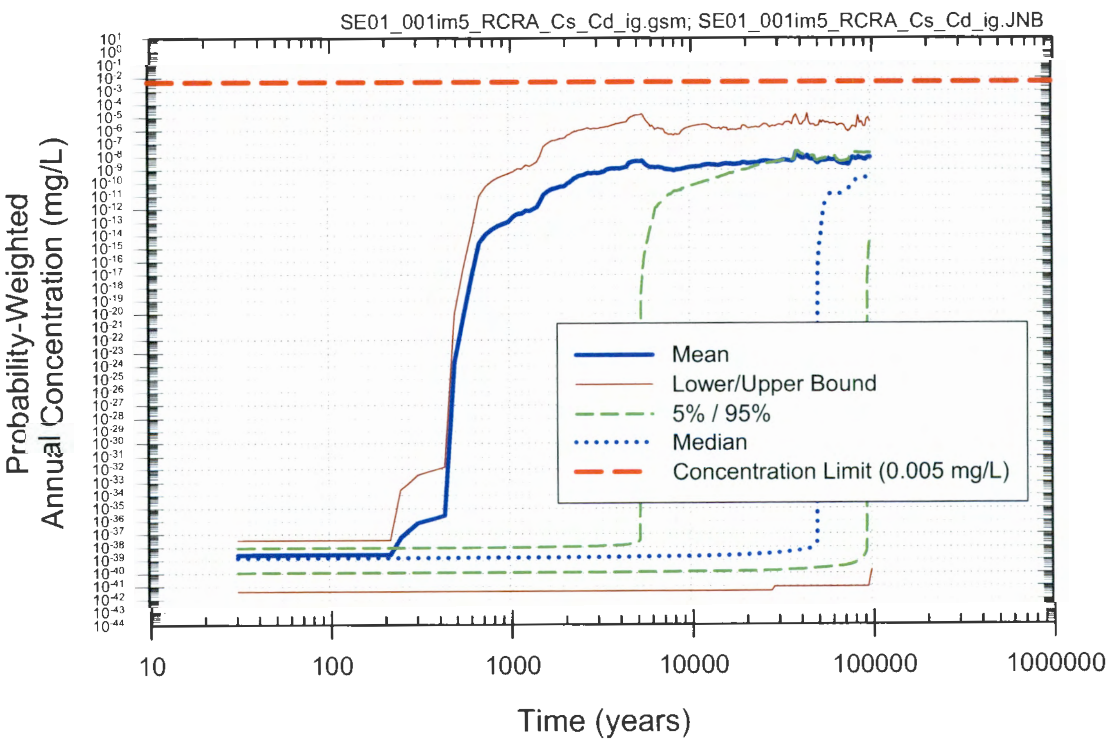

Figure B-19. Statistical curve set for the Cesium Contaminant 8 case analysis.

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Figure B-20 shows the statistical plots of the annual chromium release for the Cesium Contaminant 9 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

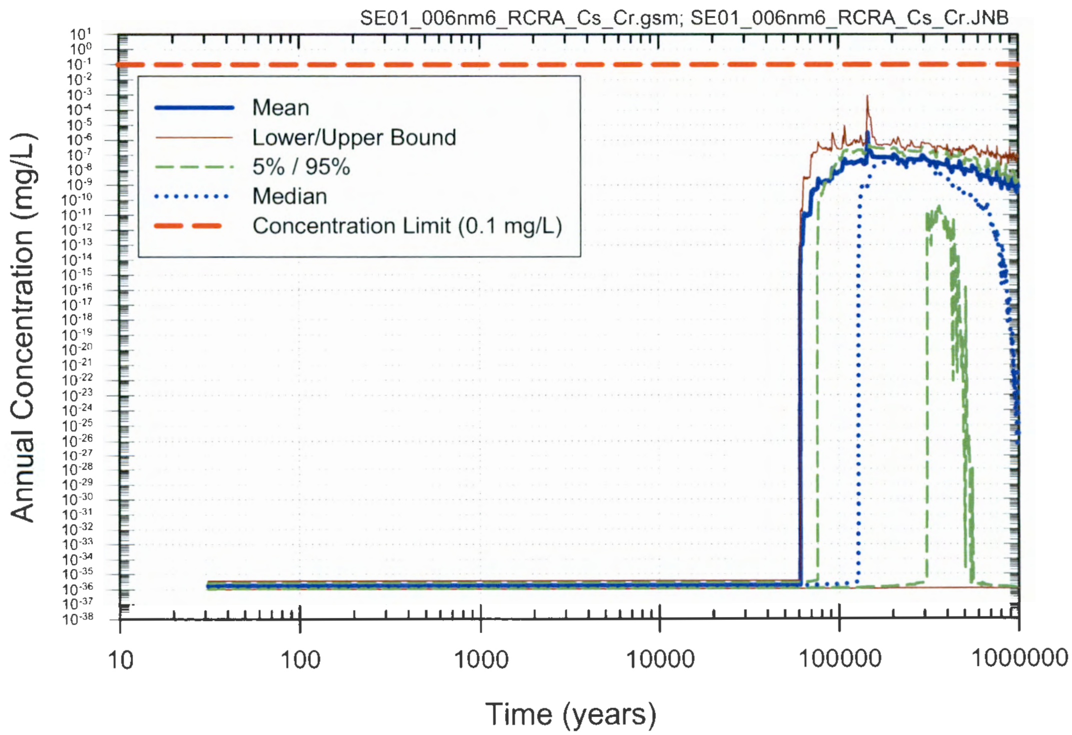

Figure B-20. Statistical curve set for the Cesium Contaminant 9 case analysis.

Figure B-21 shows the statistical plots of the annual chromium release for the Cesium Contaminant 10 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

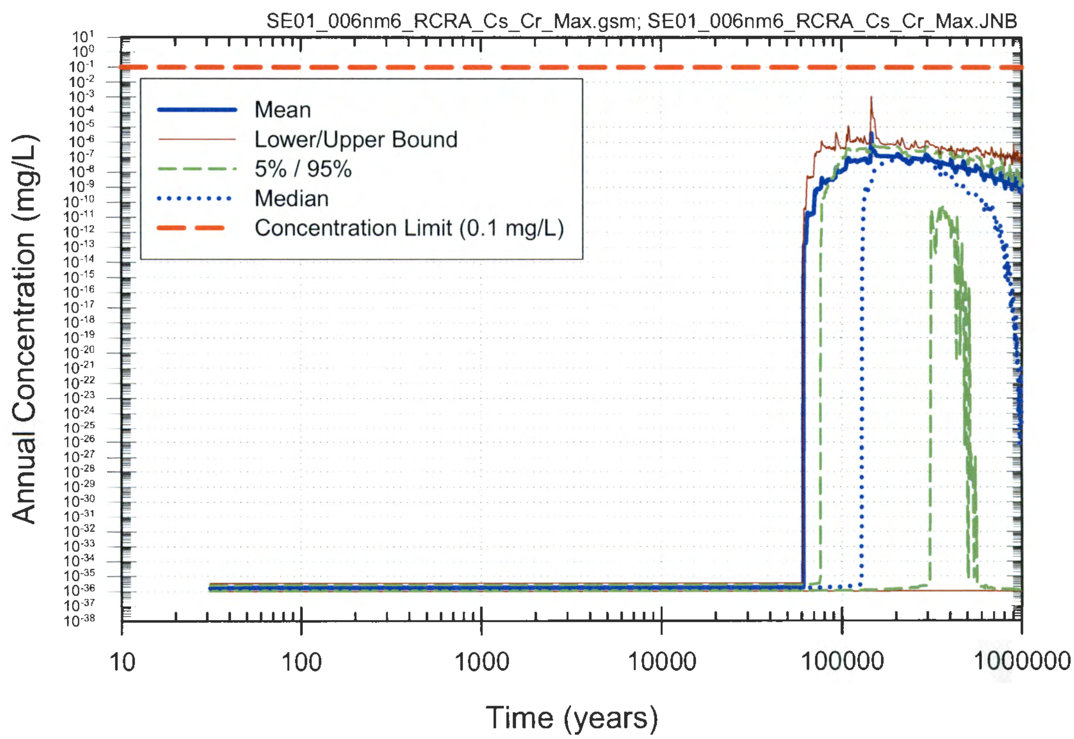

Figure B-21. Statistical curve set for the Cesium Contaminant 10 case analysis.

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Figure B-22 shows the statistical plots of the annual chromium release for the Cesium Contaminant 11 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

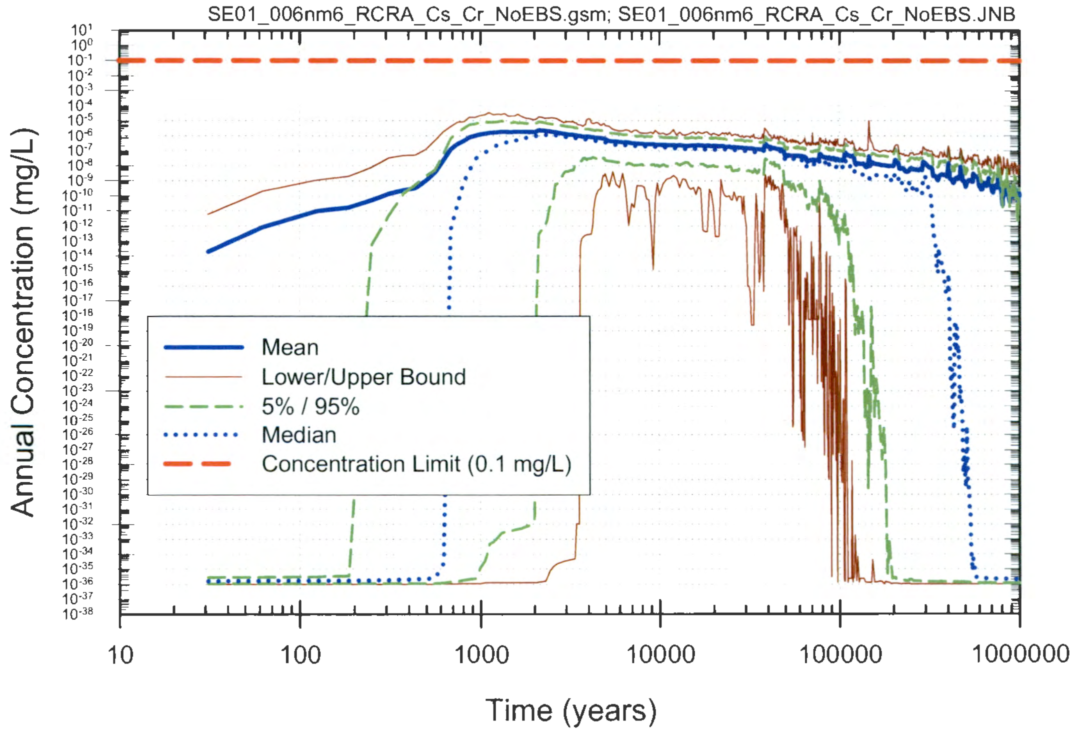

Figure B-22. Statistical curve set for the Cesium Contaminant 11 case analysis.

Figure B-23 shows the statistical plots of the annual chromium release for the Cesium Contaminant 12 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each cesium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 5,000 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

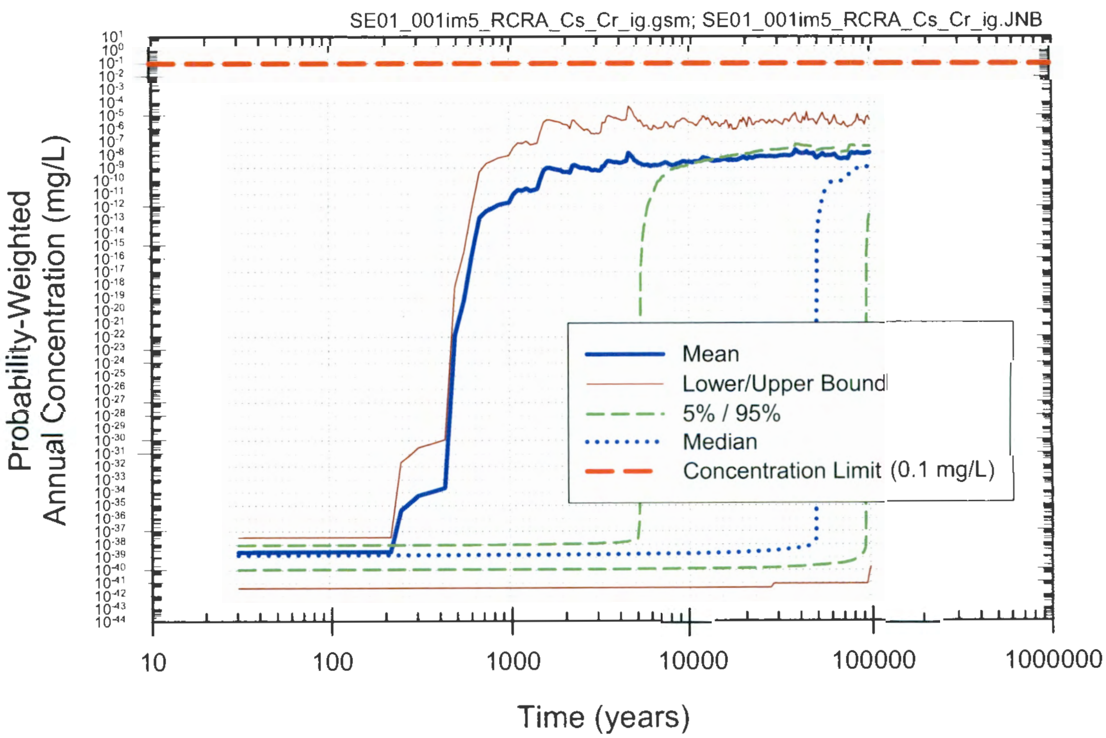

Figure B-23. Statistical curve set for the Cesium Contaminant 12 case analysis.

Figure B-24 shows the statistical plots of the annual lead release for the Cesium Contaminant 13 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

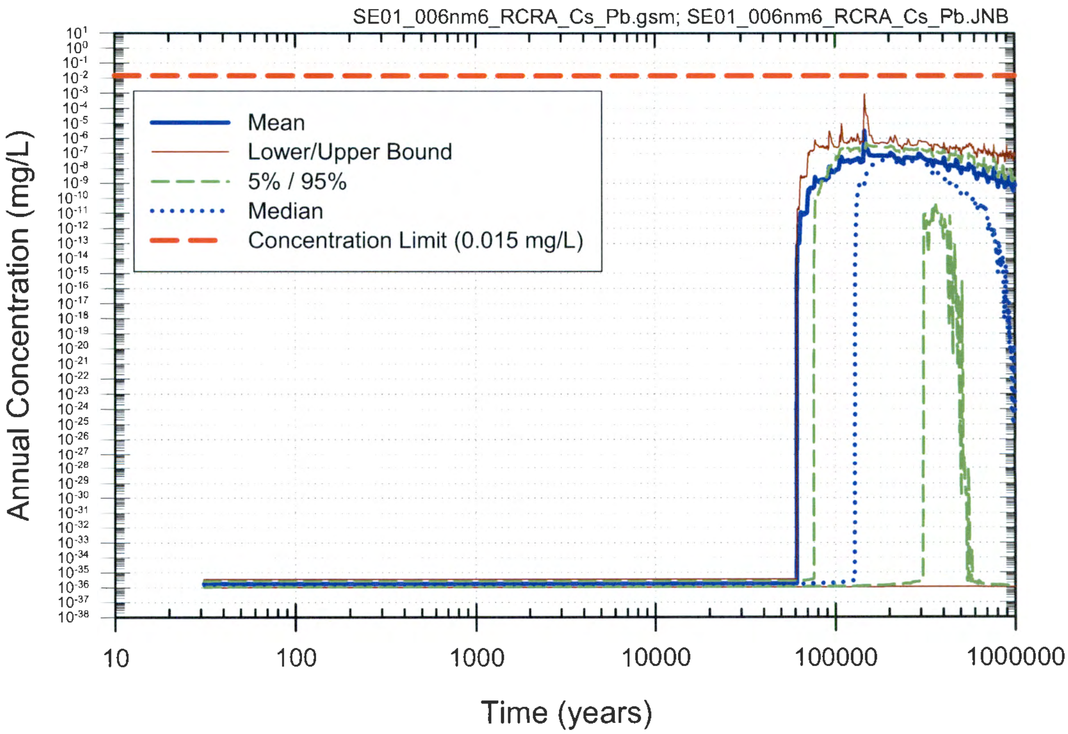

Figure B-24. Statistical curve set for the Cesium Contaminant 13 case analysis.

Figure B-25 shows the statistical plots of the annual lead release for the Cesium Contaminant 14 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

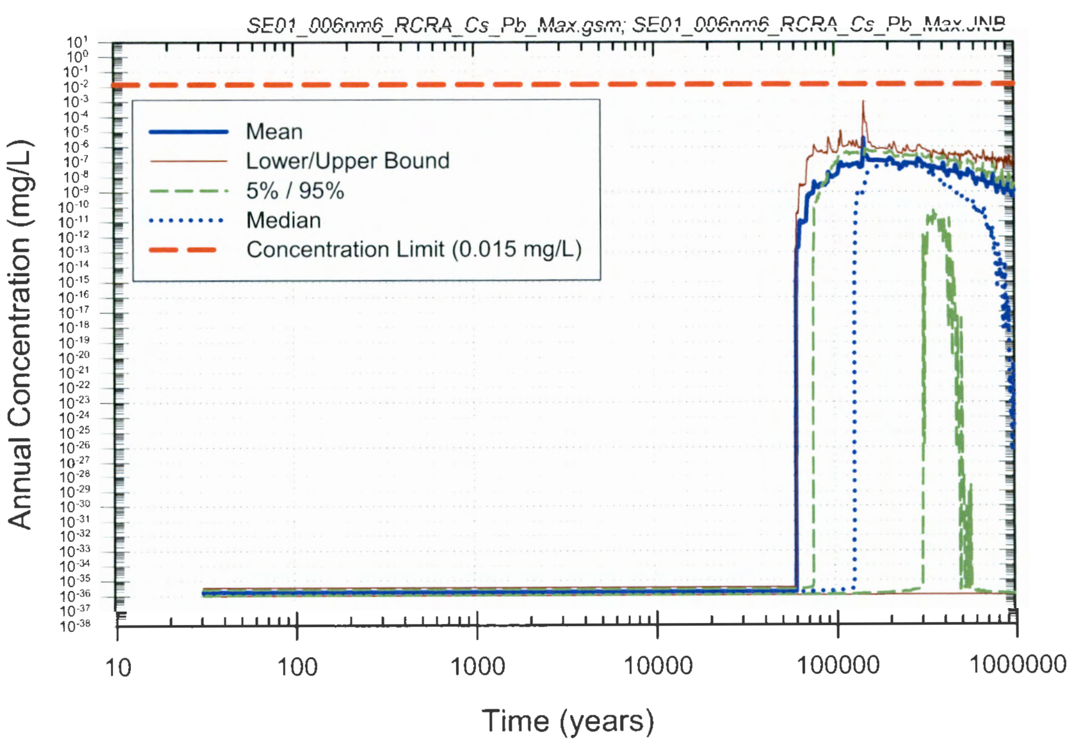

Figure B-25. Statistical curve set for the Cesium Contaminant 14 case analysis.

Figure B-26 shows the statistical plots of the annual lead release for the Cesium Contaminant 15 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

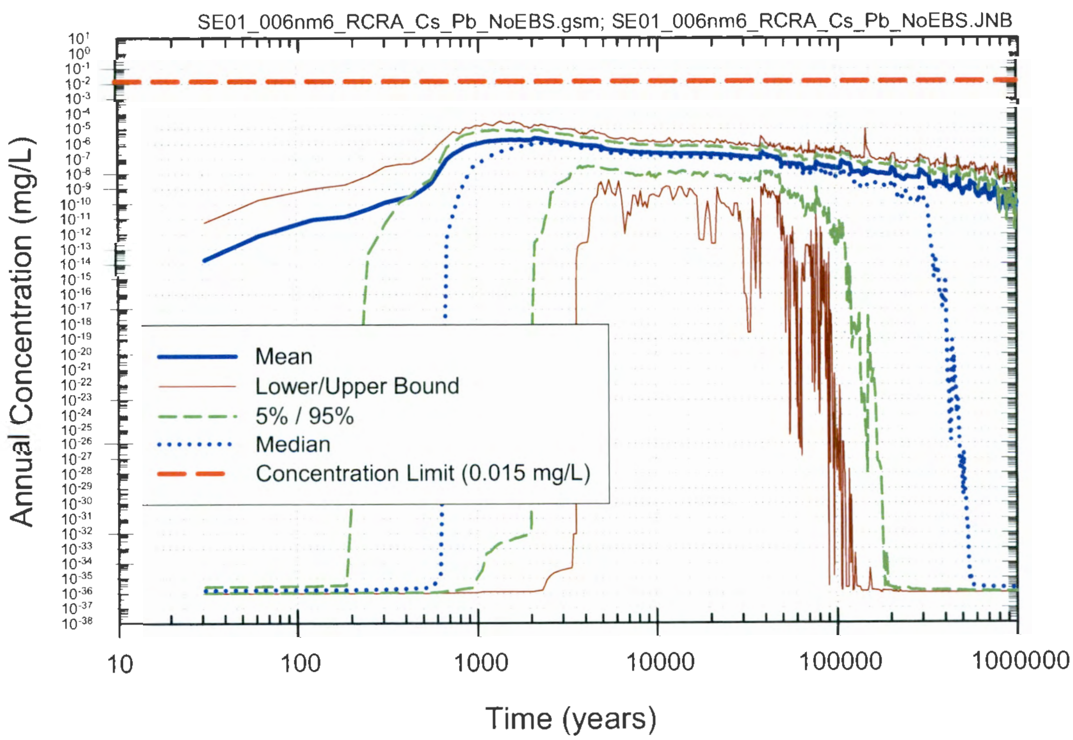

Figure B-26. Statistical curve set for the Cesium Contaminant 15 case analysis.

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Figure B-27 shows the statistical plots of the annual lead release for the Cesium Contaminant 16 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each cesium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 5,000 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

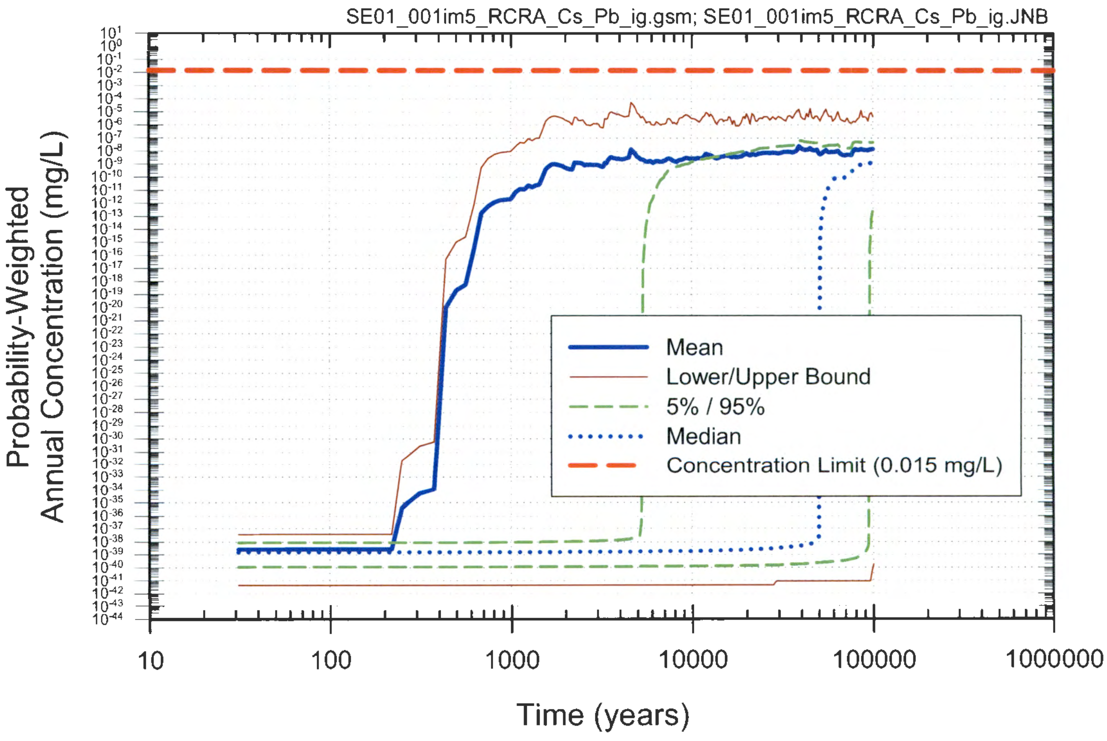

Figure B-27. Statistical curve set for the Cesium Contaminant 16 case analysis.

Figure B-28 shows the statistical plots of the annual silver release for the Cesium Contaminant 17 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

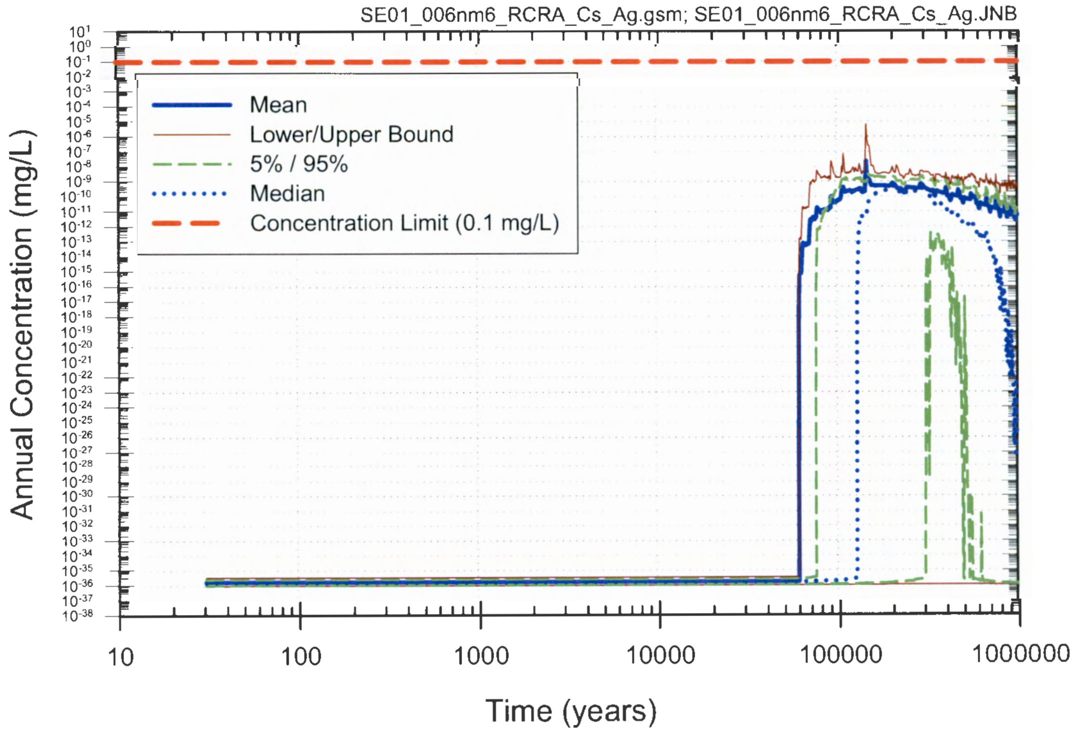

Figure B-28. Statistical curve set for the Cesium Contaminant 17 case analysis.

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Figure B-29 shows the statistical plots of the annual silver release for the Cesium Contaminant 18 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

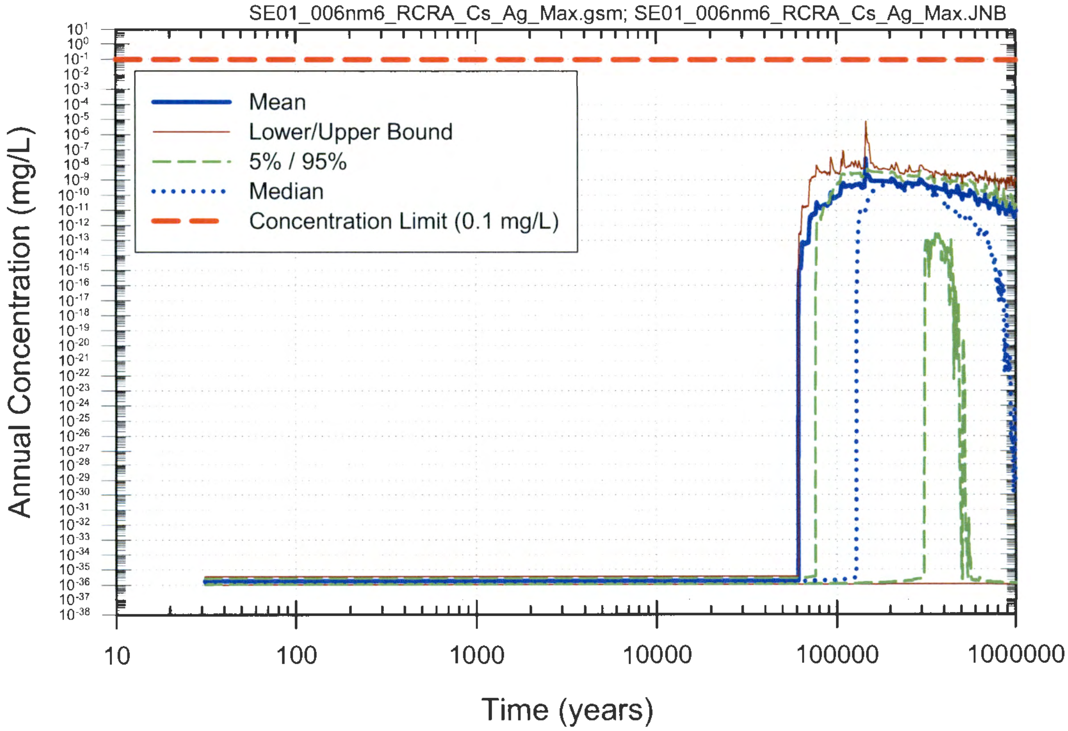

Figure B-29. Statistical curve set for the Cesium Contaminant 18 case analysis.

Figure B-30 shows the statistical plots of the annual silver release for the Cesium Contaminant 19 case (see Table 25 for specific case detail), in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

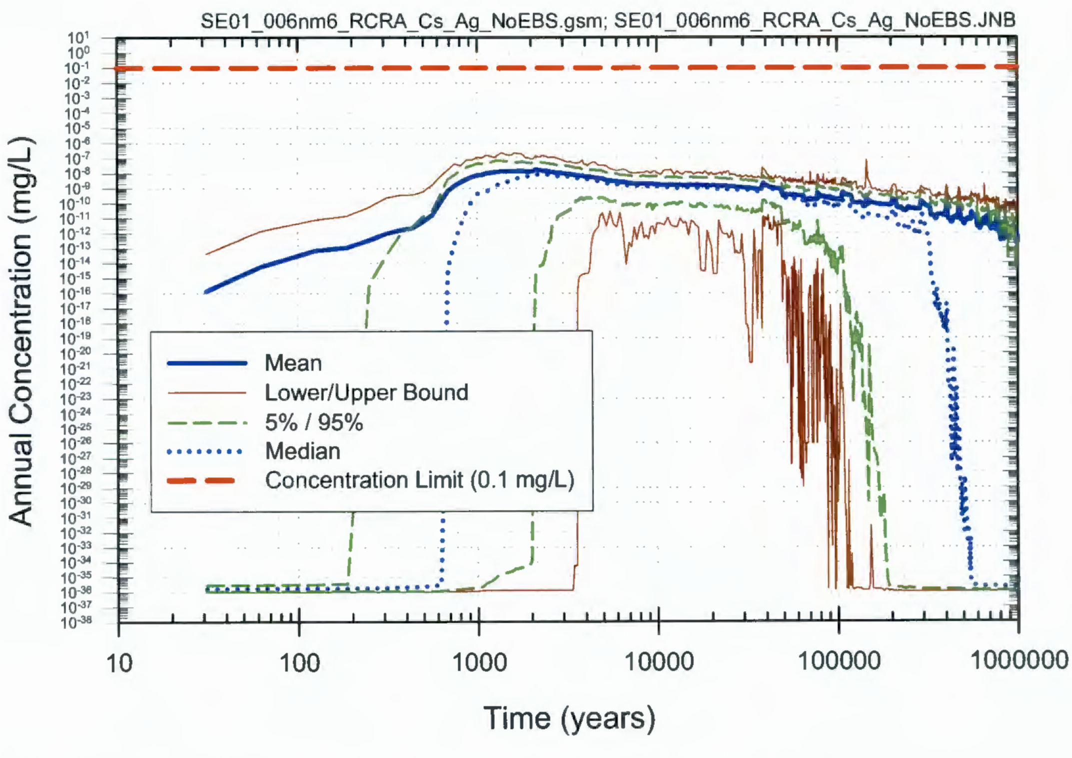

Figure B-30. Statistical curve set for the Cesium Contaminant 19 case analysis.

Figure B-31 shows the statistical plots of the annual silver release for the Cesium Contaminant 20 case (see Table 25 for specific case detail) in which the repository inventory is reduced to 84 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each cesium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 5,000 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

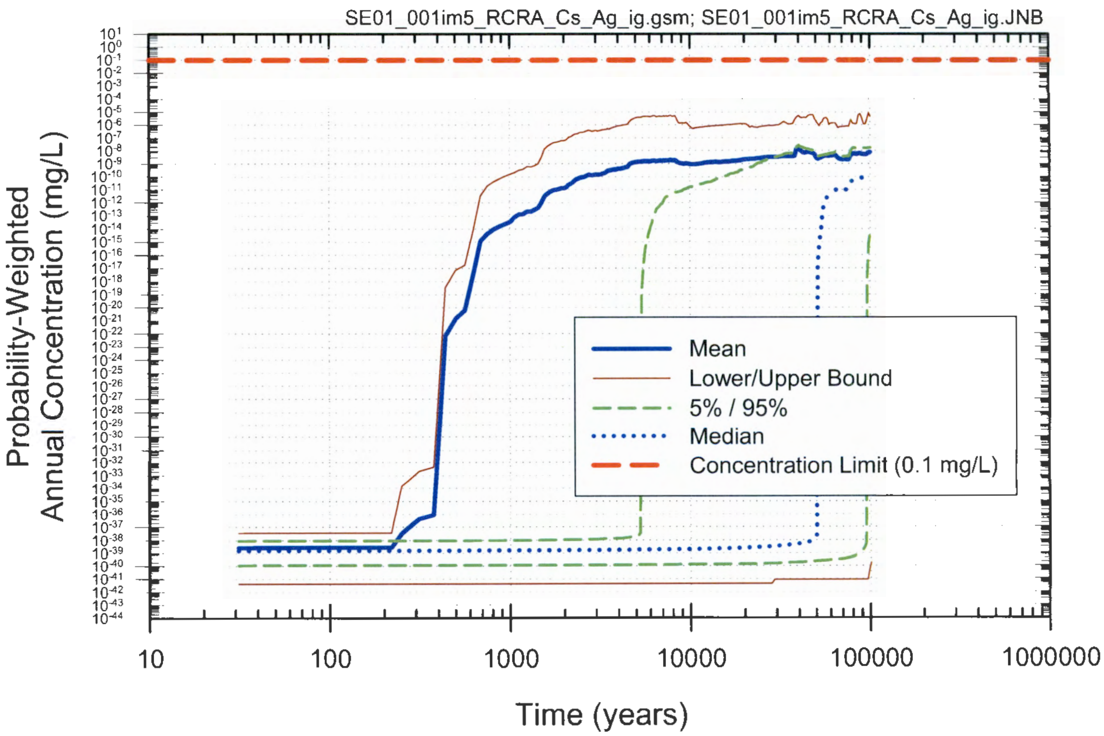

Figure B-31. Statistical curve set for the Cesium Contaminant 20 case analysis.

Figure B-32 shows the statistical plots of the annual barium release for the Strontium Contaminant 1 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each strontium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

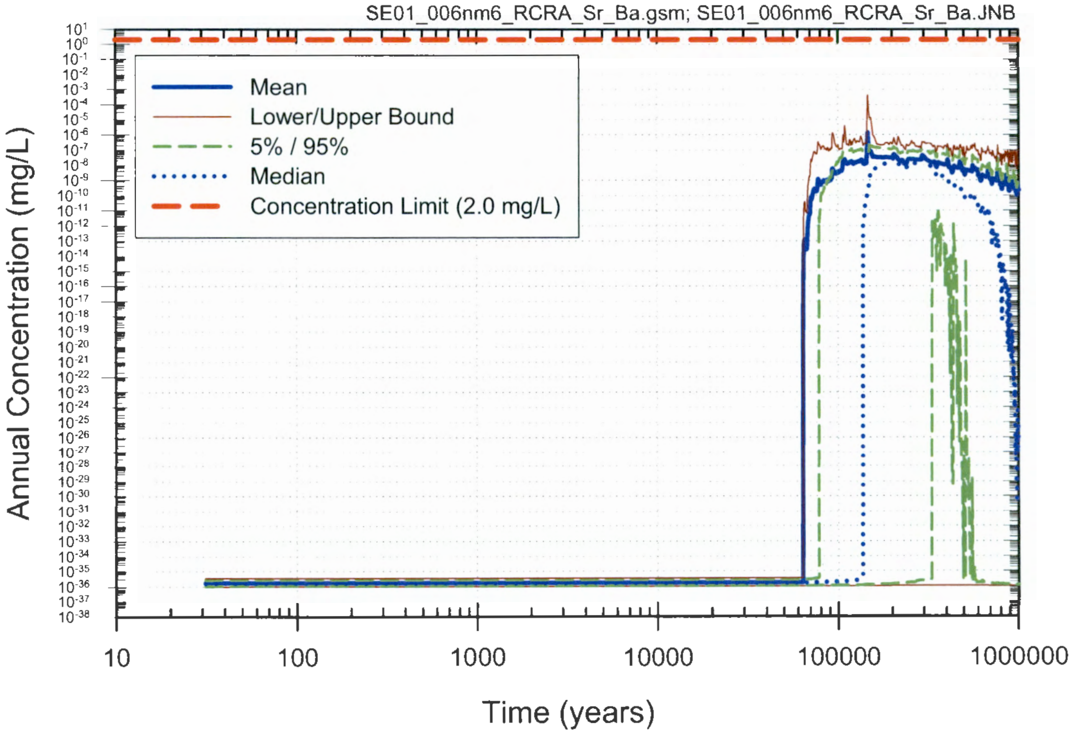

Figure B-32. Statistical curve set for the Strontium Contaminant 1 case analysis.

Figure B-33 shows the statistical plots of the annual barium release for the Strontium Contaminant 2 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

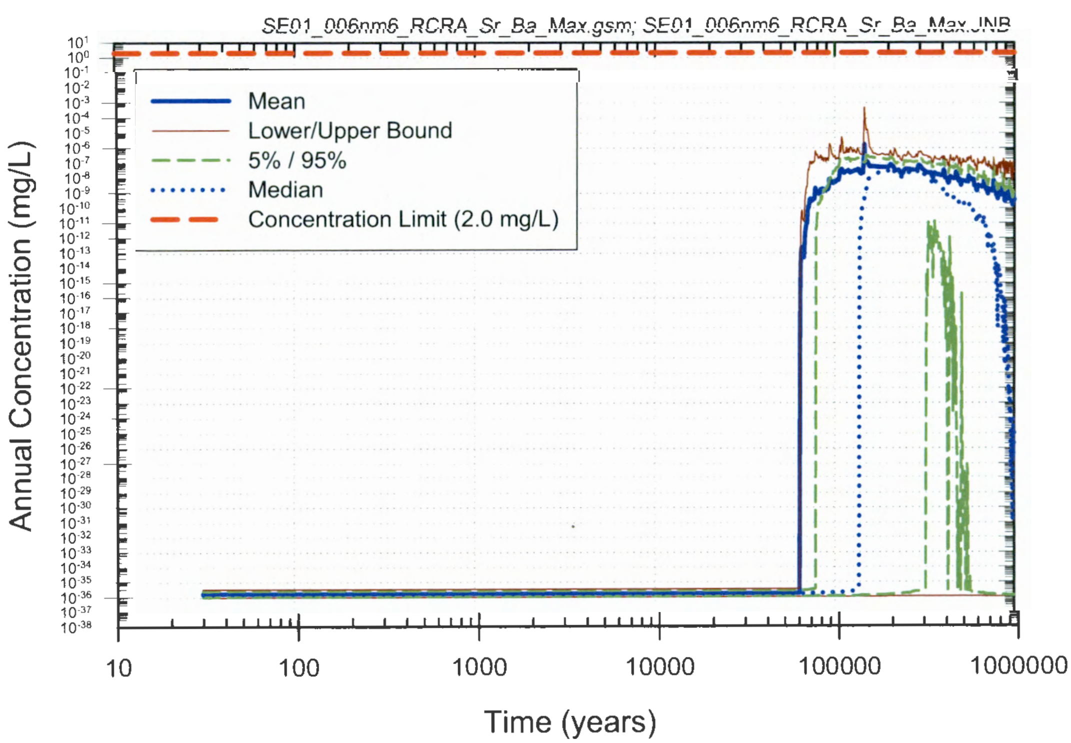

Figure B-33. Statistical curve set for the Strontium Contaminant 2 case analysis.

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Figure B-34 shows the statistical plots of the annual barium release for the Strontium Contaminant 3 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 300 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

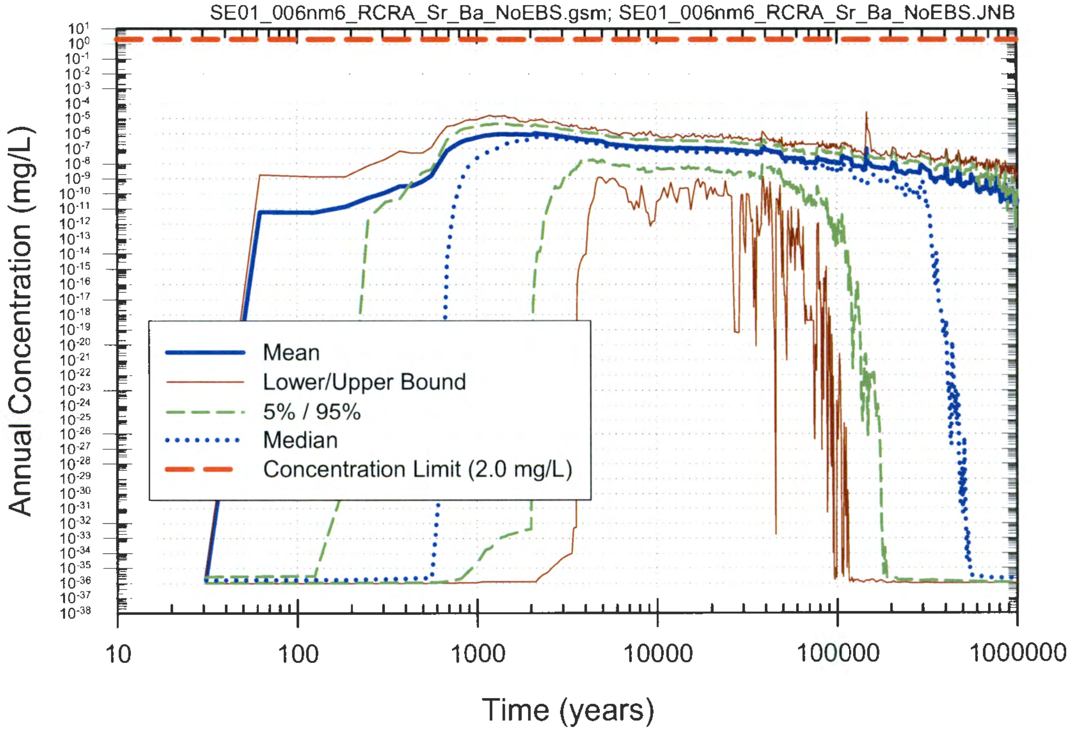

Figure B-34. Statistical curve set for the Strontium Contaminant 3 case analysis.

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Figure B-35 shows the statistical plots of the annual barium release for the Strontium Contaminant 4 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each strontium capsule waste package contains the full range of barium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for barium. The mean line displays the mean value of the 5,000 realization concentration results for the barium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the barium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

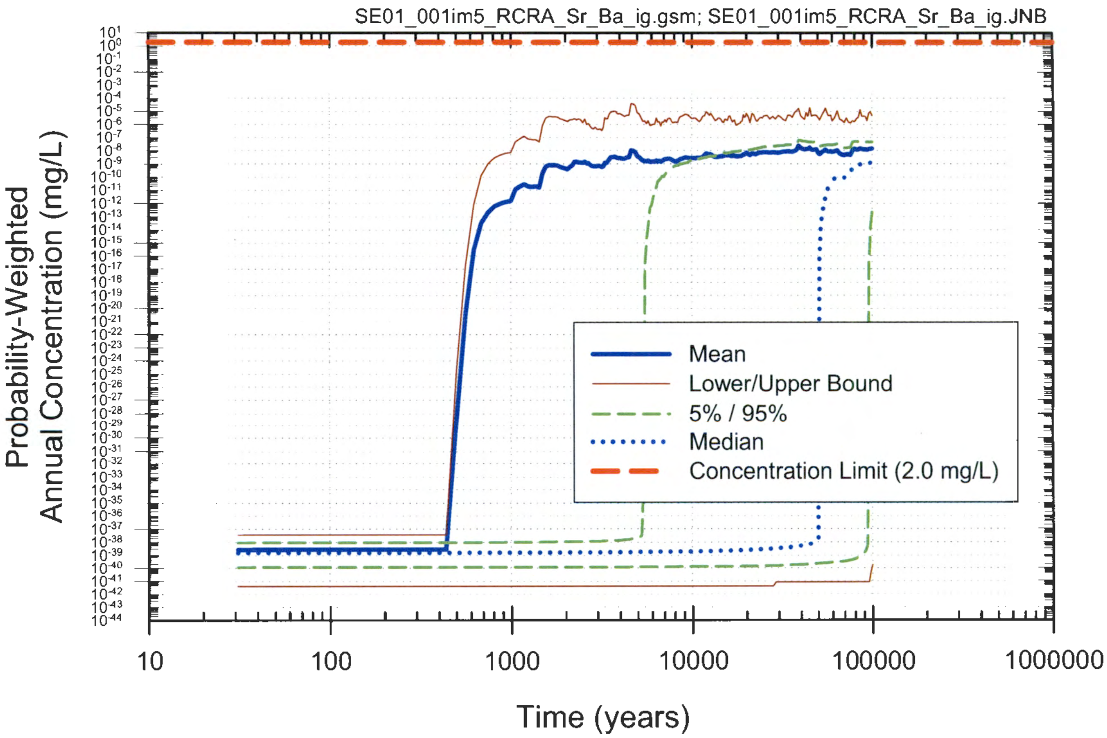

Figure B-35. Statistical curve set for the Strontium Contaminant 4 case analysis.

Figure B-36 shows the statistical plots of the annual cadmium release for the Strontium Contaminant 52 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each strontium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

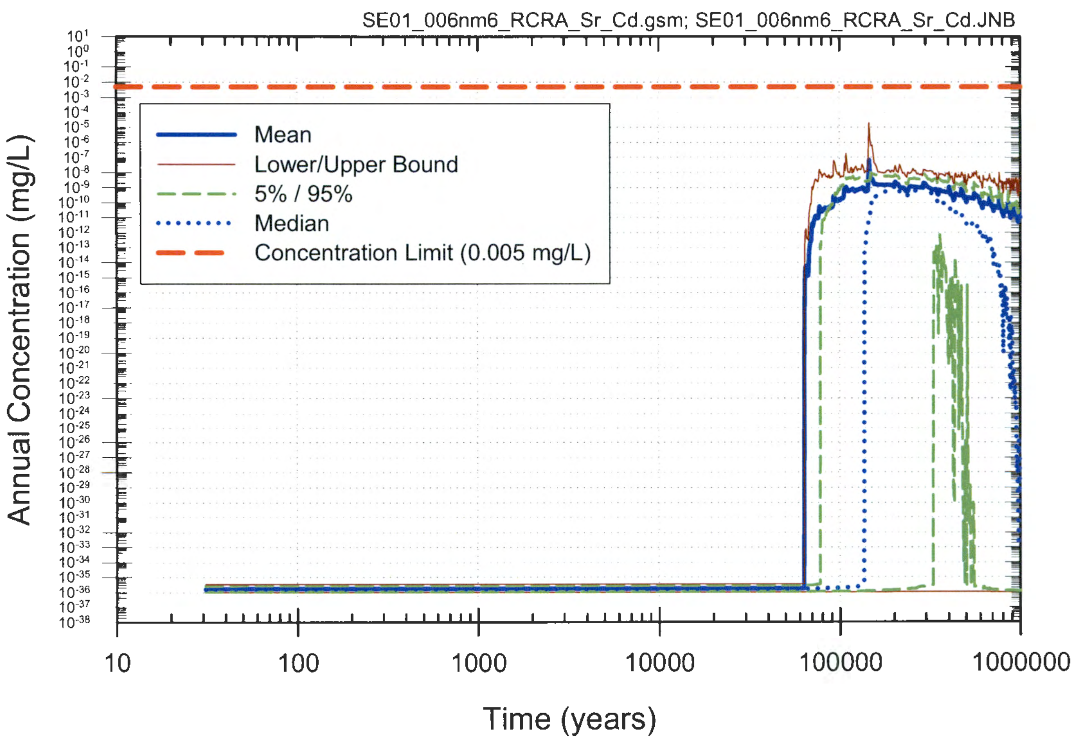

Figure B-36. Statistical curve set for the Strontium Contaminant 5 case analysis.

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Figure B-37 shows the statistical plots of the annual cadmium release for the Strontium Contaminant 6 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

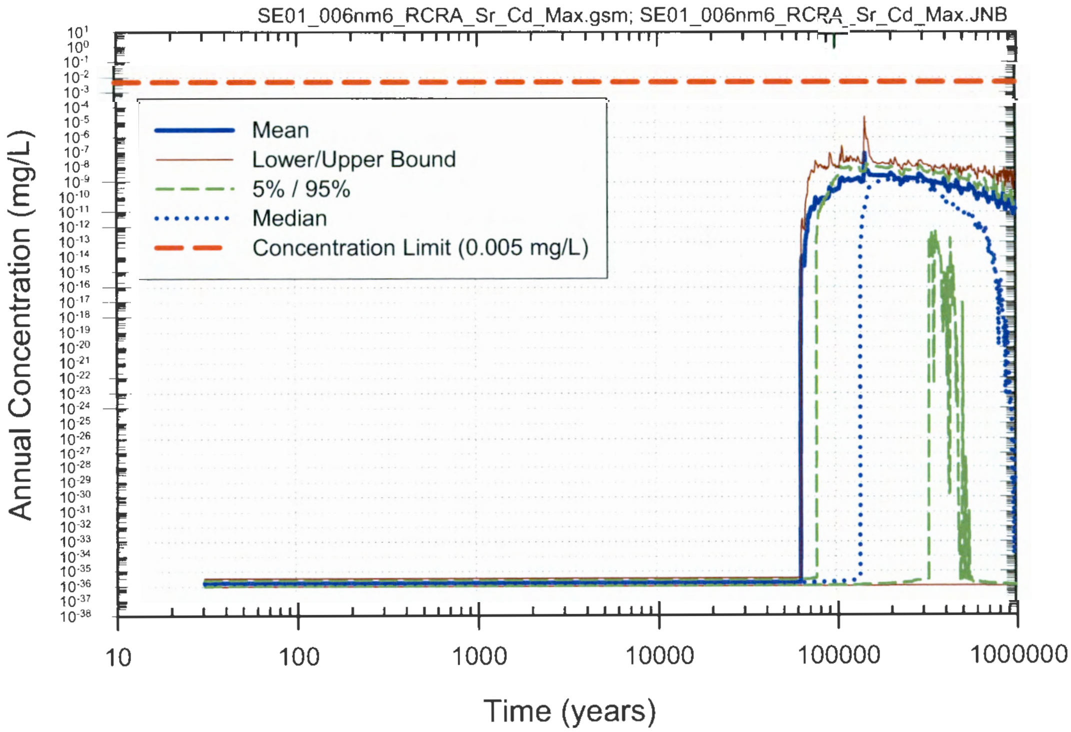

Figure B-37. Statistical curve set for the Strontium Contaminant 6 case analysis.

Figure B-38 shows the statistical plots of the annual cadmium release for the Strontium Contaminant 7 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 300 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

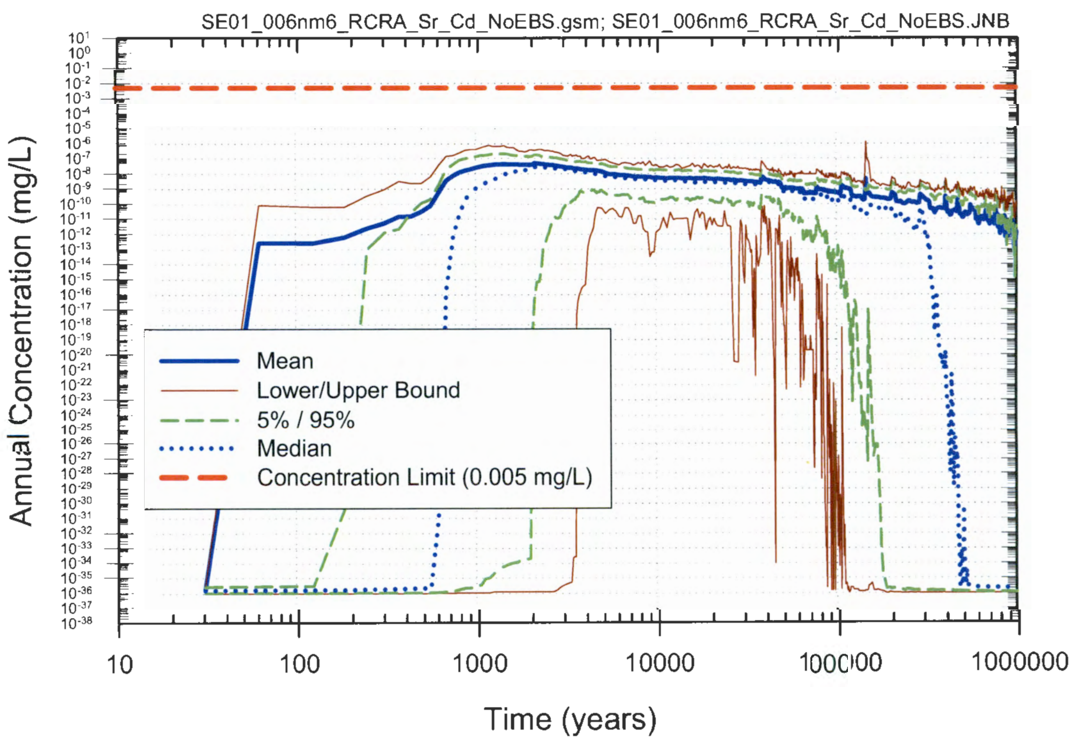

Figure B-38. Statistical curve set for the Strontium Contaminant 7 case analysis.

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Figure B-39 shows the statistical plots of the annual cadmium release for the Strontium Contaminant 8 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each strontium capsule waste package contains the full range of cadmium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for cadmium. The mean line displays the mean value of the 5,000 realization concentration results for the cadmium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the cadmium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

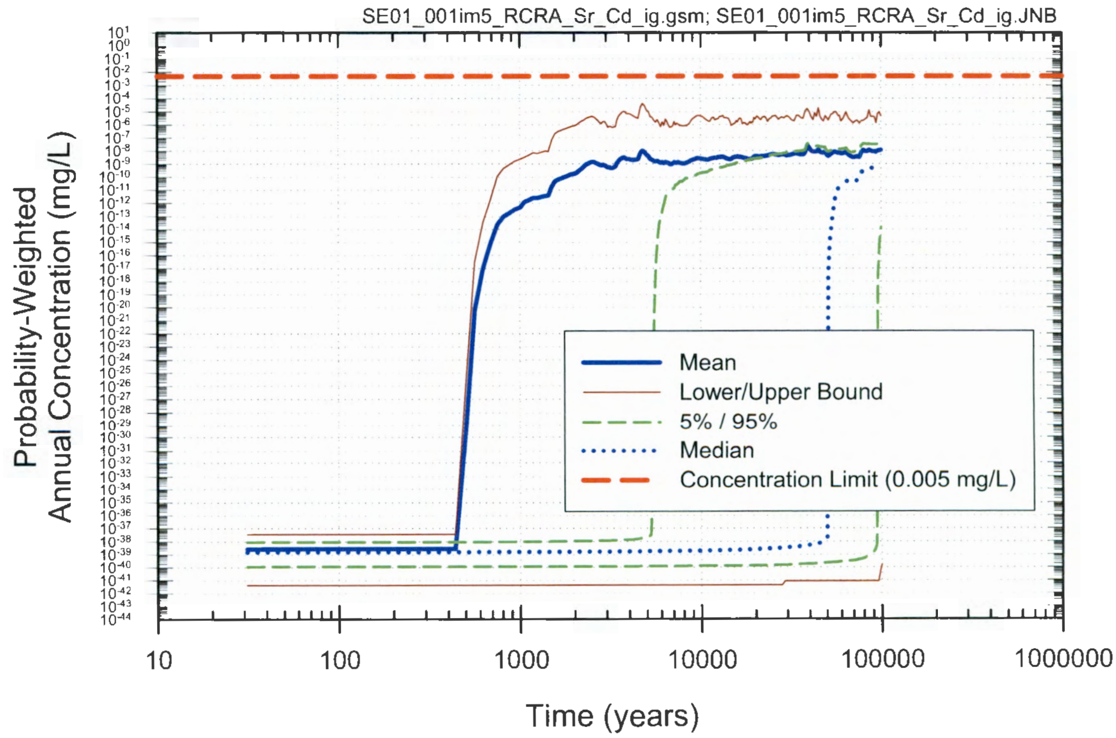

Figure B-39. Statistical curve set for the Strontium Contaminant 8 case analysis.

Figure B-40 shows the statistical plots of the annual chromium release for the Strontium Contaminant 9 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each strontium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

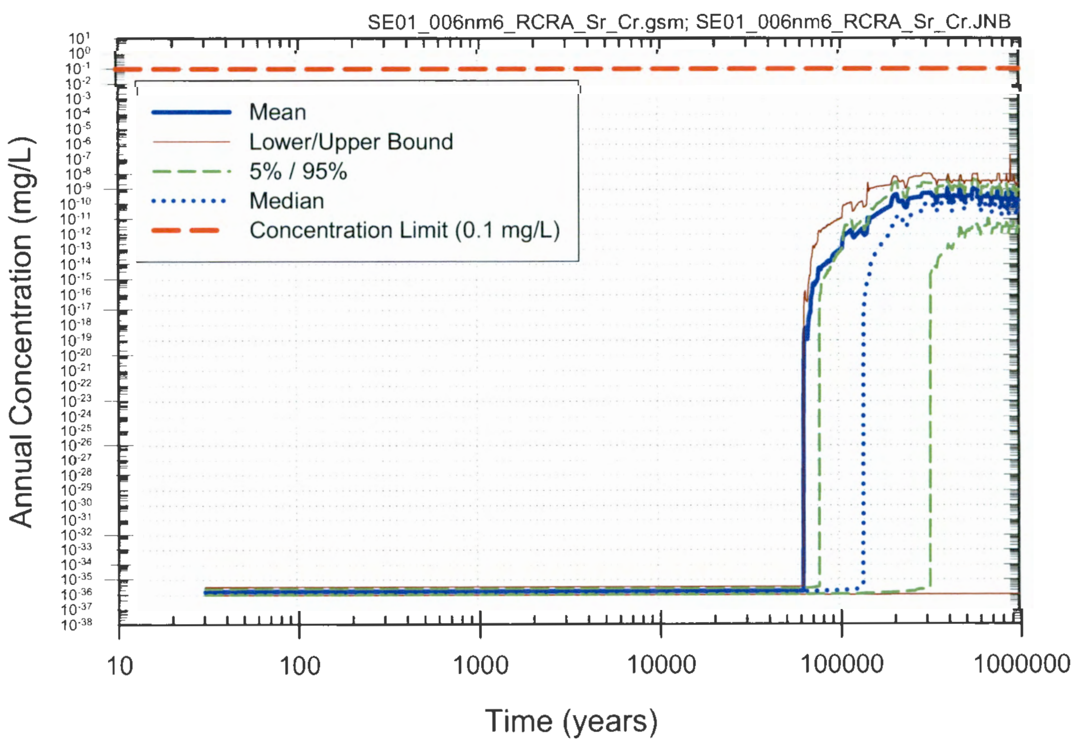

Figure B-40. Statistical curve set for the Strontium Contaminant 9 case analysis.

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Figure B-41 shows the statistical plots of the annual chromium release for the Strontium Contaminant 10 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

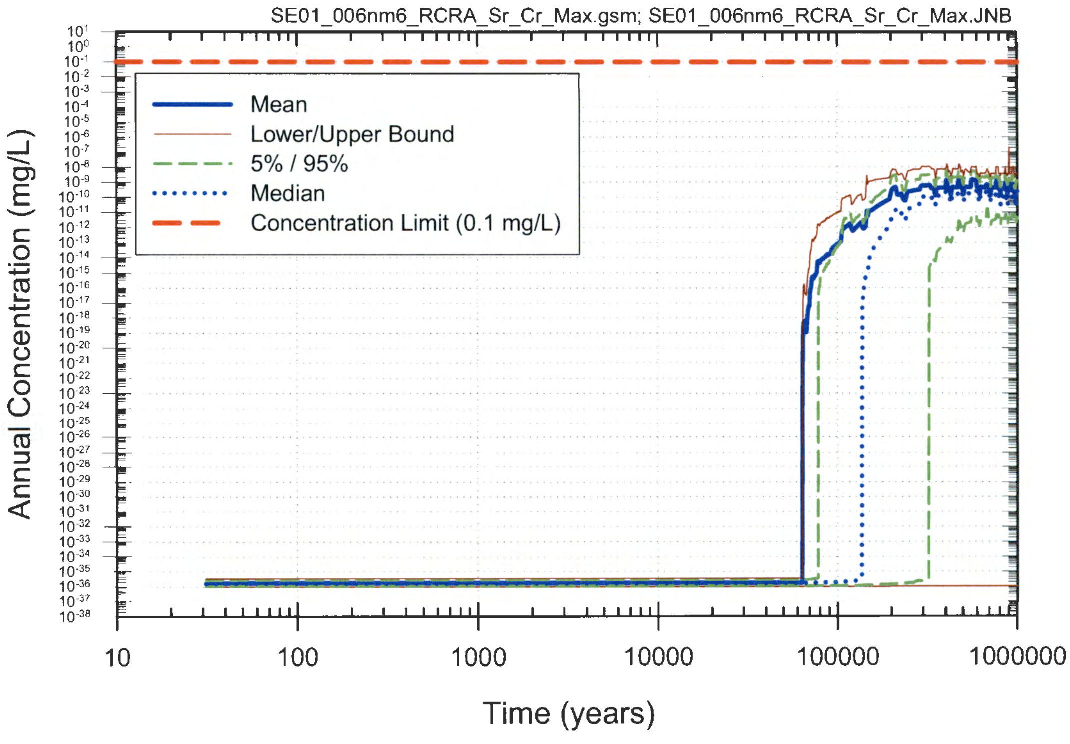

Figure B-41. Statistical curve set for the Strontium Contaminant 10 case analysis.

Figure B-42 shows the statistical plots of the annual chromium release for the Strontium Contaminant 11 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 300 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

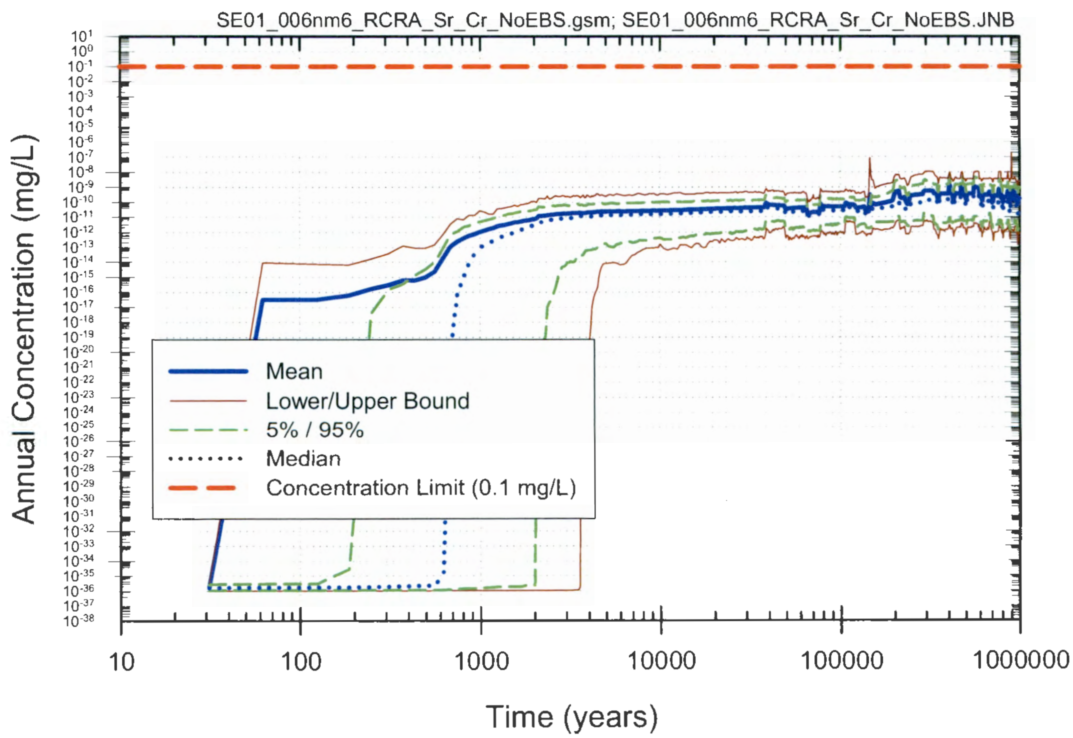

Figure B-42. Statistical curve set for the Strontium Contaminant 11 case analysis.

Figure B-43 shows the statistical plots of the annual chromium release for the Strontium Contaminant 12 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each strontium capsule waste package contains the full range of chromium inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for chromium. The mean line displays the mean value of the 5,000 realization concentration results for the chromium in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the chromium concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

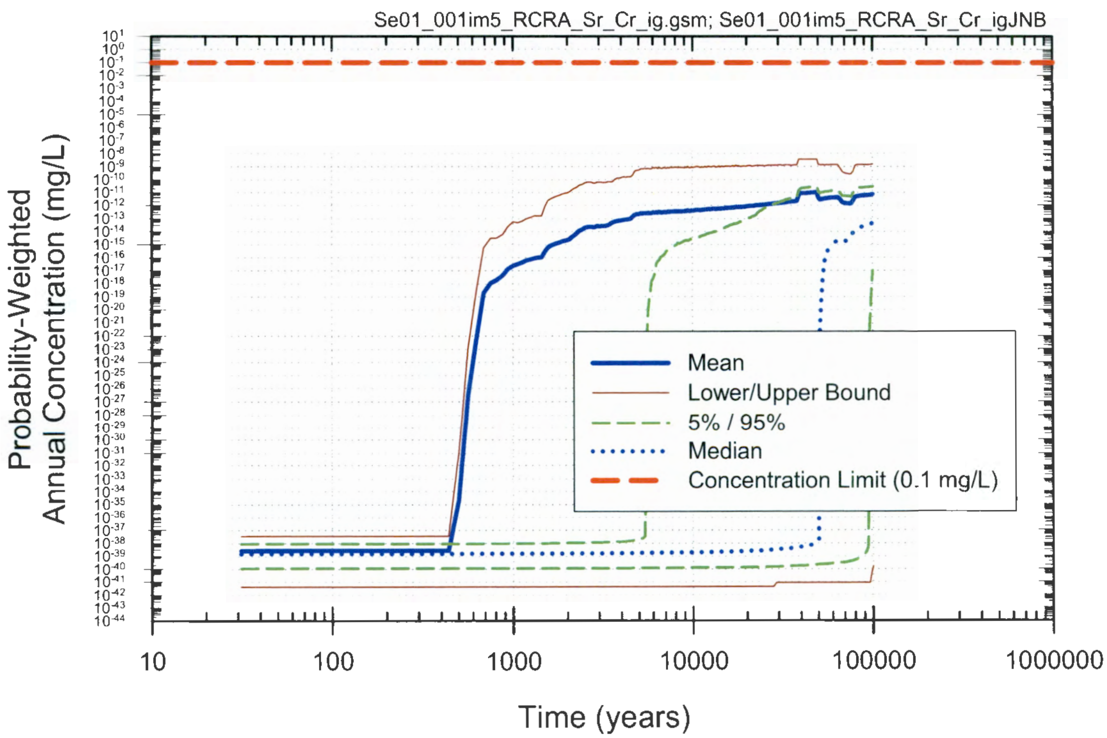

Figure B-43. Statistical curve set for the Strontium Contaminant 12 case analysis.

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Figure B-44 shows the statistical plots of the annual lead release for the Strontium Contaminant 13 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each strontium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

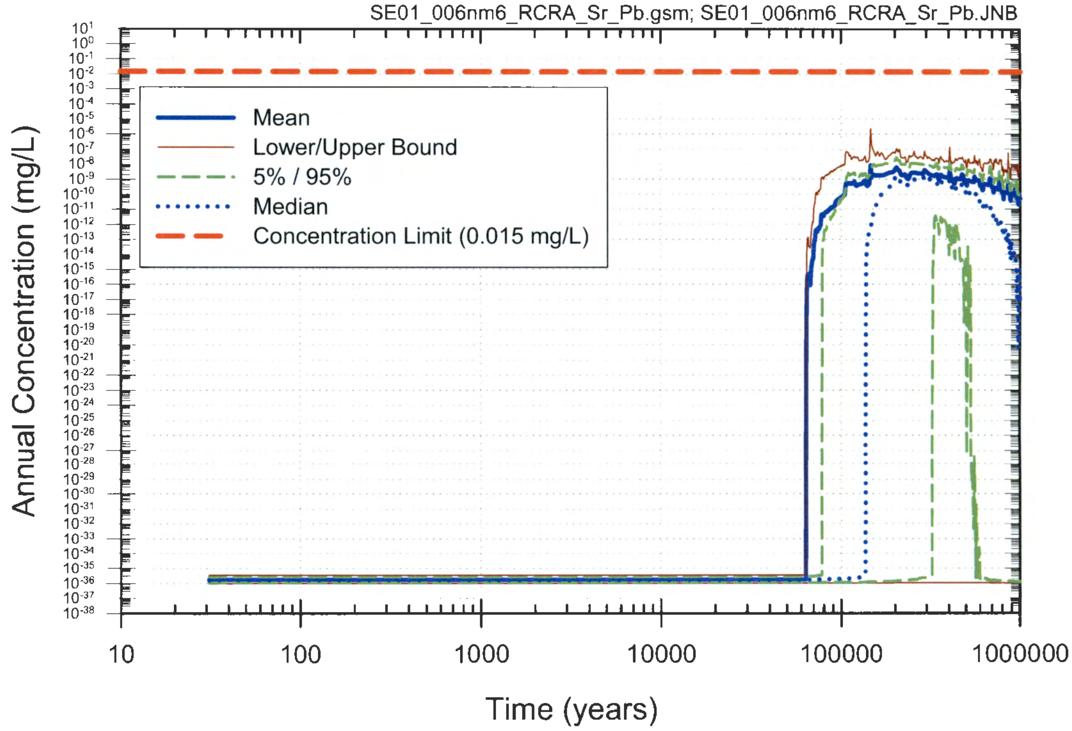

Figure B-44. Statistical curve set for the Strontium Contaminant 13 case analysis.

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Figure B-45 shows the statistical plots of the annual lead release for the Strontium Contaminant 14 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each cesium capsule waste package contains the maximum lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

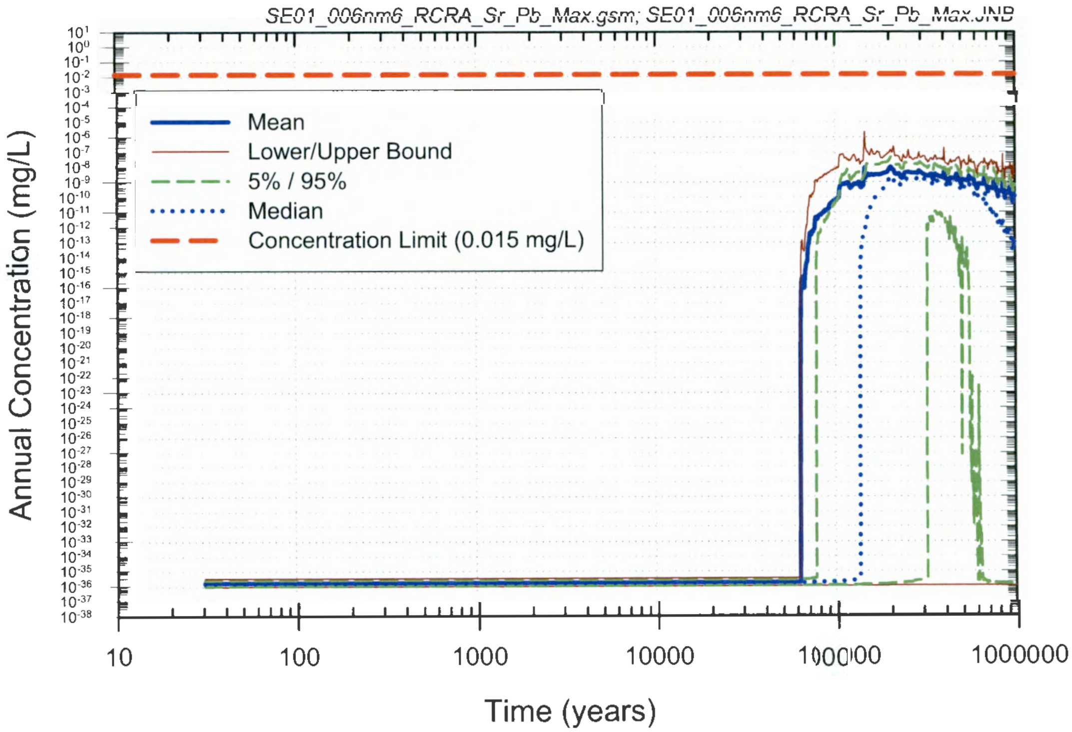

Figure B-45. Statistical curve set for the Strontium Contaminant 14 case analysis.

Figure B-46 shows the statistical plots of the annual lead release for the Strontium Contaminant 15 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 300 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

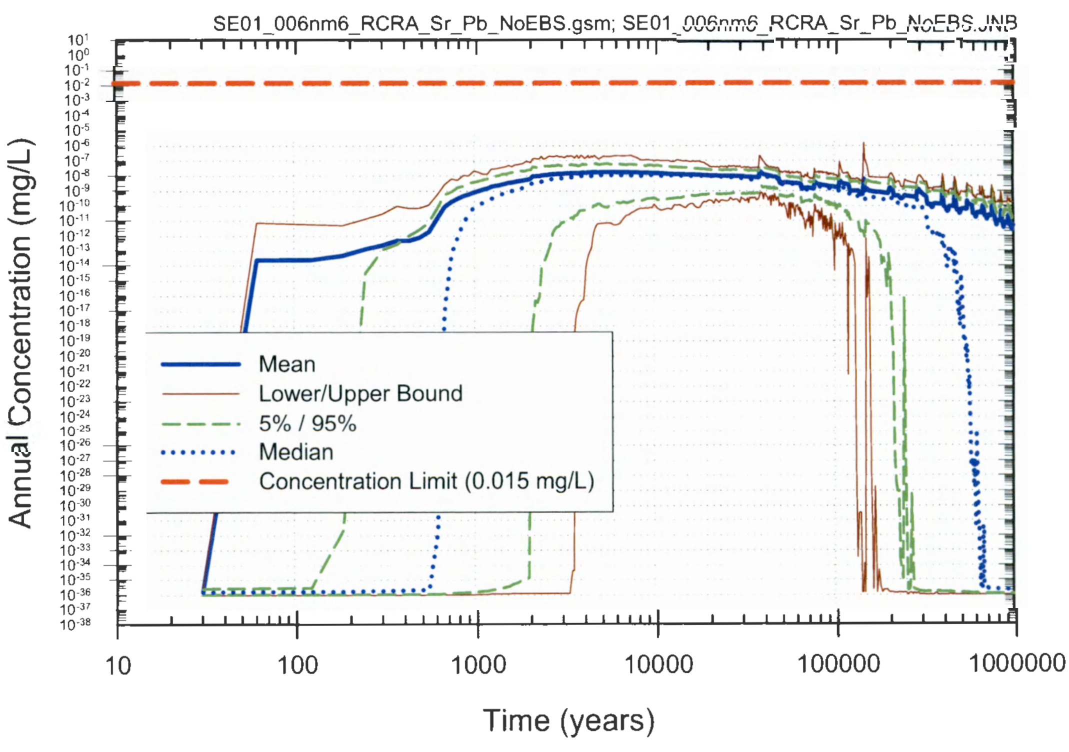

Figure B-46. Statistical curve set for the Strontium Contaminant 15 case analysis.

Figure B-47 shows the statistical plots of the annual lead release for the Strontium Contaminant 16 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each strontium capsule waste package contains the full range of lead inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for lead. The mean line displays the mean value of the 5,000 realization concentration results for the lead in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the lead concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

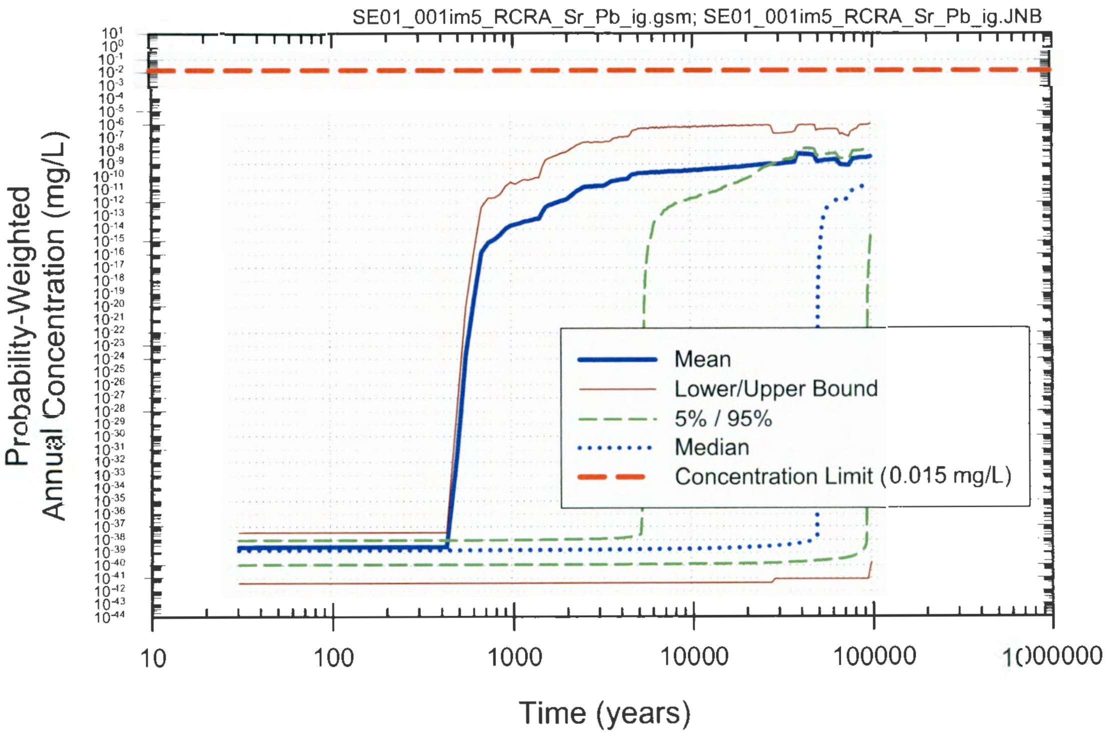

Figure B-47. Statistical curve set for the Strontium Contaminant 16 case analysis.

Figure B-48 shows the statistical plots of the annual silver release for the Strontium Contaminant 17 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. Each strontium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

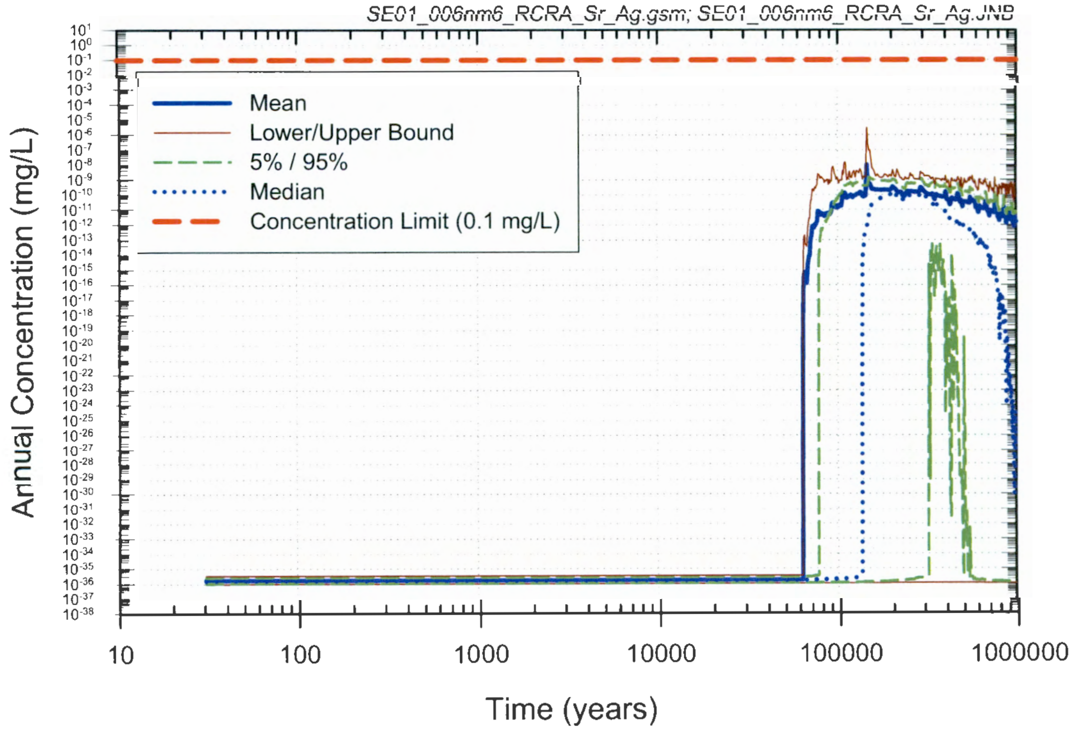

Figure B-48. Statistical curve set for the Strontium Contaminant 17 case analysis.

Figure B-49 shows the statistical plots of thc annual silver release for the Strontium Contaminant 18 case (sec Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the releasc of all radionuclides set to zero. Each cesium capsule waste packagc contains the maximum silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays thc mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

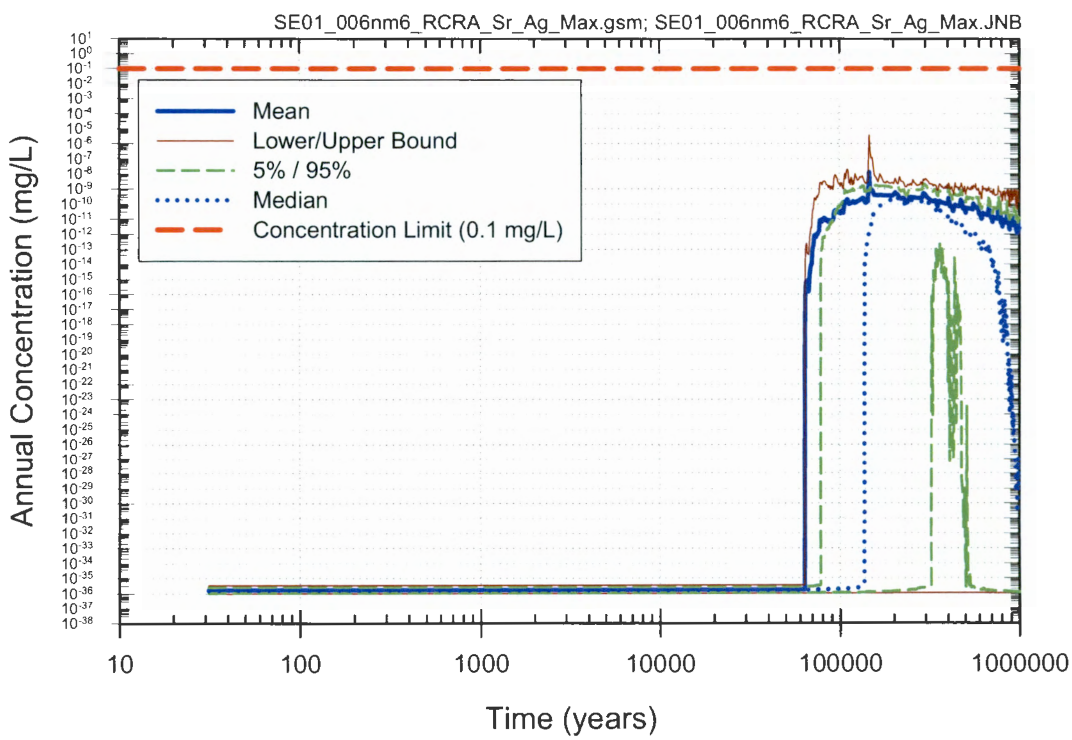

Figure B-49. Statistical curve set for the Strontium Contaminant 18 case analysis.

Title: Hanford Cs-Sr Repository Disposal Performance Analysis Using the TSPA-FEIS Model

Figure B-50 shows the statistical plots of the annual silver release for the Strontium Contaminant 19 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the engineered barrier system is removed. Each cesium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 300 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 300 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

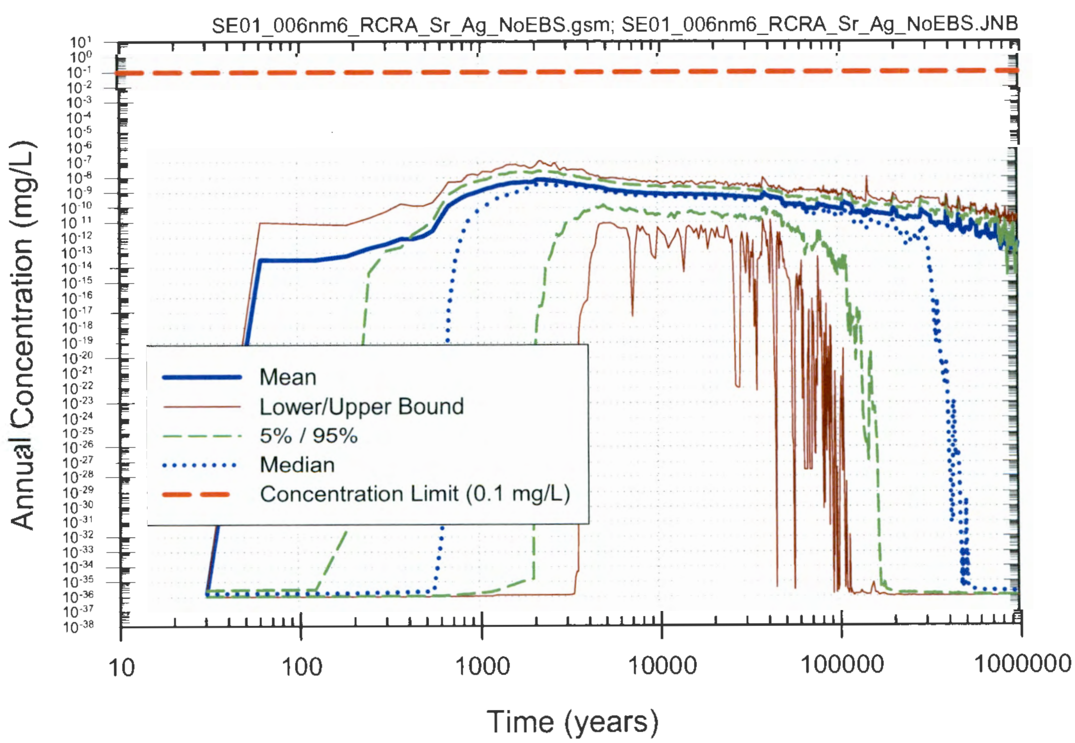

Figure B-50. Statistical curve set for the Strontium Contaminant 19 case analysis.

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Figure B-51 shows the statistical plots of the annual silver release for the Strontium Contaminant 20 case (see Table 26 for specific case detail) in which the repository inventory is reduced to 38 codisposal waste packages with the release of all radionuclides set to zero. For this case, the igneous scenario is used. Each strontium capsule waste package contains the full range of silver inventory. The plot displays separate curves for various statistical values of the set of 5,000 realizations. The concentration limit line represents the groundwater concentration limit for silver. The mean line displays the mean value of the 5,000 realization concentration results for the silver in the groundwater. The most significant comparison to be made for this data is the comparison of the mean against the concentration limit since the mean is the most likely value of the silver concentration. Also shown on the plot are the upper and lower bounds for the range of calculated concentrations. These curves represent the maximum and minimum results of all realizations for the case. The 5th and 95th percentile are also shown on the plot. The area between these two lines contains the results of 90% of the realizations. In addition, the median is shown on the plot, representing the middle of all realizations or the value above and below which 50% of the realizations fall.

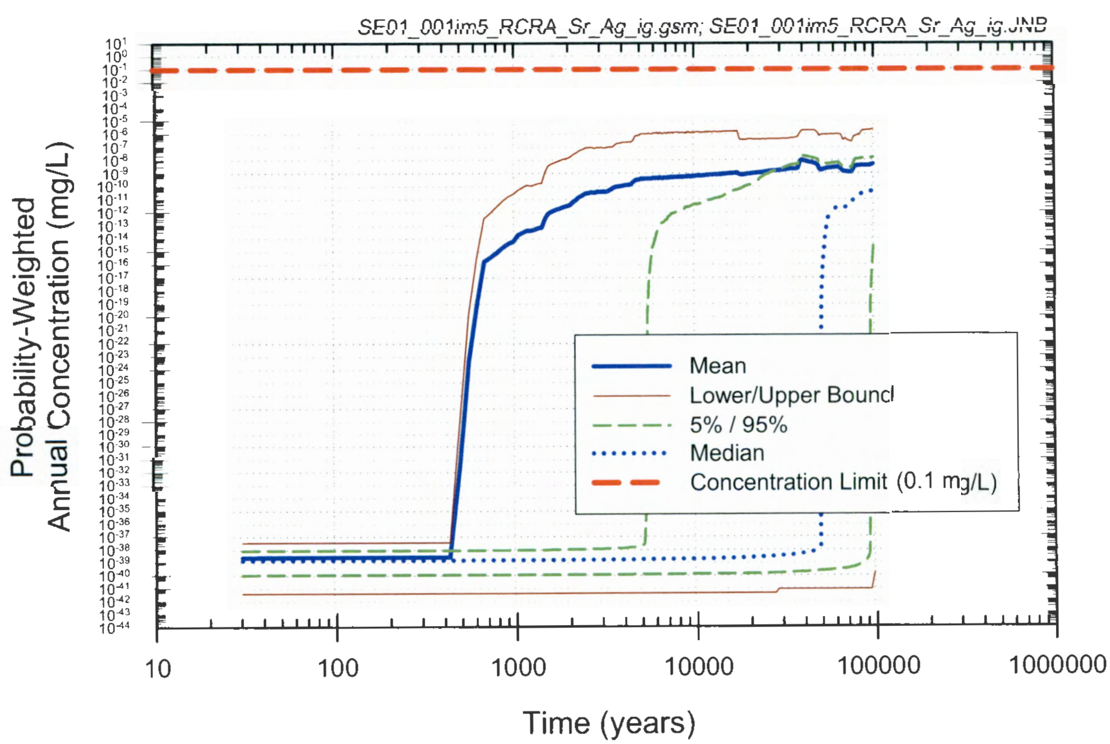

Figure B-51. Statistical curve set for the Strontium Contaminant 20 case analysis.