Systems Study on Engineered Barriers

**An Analysis on the Use of
Engineered Barriers for
Geologic Isolation of Spent
Fuel in a Reference Salt Site
Repository**

**M. O. Cloninger
C. R. Cole
J. F. Washburn**

December 1980

**Prepared for the
Office of Nuclear Waste Isolation
under its Contract with the
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SYSTEMS STUDY ON ENGINEERED BARRIERS

AN ANALYSIS ON THE USE OF ENGINEERED
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Richland, Washington 99352

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SUMMARY

A perspective on the potential durability and effectiveness requirements for the waste form, container and other engineered barriers for geologic disposal of spent nuclear fuel has been developed. This perspective is based on calculated potential doses to individuals who may be exposed to radioactivity released from a repository via a groundwater transport pathway.

These potential dose commitments were calculated with an integrated geosphere transport and biosphere transport model. The one-dimensional geosphere transport model simulates the release of radionuclides from a repository through contact and leaching by flowing groundwater, subsequent transport of nuclides in the groundwater (including the effects of convection, reversible sorption and mineralization, and radioactive chain decay), and ultimate release of the nuclides to the surface water (lake or river) or to an intrusion water well borehole. The output of the geosphere model is the input for the biosphere model. The biosphere model predicts the radiation dose to humans from the nuclide release to surface waters via several pathways, including direct ingestion of water, aquatic foods, and irrigated food products, as well as irradiation from shoreline deposition and swimming. Food chain reconcentration/accumulation effects are included.

A sensitivity analysis was accomplished by varying four important system parameters, namely the waste radionuclide release rate from the repository, the delay prior to groundwater contact with the waste (leach initiation), aquifer flow velocity and flow path length. The first two parameters represent the net effectiveness of the near-field repository system and the latter two are partially representative of the far-field effectiveness. The nuclide retarding capacity of the geologic media, a major determinant of the isolation effectiveness, was not varied as a parameter but was held constant for a particular reference site.

This analysis is limited to looking only at engineered barriers whose net effect is either to delay groundwater contact with the waste form or to limit the rate of release of radionuclides into the groundwater once contact has occurred. It does not address the effectiveness of engineered barriers that provide other functions, such as altering the characteristics of the near-field groundwater system (Eh, pH, etc.) except as these functions accomplish delay or reduced rate of release from the waste package, or barriers that provide warning of the existence of the waste to future generations. Further, the analysis considers only leach incident scenarios, including a water well intrusion into the groundwater near a repository, but does not consider other human intrusion events (solution salt mining, excavation, etc.) or catastrophic events (volcano through the repository, sudden thrusting of repository to the surface, etc.).

The analysis has so far been applied to a reference salt site repository system. The following conclusions were reached:

- In nearly all cases, the regional geology is the most effective barrier to release of radionuclides to the biosphere; however, for long-lived isotopes of carbon, technetium and iodine, which were poorly sorbed on the geologic media, the geology is not very effective once a leach incident is initiated.

- The effect of the rate limiting barrier function is shown below. While the need for and the effectiveness of a release rate limiting barrier function is somewhat dependent on the sorption properties of the geologic media, generally a release rate of less than 10^{-3}yr^{-1} (fractional) is necessary to reduce the potential dose from ^{14}C , ^{99}Tc and ^{129}I to a baseline level below that of the actinides. Beyond that a rate of less than 10^{-5}yr^{-1} is required before the potential dose from the actinide chains can be further lowered by this mechanism (lower two lines). This is because the distribution of actinide chain members in time and space, due to their different sorption properties and the characteristics of the groundwater flow field, has the same effect as a release rate reduction of between 10^{-5} to 10^{-6}yr^{-1} . Only in extreme cases of the intrusion water well scenario (upper line) is there a direct relationship between release rate from the repository and release to the biosphere.

General Effect of Rate Limiting Barrier Function

- The following figure shows the general effect of the barrier delay function. Generally, the delay in leach incident initiation that an engineered delay function (container, sealant backfill, etc.) might provide, 10^4 years or less, is insufficient to accomplish any maximum potential dose reduction. Only the delay provided by a dry, stable geology, 10^5 years or more, can accomplish this (bottom two lines). However, in the extreme and very unlikely case of the water well scenario (upper line), the maximum potential dose is optimally reduced by a containment function lasting about 400 years. If the containment should last beyond 1000 years, the maximum potential dose can actually be increased due to ^{226}Ra accumulation (from uranium decay) in the repository confines.

General Effect of Barrier Delay Function

Specific nuclides of primary concern, in no particular order, are ^{99}Tc , ^{129}I , ^{14}C , ^{226}Ra + daughters (U) and, for the extreme case of the well scenario, ^{90}Sr .

These conclusions depend on the adequacy of the analysis assumptions (summarized in Section 6.0) and should be viewed in the context of the discussion in Section 5.0 (Perspective) of this report.

These conclusions are intended to be general guides as to the likely desirable characteristics of engineered barriers. Site-specific analysis is necessary for the final determination of the barrier characteristics that will provide the highest degree of safety for any particular repository; however, this analysis was designed to maximize both the need for and the resultant effectiveness of the engineered barriers in the context of the overall repository system, thereby maximizing the apparent incentive for providing them. In this way, the conditions under which an incentive is indicated for providing an engineered barrier, as well as the degree of barrier effectiveness indicated, are subject to some doubt. Conversely, a large degree of confidence can be attached to conclusions regarding conditions for which there is no apparent incentive or is even a disincentive for providing engineered barriers.

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1.0 INTRODUCTION

The development and characterization of waste forms, containers and other engineered barriers destined for use in the isolation of nuclear waste in deep geologic repositories has progressed to the point where there are several options and combinations of barrier systems that are available to help assure safe disposal of nuclear wastes. However, a rigorous basis has not yet been developed to define whether various concepts or products are required or desirable, or how durable they should be for how long. This analysis is an attempt to contribute to that basis. The intent of the analysis is to determine what incentives exist for providing highly effective engineered barriers for the isolation of radioactive waste in a deep geologic repository, based on what effect, if any, the engineered barrier may have on the ultimate potential dose to humans.

Since the long-term dose risks from geologic disposal cannot be directly measured nor totally determined from accelerated testing, a degree of theoretical modeling is required to estimate them. An interactive, cyclic process involving four general areas of endeavor can focus in on a final objective, with a greater degree of sophistication with each cycle. These four general areas are diagrammed in Figure 1. The large arrows represent the transfer of information clockwise, and the small arrows show the communication of types of information needed counterclockwise. The development and characterization of waste forms is at a fairly advanced stage; however, the development of other engineered barriers (engineered barriers as

FIGURE 1. Interactive Process for Repository System Definition

used here are considered to be anything that man places in the repository to delay the initiation of release or reduce the rate of release of radionuclides once initiation has occurred, including the waste form, containers, backfill material, etc.) and near-field analysis of their in situ behavior is just beginning and will be useful for comparison to the results of consequence analyses to follow. When a satisfactory level of confidence has been attained in the four general areas, the methodology and products can be applied to licensing and construction of a repository system.

This study is a consequence analysis (system response analysis) consistent with the state-of-the-art in the other three primary areas of Figure 1. The intent of the analysis is to determine what technical incentives exist for providing highly effective engineered barriers for the isolation of radioactive waste in a deep geologic repository. The underlying criteria for determining incentives is what effect, if any, the engineered barrier may have on the ultimate potential doses to humans living at a future time due to a release from the repository.

While the concept of assuring that resultant doses are below a maximum allowable (acceptable) level and of then applying an "As Low As Reasonably Achievable" (ALARA) philosophy beyond that point (using engineered barrier cost and performance data in combination with the dose consequence results of this study) is presented, it cannot be actually achieved until those "acceptable" dose levels are established. It is not within the scope of this work to establish acceptable dose consequences. Thus, the basis for engineered barrier incentives here is the relative dose reduction attained through specific and relative degrees of engineered barrier effectiveness over a wide range of geohydrologic conditions and scenario severities.

In past consequence analyses (Burkholder and Cloninger 1978; Burkholder, Cloninger, Baker and Jansen 1976; Burkholder 1976) of generic repositories, one containing the reprocessing waste (high-level waste) and one containing the spent fuel from the projected U.S. nuclear power economy through the year 2000, a methodology has been developed for assessing potential consequences of nuclide release from a repository.

2.0 METHODOLOGY

The analysis is based on predicting the potential releases from a deep geologic repository due to a scenario involving groundwater intrusion into the repository, leaching and transport of nuclides to the surface, and transport of the nuclides in the biosphere where they interact with humans.

The release to the biosphere is converted to a dose to a maximally exposed individual ("maximum individual") in order to compare the resultant dose to an assumed maximum allowable dose limit and to determine, through parametric analysis, what effects the properties of engineered barriers may have on that resultant dose for a range of geohydrologic conditions. The analysis reported here is partly based on an assumed acceptable 100-mrem/yr average lifetime annual dose limit to the maximum individual from a repository located in a reference salt site. This dose results from a leach incident scenario involving groundwater transport of the nuclides to the surface via natural processes and, as a limiting case, to a water well borehole.

2.1 THE SCENARIO

The highest risk path from the repository through the geosphere to the biosphere is assumed to be the leach incident pathway. While the relative risks of the various pathways from final geologic storage have not been evaluated, the leach incident appears to be the highest probability release mechanism. The scenario involves the following steps:

- penetration of the repository by groundwater
- failure of the waste container
- leaching of the radionuclides from the waste form
- transport of the nuclides through the surrounding geology to the biosphere
- transport of the nuclides through the biosphere to man
- interaction of the nuclides with man.

A pictorial representation of the leach incident scenario is shown in Figure 2.

The geologic isolation system provides barriers to the first four steps in the process. The transport of nuclides from the repository to the biosphere is limited by several general factors. Some important factors are the solubility of the waste form and container at repository conditions, the chemical composition of the groundwater (especially its pH and Eh, its ionic strength and the presence in the groundwater of complexing agents) and the sorption capability of the repository media and all geologic media along the groundwater flow path.

These factors are, of course, related to other factors. For example, water velocity and flow direction are a function of aquifer porosity, effective permeability, and hydraulic gradient. They can also be affected by the thermal gradient near the repository. Factors are also interrelated. For example, the solubility of the waste form and the net sorption capacity of the geologic media can be greatly affected by the pH, Eh and ionic strength of the groundwater.

FIGURE 2. Pictorial Representation of the Leach Incident Scenario

Through these factors the geologic repository system provides two general means of protection from radioactive waste. The first means is containment of waste for a sufficient length of time for the hazardous nuclides to decay to innocuous levels such that unrestricted release to the environment presents no radiological hazard. The second means is to limit the rate of release of nuclides to the biosphere such that their concentration in the constantly renewed local surface water and air never exceed acceptable limits. The actual repository system will provide protection using some effective balance of these two means.

The available system components that provide the means for this protection can be reduced to 1) the waste form, 2) the containment package, and 3) the geology (including hydrology). Engineered barriers such as nonhomogeneous waste forms (micro-encapsulation, etc.), overpacks, specialized backfill, etc., can be considered part of one of these components.

The human-caused intrusion water well scenario can essentially short-circuit the protection from nuclides already dissolved in the groundwater that the geologic system provides. The intrusion well scenario was chosen as a limiting case of the leach incident pathway.

The radionuclide inventory used in the analysis is one-fifth of the total for the spent, unprocessed fuel (no-recycle case) accumulated in the U.S. through the year 2050 that was used in the Commercial Waste Management Generic Impact Statement (CWM/GEIS) (DOE 1979a). The assumption was that there would be five operating repositories, each containing an equal fraction of the total U.S. spent fuel accumulation. The inventories of the radionuclides in the repository are shown in Table 1 for various times after repository sealing in the year 2050.

2.2 THE MODELS

The geosphere transport model is a second-generation Fortran version of the GETOUT code (Demier, Cloninger, Burkholder and Liddell 1979), which is a one-dimensional analytical model that simulates the release of radionuclides from a repository through contact and leaching by flowing groundwater, the subsequent transport of the nuclides in the groundwater (including the effects of convection, axial hydrodynamic dispersion, reversible sorption and mineralization, and radioactive decay), and predicts the ultimate time and rate of release of the nuclides to the surface water (lake or river) or water well intake.

In order to simplify the analysis, a multitude of parameters was reduced to terms representing the net effect of several more complex phenomena. For example, the release rate of nuclides into the flowing groundwater (source term) is a constant rate approximation of what may in reality be a more complex release function that, if necessary, can be more explicitly modeled after simulated in situ performance analyses have progressed sufficiently. The model parameter representing the release rate limiting capacity of the engineered barriers is the inverse of the release rate (fraction/yr), or the constant rate release duration in years. A parameter representing the combined effectiveness of the engineered barrier containment function and the stability (or integrity of the surrounding geology) is the delay (years) in release initiation measured from the date of repository closure.

The major hydrologic parameters, which are functions of geologic media factors such as porosity, permeability, net hydraulic head and gradient, and fracture patterns, are the dispersivity, groundwater flow rates and total path length to the biosphere. For this analysis, these parameters have been reduced to net groundwater flow velocity, total migration path length and a net dispersion coefficient. Flow velocity and path length, though modeled separately, are combined for graphic presentation into a single parameter, groundwater travel time (path length/flow velocity). A minor amount of accuracy is lost in combining path length and flow velocity parameters due to somewhat different net hydrodynamic dispersion effects at

TABLE 1. Repository Nuclide Inventories at Various Years after Closure(a)

Nuclide	Nuclide Inventories, Ci									
	1.00D+00(b)	1.00D+02	3.00D+02	1.00D+03	3.00D+03	1.00D+04	3.00D+04	1.00D+05	3.00D+05	1.00D+06
³ H	4.38D+06	1.57D+04	7.22D-04	1.53D-18	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
⁹⁹ Tc	9.64D+05	9.64D+05	9.62D+05	9.60D+05	9.54D+05	9.32D+05	8.72D+05	6.92D+05	3.58D+05	3.56D+04
¹²⁹ I	2.48D+03	2.48D+03	2.48D+03	2.48D+03	2.48D+03	2.46D+03	2.46D+03	2.46D+03	2.44D+03	2.38D+03
¹⁴ C	2.50D+04	2.46D+04	2.38D+04	2.22D+04	1.74D+04	7.46D+03	6.64D+02	1.40D-01	4.44D-12	.00D+0
⁹³ Mo	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
⁴¹ Ca	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
⁷⁹ Se	2.62D+04	2.62D+04	2.62D+04	2.60D+04	2.54D+04	2.36D+04	1.90D+04	9.04D+04	1.07D+03	6.18D-01
⁹⁰ Sr	2.02D+09	1.71D+08	1.05D+05	3.96D-02	1.53D-23	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
¹⁰ Be	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
⁶⁰ Co	8.34D+06	1.59D+01	1.11D-16	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
⁵⁹ Ni	2.30D+05	2.30D+05	2.28D+05	2.28D+05	2.24D+05	2.10D+05	1.77D+05	9.66D+04	1.71D+04	3.98D+01
⁶³ Ni	2.72D+07	1.28D+07	1.34D+06	1.47D+04	4.22D-03	5.46D-26	.00D+0	.00D+0	.00D+0	.00D+0
⁸⁷ Rb	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00	1.29D+00
¹³⁵ Cs	2.00D+04	2.00D+04	2.00D+04	2.00D+04	2.00D+04	2.00D+04	1.99D+04	1.96D+04	1.87D+04	1.59D+04
¹³⁷ Cs	2.88D+09	2.86D+08	2.80D+05	2.70D-01	2.38D-21	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
¹⁰⁷ Pd	7.32D+03	7.32D+03	7.32D+03	7.32D+03	7.32D+03	7.32D+03	7.30D+03	7.26D+03	7.10D+03	6.64D+03
¹²⁶ Sn	3.54D+04	3.54D+04	3.54D+04	3.52D+04	3.48D+04	3.32D+04	2.88D+04	1.63D+04	4.44D+03	3.50D+01
¹⁵¹ Sm	6.36D+07	2.86D+07	2.62D+06	2.22D+04	2.68D-03	1.68D-27	.00D+0	.00D+0	.00D+0	.00D+0
¹⁶⁶ Nd	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
¹⁵² Eu	1.33D+05	4.14D+02	1.25D-05	1.14D-20	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
¹⁵⁴ Eu	9.02D+07	1.19D+06	2.72D+00	1.42D-11	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0

(a) Years after closure.

(b) 4.38D+06 is notation equivalent to 4.38×10^6 .

TABLE 1. (contd)

Nuclide	Nuclide Inventories, Ci									
	1.00D+00 ^(b)	1.00D+02	3.00D+02	1.00D+03	3.00D+03	1.00D+04	3.00D+04	1.00D+05	3.00D+05	1.00D+06
⁹³ Zr	1.24D+05	1.24D+05	1.24D+05	1.24D+05	1.24D+05	1.24D+05	1.23D+05	1.19D+05	1.08D+05	7.84D+04
^{113m} Cd	1.10D+05	7.84D+02	2.80D-04	3.58D-17	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁸ Cm	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁴ Pu	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁴ Cm	2.38D+07	5.18D+05	5.30D+00	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁰ Pu	3.38D+07	3.34D+07	3.24D+07	3.04D+07	2.48D+1	1.21D+07	1.56D+03	1.19D+03	1.47D-06	.00D+0
²³⁶ U	1.69D+04	1.70D+04	1.73D+04	1.78D+04	1.88D+04	2.30D+04	2.46D+04	2.64D+04	2.62D+04	2.58D+04
²³² Th	2.04D-05	8.66D-05	3.16D-04	1.30D-03	1.99D-03	1.01D-02	7.30D-02	1.88D-01	2.84D-01	1.27D+00
²³² U	1.01D+03	3.88D+02	2.16D+01	6.68D-02	2.90D-10	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁵ Cm	1.30D+04	1.29D+04	1.25D+04	1.19D+04	1.01D+04	5.60D+03	1.05D+03	2.96D+00	1.53D-07	4.86D-33
²⁴¹ Pu	1.55D+09	1.43D+07	1.26D+04	1.20D+04	1.01D+04	5.62D+03	1.05D+03	2.96D+00	1.54D-07	4.88D-33
²⁴¹ Am	2.30D+08	2.40D+08	1.50D+08	5.74D+07	2.34D+06	5.62D+03	1.05D+03	2.96D+00	1.58D-07	5.14D-33
²³⁷ Np	2.52D+04	6.34D+04	4.84D+04	7.04D+04	7.60D+04	8.22D+04	8.18D+04	8.00D+04	7.50D+04	5.98D+04
²³³ U	9.32D+00	1.91D+01	6.58D+01	2.32D+02	6.04D+02	3.30D+03	7.18D+03	2.82D+04	4.28D+04	6.34D+04
²²⁹ Th	2.46D-02	1.32D-01	1.16D+00	9.58D+00	5.32D+01	1.14D+03	3.80D+03	2.58D+04	4.10D+04	6.38D+04
²⁴⁶ Cm	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴² Pu	1.18D+05	1.18D+05	1.18D+05	1.18D+05	1.18D+05	1.16D+05	1.12D+05	9.86D+04	6.84D+04	1.90D+04
²³⁸ U	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04	2.40D+04
²⁴² Cm	5.50D+05	3.48D+05	8.86D+04	5.74D+03	6.28D-01	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
^{242m} Am	6.70D+05	4.24D+05	1.08D+05	7.00D+03	7.74D-01	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0

(a) Years after closure.

(b) 4.38D+06 is notation equivalent to 4.38×10^6 .

TABLE 1. (contd)

Nuclide	Nuclide Inventories, Ci									
	1.00D+00 ^(b)	1.00D+02	3.00D+02	1.00D+03	3.00D+03	1.00D+04	3.00D+04	1.00D+05	3.00D+05	1.00D+06
²³⁶ Pu	5.72D+01	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²³⁸ Pu	1.17D+08	5.40D+07	5.34D+06	6.20D+04	1.49D+00	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²³⁴ U	8.80D+04	1.07D+05	1.24D+05	1.30D+05	1.30D+05	1.28D+05	1.22D+05	1.05D+05	6.66D+04	3.04D+04
²³⁰ Th	2.94D+01	9.86D+01	3.72D+02	1.08D+03	2.44D+03	1.07D+04	2.14D+04	6.68D+04	5.96D+04	3.34D+04
²²⁶ Ra	2.86D-01	2.44D+00	2.78D+01	2.00D+02	2.44D+03	8.30D+03	1.91D+04	6.74D+04	5.96D+04	3.34D+04
²⁴⁷ Cm	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴³ Am	1.02D+06	1.01D+06	9.80D+05	9.28D+05	7.74D+05	4.10D+05	6.70D+04	1.18D+02	1.59D-06	4.50D-34
²⁴³ Cm	1.30D+05	4.88D+03	2.24D+01	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²³⁹ Pu	1.00D+00	2.18D+07	2.16D+07	2.14D+07	2.02D+07	1.67D+07	9.48D+06	1.31D+06	4.46D+03	1.03D-05
²³⁵ U	9.30D+01	1.34D+03	1.35D+03	1.36D+03	1.39D+03	1.53D+03	1.67D+03	2.06D+03	2.08D+03	2.10D+03
²³¹ Pa	1.00D+00	5.42D+00	1.30D+01	3.10D+01	6.58D+01	2.78D+02	5.50D+02	1.72D+03	1.90D+03	2.10D+03
²⁵⁰ Cm	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁵⁰ Cf	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁴⁹ Cf	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁵¹ Cf	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0
²⁵² Cf	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0	.00D+0

(a) Years after closure.

(b) 4.38D+06 is notation equivalent to 4.38×10^6 .

different flow velocity and path length combinations; however, combining the two allows the results from a multitude of transport calculations to be presented keyed to a single parameter.

Output data from the geosphere model is the input data for the biosphere model PABLM (Napier, Kennedy and Soldat 1980). The biosphere model predicts the radiation dose to humans from the nuclide release to surface waters via several pathways, including direct ingestion of water, aquatic foods and irrigated food products, as well as irradiation from shoreline deposition and swimming. Food chain reconcentration/accumulation effects are included. The biosphere parameters are the same as were used in CWM/GEIS (DOE 1979a) and were held constant throughout the analysis.

3.0 REFERENCE SALT REPOSITORY SITE

The models were applied to simulate a leach incident release from a repository in a reference salt site having a potential range of characteristics as listed in Table 2. The 100-year constant rate leach duration was set as a minimum, representing the fastest possible release of nuclides (1%/yr) from the repository due to solubility and mass transfer limitations in a backfilled repository. This 100-year duration is taken as representative of a waste form that by itself provides no resistance to leaching or dissolution. The 100-year value was not based on any solubility or volumetric flow data. Concentration limits to release rate are discussed further in Section 5.0. The "delay prior to leach initiation" parameter range was arbitrarily chosen in order to cover a very wide range of possibilities. The remaining site parameters and parameter ranges in Table 2 are based on measured and estimated data from characterization efforts at various salt sites as summarized in Table 3 and as discussed in the following subsections.

TABLE 2. Reference Salt Site Characteristics

<u>Parameter</u>	<u>Range</u>
Release duration	100 yr to 100 M yr
Migration path length ^(a)	0.0 km to 60 km
Groundwater velocity ^(a)	0.13 m/yr to 11 m/yr
Delay prior to leach initiation	1 yr to 1 M yr
CWM/GEIS nuclide inventories	(b)

(a) Groundwater travel time: 0.0 to 400,000 yr; hydro-logic parameters simplified from composite real site ranges of porosity, permeability, head differential, etc. (see Table 3).

(b) DOE 1979a.

3.1 ISOLATION EFFECTIVENESS AND GEOHYDROLOGIC PARAMETERS

Determining a reasonable range of geohydrologic parameters for a reference repository is a difficult task because of the complex interactions between the various parameters. To determine expected values and ranges for the major parameters that control the release of nuclides via a groundwater pathway, one must not only know the geohydrologic properties and waste-water-media interactive properties of the host rock but also the properties of the media that lie between the host rock and the biosphere. One must also know what kind of environment and climate the site is located in and many other factors such as the location of the recharge and discharge sites of the aquifer above and below the host rock, and the size and extent of the aquifer networks.

TABLE 3. Typical Values and Ranges for Various Measured Hydrologic Properties and Other Important Hydrologic Parameters Determined from Modeling Studies of the Sites

Site ^(a)	Measured Hydrologic Properties		Hydrologic Parameters Related to Particular Breach Scenarios and Active Model Predictions for the Site			
	Permeability, m/s (ft/yr)	Porosity	Path Length From Source to Discharge, m (mi)	Velocity, m/yr (ft/yr)	Travel ^(b) Time, yr	Flow from Repository, m ³ /yr (ft ³ /yr)
INFCE ^(c)						
Average	5.8×10^{-7} (60)	0.2	6,100 (3.79)	0.06 (.197)	100,000	190 (6,700)
Low	5.0×10^{-10} (5.0×10^{-2})	0.13	5,950 (3.70)	0.059 (.194)	97,000	--
High	1.0×10^{-5} (1040)	0.2	6,400 (3.98)	0.061 (.200)	109,000	--
WIPP ^(d)						
Average	8.0×10^{-7} (83)	.1	28,400 (17.6)	.826 (2.71)	34,400	620 (21,900)
Low	1.8×10^{-7} (18)	.1	26,800 (16.7)	.790 (2.60)	33,900	--
High	1.12×10^{-4} (12,000)	.1	29,700 (18.5)	.850 (2.79)	35,000	--
Paradox ^(e)						
Average	4.9×10^{-7} (51)	.05	55,650 (34.6)	1.28 (4.21)	43,280	3.9×10^4 (1.4×10^6)
Low	2.9×10^{-9} (.3)	.05	54,700 (34.0)	1.26 (4.16)	43,000	--
High	9.9×10^{-7} (102)	.05	56,750 (35.3)	1.30 (4.26)	43,700	--
Hainsville ^(f)						
Average	4.9×10^{-5} (5075)	.2	59,950 (37.25)	4.04 (13.26)	14,825	5.2×10^5 (1.8×10^7)
Low	1.4×10^{-6} (146)	--	55,700 (34.6)	3.55 (11.66)	11,950	--
High	2.1×10^{-4} (22,000)	.3	66,800 (41.5)	4.67 (15.33)	18,800	--

(a) Gradient (all sites): average = .002; low = .005; high = .01.

(b) Basis for reference salt site:

$$\text{Groundwater travel time} = \frac{(\text{path length})(\text{porosity})}{(\text{gradient})(\text{permeability})}$$

$$\text{Reasonable travel time minimum} = \frac{(3.79)(.05)(5280)}{(.002)(1040)} \approx 500 \text{ yr}$$

$$\text{Reasonable travel time maximum} = \frac{(34.0)(0.2)(5280)}{(.002)(51)} \approx 350,000 \text{ yr}$$

(c) INFCE Working Group 7 1980a.

(d) Cole and Bond 1980.

(e) Raymond, et al. 1980.

(f) Harwell, et al. 1979.

Three principal geohydrologic parameters determine the effectiveness of the geohydrologic system in minimizing the impact on man of releases from a breached repository. These parameters are groundwater travel time, the variation in travel time, and the sorption capacity of the geologic media.

$$\text{Travel time} = \int_{\text{source}}^{\text{discharge}} \frac{\theta(s)}{K(s)G(s)} ds,$$

where:

- s = position along the flow path from the repository to the discharge site
- $\theta(s)$ = porosity at position s
- K(s) = permeability at position s
- G(s) = gradient in potential parallel to the flow path at position s.

The variation in the travel time from the repository to the biosphere can result from various sources. Variation in travel time is a function of:

- (1) the character of the flow field, the geometry of discharge site, the type of release scenario, etc.
- (2) the distribution of the source in the geohydrologic system
- (3) the hydrodynamic dispersion caused by the tortuosity and heterogeneity of the geologic media.

The variation in travel time that occurs from (1) and (2) above can be much greater than (3) in effect, yet the effects of (1) and (2) are omitted in a one-dimensional analysis; however, the significance of any errors due to ignoring such effects is large only when the dimensions of the repository are large compared to the flow path to the biosphere entry point as in the case of the extreme water well scenario. Thus, the extreme well scenario is quite conservative. The relationship between (1), (2) and (3) and the relative importance of each are discussed more fully in Appendix D.

3.2 GEOHYDROLOGIC DESCRIPTION OF A REFERENCE REPOSITORY IN SALT

Information from one generic study (INFCE Working Group 7 1980a) and three initial site specific studies (Cole and Bond 1980; Raymond et al. 1980; Harwell et al. 1979) on nuclear waste repositories in bedded and/or dome salt were used to determine the typical values and range in values for the important geohydrologic parameters required for this analysis.

3.2.1 Background

For long-term geologic isolation of radioactive wastes, salt has many distinguishing characteristics that make it an excellent candidate host rock. These include relative abundance,

ease of excavation, relatively high thermal conductivity, impermeability, very low water content, plasticity and self-sealing properties, and lack of fracturing. However, some potential disadvantages are its frequent proximity to oil and gas fields, the specific commercial value of the salt itself, and its suitability for storage of other materials. Salt is also water-soluble and in the presence of water it can be corrosive to materials that may be used in waste packages.

At the depths of interest for the siting and construction of a repository, salt deposits are found throughout the world in two principal forms. One type is an undeformed, bedded, sedimentary formation, laid down as the result of natural evaporation of sea water from pre-historic oceans. This type of deposit, commonly called "bedded salt," is generally found to extend laterally for appreciable distances, although the vertical extent may be limited. The other type of salt deposit can be characterized as an extensive mass or rock salt that has intruded upward through overlying sedimentary strata as the result of overburden-induced plastic deformation of an extremely deep, bedded salt formation. This type of deposit, commonly called "dome salt," generally has restricted lateral dimensions, although it extends for appreciable distances vertically.

The characteristics of salt that make it attractive for disposal of radioactive wastes are common to both bedded and dome salt deposits. The two types of deposits are considered equally suitable, with the choice of one type over the other influenced more by their range of natural occurrence and the thrust of site exploration programs within a specific area.

3.2.2 Generic Geohydrology

Salt formations are found in sedimentary basins. Depending on the actual site and form (bedded or dome), salt deposits are generally overlain by various sequences of sedimentary formations ranging from unconsolidated sands, gravels and clays to sandstones, limestones, and anhydrites. Underlying sequences are typically of the same character, but unconsolidated sequences are generally much less prevalent to nonexistent. Figures 3, 4, 5 and 6 illustrate the cross sections for the INFCE (INFCE Working Group 7 1980a), WIPP (Cole and Bond 1980), Paradox (Raymond et al. 1980), and the Hainsville (Harwell et al. 1979) study areas, respectively. Climatic conditions vary from arid (Cole and Bond 1980; Raymond et al. 1980) to wet and humid (INFCE Working Group 7 1980a; Harwell 1979). Some of the sedimentary formations or sequences of these formations overlaying or underlying the salt contain water but are generally not prolific aquifers. Water in the deeper underlying formations is typically of poor quality, ranging from total dissolved solids generally above 100,000 ppm to nearly saturated brine (Powers et al. 1978; DOE 1979b). Water in aquifer systems directly overlie these salt formations is generally more variable and can range from potable water (Harwell 1979) to various quality brine (INFCE Working Group 7 1980a; Cole and Bond 1980; Raymond et al. 1980).

FIGURE 3. Representative Stratigraphic Section for Salt^(b)

- (a) Potential aquifer.
(b) INFCE Working Group 7 1980a.

Generally the salt formation itself is surrounded by various forms of cap rock that act as aquitards to prevent water from dissolving the salt. The effectiveness and long-term stability of this seal is evident by the existence of the easily dissolvable salt formation. Because of the long-term stability of salt, various Delphi-type analyses, aimed at determining how a repository in salt might be breached, have always reached the same general conclusions. Natural dissolution methods will lead to a breach in no sooner than a few to many millions of years. Other means such as multiple fracturing (INFCE Working Group 7 1980a) or faulting (Raymond et al. 1980) can be better described as "cataclysmic events." The general consensus (Cole and Bond 1980; Harwell 1979) is that some form of human-induced breach is the only reasonable event having a time frame of less than millions of years. However, in order to not prematurely rule out any reasonably possible repository breach, the parametric range for delay prior to leach initiation is varied from one to one million years. Other parameters such as release rate, groundwater velocity and path length to the biosphere reflect the severity of the breach, without reference to the particular process or event that caused it.

FIGURE 4. Cross Section of Capitan Reef Area(a)

(a) Powers et al. 1978; Cole and Bond 1980. This is a stratigraphic summary of the Guadalupe, Leonard, and adjacent series of the Permian System in the Southern Guadalupe Mountains. The Delaware basin area is to the right and the shelf or platform area is to the left. Rock facies are greatly generalized.

ERA	SYSTEM	SERIES	FORMATION	THICKNESS (ft)	LITHOLOGY	TIME (BP) (my)
CENOZOIC	QUATERNARY AND TERTIARY		Unnamed Quaternary Tertiary Intrusives Wasatch Formation	0-?	Quaternary and Tertiary fluvial and aeolian deposits; Tertiary volcanics and intrusive rocks; gravel; dunes.	70
MESOZOIC	CRETACEOUS	UPPER	Mesaverde Group	0-500	Sandstone, siltstone, shale	135
			Mancos Shale	1000-3500	Shale and Siltstone	
			Ferrun Member		Carboniferous shale	
			Dakota Sandstone	100-150	Conglomerate, sandstone and shale	
		LOWER	Burro Canyon Formation	100-200	Conglomerate, sandstone and shale	
	JURASSIC		Morrison Formation		Varicolored claystone, siltstone and sandstone	180
			Brushy Basin Member	300-400	Siltstone	
			Salt Wash Member		Siltstone	
			Summerville Formation	25-100	Red shale and siltstone	
			Entrada Sandstone	100-500	Dune sandstone	
			Carmel Formation	75-100	Red shale and siltstone	
	TRIASSIC	? — ? — ? — ? — ? — ?	Navajo Sandstone	100-400	Dune sandstone	225
			Kayenta Formation	0-500	Red shale and sandstone	
			Wingate Sandstone	0-450	Dune sandstone	
			Chinle Formation		Red siltstone	
			Moss Back Formation	(?) 2000	Sandstone	
			Moenkapi Formation		Red shale and siltstone	
PALEOZOIC	PERMIAN		White Rim		Sandstone	270
			De Chelly	1500-2000	Dune sandstone	
			Organ Rock		Red shale and sandstone	
			Cedar Mesa		Sandstone	
			Halgaito		Red shale and siltstone	
			Cutler Group	300-500	grading into Arkose and conglomerate (Rico)	
			Rico			
	PENNSYLVANIAN	VIRGIL-MISSOURI	Honaker Trail Fm.	1000-2000	Dolomite and black shale	305
		DES MOINES	Hermosa Group	0-6000	Carbonates	
			Paradox Formation		Saline deposits	
			Pinkerton Trail	0-200	grading into Arkose and conglomerate	
		ATOKA-MORROW	Molas Formation	0-150	Dolomite and black shale	
	MISSISSIPPIAN		Leadville Limestone	200-500	Limestone and dolomite	350
			Ouray Limestone	75-100	Limestone	
	DEVONIAN		Elbert Dolomite	200-350	Dolomite and limestone with marine sandstone at base	400
			McCracken Ss. Member			
			Aneth Dolomite	0-200	Dolomite and minor sandstone and shale	
	CAMBRIAN		Lynch Dolomite	0-400	Brown dolomite	600
			Maxfield Limestone	(?) 660	Limestone and shale	
			Ophir Shale	0-500	Shale	
			Ignacio Quartzite	0-200	Quartzitic sandstone and conglomerate	
PRECAMBRIAN			Unnamed	18,000(?)	Sediments and metasediments	
					Schists, gneisses, quartzites, intrusives

Rock storage unit

Unconformity

FIGURE 5. Generalized Geologic Column of the Paradox Bedded Salt Region^(a)

(a) Raymond et al. 1980.

FIGURE 6. Hainsville Salt Dome Site Cross Section North-South(a)

(a) Harwell et al. 1979.

Studies on a so-called normal scenario for salt (INFCE Working Group 7 1980a) examined the consequence of diffusion of the solid waste through the host salt. These analyses indicate that first arrival of the waste in any overlaying sediments is conservatively placed at 5×10^8 yr; therefore, diffusion through the salt itself is of little concern.

3.2.3 Permeability and Porosity

The permeability and porosity of salt itself are of little concern for the reasons stated above but are included for completeness. Estimates of the permeability of salt range from 2×10^{-19} to 1×10^{-6} m/s (2.1×10^{-15} to 1.0×10^{-3} ft/yr) with an expected value of 2×10^{-16} m/s (2×10^{-12} ft/yr) (INFCE Working Group 7 1980b). Porosity (INFCE Working Group 7 1980a) is

estimated at 0.2. The most important parameters, however, are those for the overlaying and/or underlying sediments. Typically, the underlying sediments provide no path to the biosphere but interact with the overlaying sediments to control the rate of movement of waters through the repository breached via a borehole or other man-caused failure (Cole and Bond 1980; Harwell et al. 1979; DOE 1979b) or by fracturing and faulting (INFCE Working Group 7 1980a; Raymond et al. 1980). Table 3 shows the typical values and ranges of permeability and porosity for the four sites studied (INFCE Working Group 7 1980a; Cole and Bond 1980; Raymond et al. 1980; Harwell et al. 1979). It is important to note that while permeabilities range over six orders of magnitude from 2.1×10^{-4} (22,000 ft/yr) to 5×10^{-10} m/s (.05 ft/yr) and porosity values range over about one order of magnitude from .05 to .3 (along the path from the breached repository to the biosphere), the hydrologic-model-predicted travel times range over less than one order of magnitude from 12,000 to 109,000 yr.

The effectiveness of a geohydrologic system is controlled by the path to the discharge site. Flow from repositories sited at depth in or near a recharge zone will be forced to remain for longer periods in the deeper, less permeable systems as shown in Figure 7 (INFCE Working Group 7 1980a). Another important aspect of the geosphere effectiveness is the spreading of contaminant arrival time. Figures 8 through 11 illustrate the hydrologic-model-predicted paths from the repository to the biosphere. This spreading of arrival times is extremely important for contaminants that move through the system at sorption-retarded velocities and is discussed in detail in Appendix D. Variations in arrival time to the natural discharge site for the four studies range from 700 yr for the Paradox site (Raymond et al. 1980) to 12,000 yr for the INFCE (INFCE Working Group 7 1980a). Path lengths vary from a minimum of 5950 m (3.7 m) for the INFCE study to a maximum of 66,800 m (41.5 m) for the Hainsville dome site (Harwell et al. 1979). Average water velocities over the water paths vary from a minimum of .059 m/yr (.194 ft/yr) to a maximum of 4.67 m/yr (15.3 ft/yr).

The effect of sorption is modeled explicitly; however, the sorption equilibrium coefficients (K_d) for any particular reference site are held constant for the entire analysis. The sorption coefficients for the reference salt site (see Table 4) were determined from a composite of measurements on geologic media from the WIPP bedded salt site (Serne et al. 1977).

For application in the GETOUT model, the K_d values were incorporated as "K-values" according to the equation

$$K = 1 + \beta K_d,$$

where β represents the ratio of geologic material available for sorption to the specific volume available for saturated groundwater flow. The value of β used for the reference site was 11.5. The values of K_d from Table 4 that were used in this analysis were those for the more conservative oxic conditions.

FIGURE 7. Cross Section View of Regional Discharge to a River^(a)

(a) Vertical scale exaggerated.

FIGURE 8. Potential Contours and Streamline Plot for the Breached Hypothetical Repository in Salt from the INFCE Study^(a)

(a) INFCE Working Group 7 1980a.

FIGURE 9. Model Predicted Potentials and Streamlines from the WIPP Site to the Natural Discharge Site^(a)

(a) Cole and Bond 1980.

The intrusion water well scenario was chosen as the limiting case of the leach incident pathway. The parameter set for the well scenario differs from the general leach incident scenario in three important ways. First, the groundwater travel time from the repository to the well borehole varies from 0 to 4×10^5 yr, the zero time representing the borehole penetration of an aquifer at the downstream edge of the repository. Second, the biosphere dose pathways from the aquatic foods (mollusks, fish, plants, etc.), a potential major dose pathway, is eliminated from the biosphere transport/dose model for the well scenario. Third, the contaminated groundwater is not diluted in a surface water body before it is used, resulting in much higher nuclide concentrations than in the general leach incident scenario. However, in the case of the salt repository, it is assumed that the saturated brine (see Table 5) exiting from the repository must somehow be diluted to at least recommended maximum allowable saline content for irrigation of food crops, either by mixing with a fresh water aquifer prior to entering the

FIGURE 10. Predicted Groundwater Flow Tubes and Streamlines from the Breached Repository to the Colorado River^(a)

(a) Raymond et al. 1980.

well borehole or by some other, unspecified process. The value used for the maximum saline content for irrigation water was 10^3 mg/L total dissolved salts (Federal Water Pollution Control Administration 1978). This compares with 2.9×10^5 mg/L NaCl in the water exiting the repository. A total assumed flow rate of 10^5 m³/yr (50 gpm) through the repository must then be diluted to 2.9×10^7 m³/yr before being used by the maximum individual for all of his water needs (other than aquatic foods). These flow volumes are somewhat arbitrary; however, resultant doses to the maximum individual are linearly proportional to nuclide concentrations in the water. Therefore, the results of the intrusion well analysis can be adjusted accordingly for any flow through the repository. The range of flow volume rates (through the repository) on which the reference site is based is listed in the last column in Table 3.

Water extraction through the well borehole is assumed to coincide with the passing of the peak concentrations of the most dose-significant nuclide for each parametric set in the well scenario analysis. The borehole is assumed to penetrate the contaminated plume exiting the repository at a point such that the above dilution is attained.

FIGURE 11. Modeled Groundwater Aquifer Showing Potential Contours and Flow Tubes from the Hainesville Dome^(a)

(a) Harwell et al. 1979.

TABLE 4. Bedded Salt Site Equilibrium Sorption Coefficients(a,b)

Element	Sorption Coefficient (K_d), ml/g	
	Oxic Condition (.2atm O_2) ^(c)	Anoxic Condition (negligible O_2)
H	0	0
Se	10	50
Kr	0	0
Rb	0-1(1)	0-1
Sr	0-1*(1)	0-1
Ca	0-1(1)	0-1
Y	10	10
Zr	40	40
Cd	40	40
Tc	0*	1-5
Ru	5*	5
Pd	50	50
Sn	25	25
Te	25	25
I	0*	0
Xe	0	0
Cs	1-10*(6)	1-10
Ba	0-1	50
Ce	50	50
Pr	50	50
Nd	50	50
Pm	50	50
Sm	50	50
Eu	50*	50
Gd	50	50
Tb	50	50
Ho	50	50
C	0	0
Ni	1-10(6)	1-10
Co	10-5-(30)	10-50
Be	10-50(30)	10-50
Th	100*	100
Pa	50*	50
U	5*	50
Np	20*	100
Pu	50*	200
Am	100*	100
Cm	100	100
Ra	1-10(6)	1-10

- (a) Assumptions (1) Geologic media nominally the same as Magenta and Culebra dolomite from WIPP site
 (2) Water same as WIPP Brine B (Table 5)
 (3) Room temperature as opposed to elevated T_0 ; i.e., far-field scenario
 (4) K_d 's for porous flow as opposed to fracture flow
 (5) Values with * are measured, others are estimates

(b) Serne et al. 1977.

(c) () = Value used where range is given

TABLE 5. Chemical Composition of WIPP B Salt Brine(a,b)

Compound	Concentration, g/L
NaCl	287.00
Na ₂ SO ₄	6.20
Na ₂ B ₄ O ₇ ·10H ₂ O	0.0160
NaHCO ₃	0.0140
NaBr	0.5200
KCl	0.0290
KI	0.0130
MgCl ₂	0.0400
CaCl ₂ ·2H ₂ O	3.30
FeCl ₃	0.0060
SrCl ₂ ·2H ₂ O	0.0330
Rb ₂ SO ₄	0.0016
CsCl	0.0013
Total Dissolved	297.174

(a) Serne et al. 1977
(b) pH = 6.5

4.0 RESULTS AND DISCUSSION

The calculations for the potential doses to a maximum individual for all the conditions modeled are summarized in the tables in Appendix A. These dose calculation results are shown in more detail in the tables in Appendix B. The following sections present the results in terms of the effect of individual engineered and natural barriers' characteristics on the maximum potential dose, and then develop the relationships for the combined, interactive effects of the barriers.

4.1 GENERAL LEACH INCIDENT SCENARIO RESULTS

Figure 12 shows the effect of release duration (release rate⁻¹) on the potential maximum dose for the general leach-incident scenario for constant values of leach initiation time and groundwater travel time. The horizontal, dashed line represents the assumed lifetime (70 yr) acceptable dose rate of 100 mrem/yr (average). Note that for the most conservative groundwater travel time (500 yr) and time of event initiation (1 yr), the release duration necessary to bring the dose below the acceptable level is about 10^5 yr (release rate of 10^{-5} /yr). The necessary release duration is only reduced to about 3×10^4 yr (3×10^{-5} /yr rate) if the event initiation is delayed for 1 million years as shown by the middle line in Figure 12. This reduced release duration requirement is mainly due to a lower ^{234}U inventory at one million years (see Table 1), since the maximum dose for a groundwater travel time of 500 yr is dominated by ^{226}Ra , which decays from uranium parent nuclides (except for release durations of <1000 yr, where ^{129}I is the dominant nuclide).

The lowest line in Figure 12 shows the effect of release rate at the maximum groundwater travel time of 4×10^5 yr. Note that the release duration has little effect on the resultant dose until the release duration exceeds about 10^5 yr. This is because the dispersive effects

FIGURE 12. The Effect of Release Duration on Maximum Dose for the General Leach Incident Scenario

of different migration rates for various members of decay chains, as well as hydrodynamic dispersion, spread the dissolved nuclide band by a much greater factor than the effects of release durations less than 10^5 yr. It is also interesting to note that when the groundwater travel time is at its maximum value, 4×10^5 yr, there is no difference due to leach initiation time since the transport time of even the fastest-moving nuclides is in the same range as the delay time. Actually, there is a slight difference noted for ^{129}I dose with delay; however, it cannot be shown on the scale of Figure 12. Furthermore, ^{226}Ra from uranium parents totally dominates the dose for the 4×10^5 -yr groundwater travel time. Also note that for the maximum groundwater travel time, neither of the net characteristic functions of engineered barriers, leach initiation delay or release rate reduction, are necessary to keep the dose below the assumed acceptable limit. However, if the release rate is low enough (i.e., release duration long enough), a dose-reducing benefit can still be obtained, which is a potential ALARA incentive if cost-effective.

Figure 13 shows the effect of delaying leach initiation for up to one million years. Again the light, dashed line represents the assumed acceptable dose limit. The heavy, dashed line in Figure 13 shows the effect of delay for the most conservative values of the other two representative system parameters (groundwater travel time and release duration). The dose for this case is dominated by ^{129}I with a half-life of about 16 M yr; thus, a delay of up to one million years does not significantly reduce the dose. However, if the release duration is increased to 1000 yr, as in the uppermost solid line in Figure 13, ^{129}I no longer dominates the dose (^{226}Ra does) and a reduction in maximum potential dose is observed after the delay exceeds 10^4 yr. This is mainly because one of the ^{226}Ra sources, ^{234}U , begins to significantly decay away at this point (see Table 1). The lower solid line in Figure 13 shows the effect of event delay when the groundwater travel time is at the maximum value (4×10^5 yr). The delay of

FIGURE 13. The Effect of Delay Prior to Leach Initiation for the General Leach Incident Scenario

up to one million years has no effect on maximum potential dose in this case, since the migration time itself for the ^{226}Ra dose source nuclides well exceeds one million years.

Figure 14 depicts the effect of the groundwater travel time from the repository to the biosphere on the ultimate potential dose. The uppermost line in Figure 14 depicts the effect of groundwater travel time for the most conservative release duration and the most and least conservative leach initiation times. In this case, the travel time has no effect on the dose level until it exceeds 10^4 yr. This is because the dose in this situation is dominated by ^{129}I , which is not sorbed on the geologic media and thus travels at the same velocity as the groundwater. Dispersion effects are finally great enough at long path lengths (such that groundwater travel times are greater than about 4×10^4 yr) to reduce the ^{129}I band peak almost linearly with increasing travel time until the travel exceeds 10^5 yr, at which point the dose is again dominated by ^{226}Ra from uranium parents. The middle line in Figure 14 shows the effect of groundwater travel time for leach initiation at one year and release duration of 1000 yr; the dose for this line is totally dominated by ^{226}Ra from uranium parents. The initial dose reduction when travel time increases from 10^3 to 10^4 yr is due to the elimination of the dose contribution of ^{226}Ra from the original inventory of ^{234}U parent. The remaining dose contribution beyond the 10^4 -yr travel time is due to ^{226}Ra from the original inventory of ^{238}U parent. The lower line in Figure 14 also shows this effect for leach initiation of 10^6 yr, but to a lesser degree since a large proportion of the original ^{234}U has already decayed away by this time.

Figures 12, 13 and 14, while presenting interesting and hopefully useful information, do not explicitly show the interrelationships among the three representative parameters and the maximum potential dose on any single graph. The results of the calculations will now be presented in the form of isodose lines and surfaces that portray these relationships in such a

FIGURE 14. The Effect of Groundwater Travel Time on Maximum Dose for the General Leach Incident Scenario

way as to develop a perspective on the combined effects of engineered and natural barriers on nuclide releases to the biosphere.

Figure 15 shows the relationship between release duration and groundwater travel time relative to the assumed 100-mrem/yr lifetime average annual dose limit. The isodose line represents combinations of these two parameters that result in a dose to the maximum individual equal to the assumed limit. Any combination of these parameters represented by a point below the isodose line, such as point A, would result in a dose exceeding the assumed limit. Any combination represented by a point above the graph, such as point B, would result in a dose less than the limit. Figure 15 shows only the relationship between two of the major parameters, release duration and groundwater travel time. To include the effect of delaying leach initiation, a third axis must be added as in Figure 16. The isodose line from Figure 15 is repeated on the "one-year delay prior to leach initiation" plane perpendicular to the new axis. The line showing the relationship between release duration and groundwater travel time is then constructed for various times of leach initiation along the third axis as shown in Figure 17. When enough of these lines are defined to obtain adequate resolution, an isodose surface is formed as in Figure 18, representing the interactive effect of all three major parameters relative to the assumed dose limit. Again, as for the isodose line in Figure 15, any combination of the parameters represented by a point below the surface in Figure 18 would result in a dose exceeding the assumed limit, and any combination represented by a point above the surface would result in a dose of less than the assumed limit.

As an example of the usefulness of the isodose surface, Figure 19 depicts a hypothetical salt repository system with properties in the range of the reference repository. The suspended box partly above the isodose surface represents the range of uncertainty in the performance variables for a specific repository system designated A. If A remained totally above the isodose surface, the potential dose resulting from the repository system would be below the

FIGURE 15. Isodose Line at One-Year Leach Initiation Time for General Leach Incident Scenario Based on a 100-mrem/yr Assumed Limit

FIGURE 18. Isodose Surface for the General Leach Incident Scenario Based on a 100-mrem/yr Assumed Limit

FIGURE 19. An Application of the Isodose Surface

assumed limit. However, since A extends below the surface, the adequacy of the system is in question. If the lower, vertical uncertainty range for system A could be raised by assuring a less leachable waste form (or the equivalent), the system representation would then be completely above the isodose surface and would become marginally adequate.

The representation for system B is already far beyond the isodose surface, which indicates that repository system B is already quite adequate and would be the preferred candidate of the two systems for more detailed analysis and possibly testing, demonstration and licensing.

4.2 INTRUSION WATER WELL RESULTS

As might be expected, a water well intrusion scenario would result in much more severe doses than the general leach incident scenario, since the protection from nuclides already dissolved in the groundwater that is provided by the geohydrologic system's resistance can be short-circuited by the water well borehole. Further, the nuclide contamination level in the groundwater used directly out of the well is much higher than that in the surface water, which has normally been diluted by additional water from other sources. This is true even though considerable dilution of the saline groundwater exiting the repository by groundwater from fresh sources was assumed prior to its use by the maximum individual.

Figure 20 shows the effect of release duration (inverse of release rate) on the ultimate dose for a leach initiation time of one year over a broad range of groundwater travel times.

FIGURE 20. The Effect of Release Duration on Maximum Dose for the Intrusion Water Well Scenario

The upper line in Figure 20 represents the result for the extreme water well scenario with the well borehole penetrating so close to the repository that the groundwater travel time from the repository to the well intake is only 14 yr. The resultant dose is entirely dominated by ^{90}Sr and is reduced linearly with decreasing release rate (increasing release duration).

The result for a more reasonable groundwater travel time for the well scenario, 500 yr, is shown in the middle line. The resultant dose for this case is dominated by ^{99}Tc , ^{14}C and ^{129}I until the release duration is greater than 10^3 yr (release rate less than 10^{-3} yr^{-1}) and is then dominated by ^{226}Ra from uranium and plutonium parents. Between 10^3 yr and 10^5 yr, there is no resultant dose reduction with increasing release duration, since geohydrologic resistances spread the band of ^{226}Ra equivalently. At release durations of greater than 10^5 yr (release rate of less than 10^{-4} yr^{-1}), the resultant dose begins to become inversely linear with release duration. The lower line in Figure 20 represents the result for a groundwater travel time of 3.7×10^5 yr and is dominated entirely by ^{226}Ra from the ^{238}U parent.

Figure 21 shows the effect of delaying the leach initiation for representative combinations of the other two major parameters. The top line represents the results for the extreme intrusion well scenario with a groundwater travel time of only 14 yr and release rate of $1\% \text{ yr}^{-1}$ (release duration of 100 yr), the assumed maximum possible. This curve generally parallels a relative toxicity curve for spent fuel. Note that in this extreme case, the optimum delay (containment) period is about 300 to 400 yr. Delay beyond 1000 yr holds the nuclides in place and results in a buildup of ^{226}Ra in the repository, peaking at about 10^5 yr as seen by the upper curve beyond a delay time of 10^3 yr. The middle line shows the result for a more reasonable, moderate well scenario where the groundwater travel time is 500 yr and the release duration is 10^4 yr. In this case and particularly in the case depicted by the lower line in Figure 21, the delay prior to leach initiation has no effect on resultant dose for time periods that can be relevant for engineered barriers.

Figure 22 shows the effect of groundwater travel time from the repository to the well borehole on the potential maximum dose for a range of representative values of the other two major parameters. The important point of Figure 22 is that as groundwater travel time begins to exceed 500 yr, the difference between the extreme case (upper line) and a more reasonable moderate case (middle line) of engineered barriers performance begins to become very small, indicating less dependence on the engineered barriers' properties. In contrast, the lower line in Figure 22, representing highly effective engineered barriers, still shows a reduced dose that is less than that provided by only the effects of the geohydrologic system.

Figure 23 shows the isodose surface for the well scenario. Note that the surface is defined for groundwater travel time from 0 to 4×10^5 yr as compared to the general scenario surface, for which a minimum possible travel time of 500 yr was used. As might be expected, the release duration required for limiting the dose to 100 mrem/yr is greater for the well scenario than for the general scenario (Figure 18) over the entire range of the other two parameters (delay prior to leach initiation and groundwater travel time). This required release

FIGURE 21. The Effect of Delaying Leach Initiation for the Intrusion Water Well Scenario

FIGURE 22. The Effect of Groundwater Travel Time on Maximum Dose for the Intrusion Water Well Scenario

FIGURE 23. Isodose Surface for the Intrusion Water Well Scenario
Based on 100-mrem/yr Assumed Limit

duration becomes very great, 10^7 to 10^{10} yr (10^{-7} to 10^{-10} /yr release rate) if the delay prior to leach initiation and the groundwater travel time simultaneously become less than a few hundred years. The basis for Figure 23 is Table A.2 in Appendix A. Detailed summaries for the intrusion well scenario dose calculations are in Appendix B following those for the general scenario results.

5.0 PERSPECTIVE

There are several considerations that may limit the usefulness of any analyses of this type in providing an accurate basis for what is necessary or desirable for nuclear waste isolation. These considerations are discussed below.

The potential doses indicated in Figures 12 through 14 and 20 through 22 are maximums taken at the peak release rate to the biosphere of the controlling nuclide, regardless of when it might occur. The resultant doses from the general leach incident scenario occur anytime from 500 yr to 22 M yr or more after the repository is sealed, with peak doses occurring at about 10^6 yr in most cases. It has been suggested that 10,000 yr (Egan 1978) or even as little as 1,000 yr (Environmental Protection Agency 1978), should be the period of concern for analyses of this kind; however, under most credible release pathways for a properly chosen deep repository site, 10,000 yr would probably be somewhat early for any release to the biosphere, even for nonsorbed nuclides. The 500-yr-minimum groundwater travel time, an extraordinarily conservative value, was used in the general leach incident scenario analysis to cover the range of all reasonable "what if" considerations. Because the value of delaying releases to the biosphere (and thereby delaying potential doses to humans) is largely a subjective consideration, no credit is given in this analysis for such delay. In other words, a mrem dose received by a person living in the year 2051 is equivalent in all respects to a mrem dose received by a person living in the year 1002051, 10^6 yr later. There exists a wide spectrum of opinions (which won't be addressed further here) on whether this equivalency assumption is conservative or nonconservative.

Another area of uncertainty is that the applicability of any model, no matter how sophisticated, that attempts to predict the behavior of a system decreases significantly with increasing time periods being considered. Even though the deep geologic conditions may remain about the same for perhaps millions of years and thereby may "comply" with the geologic transport model predictions, surface characteristics such as meteorology, location of rivers, biota, living habits of humans, etc., have and probably will undergo radical changes over the time periods relevant to the existence of a repository.

While the gross rate of release of nuclides into the biosphere is converted into human doses by the biosphere model in a way that is significant to a broader audience, this adds another and possibly very large level of uncertainty to the result since the biosphere is so dynamic. Further conversion to a population dose would probably be even more useful (statistically), but would add yet another large factor of uncertainty since population distributions are also quite dynamic (consider the last 2000 yr). However, individuals have consumed roughly constant proportions of the basic food types for thousands of years. Since the food chain is the primary pathway for resultant doses, there may be some rationale for converting repository release consequences into maximum individual doses (the approach used in this study). Conversion to integrated population dose, once some assumed population distribution is established, is roughly proportional to the maximum individual dose; thus, the data from this analysis may be used for such a conversion if desired.

There are also limitations on the accuracy of geotransport modeling, both in general and specific to the model used in this analysis. The geotransport model used for this work is conservative to a degree not yet determined. The model assumes that on the scale of the total system the repository is a point source of release into the groundwater, when in reality the dimensions of the repository may be large enough to provide a considerable initial dispersion of the nuclides in addition to that provided by low leach rates. This is particularly true in the intrusion water well scenario, where the dimensions of the repository can be quite large compared to the groundwater travel path lengths. The degree of significance of this effect is not entirely known but is analyzed to some degree in Appendix D. The release durations (inverse of release rates) used in the analysis are taken to be those equivalent rates at the groundwater downstream edge of the repository. Near-field modeling in two or three dimensions of actual repository designs will be necessary to relate these release durations to actual leach rates from the individual waste packages themselves (see Figure 1).

A further conservatism is introduced by using a one-dimensional transport model simulating nuclide transport along only one representative flowline from the repository to the biosphere. The spread in peak release arrival times to the biosphere due to differences in travel times of different flowlines is not accounted for. This dispersive effect can be great enough that instead of just rounding off the peaks slightly, it can cause such a great dispersion in time and space that the net effect is the same as greatly reducing the release rate from the repository. Not accounting for this phenomenon tends to maximize the apparent incentive for providing an engineered barrier system that will lower the release rate. It would have been impractical to explicitly model these dispersion effects for the entire parametric set (It would have required about a six-fold increase in the number of simulation runs.); however, to provide a perspective on the potential magnitude of the various dispersive effects, a general analysis of them is presented in Appendix D.

One final point regarding the geologic transport model used is that the essentially irreversible mineralization that may occur under reducing conditions for some nuclides (the formation of uranium ore deposits is one example) is not treated explicitly by the model.

Limitations that also apply to even more complex geotransport models include the impracticality of simulating all of the parameters that may affect the ultimate transport of nuclides to the biosphere. Even if such a universal model could be developed, it would be quite unwieldy. Probably the most restrictive limitation, however, is the difficulty of accurately characterizing a geologic site without destroying it; thus, the accuracy of descriptive site data provides a reasonable limit on the required detail for simulation models.

A built-in conservatism in the methodology is that the probability of a leach/transport incident is not considered. The probability is assumed to be equal to one; thus, a consequence analysis rather than a formal risk analysis is accomplished. This approach is taken due to the current difficulty in predicting the probability of the occurrence of a series of events or processes that could lead to a repository breach over very long time periods (Bredehoeft et al. 1978). Future analyses may be able to address such probabilities in a defensible manner.

No consideration was given (other than an assumed 100-yr minimum possible release duration) to the combined effects of solubility limits and mass transport resistance very near the waste package in limiting the release rate of most nuclides from the waste package. Should a leach incident occur, it is possible that release of most nuclides into the near-field groundwater will be solubility-limited. While the magnitude of this effect has not been rigorously determined, estimates (INFCE Working Group 7 1979) of maximum release rates that are solubility-limited are on the order of 10^{-5} yr^{-1} (fractional) for all significant nuclides except the highly mobile iodine. In the future, it should be possible to determine maximum release rates for a specific site when the temperature projection and geochemistry are better known.

The water well scenario may not be totally reasonable for a salt site analysis where the well borehole is assumed to penetrate very near the downstream edge of the repository, since the groundwater exiting a salt repository would have such a high salt content and would require substantial dilution before it was used for drinking, irrigation or stock watering. This dilution was assumed to occur for the analysis; however, it is not immediately apparent how it could occur very near the salt repository. Since it is not known exactly how close to the actual salt repository that acceptably low saline water could be drawn through a well, the well borehole penetration was arbitrarily varied from 0 to 60 km from the downstream edge of the repository.

If a water well scenario is not reasonable for a salt site, the limiting scenario may still be a human intrusion into the repository, either via salt solution mining or excavation mining for the salt for use as table salt, block salt for field animals, rock salt for icy roads, etc. The salt mining scenario is being analyzed in other studies and won't be addressed further here.

Finally, it should be noted that the sorption properties of the reference site (K_d and β) were not part of the parameter set but were fixed constants. Thus, the application of these results is limited to repository systems whose net sorption effects are similar to those used for the reference site.

The above considerations should be kept in mind when reviewing the results and conclusions of this work, not as a detraction but as a realization that the analysis tends to maximize both the incentive for, and the resultant effectiveness of, the engineered barriers in the context of the overall repository system. In this way, the conditions under which an incentive is indicated for providing an engineered barrier and the degree of barrier effectiveness indicated are subject to some doubt. Conversely, a large degree of confidence can be attached to conclusions regarding conditions for which there is no apparent incentive or even a disincentive for providing engineered barriers.

6.0 ASSUMPTIONS AND CONCLUSIONS

Several assumptions were made to perform the analysis. The conclusions are based on the validity of the assumptions and are limited to the reference salt repository system and real systems whose properties are within or near the range of the reference site parameters and constants.

6.1 SUMMARY OF ASSUMPTIONS AND APPROACH

1. The radionuclide source is 1/5 of the spent nuclear fuel accumulated in the U.S. through the year 2000 as defined in CWM/GEIS (DOE 1979a).
2. The release pathways with the greatest risk to man originate from the waste after ultimate disposal.
3. A nonsalt particulate geologic medium similar in sorption characteristics to WIPP site Magenta/Culebra dolomite characterizes the geology beyond the repository itself. The groundwater leaving the repository is the same as WIPP Brine B (Table 5).
4. The highest risk pathway from the repository to the biosphere is the groundwater transport pathway.
5. All nuclides are soluble in groundwater, and the dissolved nuclides do not change speciation during migration.
6. The migrating nuclides are in sorption equilibrium at all points.
7. The water velocity and the axial dispersion coefficients are constant for any single parametric calculation.
8. Estimates of the sorption equilibrium constants are used in most cases.
9. Transverse convection and dispersion are neglected.
10. The nuclides are dissolved in the groundwater in trace concentrations such that there is no inter- or intra-species competition for sorption, nor are solubility limits ever approached in the far-field hydrology.
11. The release of nuclides from the repository is a constant rate band (fraction per year) term, except for the effect of radioactive decay (decaying band release).
12. Doses are calculated for a "maximum" individual.
13. For all dose calculations, the discharging nuclides accumulate in the biosphere for 70 yr; the "maximum individual" is exposed to that accumulation during those 70 yr, and the nuclides are subsequently dispersed into the biosphere with no dose after the exposure period.
14. Humans' dietary and living habits will remain constant throughout geologic time.
15. If the "maximum individual" is adequately protected, all individuals are adequately protected. This tends to ignore any statistical consequences due to integrated population doses based on a linear consequences approach.

16. A mrem dose received by a person living in the year 2051 is of equivalent value in all respects to a mrem dose received by a person living in the year 1002051 (10^6 yr later). There is no dose value discounting with time of dose occurrence.

6.2 CONCLUSIONS

Even in view of the uncertainty inherent in the analysis, these results indicate trends that do not appear to be overly sensitive to a reasonable variation in geohydrologic properties:

- In nearly all cases, the regional geology is the most effective barrier to release of radionuclides to the biosphere; however, for long-lived isotopes of carbon, technetium and iodine, which were poorly sorbed on the geologic media, the geology is not very effective once a leach incident is initiated.
- While the need for and the effectiveness of a release rate limiting barrier function is somewhat dependent on the sorption properties of the geologic media, generally a release rate of less than 10^{-3} yr $^{-1}$ (fractional) is necessary to reduce the potential dose from ^{14}C , ^{99}Tc and ^{129}I to a baseline level below that of the actinides. Beyond that, a release rate of less than 10^{-5} yr $^{-1}$ is required before the potential dose from the actinide chains can be further lowered by this mechanism (Figure 24, lower two lines). This is because the distribution of actinide chain members in time and space, due to their different sorption properties and the characteristics of the groundwater flow field, has the same effect as a release rate reduction of between 10^{-5} to 10^{-6} yr $^{-1}$. Only in extreme cases of the intrusion water well scenario (upper line, Figure 24) is there a direct relationship between release rate from the repository and release to the biosphere.
- Generally, the delay in leach incident initiation that an engineered delay function (container, sealant backfill, etc.) might provide, 10^4 yr or less, is insufficient to accomplish any maximum potential dose reduction. Only the delay provided by a dry, stable geology, 10^5 yr or more, can accomplish this (bottom two lines in Figure 25). However, in the extreme and very unlikely case of the water well scenario case (upper line in Figure 25), the maximum potential dose is optimally reduced by a containment function lasting about 400 yr. If the containment should last beyond 1000 yr, the maximum potential dose can actually be increased due to ^{226}Ra accumulation (from uranium decay) in the repository confines.

Specific nuclides of concern, in no particular order, are ^{99}Tc , ^{129}I , ^{14}C , ^{226}Ra + daughters (U), and, for the extreme case of well scenario, ^{90}Sr .

FIGURE 24. General Effect of Rate Limiting Barrier Function

FIGURE 25. General Effect of Barrier Delay Function

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APPENDIX A

REFERENCE SALT SITE
CALCULATION SUMMARY TABLES

TABLE A.1. Reference Salt Site Calculation Summary for General Leach Incident Scenario

Run I.D.	Critical Nuclide	Critical Organ	70-yr Dose Commitment at Max. Rate, rem	Time After Closure of Max. Dose, yr	Release Duration, yr	Release Initiation Time, yr After Closure	Groundwater Travel Time, yr	70-yr Total Body Dose Commitment, rem
SLT001	²²⁶ Ra	Bone	2.6E1	3.5E4	1.0E3	1.0E0	5.0E2	1.7E1
SLT002	²²⁶ Ra	Bone	1.9E0	2.5E5	1.0E6	1.0E0	5.0E2	1.2E0
SLT003	²²⁶ Ra	Bone	7.5E-1	1.4E6	1.0E6	1.0E6	5.0E2	4.9E-1
SLT004	²²⁶ Ra	Bone	9.4E0	1.0E6	1.0E3	1.0E6	5.0E2	6.1E0
SLT005	²²⁶ Ra	Bone	2.4E0	2.2E7	1.0E2	1.0E0	3.7E5	1.5E0
SLT006	²²⁶ Ra	Bone	2.2E0	2.2E7	1.0E5	1.0E0	3.7E5	1.4E0
SLT007	²²⁶ Ra	Bone	2.2E0	2.3E7	1.0E5	1.0E6	3.7E5	1.4E0
SLT008	²²⁶ Ra	Bone	2.4E0	2.3E7	1.0E2	1.0E6	3.7E5	1.5E0
SLT009	²²⁶ Ra	Bone	1.0E1	1.8E5	1.0E5	1.0E0	5.0E2	6.5E0
SLT010	²²⁶ Ra	Bone	5.3E0	1.1E6	1.0E5	1.0E6	5.0E2	3.5E0
SLT011	²²⁶ Ra	Bone	7.2E0	5.9E5	1.0E4	1.0E0	1.0E4	4.6E0
SLT012	²²⁶ Ra	Bone	5.3E0	1.6E6	1.0E4	1.0E6	1.0E4	3.3E0
SLT013	²²⁶ Ra	Bone	8.6E0	5.8E5	1.0E3	1.0E0	1.0E4	4.7E0
SLT014	²²⁶ Ra	Bone	6.4E0	1.6E6	1.0E3	1.0E6	1.0E4	3.5E0
SLT015	²²⁶ Ra	Bone	3.7E0	5.7E6	1.0E3	1.0E6	8.0E4	2.4E0
SLT016	⁹⁹ Tc	GI-LLI (a)	4.8E0	8.1E4	1.0E3	1.0E0	8.0E4	2.4E0
SLT017	- - - - QA check run - same as SLT011 - - - - -							
SLT018	- - - - QA check run - same as SLT012 - - - - -							
SLT019	⁹⁹ Tc	GI-LLI	1.4E1	7.8E4	1.0E2	1.0E0	8.0E4	2.4E0
SLT020	¹²⁹ I	Thyroid	7.5E0	1.1E6	1.0E2	1.0E6	8.0E4	2.4E0
SLT021	²²⁶ Ra	Bone	5.0E0	6.7E5	1.0E5	1.0E0	1.0E4	3.3E0
SLT022	²²⁶ Ra	Bone	3.2E0	1.7E6	1.0E5	1.0E6	1.0E4	2.1E0
SLT023	²²⁶ Ra	Bone	4.1E0	2.3E6	1.0E4	1.0E0	4.0E4	2.5E0
SLT024	²²⁶ Ra	Bone	4.2E0	3.3E6	1.0E4	1.0E6	4.0E4	2.6E0
SLT025	²²⁶ Ra	Bone	1.5E1	1.3E5	1.0E5	1.0E4	5.0E2	9.7E0
SLT026	²²⁶ Ra	Bone	1.7E0	2.7E5	1.0E6	1.0E4	5.0E2	1.1E0
SLT027	²²⁶ Ra	Bone	5.0E0	6.8E5	1.0E5	1.0E4	1.0E4	3.3E0
SLT028	⁹⁹ Tc	GI-LLI	1.3E1	9.0E4	1.0E2	1.0E4	8.0E4	2.4E0
SLT029	²²⁶ Ra	Bone	8.9E0	3.2E5	1.0E5	1.0E0	4.0E3	5.9E0
SLT030	²²⁶ Ra	Bone	4.3E0	1.3E6	1.0E5	1.0E6	4.0E3	2.9E0
SLT031	²²⁶ Ra	Bone	1.2E0	4.7E5	1.0E6	1.0E0	4.0E3	7.7E-1
SLT032	²²⁶ Ra	Bone	5.9E-1	1.5E6	1.0E6	1.0E6	4.0E3	3.9E-1
SLT033	²²⁶ Ra	Bone	9.4E0	3.3E5	1.0E5	1.0E4	4.0E3	6.2E0
SLT034	²²⁶ Ra	Bone	1.1E0	4.8E5	1.0E6	1.0E4	4.0E3	7.5E-1
SLT035	⁹⁹ Tc	GI-LLI	5.5E0	4.0E4	1.0E3	1.0E0	4.0E4	2.6E0
SLT036	²²⁶ Ra	Bone	4.1E0	3.3E6	1.0E3	1.0E6	4.0E4	2.6E0
SLT037	²²⁶ Ra	Bone	1.5E1	1.2E5	1.0E5	1.0E3	5.0E2	9.8E0
SLT038	²²⁶ Ra	Bone	1.3E1	2.2E5	1.0E5	1.0E5	5.0E2	8.3E0
SLT039	⁹⁹ Tc	GI-LLI	5.9E0	2.0E4	1.0E3	1.0E0	2.0E4	3.2E0
SLT040	²²⁶ Ra	Bone	1.5E0	3.6E5	1.0E6	1.0E5	5.0E2	9.9E-1

(a) GI-LLI: Gastrointestinal-- lower large intestine.

TABLE A.1. (contd)

Run I.D.	Critical Nuclide	Critical Organ	70-yr Dose Commitment at Max. Rate, rem	Time After Closure of Max. Dose, yr	Release Duration, yr	Release Initiation Time, yr After Closure	Groundwater Travel Time, yr	70-yr Total Body Dose Commitment, rem
SLT041	²²⁶ Ra	Bone	5.0E0	1.2E6	1.0E4	1.0E0	2.0E4	3.0E0
SLT042	²²⁶ Ra	Bone	4.6E-1	1.4E6	1.0E6	1.0E0	2.0E4	3.0E-1
SLT043	- - - - QA check run - same as SLT023 - - - - -							
SLT044	⁹⁹ Tc	GI-LLI	5.7E0	3.0E4	1.0E3	1.0E4	2.0E4	3.4E0
SLT045	²²⁶ Ra	Bone	5.0E0	2.2E6	1.0E3	1.0E6	2.0E4	2.9E0
SLT046	⁹⁹ Tc	GI-LLI	3.1E1	4.0E4	1.0E2	1.0E0	4.0E4	2.7E0
SLT047	¹²⁹ I	Thyroid	1.4E1	1.0E6	1.0E2	1.0E6	4.0E4	2.7E0
SLT048	²²⁶ Ra	Bone	2.8E0	2.2E7	1.0E3	1.0E0	3.7E5	1.8E0
SLT049	⁹⁹ Tc	GI-LLI	6.2E1	5.6E2	1.0E2	1.0E0	5.0E2	1.7E1
SLT050	⁹⁹ Tc	GI-LLI	6.2E1	4.0E3	1.0E2	1.0E0	4.0E3	1.0E1
SLT051	⁹⁹ Tc	GI-LLI	6.4E1	1.0E4	1.0E2	1.0E0	1.0E4	5.5E0
SLT052	⁹⁹ Tc	GI-LLI	5.6E1	2.0E4	1.0E2	1.0E0	2.0E4	3.4E0
SLT053	²²⁶ Ra	Bone	1.8E-1	2.6E5	1.0E7	1.0E0	5.0E2	1.2E-1
SLT054	²²⁶ Ra	Bone	2.7E0	4.7E6	1.0E5	1.0E0	8.0E4	1.8E0
SLT055	- - - - QA check run - same as SLT006 - - - - -							
SLT056	- - - - QA check run - same as SLT052 - - - - -							
SLT057	²²⁶ Ra	Bone	5.1E0	1.3E6	1.0E3	1.0E5	2.0E4	3.2E0
SLT058	²²⁶ Ra	Bone	8.6E0	6.0E5	1.0E4	1.0E4	1.0E4	5.5E0
SLT059	²²⁶ Ra	Bone	8.8E0	1.1E6	1.0E4	1.0E6	5.0E2	5.8E0
SLT060	²²⁶ Ra	Bone	7.1E0	1.2E6	1.0E4	1.0E6	4.0E3	4.5E0
SLT061	¹²⁹ I	Thyroid	2.4E1	1.0E6	1.0E2	1.0E6	2.0E4	3.1E-1
SLT062	²²⁶ Ra	Bone	1.9E0	2.6E5	1.0E6	1.0E3	5.0E2	1.3E0
SLT063	²²⁶ Ra	Bone	9.0E0	5.9E5	1.0E4	1.0E3	1.0E4	5.4E0
SLT064	⁹⁹ Tc	GI-LLI	5.5E0	4.1E4	1.0E3	1.0E3	4.0E4	2.7E0
SLT065	²²⁶ Ra	Bone	8.2E0	6.9E5	1.0E4	1.0E5	1.0E4	5.0E0
SLT066	²²⁶ Ra	Bone	2.1E1	1.4E5	1.0E3	1.0E5	5.0E2	1.4E1
SLT067	²²⁶ Ra	Bone	2.7E1	3.6E4	1.0E3	1.0E3	5.0E2	1.8E1
SLT068	- - - - QA check run - same as SLT057 - - - - -							
SLT069	²²⁶ Ra	Bone	4.6E-1	2.2E7	1.0E6	1.0E0	3.7E5	3.0E-1
SLT070	²²⁶ Ra	Bone	7.3E-2	1.3E6	1.0E7	1.0E6	5.0E2	4.8E-2
SLT071	²²⁶ Ra	Bone	2.0E1	6.4E4	1.0E4	1.0E0	5.0E2	1.3E1
SLT072	²²⁶ Ra	Bone	6.8E-2	2.6E5	2.6E7	1.0E0	5.0E2	4.5E-2
SLT073	²²⁶ Ra	Bone	6.4E-2	4.7E5	1.7E7	1.0E0	4.0E3	4.2E-2
SLT074	²²⁶ Ra	Bone	7.1E-2	2.3E6	6.6E6	1.0E0	2.0E4	4.6E-2
SLT075	²²⁶ Ra	Bone	2.5E1	7.4E4	1.0E4	1.0E4	5.0E2	1.6E1
SLT076	⁹⁹ Tc	GI-LLI	6.0E1	1.1E4	1.0E2	1.0E4	5.0E2	1.6E1
SLT077	²²⁶ Ra	Bone	2.5E0	2.2E7	1.0E4	1.0E4	3.7E5	1.6E0
SLT078	²²⁶ Ra	Bone	2.3E0	2.2E7	1.0E2	1.0E4	3.7E5	1.5E0

TABLE A.2. Reference Salt Site Calculation Summary for Intrusion Well Scenario

Run I.D.	Critical Nuclide	Critical Organ	70-yr Dose Commitment at Max. Rate, rem	Time After Closure of Max. Dose, yr	Release Duration, yr	Release Initiation Time, yr After Closure	Groundwater Travel Time, yr	70-yr Total Body Dose Commitment, rem
SLTW01	²²⁶ Ra	Bone	1.2E3	3.6E4	1.0E4	1.0E0	2.9E2	7.3E2
SLTW02	²²⁶ Ra	Bone	1.3E3	1.8E4	1.0E4	1.0E0	1.4E2	8.0E2
SLTW03	²²⁶ Ra	Bone	1.6E3	8.3E4	1.0E4	1.0E0	7.2E1	1.1E3
SLTW04	⁹⁰ Sr	Bone	4.9E3	3.7E2	1.0E4	1.0E0	2.9E1	1.2E3
SLTW05	⁹⁰ Sr	Bone	1.1E4	3.0E2	1.0E4	1.0E0	2.4E1	3.0E3
SLTW06	⁹⁰ Sr	Bone	1.1E6	3.0E2	1.0E2	1.0E0	2.4E1	3.0E5
SLTW07	⁹⁰ Sr	Bone	1.1E5	3.0E2	1.0E3	1.0E0	2.4E1	3.0E4
SLTW08	²²⁶ Ra	Bone	8.7E3	1.2E4	1.0E3	1.0E4	2.4E1	2.7E3
SLTW09	²²⁶ Ra	Bone	4.8E4	1.0E5	1.0E3	1.0E5	2.4E1	3.0E4
SLTW10	²²⁶ Ra	Bone	2.4E4	1.0E6	1.0E3	1.0E6	2.4E1	1.4E4
SLTW11	²²⁶ Ra	Bone	3.3E2	4.6E4	1.0E6	1.0E0	2.4E1	2.6E2
SLTW12	²²⁶ Ra	Bone	3.6E2	4.7E4	1.0E6	1.0E3	2.4E1	2.7E2
SLTW13	²²⁶ Ra	Bone	4.2E2	2.3E5	1.0E6	1.0E4	2.4E1	3.2E2
SLTW14	²²⁶ Ra	Bone	3.4E2	1.0E6	1.0E6	1.0E6	2.4E1	2.1E2
SLTW15	²²⁶ Ra	Bone	5.5E2	9.4E4	1.0E6	1.0E0	7.2E1	4.2E2
SLTW16	²²⁶ Ra	Bone	5.6E2	1.0E5	1.0E6	1.0E3	7.2E1	4.2E2
SLTW17	²²⁶ Ra	Bone	6.2E2	1.1E5	1.0E6	1.0E4	7.2E1	4.7E2
SLTW18	⁹⁰ Sr	Bone	2.4E5	1.9E2	1.0E4	1.0E0	1.4E1	6.6E4
SLTW19	⁹⁰ Sr	Bone	2.4E7	1.9E2	1.0E2	1.0E0	1.4E1	6.6E4
SLTW20	⁹⁰ Sr	Bone	2.7E3	1.9E2	1.0E6	1.0E0	1.4E1	7.4E2
SLTW21	⁹⁰ Sr	Bone	2.6E1	1.9E2	1.0E8	1.0E0	1.4E1	7.1E0
SLTW22	²⁴⁰ Pu	Bone	1.3E4	8.6E3	1.0E2	3.0E2	1.4E1	8.7E2
SLTW23	²⁴⁰ Pu	Bone	1.2E4	9.3E3	1.0E2	1.0E3	1.4E1	1.0E3
SLTW24	²²⁶ Ra	Bone	3.9E4	1.1E4	1.0E2	1.0E4	1.4E1	2.5E4
SLTW25	²²⁶ Ra	Bone	3.1E5	1.0E5	1.0E2	1.0E5	1.4E1	1.9E5
SLTW26	²²⁶ Ra	Bone	1.5E5	1.0E6	1.0E2	1.0E6	1.4E1	9.4E4
SLTW27	²²⁶ Ra	Bone	6.3E2	3.0E5	1.0E6	3.0E2	1.4E1	3.9E2
SLTW28	²²⁶ Ra	Bone	5.4E0	3.0E5	1.0E8	3.0E2	1.4E1	3.4E0
SLTW29	⁹⁰ Sr	Bone	2.4E0	1.9E2	1.0E9	1.0E0	1.4E1	6.6E-1
SLTW30	⁹⁰ Sr	Bone	2.4E1	1.9E2	1.0E8	1.0E0	2.4E1	6.6E0
SLTW31	²²⁶ Ra	Bone	2.6E1	1.0E6	1.0E7	1.0E6	1.4E1	1.6E1
SLTW32	²²⁶ Ra	Bone	2.0E1	3.3E4	1.0E7	1.0E4	1.4E1	1.2E1
SLTW33	²²⁶ Ra	Bone	3.1E1	4.4E4	1.0E7	1.0E0	2.9E1	1.9E1
SLTW34	²²⁶ Ra	Bone	7.1E0	2.6E5	1.3E7	1.0E0	5.0E2	4.3E0
SLTW35	²²⁶ Ra	Bone	1.5E1	2.2E7	1.6E6	1.0E0	3.7E5	9.0E0
SLTW36	⁹⁰ Sr	Bone	2.9E3	2.2E0	1.0E8	1.0E0	7.2E-3	7.7E2
SLTW37	²²⁶ Ra	Bone	7.9E-1	1.0E5	1.0E8	1.0E5	7.2E-3	4.9E-1
SLTW38	²²⁶ Ra	Bone	7.9E0	1.3E6	5.4E6	1.0E6	5.0E2	4.9E0
SLTW39	²²⁶ Ra	Bone	6.9E0	3.1E5	8.3E7	1.0E4	1.4E1	4.3E0
SLTW40	²²⁶ Ra	Bone	7.0E0	2.2E7	3.3E6	1.0E0	3.7E5	4.3E0

TABLE A.2. (contd)

Run I.D.	Critical Nuclide	Critical Organ	70-yr Dose Commitment at Max. Rate, rem	Time After Closure of Max. Dose, yr	Release Duration, yr	Release Initiation Time, yr After Closure	Groundwater Travel Time, yr	70-yr Total Body Dose Commitment, rem
SLTW41	²²⁶ Ra	Bone	6.9E0	3.6E5	1.1E7	1.0E5	5.0E2	4.3E0
SLTW42	²²⁶ Ra	Bone	1.3E3	6.4E4	1.0E4	1.0E0	5.0E2	7.6E2
SLTW43	¹²⁹ I	Thyroid	3.4E3	1.0E6	1.0E2	1.0E6	5.0E2	2.9E2
SLTW44	²²⁶ Ra	Bone	1.5E3	4.5E4	1.0E3	1.0E4	5.0E2	8.6E2
SLTW45	⁹⁹ Tc	GI-LLI	4.0E3	4.0E4	1.0E2	1.0E0	4.0E4	1.2E2
SLTW46	²²⁶ Ra	Bone	4.6E2	5.9E5	1.0E4	1.0E3	1.0E4	2.5E2
SLTW47	⁹⁰ Sr	Bone	1.4E6	1.9E2	3.0E3	1.0E0	1.4E1	3.5E5
SLTW48	²³⁹ Pu	Bone	2.5E3	3.0E4	3.0E3	3.0E2	1.4E1	1.2E2
SLTW49	²³⁹ Pu	Bone	2.4E3	3.3E4	3.0E3	3.0E3	1.4E1	1.1E2
SLTW50	²²⁶ Ra	Bone	1.3E3	1.4E5	3.0E3	1.0E0	5.0E2	8.0E2
SLTW51	²²⁶ Ra	Bone	1.3E3	1.4E5	3.0E3	3.0E2	5.0E2	7.9E2
SLTW52	²²⁶ Ra	Bone	1.2E3	3.9E4	3.0E3	3.0E3	5.0E2	7.9E2
SLTW53	²²⁶ Ra	Bone	3.6E3	9.3E4	1.0E4	1.0E4	7.2E1	2.2E3
SLTW54	²²⁶ Ra	Bone	7.0E3	1.1E6	1.0E4	1.0E6	7.2E1	4.4E3
SLTW55	²²⁶ Ra	Bone	1.2E3	7.4E4	1.0E4	1.0E4	5.0E2	7.5E2
SLTW56	²²⁶ Ra	Bone	4.7E2	1.1E6	1.0E4	1.0E6	5.0E2	2.7E2
SLTW57	²²⁶ Ra	Bone	8.0E2	2.7E6	1.0E4	1.0E4	4.0E3	4.9E2
SLTW58	²²⁶ Ra	Bone	3.1E2	1.2E6	1.0E4	1.0E6	4.0E3	1.7E2
SLT001W ^(a)	²²⁶ Ra	Bone	1.3E3	3.5E4	1.0E3	1.0E0	5.0E2	8.0E2
SLT002W	²²⁶ Ra	Bone	9.3E1	2.6E5	1.0E6	1.0E0	5.0E2	5.6E1
SLT003W	²²⁶ Ra	Bone	3.8E1	1.3E6	1.0E6	1.0E6	5.0E2	2.3E1
SLT004W	²²⁶ Ra	Bone	4.7E2	1.0E6	1.0E3	1.0E6	5.0E2	2.9E2
SLT005W	¹²⁹ I	Thyroid	2.3E2	3.7E5	1.0E2	1.0E0	3.7E5	7.4E1
SLT006W	²²⁶ Ra	Bone	1.1E2	2.2E7	1.0E5	1.0E0	3.7E5	6.8E1
SLT007W	²²⁶ Ra	Bone	1.1E2	2.3E7	1.0E5	1.0E6	3.7E5	6.8E1
SLT008W	¹²⁹ I	Thyroid	2.1E2	1.4E6	1.0E2	1.0E6	3.7E5	7.4E1
ESTW01 ^(b)	²²⁶ Ra	Bone	7.0E0	1.3E6	5.4E6	1.0E6	5.0E2	4.2E0
ESTW02	²²⁶ Ra	Bone	7.0E0	1.3E6	4.0E7	1.0E6	1.4E1	4.2E0
ESTW03	²²⁶ Ra	Bone	7.0E0	3.1E5	8.3E7	1.0E4	1.4E1	4.2E0
ESTW04	²²⁶ Ra	Bone	7.0E0	5.8E5	9.0E7	1.0E0	2.9E1	4.2E0
ESTW05	²²⁶ Ra	Bone	7.0E0	1.3E6	8.4E6	1.0E6	1.4E1	4.2E0
ESTW06	²²⁶ Ra	Bone	7.0E0	6.7E5	3.6E6	1.0E0	1.0E4	4.2E0
ESTW07	²²⁶ Ra	Bone	7.0E0	1.4E6	3.3E6	1.0E0	2.0E4	4.2E0
ESTW08	²²⁶ Ra	Bone	7.0E0	2.2E7	3.3E6	1.0E0	3.7E5	4.2E0
ESTW09	²²⁶ Ra	Bone	7.0E0	2.0E5	1.3E8	1.0E3	2.4E1	4.2E0
ESTW10	²²⁶ Ra	Bone	7.0E0	3.6E5	1.1E7	1.0E5	5.0E2	4.2E0
ESTW11	²²⁶ Ra	Bone	7.0E0	2.7E5	1.3E7	1.0E4	5.0E2	4.2E0
ESTW12	²²⁶ Ra	Bone	7.0E0	4.8E5	8.3E6	1.0E4	4.0E3	4.2E0

(a) SLT001W - SLT008W based on input of general leach scenario geosphere transport results into the biosphere transport/dose model for well water use.

(b) ESTW01 - ESTW12 based on linear inverse relationship between resultant dose and large ($>10^6$) release durations and results of prior calculations.

APPENDIX B

REFERENCE SALT SITE
EXPANDED DOSE SUMMARY TABLES

APPENDIX B

REFERENCE SALT SITE EXPANDED DOSE SUMMARY TABLES

B.1 SUMMARY TABLES FOR GENERAL LEACH INCIDENT SCENARIOS

The following tables are expanded summaries of the consequence calculations for the parametric sets summarized in Appendix A. These tables list the nuclides in descending order of dose commitment to a critical organ, along with the associated total body dose and time of maximum dose occurrence. Tables B.1.1 through B.1.78 contain the results for the general leach incident scenario. Only Tables B.1.1 and B.1.11 are complete lists of all dose-causing nuclides for the respective parameter sets. Tables B.1.12 through B.1.78 are arbitrarily cut off at the twenty most dose-significant (to critical organ) nuclides in order to save space. Very little information is lost, since generally only a few isotopes dominate the dose and all others are orders of magnitude less significant.

Note that the tables in Appendix A show the maximum total critical organ dose for all times as the sum of dose contributions from each nuclide at the time of occurrence of the maximum critical organ dose, whereas the tables in Appendix B show the level and time of occurrence of the maximum critical organ dose for each nuclide and therefore the reported dose levels don't always coincide between the two sets of tables. For example, in Table A.1, the first entry is for the cost SLT001 showing a maximum bone dose commitment of 2.6E1 rem, dominated by ^{226}Ra and occurring 3.5E4 years after repository closure. This dose is the sum of contributions to the bone dose at the peak bone dose time of 3.5E4 years from ^{226}Ra , ^{14}C , ^{99}Tc and all other nuclides present in the biosphere at that time, with ^{226}Ra the primary source of the dose. The related table in Appendix B, Table B.1.1 for case SLT001 shows the peak ^{226}Ra critical organ dose, bone in this case, of 2.1+001 rem occurring also at 3.5E4 years, the peak ^{14}C dose of 7.2+000 rem to the bone at 5.9E2 years, and etc for all remaining nuclides. In this case, the maximum critical organ dose of 2.6E1 rem on Table A.1 for case SLT001 is the sum of the 2.1+001 rem due to ^{226}Ra (from Table B.1.1) plus whatever contribution is occurring from other nuclides at 3.5E4 years. It is usually the case that the time of maximum dose in the tables in Appendix A will coincide with the time of the maximum dose from the largest contributor nuclide (as it is in the example case of SLT001, time = 3.5E4 years) listed first in the tables in Appendix B, however, it is not a necessary condition, since the maximum critical organ dose for all time over all nuclides in Appendix A can be a sum of many separate nuclide doses less than the maximum per nuclide for any of the contributing nuclides.

TABLE B.1.1 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT001

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.35E+05	1.6+001	2.1+001	2.3-002	2.3-002	2.3-002
14C	.59E+03	1.5+000	7.2+000	1.5+000	1.5+000	1.5+000
99Tc	.59E+03	4.6-002	1.1-001	1.4-002	3.5-007	6.2+000
237Np	.12E+06	2.7-001	4.1+000	9.3-002	9.3-002	9.3-002
234U	.30E+05	1.8-001	2.9+000	8.5-004	8.5-004	2.4-001
129I	.59E+03	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.35E+05	9.1-002	2.3+000	1.3-005	1.3-005	1.3-005
210Po	.35E+05	3.6-001	1.5+000	1.6-009	1.6-009	1.6-009
238U	.30E+05	2.2-002	2.8-001	4.9-003	4.9-003	2.8-002
236U	.30E+05	1.7-002	2.7-001	2.4-006	2.4-006	2.4-006
229Th	.59E+05	1.3-002	2.4-001	1.1-003	1.1-003	1.1-003
225Ra	.59E+05	3.0-002	1.5-001	.0	.0	.0
126Sn	.15E+06	1.6-002	7.6-002	1.4-002	1.5-002	1.4-002
59Ni	.36E+05	1.0-002	6.9-002	3.2-007	3.2-007	3.2-007
242Pu	.29E+06	1.7-003	3.5-002	4.8-006	4.8-006	9.3-003
233U	.59E+05	1.2-003	1.9-002	4.2-006	4.2-006	4.2-006
235U	.30E+05	2.1-003	1.8-002	1.1-003	1.1-003	3.0-003
230Th	.35E+05	3.6-004	1.2-002	8.6-007	8.6-007	8.6-007
135Cs	.35E+06	2.0-003	4.9-003	5.1-004	1.0-010	1.0-010
239Pu	.29E+06	1.5-004	3.2-003	2.9-007	2.9-007	8.1-004
225Ac	.59E+05	8.4-004	1.1-003	8.2-004	8.2-004	8.2-004
227Ac	.35E+05	6.7-005	9.7-004	5.7-006	5.7-006	5.7-006
93mNb	.23E+06	6.1-005	7.3-004	2.9-006	2.9-006	2.9-006
231Pa	.35E+05	3.2-005	5.0-004	1.2-005	1.2-005	1.2-005
210Bi	.35E+05	5.0-006	8.8-006	8.2-009	8.2-009	8.2-009
126Sb	.15E+06	6.5-006	6.5-006	6.5-006	6.5-006	6.5-006
93Zr	.23E+06	1.7-007	6.4-006	.0	.0	.0
228Ra	.18E+06	6.6-007	6.0-007	2.9-010	2.9-010	2.9-010
232Th	.18E+06	8.2-010	1.4-008	3.5-010	3.5-010	8.6-010
224Ra	.18E+06	1.3-009	6.3-009	9.2-013	9.3-013	9.2-013
228Th	.18E+06	2.2-010	4.3-009	7.8-011	7.8-011	7.8-011
79Se	.59E+05	2.9-002	2.4-010	2.4-010	2.4-010	2.4-010
240Pu	.29E+06	3.5-014	7.5-013	1.1-016	1.1-016	1.9-013
87Rb	.69E+04	3.4-006	4.0-013	4.0-013	4.0-013	4.0-013
3H	.51E+03	1.6-015	.0	1.6-015	1.6-015	1.6-015
245Cm	.58E+06	6.5-024	1.4-022	9.5-025	9.5-025	9.5-025
241Am	.58E+06	5.3-024	1.3-022	1.8-025	1.8-025	1.1-023
243Am	.58E+06	3.4-025	6.9-024	6.9-026	6.9-026	6.9-026
241Pu	.58E+06	7.6-027	2.0-025	.0	.0	4.6-026

TABLE B.1.2 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT002

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E +1 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.23E+06	1.1+000	1.5+000	1.7-003	1.7-003	1.7-003
210Pb	.23E+06	6.4-003	1.6-001	9.2-007	9.2-007	9.2-007
210Po	.23E+06	2.5-002	1.1-001	1.1-001	1.1-010	1.1-010
229Th	.70E+06	2.7-003	5.0-002	2.4-004	2.4-004	2.4-004
225Ra	.70E+06	6.3-003	3.1-002	.0	.0	.0
237Np	.16E+06	5.3-004	8.0-003	1.8-004	1.8-004	1.8-004
14C	.59E+03	1.4-003	7.2-003	1.4-003	1.4-003	1.4-003
99Tc	.59E+03	4.6-005	1.1-004	1.4-005	3.5-010	6.2-003
234U	.35E+05	3.1-004	5.0-003	1.5-006	1.5-006	4.1-004
233U	.58E+06	2.4-004	3.9-003	8.7-007	1.5-006	4.1-004
129I	.59E+03	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
236U	.64E+05	6.7-005	1.1-003	9.4-009	9.4-009	9.4-009
126Sn	.16E+06	2.0-004	9.7-004	1.8-004	1.8-004	1.8-004
242Pu	.33E+06	4.2-005	8.7-004	1.2-007	1.2-007	2.3-004
230Th	.26E+06	2.6-005	8.7-004	6.1-008	6.1-008	6.1-008
238U	.64E+05	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
225Ac	.70E+06	1.8-004	2.3-004	1.7-004	1.7-004	1.7-004
159N	.39E+05	3.1-005	1.9-004	1.0-009	1.0-009	1.0-009
135Cs	.39E+06	6.5-005	1.6-004	1.7-005	3.3-012	3.3-012
235U	.16E+06	9.4-006	8.0-005	4.8-006	4.8-006	1.3-005
227Ac	.39E+06	4.6-006	6.7-005	3.9-007	3.9-007	3.9-007
239Pu	.29E+06	2.0-006	4.2-005	3.8-009	3.8-009	1.1-005
231Pa	.39E+06	2.2-006	3.5-005	8.0-007	8.0-007	8.0-007
93mNb	.33E+06	1.3-006	1.5-005	6.1-008	6.1-008	6.1-008
228Ra	.70E+06	1.7-006	1.5-006	7.5-010	7.5-010	7.5-010
210Bi	.23E+06	3.6-007	6.2-007	5.8-010	5.8-010	5.8-010
93Zr	.33E+06	3.6-009	1.4-007	.0	.0	.0
126Sb	.16E+06	8.2-008	8.2-008	8.2-008	8.2-008	8.2-008
232Th	.70E+06	2.1-009	3.6-008	9.0-010	9.0-010	2.2-009
224Ra	.70E+06	3.2-009	1.6-008	2.4-012	2.4-012	2.4-012
228Th	.70E+06	5.7-010	1.1-008	2.0-010	2.0-010	2.0-010
79Se	.64E+05	1.5-004	1.2-012	1.2-012	1.2-012	1.2-012
240Pu	.29E+06	4.6-016	9.9-015	1.5-018	1.5-018	2.6-015
87Rb	.93E+04	3.6-009	4.3-016	4.3-016	4.3-016	4.3-016
3H	.51E+03	1.6-018	.0	1.6-018	1.6-018	1.6-018
245Cm	.55E+06	2.8-025	5.9-024	4.1-026	4.1-026	4.1-026
241Am	.55E+06	2.3-025	5.6-024	7.8-027	7.8-027	4.8-025
243Am	.55E+06	2.2-026	4.5-025	4.5-027	4.5-027	4.5-027
241Pu	.55E+06	3.3-028	8.8-027	.0	.0	2.0-027

TABLE B.1.3 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT003

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.13E+07	4.7-001	6.2-001	6.8-004	6.8-004	6.8-004
210Pb	.13E+07	2.6-003	6.8-002	3.7-007	3.7-007	3.7-007
210Po	.13E+07	1.0-002	4.3-002	4.5-011	4.5-011	4.5-011
237Np	.12E+07	3.8-004	5.8-003	1.3-004	1.3-004	1.3-004
233U	.11E+07	2.2-004	3.5-003	7.8-007	7.8-007	7.8-007
229Th	.12E+07	1.7-004	3.2-003	1.5-005	1.5-005	1.5-005
129I	.10E+07	5.2-006	3.0-006	1.8-006	2.7-003	2.0-006
225Ra	.12E+07	3.9-004	2.0-003	.0	.0	.0
234U	.10E+07	7.8-005	1.2-003	3.6-007	3.6-007	1.0-004
236U	.11E+07	6.4-005	1.0-003	9.1-009	9.1-009	9.1-009
238U	.11E+07	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.13E+07	1.1-005	3.5-004	2.5-008	2.5-008	2.5-008
99Tc	.10E+07	1.7-006	4.3-006	5.4-007	1.3-011	2.3-004
242Pu	.13E+07	6.5-006	1.3-004	1.8-008	1.8-008	3.6-005
135Cs	.14E+07	5.1-005	1.2-004	1.3-005	2.6-012	2.6-012
235U	.11E+07	8.9-006	7.6-005	4.5-006	4.5-006	1.2-005
227Ac	.14E+07	4.6-006	6.7-005	3.9-007	3.9-007	3.9-007
231Pa	.14E+07	2.2-006	3.5-005	8.0-007	8.0-007	8.0-007
225Ac	.12E+07	1.1-005	1.4-005	1.1-005	1.1-005	1.1-005
228Ra	.17E+07	1.4-005	1.3-005	6.2-009	6.2-009	6.2-009
93mNb	.13E+07	8.2-007	9.6-006	3.8-008	3.8-008	3.8-008
126Sn	.12E+07	1.8-007	8.8-007	1.6-007	1.7-007	1.6-007
232Th	.17E+07	1.7-008	3.0-007	7.5-009	7.5-009	1.8-008
210Bi	.13E+07	1.5-007	2.6-007	2.4-010	2.4-010	2.4-010
224Ra	.17E+07	2.7-008	1.4-007	2.0-011	2.0-011	2.0-011
228Th	.17E+07	4.8-009	9.2-008	1.7-009	1.7-009	1.7-009
93Zr	.13E+07	2.3-009	8.4-008	.0	.0	.0
59Ni	.10E+07	5.5-009	3.3-008	1.8-013	1.8-013	1.8-013
126Sb	.12E+07	7.5-011	7.5-011	7.5-011	7.5-011	7.5-011
87Rb	.10E+07	3.6-009	4.3-016	4.3-016	4.3-016	4.3-016
79Se	.11E+07	3.5-009	2.9-017	2.9-017	2.9-017	2.9-017
239Pu	.13E+07	8.7-019	1.9-017	1.7-021	1.7-021	4.7-018

TABLE B.1.4 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT004

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+07	5.9+000	7.7+000	8.6-003	8.6-003	8.6-003
129I	.10E+07	5.2-003	3.0-003	1.8-003	2.7+000	2.0-003
233U	.10E+07	5.3-002	8.6-001	1.9-004	1.9-004	1.9-004
210Pb	.10E+07	3.3-002	8.5-001	4.7-006	4.7-006	4.7-006
237Np	.11E+07	3.6-002	5.5-001	1.3-002	1.3-002	1.3-002
210Po	.10E+07	1.3-001	5.4-001	5.7-010	5.7-010	5.7-010
234U	.10E+07	2.9-002	4.5-001	1.3-004	1.3-004	3.8-002
236U	.10E+07	2.3-002	3.6-001	3.2-006	3.2-006	3.2-006
238U	.10E+07	2.2-002	2.8-001	4.9-003	4.9-003	2.8-002
99Tc	.10E+07	1.7-003	4.3-003	5.4-004	1.3-008	2.3-001
229Th	.10E+07	7.4-003	1.4-001	6.6-004	6.6-004	6.6-004
225Ra	.10E+07	1.7-002	8.7-002	.0	.0	.0
235U	.10E+07	3.2-003	2.7-002	1.6-003	1.6-003	4.4-003
242Pu	.13E+07	2.7-004	5.6-003	7.7-007	7.7-007	1.5-003
230Th	.10E+07	1.3-004	4.4-003	3.1-007	3.1-007	3.1-007
135Cs	.14E+07	1.6-003	3.9-003	4.1-004	8.1-011	8.1-011
227Ac	.10E+07	9.4-005	1.4-003	8.0-006	8.0-006	8.0-006
231Pa	.10E+07	4.6-005	7.1-004	1.6-005	1.6-005	1.6-005
225Ac	.10E+07	4.9-004	6.3-004	4.8-004	4.8-004	4.8-004
93mNb	.12E+07	3.9-005	4.6-004	1.8-006	1.8-006	1.8-006
228Ra	.16E+07	2.3-004	2.1-004	1.0-007	1.0-007	1.0-007
126Sn	.11E+07	1.6-005	7.6-005	1.4-005	1.4-005	1.4-005
59Ni	.10E+07	1.7-006	1.0-005	5.6-011	5.6-011	5.6-011
232Th	.16E+07	2.8-007	4.8-006	1.2-007	1.2-007	2.9-007
93Zr	.12E+07	1.1-007	4.0-006	.0	.0	.0
210Bi	.10E+07	1.8-006	3.2-006	3.0-009	3.0-009	3.0-009
224Ra	.16E+07	4.3-007	2.2-006	3.2-010	3.2-010	3.2-010
228Th	.16E+07	7.7-008	1.5-006	2.7-008	2.7-008	2.7-008
126Sb	.11E+07	6.4-009	6.4-009	6.4-009	6.4-009	6.4-009
87Rb	.10E+07	3.4-006	4.0-013	4.0-013	4.0-013	4.0-013
79Se	.11E+07	6.9-007	5.8-015	5.8-015	5.8-015	5.8-015
239Pu	.13E+07	6.7-017	1.4-015	1.3-019	1.3-019	3.6-016

TABLE B.1.5 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT005

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure (yr)	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.5+000	2.0+000	2.1-003	2.1-003	2.1-003
129I	.37E+06	3.4-003	2.0-003	1.2-003	1.8+000	1.3-003
99Tc	.37E+06	8.6-003	2.1-002	2.7-003	6.5-008	1.2+000
210Pb	.22E+08	8.3-003	2.1-001	1.2-006	1.2-006	1.2-006
210Po	.22E+08	3.3-002	1.4-001	1.4-010	1.4-010	1.4-010
234U	.22E+08	6.8-004	1.1-002	3.1-006	3.1-006	9.0-004
238U	.22E+08	6.6-004	8.6-003	1.5-004	1.5-004	8.4-004
236U	.22E+08	3.5-004	5.6-003	4.9-008	4.9-008	4.9-008
230Th	.22E+08	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
235U	.22E+08	1.1-004	9.4-004	5.6-005	5.6-005	1.5-004
227Ac	.22E+08	4.0-005	5.8-004	3.4-006	3.4-006	3.4-006
231Pa	.22E+08	1.9-005	3.0-004	6.9-006	6.9-006	6.9-006
228Ra	.26E+09	5.0-007	4.5-007	2.2-010	2.2-010	2.2-010
210Bi	.22E+08	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
232Th	.26E+09	6.2-010	1.0-008	2.7-010	2.7-010	6.5-010
224Ra	.26E+09	9.5-010	4.8-009	7.0-013	7.0-013	7.0-013
228Th	.26E+09	1.7-010	3.3-009	5.9-011	5.9-011	5.9-011
229Th	.86E+08	1.2-014	2.3-013	1.1-015	1.1-015	1.1-015
225Ra	.86E+08	2.9-014	1.4-013	.0	.0	.0
87Rb	.46E+07	1.8-007	2.2-014	2.2-014	2.2-014	2.2-014
233U	.86E+08	1.1-015	1.9-014	4.1-018	4.1-018	4.1-018
237Np	.86E+08	4.2-016	6.3-015	1.4-016	1.4-016	1.4-016
225Ac	.86E+08	8.1-016	1.1-015	7.9-016	7.9-016	7.9-016
14C	.37E+06	3.3-020	1.6-019	3.3-020	3.3-020	3.3-020

TABLE B.1.6 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT006

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.3+000	1.8+000	2.1-003	2.1-003	2.1-003
210Pb	.22E+08	7.8-003	2.0-001	1.1-006	1.1-006	1.1-006
210Po	.22E+08	3.1-002	1.3-001	1.3-010	1.3-010	1.3-010
129I	.37E+06	5.2-005	3.0-005	1.8-005	2.6-002	2.0-005
99Tc	.37E+06	1.4-004	3.5-004	4.3-005	1.1-009	1.9-002
234U	.22E+08	5.2-004	8.3-003	2.4-006	2.4-006	6.9-004
238U	.22E+08	5.1-004	6.6-003	1.2-004	1.2-004	6.5-004
236U	.22E+08	3.0-004	4.8-003	4.2-008	4.2-008	4.2-008
230Th	.22E+08	2.7-005	8.8-004	6.2-008	6.2-008	6.2-008
235U	.22E+08	8.1-005	6.9-004	4.1-005	4.1-005	1.1-004
227Ac	.22E+08	2.9-005	4.3-004	2.5-006	2.5-006	2.5-006
231Pa	.22E+08	1.4-005	2.2-004	5.1-006	5.1-006	5.1-006
228Ra	.43E+09	5.6-006	5.1-006	2.5-009	2.5-009	2.5-009
210Bi	.22E+08	3.6-007	6.2-007	5.8-010	5.8-010	5.8-010
232Th	.43E+09	6.9-009	1.2-007	2.9-009	2.9-009	7.2-009
224Ra	.43E+09	1.1-008	5.3-009	7.8-012	7.8-012	7.8-012
228Th	.43E+09	1.9-009	3.6-008	6.6-010	6.6-010	6.6-010
229Th	.86E+08	7.0-015	1.3-013	6.2-016	6.2-016	6.2-016
225Ra	.86E+08	1.6-014	8.2-014	.0	.0	.0
237Np	.86E+08	3.8-015	5.8-014	1.3-015	1.3-015	1.3-015
233U	.86E+08	6.3-016	1.0-014	2.3-018	2.3-018	2.3-018
27Rb	.47E+07	3.6-008	4.3-015	4.3-015	4.3-015	4.3-015
225Ac	.86E+08	4.6-016	6.0-016	4.5-016	4.5-016	4.5-016
14C	.37E+06	4.3-022	2.2-021	4.3-022	4.3-022	4.3-022

TABLE B.1.7 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT007

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLT
226Ra	.23E+08	1.3+000	1.8+000	2.1-003	2.1-003	2.1-003
210Pb	.23E+08	7.8-003	2.0-001	1.1-006	1.1-006	1.1-006
210Po	.23E+08	3.1-002	1.3-001	1.3-001	1.3-001	1.3-001
129I	.14E+07	4.9-005	2.9-005	1.7-005	2.5-002	1.9-005
234U	.23E+08	5.2-004	8.3-003	2.4-006	2.4-006	6.9-004
238U	.23E+08	5.1-004	6.6-003	1.2-004	1.2-004	6.5-004
236U	.23E+08	2.7-004	4.4-003	3.8-008	3.8-008	3.8-008
230Th	.23E+08	2.7-005	8.8-004	6.2-008	6.2-008	6.2-008
99Tc	.14E+07	5.3-006	1.3-005	1.6-006	4.0-011	7.1-004
235U	.23E+08	7.2-005	6.2-004	3.7-005	3.7-005	1.0-004
227Ac	.23E+08	3.1-005	4.6-004	2.7-006	2.7-006	2.7-006
231Pa	.23E+08	1.5-005	2.4-004	5.5-006	5.5-006	5.5-006
228Ra	.43E+09	1.2-005	1.1-005	5.4-009	5.4-009	5.4-009
210Bi	.23E+08	3.6-007	6.2-007	5.8-010	5.8-010	5.8-010
232Th	.43E+09	1.5-008	2.6-007	6.5-009	6.5-009	1.6-008
224Ra	.43E+09	2.3-008	1.2-007	1.7-011	1.7-011	1.7-011
228Th	.43E+09	4.1-009	8.0-008	1.4-009	1.4-009	1.4-009
237Np	.87E+08	9.4-016	1.4-014	3.3-016	3.3-016	3.3-016
233U	.87E+08	4.8-016	7.7-015	1.7-018	1.7-018	1.7-018
229Th	.87E+08	4.1-016	7.7-015	3.7-017	3.7-017	3.7-017
225Ra	.87E+08	9.6-016	4.8-015	.0	.0	.0
87Rb	.57E+07	3.6-008	4.3-015	4.3-015	4.3-015	4.3-015
225Ac	.87E+08	2.7-017	3.5-017	2.6-017	2.6-017	2.6-017

TABLE B.1.8 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT008

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.23E+08	1.5+000	1.9+000	2.1-003	2.1-003	2.1-003
129I	.14E+07	3.2-003	1.9-003	1.1-003	1.7+000	1.2-003
210Pb	.23E+08	8.1-003	2.1-001	1.2-006	1.2-006	1.2-006
210Po	.23E+08	3.2-002	1.3-001	1.4-010	1.4-010	1.4-010
99Tc	.14E+07	3.3-004	8.1-004	1.0-004	2.5-009	4.4-002
234U	.23E+08	6.8-004	1.1-002	3.1-006	3.1-006	9.0-004
238U	.23E+08	6.6-004	8.6-003	1.5-004	1.5-004	8.4-004
236U	.23E+08	3.7-004	6.0-003	5.2-008	5.2-008	5.2-008
230Th	.23E+08	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
227Ac	.23E+08	6.3-005	9.1-004	5.3-006	5.3-006	5.3-006
235U	.23E+08	9.3-005	8.0-004	4.8-005	4.8-005	1.3-004
231Pa	.23E+08	3.0-005	4.7-004	1.1-005	1.1-005	1.1-005
228Ra	.43E+09	7.2-006	6.5-006	3.2-009	3.2-009	3.2-009
210Bi	.23E+08	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
232Th	.43E+09	8.9-009	1.5-007	3.8-009	3.8-009	9.3-009
224Ra	.43E+09	1.4-008	6.8-008	1.0-011	1.1-011	1.0-011
228Th	.43E+09	2.4-009	4.7-008	8.5-010	8.5-010	8.5-010
87Rb	.56E+07	1.8-007	2.2-014	2.2-014	2.2-014	2.2-014
237Np	.87E+08	1.0-015	1.5-014	3.5-016	3.5-016	3.5-016
233U	.87E+08	8.2-016	1.3-014	2.9-018	2.9-018	2.9-018
229Th	.87E+08	6.6-016	1.2-014	5.8-017	5.8-017	5.8-017
225Ra	.87E+08	1.5-015	7.7-015	.0	.0	.0
225Ac	.87E+08	4.3-017	5.6-017	4.2-017	4.2-017	4.2-017

TABLE B.1.9 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT009

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+06	8.9+000	1.2+001	1.3-002	1.3-002	1.3-002
210Pb	.12E+06	5.0-002	1.3+000	7.1-006	7.1-006	7.1-006
210Po	.12E+06	2.0-001	8.3-001	8.6-010	8.6-010	8.6-010
229Th	.18E+06	1.2-002	2.3-001	1.1-003	1.1-003	1.1-003
225Ra	.18E+06	2.9-002	1.4-001	.0	.0	.0
99Tc	.59E+03	4.5-004	1.1-003	1.4-004	3.4-009	6.3-002
234U	.35E+05	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
129I	.61E+03	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
236U	.64E+05	1.3-003	2.1-002	1.8-007	1.8-007	1.8-007
233U	.18E+06	1.1-003	1.8-002	4.0-006	4.0-006	4.0-006
242Pu	.32E+06	4.3-004	8.8-003	1.2-006	1.2-006	2.4-003
238U	.64E+05	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.12E+06	2.0-004	6.8-003	4.8-007	4.8-007	4.8-007
225Ac	.18E+06	8.1-004	1.1-003	7.9-004	7.9-004	7.9-004
235U	.64E+05	6.0-005	5.1-004	3.0-005	3.0-005	8.3-005
227Ac	.12E+06	3.3-005	4.9-004	2.8-006	2.8-006	2.8-006
231Pa	.12E+06	1.6-005	2.5-004	5.8-006	5.8-006	5.8-006
93mNb	.26E+06	1.3-005	1.5-004	6.1-007	6.1-007	6.1-007
237Np	.26E+06	7.4-006	1.1-004	2.6-006	2.6-006	2.6-006
210Bi	.12E+06	2.8-006	4.9-006	4.5-009	4.5-009	4.5-009
93Zr	.26E+06	3.6-008	1.4-006	.0	.0	.0
228Ra	.64E+06	1.9-009	1.7-009	8.3-013	8.3-013	8.3-013
232Th	.64E+06	2.3-012	4.0-011	1.0-012	1.0-012	2.5-012
224Ra	.64E+06	3.6-012	1.8-011	2.6-015	2.6-015	2.6-015

TABLE B.1.10 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT010

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+07	3.4+000	4.4+000	4.9-003	4.9-003	4.9-003
210Pb	.11E+07	1.9-002	4.9-001	2.7-006	2.7-006	2.7-006
210Po	.11E+07	7.5-002	3.1-001	3.3-010	3.3-010	3.3-010
129I	.10E+07	5.2-005	3.0-005	1.8-005	2.6-002	2.0-005
234U	.10E+07	7.8-004	1.2-002	3.6-006	3.6-006	1.0-003
238U	.11E+07	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.11E+07	7.7-005	2.6-003	1.8-007	1.8-007	1.8-007
99Tc	.10E+07	1.7-005	3.9-005	5.3-006	1.2-010	2.3-003
242Pu	.13E+07	7.1-005	1.5-003	2.0-007	2.0-007	3.9-004
228Ra	.16E+07	1.1-004	1.0-004	5.0-008	5.0-008	5.0-008
93mNb	.13E+07	8.2-006	9.6-005	3.8-007	3.8-007	3.8-007
232Th	.16E+07	1.4-007	2.4-006	6.0-008	6.0-008	1.5-007
210Bi	.11E+07	1.0-006	1.8-006	1.7-009	1.7-009	1.7-009
224Ra	.16E+07	2.2-007	1.1-006	1.6-010	1.6-010	1.6-010
93Zr	.13E+07	2.3-008	8.4-007	.0	.0	.0
228Th	.16E+07	3.8-008	7.4-007	1.3-008	1.3-008	1.3-008
79Se	.11E+07	3.5-008	2.9-016	2.9-016	2.9-016	2.9-016

TABLE B.1.11 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT011

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.59E+06	5.3+000	6.9+000	7.7-003	7.7-003	7.7-003
210Pb	.59E+06	3.0-002	7.7-001	4.2-006	4.2-006	4.2-006
99Tc	.10E+05	4.4-003	1.0-002	1.4-003	3.3-008	6.1-001
210Po	.59E+06	1.2-001	4.9-001	5.2-010	5.2-010	5.2-010
129I	.10E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
234U	.59E+06	1.1-002	1.8-001	5.3-005	5.3-005	1.5-002
238U	.59E+06	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
230Th	.70E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
93mNb	.46E+07	8.9-006	1.1-004	4.1-007	4.1-007	4.1-007
242Pu	.57E+07	1.1-007	2.3-006	3.1-010	3.1-010	6.1-007
210Bi	.59E+06	1.0-006	1.8-006	1.7-009	1.7-009	1.7-009
93Zr	.46E+07	2.5-008	9.2-007	.0	.0	.0
227Ac	.59E+06	8.8-010	1.3-008	7.5-011	7.5-011	7.5-011
231Pa	.59E+06	4.3-010	6.6-009	1.5-010	1.5-010	1.5-010
228Ra	.11E+08	4.1-009	3.8-009	1.8-012	1.8-012	1.8-012
232Th	.11E+08	5.1-012	8.7-011	2.2-012	2.2-012	5.4-012
235U	.59E+06	6.4-012	5.4-011	3.2-012	3.2-012	8.9-012
224Ra	.11E+08	7.9-012	4.0-011	5.8-015	5.8-015	5.8-015
228Th	.11E+08	1.4-012	2.7-011	4.9-013	4.9-013	4.9-013
79Se	.12E+07	1.2-007	1.0-015	1.0-015	1.0-015	1.0-015
237Np	.59E+06	2.4-020	3.6-019	8.1-021	8.1-021	8.1-021
229Th	.59E+06	9.5-021	1.8-019	8.4-022	8.4-022	8.4-022
225Ra	.59E+06	2.2-020	1.1-019	.0	.0	.0
223U	.59E+06	5.3-022	8.6-021	1.9-024	1.9-024	1.9-024
225Ac	.59E+06	6.2-022	8.1-022	6.1-022	6.1-022	6.1-022
236U	.59E+06	3.5-030	5.6-029	4.9-034	4.9-034	4.9-034

TABLE B.1.12 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT012

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.16E+07	3.3+000	4.2+000	4.7-003	4.7-003	4.7-003
210Pb	.16E+07	1.9-002	4.7-001	2.5-006	2.5-006	2.5-006
129I	.10E+07	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
210Po	.16E+07	7.2-002	3.0-001	3.1-010	3.1-010	3.1-010
234U	.16E+07	6.5-003	1.0-001	3.0-005	3.0-005	8.6-003
238U	.16E+07	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
99Tc	.10E+07	1.6-004	3.8-004	5.2-005	1.2-009	2.2-002
230Th	.17E+07	5.5-005	1.8-003	1.3-007	1.3-007	1.3-007
228Ra	.12E+08	2.5-004	2.3-004	1.1-007	1.1-007	1.1-007
93mNb	.56E+07	5.6-006	6.6-005	2.6-007	2.6-007	2.6-007
232Th	.12E+08	3.2-007	5.3-006	1.4-007	1.4-007	3.3-007
224Ra	.12E+08	4.8-007	2.4-006	3.6-010	3.6-010	3.6-010
228Th	.12E+08	8.6-008	1.7-006	3.0-008	3.0-008	3.0-008
210Bi	.16E+07	6.4-007	1.1-006	1.0-009	1.0-009	1.0-009
93Zr	.56E+07	1.5-008	5.8-007	.0	.0	.0
242Pu	.67E+07	1.7-008	3.6-007	4.9-011	4.9-011	9.7-008
79Se	.22E+07	2.8-012	2.4-020	2.4-020	2.4-020	2.4-020

TABLE B.1.13 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT013

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.58E+06	5.5+000	7.2+000	7.9-003	7.9-003	7.9-003
99Tc	.98E+04	4.4-002	1.0-001	1.8+000	3.3-007	6.1+000
129I	.10E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
234U	.58E+06	6.0-002	9.5-001	2.8-004	2.8-004	7.9-002
210Pb	.58E+06	3.1-002	7.9-001	4.3-006	4.3-006	4.3-006
210Po	.58E+06	1.2-001	5.1-001	5.2-010	5.2-010	5.2-010
238U	.58E+06	2.5-002	3.3-001	5.7-003	5.7-003	3.2-002
230Th	.70E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
93mNb	.46E+07	9.6-006	1.1-004	4.5-007	4.5-007	4.5-007
242Pu	.57E+07	1.2-007	2.4-006	3.3-010	3.3-010	6.5-007
210Bi	.58E+06	1.1-006	2.0-006	1.9-009	1.9-009	1.9-009
93Zr	.46E+07	2.7-008	9.9-007	.0	.0	.0
227Ac	.58E+06	9.4-010	1.4-008	8.0-011	8.0-011	8.0-011
231Pa	.58E+06	4.6-010	7.1-009	1.6-010	1.6-010	1.6-010
228Ra	.11E+08	4.2-009	3.9-009	1.9-012	1.9-012	1.9-012
232Th	.11E+08	5.3-012	8.9-011	2.3-012	2.3-012	5.5-012
235U	.58E+06	6.8-012	5.8-011	3.5-012	3.5-012	9.5-012
224Ra	.11E+08	8.1-012	4.0-011	5.9-015	5.9-015	5.9-015
228Th	.11E+08	1.4-012	2.8-011	5.0-013	5.0-013	5.0-013
79Se	.12E+07	2.7-007	2.3-015	2.3-015	2.3-015	2.3-015
237Np	.58E+06	2.5-020	3.8-019	8.6-021	8.6-021	8.6-021
229Th	.58E+06	1.0-020	1.9-019	9.2-022	9.2-022	9.2-022
225Ra	.58E+06	2.4-020	1.2-019	.0	.0	.0
233U	.58E+06	5.5-022	9.0-021	2.0-024	2.0-024	2.0-024
225Ac	.58E+06	6.8-022	8.8-022	6.6-022	6.6-022	6.6-022
236U	.58E+06	9.7-030	1.6-028	1.4-033	1.4-033	1.4-033

TABLE B.1.14 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT014

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.16E+07	3.4+000	4.4+000	4.9-003	4.9-003	4.9-003
129I	.10E+07	5.2-003	3.0-003	1.8-003	2.7+000	2.0-003
234U	.16E+07	2.6-002	4.1-001	1.2-004	1.2-004	3.5-002
238U	.16E+07	2.5-002	3.3-001	5.7-003	5.7-003	3.2-002
210Pb	.16E+07	1.8-002	4.9-001	2.8-006	2.8-006	2.8-006
210Po	.16E+07	7.5-002	3.1-001	3.2-010	3.2-010	3.2-010
99Tc	.10E+07	1.6-003	3.8-003	5.2-004	1.2-008	2.2-001
230Th	.17E+07	5.5-005	1.8-003	1.3-007	1.3-007	1.3-007
228Ra	.12E+08	2.6-004	2.4-004	1.2-007	1.2-007	1.2-007
93mNb	.56E+07	6.0-006	7.1-005	2.8-007	2.8-007	2.8-007
232Th	.12E+08	3.3-007	5.6-006	1.4-007	1.4-007	3.4-007
224Ra	.12E+08	5.0-007	2.5-006	3.7-010	3.7-010	3.7-010
228Th	.12E+08	8.9-008	1.7-006	3.1-008	3.1-008	3.1-008
210Bi	.16E+07	6.9-007	1.2-006	1.1-009	1.1-009	1.1-009
93Zr	.56E+07	1.7-008	6.2-007	.0	.0	.0
242Pu	.67E+07	1.9-008	3.9-007	5.3-011	5.3-011	1.0-007
79Se	.22E+07	6.4-012	5.4-020	5.4-020	5.4-020	5.4-020

TABLE B.1.15 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT015

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04 yr; dispersion coefficient = 4.2E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.57E+07	2.4+000	3.1+000	3.5-003	3.5-003	3.5-003
129I	.11E+07	5.2-003	3.0-003	1.8-003	2.7+000	2.0-003
210Pb	.57E+07	1.3-002	3.3-001	1.9-006	1.9-006	1.9-006
210Po	.57E+07	5.2-002	2.1-001	2.3-010	2.3-010	2.3-010
99Tc	.10E+07	1.3-003	3.0-003	4.1-004	9.6-009	1.8-001
234U	.57E+07	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
238U	.57E+07	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
230Th	.57E+07	3.0-005	9.9-004	7.0-008	7.0-008	7.0-008
228Ra	.93E+08	3.0-005	2.7-005	1.3-008	1.3-008	1.3-008
210Bi	.57E+07	5.5-007	9.6-007	8.9-010	8.9-010	8.9-010
232Th	.93E+08	3.7-008	6.3-007	1.6-008	1.6-008	3.9-008
224Ra	.93E+08	5.7-008	2.9-007	4.2-011	4.2-011	4.2-011
228Th	.93E+08	1.0-008	2.0-007	3.6-009	3.6-009	3.6-009
93mNb	.38E+08	2.4-013	2.8-012	1.1-014	1.1-014	1.1-014
93Zr	.38E+08	6.6-016	2.5-014	.0	.0	.0

TABLE B.1.16 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT016

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04yr; dispersion coefficient = 4.2E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.81E+05	3.5-002	8.2-002	1.1-002	2.6-007	4.8+000
226Ra	.47E+07	2.4+000	3.1+000	3.5-003	3.5-003	3.5-003
129I	.81E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.47E+07	1.3-002	3.3-001	1.9-006	1.9-006	1.9-006
229Th	.81E+05	1.1-002	2.1-001	9.9-004	9.9-004	9.9-004
210Po	.47E+07	5.2-002	2.1-001	2.3-010	2.3-010	2.3-010
225Ra	.81E+05	2.6-002	1.3-001	.0	.0	.0
234U	.47E+07	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
238U	.47E+07	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
233U	.81E+05	1.0-003	1.6-002	3.6-006	3.6-006	3.6-006
236U	.81E+05	5.7-004	9.1-003	8.0-008	8.0-008	8.0-008
230Th	.47E+07	3.0-005	9.9-004	7.0-008	7.0-008	7.0-008
225Ac	.81E+05	7.3-004	9.5-004	7.1-004	7.1-004	7.1-004
227Ac	.81E+05	6.1-005	8.8-004	5.2-006	5.2-006	5.2-006
235U	.81E+05	6.0-005	5.1-004	3.0-005	3.0-005	8.3-005
231Pa	.81E+05	2.9-005	4.6-004	1.1-005	1.1-005	1.1-005
210Bi	.47E+07	5.5-007	9.6-007	8.9-010	8.9-010	8.9-010
228Ra	.92E+08	4.9-010	4.5-010	2.2-013	2.2-013	2.2-013
232Th	.92E+08	6.1-013	1.0-011	2.6-013	2.6-013	6.4-013
224Ra	.92E+08	9.3-013	4.7-012	6.8-016	6.8-016	6.8-016

TABLE B.1.17 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT017

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.59E+06	5.3+000	6.9+000	7.7-003	7.7-003	7.7-003
210Pb	.59E+06	3.0-002	7.7-001	4.2-006	4.2-006	4.2-006
99Tc	.10E+05	4.4-003	1.0-002	1.4-003	3.3-008	6.1-001
210Po	.59E+06	1.2-001	4.9-001	5.2-010	5.2-010	5.2-010
129I	.10E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
234U	.59E+06	1.1-002	1.8-001	5.3-005	5.3-005	1.5-002
238U	.59E+06	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
230Th	.70E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
93mNb	.46E+07	8.9-006	1.1-004	4.1-007	4.1-007	4.1-007
242Pu	.57E+07	1.1-007	2.3-006	3.1-010	3.1-010	6.1-007
210Bi	.59E+06	1.0-006	1.8-006	1.7-009	1.7-009	1.7-009
93Zr	.46E+07	2.5-008	9.2-007	.0	.0	.0
227Ac	.59E+06	8.8-010	1.3-008	7.5-011	7.5-011	7.5-011
231Pa	.59E+06	4.3-010	6.6-009	1.5-010	1.5-010	1.5-010
228Ra	.11E+08	4.1-009	3.8-009	1.8-012	1.8-012	1.8-012
232Th	.11E+08	5.1-012	8.7-011	2.2-012	2.2-012	5.4-012
235U	.59E+06	6.4-012	5.4-011	3.2-012	3.2-012	8.9-012
224Ra	.11E+08	7.9-012	4.0-011	5.8-015	5.8-015	5.8-015
228Th	.11E+08	1.4-012	2.7-011	4.9-013	4.9-013	4.9-013
79Se	.12E+07	1.2-007	1.0-015	1.0-015	1.0-015	1.0-015
237Np	.59E+06	2.4-020	3.6-019	8.1-021	8.1-021	8.1-021
229Th	.59E+06	9.5-021	1.8-019	8.4-022	8.4-022	8.4-022
225Ra	.59E+06	2.2-020	1.1-019	.0	.0	.0
223U	.59E+06	5.3-022	8.6-021	1.9-024	1.9-024	1.9-024
225Ac	.59E+06	6.2-022	8.1-022	6.1-022	6.1-022	6.1-022
236U	.59E+06	3.5-030	5.6-029	4.9-034	4.9-034	4.9-034

TABLE B.1.18 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT018

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.16E+07	3.3+000	4.2+000	4.7-003	4.7-003	4.7-003
210Pb	.16E+07	1.9-002	4.7-001	2.5-006	2.5-006	2.5-006
129I	.10E+07	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
210Po	.16E+07	7.2-002	3.0-001	3.1-010	3.1-010	3.1-010
234U	.16E+07	6.5-003	1.0-001	3.0-005	3.0-005	8.6-003
238U	.16E+07	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
99Tc	.10E+07	1.6-004	3.8-004	5.2-005	1.2-009	2.2-002
230Th	.17E+07	5.5-005	1.8-003	1.3-007	1.3-007	1.3-007
228Ra	.12E+08	2.5-004	2.3-004	1.1-007	1.1-007	1.1-007
93mNb	.56E+07	5.6-006	6.6-005	2.6-007	2.6-007	2.6-007
232Th	.12E+08	3.2-007	5.3-006	1.4-007	1.4-007	3.3-007
224Ra	.12E+08	4.8-007	2.4-006	3.6-010	3.6-010	3.6-010
228Th	.12E+08	8.6-008	1.7-006	3.0-008	3.0-008	3.0-008
210Bi	.16E+07	6.4-007	1.1-006	1.0-009	1.0-009	1.0-009
93Zr	.56E+07	1.5-008	5.8-007	.0	.0	.0
242Pu	.67E+07	1.7-008	3.6-007	4.9-011	4.9-011	9.7-008
79Se	.22E+07	2.8-012	2.4-020	2.4-020	2.4-020	2.4-020

TABLE B.1.19 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT019

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04 yr; dispersion coefficient = 4.2E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.78E+05	1.0-001	2.3-001	3.2-002	7.5-007	1.4+001
129I	.80E+05	1.5-002	8.9-003	5.3-003	7.8+000	5.9-003
226Ra	.47E+07	2.4+000	3.1+000	3.4-003	3.4-003	3.4-003
210Pb	.47E+07	1.3-002	3.4-001	1.9-006	1.9-006	1.9-006
210Po	.47E+07	5.2-002	2.2-001	2.3-010	2.3-010	2.3-010
229Th	.80E+05	1.1-002	2.1-001	9.9-004	9.9-004	9.9-004
225Ra	.80E+05	2.6-002	1.3-001	.0	.0	.0
234U	.47E+07	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
238U	.47E+07	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
233U	.80E+05	1.0-003	1.6-002	3.6-006	3.6-006	3.6-006
236U	.80E+05	5.7-004	9.1-003	8.0-008	8.0-008	8.0-008
225Ac	.80E+05	7.3-004	9.5-004	7.1-004	7.1-004	7.1-004
227Ac	.80E+05	6.3-005	9.1-004	5.3-006	5.3-006	5.3-006
230Th	.56E+07	2.0-005	6.6-004	4.7-008	4.7-008	4.7-008
235U	.80E+05	6.0-005	5.1-004	3.0-005	3.0-005	8.3-005
231Pa	.80E+05	3.0-005	4.7-004	1.1-005	1.1-005	1.1-005
210Bi	.47E+07	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
228Ra	.92E+08	4.9-010	4.5-010	2.2-013	2.2-013	2.2-013
232Th	.92E+08	6.1-013	1.0-011	2.6-013	2.6-013	6.4-013
224Ra	.92E+08	9.3-013	4.7-012	6.8-016	6.8-016	6.8-016

TABLE B.1.20 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT020

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04 yr; dispersion coefficient = 4.2E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
129I	.11E+07	1.5-002	8.5-003	5.1-003	7.5+000	5.6-003
226Ra	.57E+07	2.4-001	3.1-001	3.4-003	3.4-003	3.4-003
99Tc	.11E+07	3.7-003	8.7-003	1.2-003	2.8-008	5.1-001
210Pb	.57E+07	1.3-002	3.4-001	1.9-006	1.9-006	1.9-006
210Po	.57E+07	5.2-002	2.2-001	2.3-010	2.3-010	2.3-010
234U	.57E+07	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
238U	.57E+07	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
230Th	.66E+07	2.0-005	6.6-004	4.7-008	4.7-008	4.7-008
228Ra	.93E+08	3.0-005	2.7-005	1.3-008	1.3-008	1.3-008
232Th	.93E+08	3.7-008	6.3-007	1.6-008	1.6-008	3.9-008
224Ra	.93E+08	5.7-008	2.9-007	4.2-011	4.2-011	4.2-011
228Th	.93E+08	1.0-008	2.0-007	3.6-009	3.6-009	3.6-009
210Bi	.57E+07	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
93mNp	.38E+08	2.4-013	2.8-012	1.1-014	1.1-014	1.1-014
93Zr	.38E+08	6.6-016	2.5-014	.0	.0	.0

TABLE B.1.21 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT021

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.67E+06	3.2+000	4.2+000	4.7-003	4.7-003	4.7-003
210Pb	.67E+06	1.8-002	4.6-001	2.6-006	2.6-006	2.6-006
210Po	.67E+06	7.2-002	3.0-001	3.1-010	3.1-010	3.1-010
99Tc	.10E+05	4.4-004	1.0-003	1.4-004	3.3-009	6.0-002
129I	.10E+05	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
234U	.59E+06	1.1-003	1.8-002	5.3-006	5.3-006	1.5-003
238U	.59E+06	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.70E+06	7.7-005	2.6-003	1.8-007	1.8-007	1.8-007
93mNb	.46E+07	1.8-006	2.1-005	8.3-008	8.3-008	8.3-008
210Bi	.67E+06	1.0-006	1.8-006	1.6-009	1.6-009	1.6-009
242Pu	.58E+07	2.5-008	5.2-007	7.1-011	7.1-011	1.4-007
93Zr	.46E+07	5.0-009	1.8-007	.0	.0	.0
228Ra	.12E+08	1.9-009	1.7-009	8.3-013	8.3-013	8.3-013
232Th	.12E+08	2.3-012	4.0-011	1.0-012	1.0-012	2.5-012
224Ra	.12E+08	3.6-012	1.8-011	2.6-015	2.6-015	2.6-015
228Th	.12E+08	6.4-013	1.2-011	2.2-013	2.2-013	2.2-013
79Se	.12E+07	1.2-008	1.0-016	1.0-016	1.0-016	1.0-016

TABLE B.1.22 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT022

Parametric Data

Release duration = 1.0E+05yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.17E+07	2.1+000	2.7+000	3.0-003	3.0-003	3.0-003
210Pb	.17E+07	1.2-002	3.0-001	1.6-006	1.6-006	1.6-006
210Po	.17E+07	4.6-002	1.9-001	2.0-010	2.0-010	2.0-010
129I	.10E+07	5.2-005	3.0-005	1.8-005	2.6-002	2.0-005
234U	.16E+07	6.5-004	1.0-002	3.0-006	3.0-006	8.6-004
238U	.16E+07	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
99Tc	.10E+07	1.6-005	3.8-005	5.2-006	1.2-010	2.2-003
230Th	.17E+07	4.9-005	1.6-003	1.1-007	1.1-007	1.1-007
228Ra	.13E+08	1.2-004	1.1-004	5.4-008	5.4-008	5.4-008
93mNb	.56E+07	1.1-006	1.3-005	5.1-008	5.1-008	5.1-008
232Th	.13E+08	1.5-007	2.6-006	6.5-008	6.5-008	1.6-007
224Ra	.13E+08	2.3-007	1.2-006	1.7-010	1.7-010	1.7-010
210Bi	.17E+07	6.4-007	1.1-006	1.0-009	1.0-009	1.0-009
228Th	.13E+08	4.1-008	8.0-007	1.4-008	1.4-008	1.4-008
93Zr	.56E+07	3.1-009	1.1-007	.0	.0	.0
242Pu	.68E+07	4.1-009	8.4-008	1.1-011	1.1-011	2.3-008
79Se	.22E+07	2.9-013	2.4-021	2.4-021	2.4-021	2.4-021

TABLE B.1.23 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT023

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.23E+07	2.5+000	3.3+000	3.7-003	3.7-003	3.7-003
99Tc	.40E+05	4.0-003	9.3-003	1.3-003	3.0-008	5.5-001
210Pb	.23E+07	1.4-002	3.5-001	2.0-006	2.0-006	2.0-006
129I	.40E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
210Po	.23E+07	5.5-002	2.3-001	2.3-010	2.3-010	2.3-010
234U	.23E+07	5.2-003	8.3-002	2.4-005	2.4-005	6.9-003
238U	.23E+07	5.1-003	6.6-002	1.2-003	1.2-003	6.5-003
230Th	.28E+07	3.3-005	1.1-003	7.8-008	7.8-008	7.8-008
210Pb	.23E+07	4.0-007	7.0-007	6.5-010	6.5-010	6.5-010
93mNb	.18E+08	3.9-009	4.6-008	1.8-010	1.8-010	1.8-010
228Ra	.46E+08	1.0-009	9.4-010	4.6-013	4.6-013	4.6-013
93Zr	.18E+08	1.1-011	4.0-010	.0	.0	.0
232Th	.46E+08	1.3-012	2.2-011	5.5-013	5.5-013	1.3-012
224Ra	.46E+08	2.0-012	9.9-012	1.4-015	1.4-015	1.4-015
228Th	.46E+08	3.5-013	6.8-013	1.2-013	1.2-013	1.2-013
242Pu	.23E+08	1.0-012	2.9-024	2.9-024	2.9-024	5.7-021
79Se	.46E+07	4.5-024	3.8-032	3.8-032	3.8-032	3.8-032

TABLE B.1.24 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT024

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.33E+07	2.6+000	3.4+000	3.6-003	3.6-003	3.6-003
210Pb	.33E+07	1.4-002	3.6-001	2.0-006	2.0-006	2.0-006
129I	.10E+07	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
210Po	.33E+07	5.5-002	2.4-001	2.4-010	2.4-010	2.4-010
234U	.33E+07	5.2-003	8.3-002	2.4-005	2.4-005	6.9-003
238U	.33E+07	5.1-003	6.6-002	1.2-003	1.2-003	6.5-003
99Tc	.10E+07	1.5-004	3.4-004	4.7-005	1.1-009	2.0-002
230Th	.38E+07	3.3-005	1.1-003	7.8-008	7.8-008	7.8-008
228Ra	.47E+08	6.4-005	5.8-005	2.8-008	2.8-008	2.8-008
232Th	.47E+08	7.9-008	1.4-006	3.4-008	3.4-008	8.3-008
210Bi	.33E+07	3.9-007	6.9-010	6.4-010	6.4-010	6.4-010
224Ra	.47E+08	1.2-007	6.1-007	9.0-011	9.0-011	9.0-011
228Th	.47E+08	2.2-008	4.2-007	7.6-009	7.6-009	7.6-009
93mNb	.19E+08	2.5-009	2.9-008	1.2-010	1.2-010	1.2-010
93Zr	.19E+08	6.9-012	2.6-010	.0	.0	.0
242Pu	.24E+08	1.7-022	3.5-021	4.7-025	4.7-025	9.3-022
79Se	.56E+07	1.1-028	8.9-037	8.9-037	8.9-037	8.9-037

TABLE B.1.25 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT025

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.13E+06	8.9+000	1.2+001	1.3-002	1.3-002	1.3-002
210Pb	.13E+06	5.0-002	1.3+000	7.1-006	7.1-006	7.1-006
210Po	.13E+06	2.0-001	8.3-001	8.6-010	8.6-010	8.6-010
229Th	.74E+05	1.3-002	2.4-001	1.1-003	1.1-003	1.1-003
225Ra	.74E+05	3.0-002	1.5-001	.0	.0	.0
99Tc	.11E+05	4.4-004	1.0-003	1.4-004	3.3-009	6.0-002
234U	.45E+05	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
129I	.11E+05	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
233U	.74E+05	1.1-003	1.8-002	4.0-006	4.0-006	4.0-006
236U	.74E+05	7.9-004	1.3-002	1.1-007	1.1-007	1.1-007
242U	.33E+06	4.2-004	8.7-003	1.2-006	1.2-006	2.3-003
238U	.74E+05	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.13E+06	2.0-004	6.8-003	4.8-007	4.8-007	4.8-007
225Ac	.74E+05	8.4-004	1.1-003	8.2-004	8.2-004	8.2-004
227Ac	.74E+05	6.7-005	9.7-004	5.7-006	5.7-006	5.7-006
235U	.74E+05	7.2-005	6.2-004	3.7-005	3.7-005	1.0-004
231Pa	.74E+05	3.2-005	5.0-004	1.2-005	1.2-005	1.2-005
93mNb	.27E+06	1.3-005	1.5-004	6.1-007	6.1-007	6.1-007
237Np	.27E+06	5.2-006	7.9-005	1.8-006	1.8-006	1.8-006
210Bi	.13E+06	2.8-006	4.9-006	4.5-009	4.5-009	4.5-009

TABLE B.1.26 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT026

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.27E+06	1.1+000	1.5+000	1.6-003	1.6-003	1.6-003
229Th	.74E+05	1.3-002	2.4-001	1.1-003	1.1-003	1.1-003
210Pb	.27E+06	6.3-003	1.6-001	8.9-007	8.9-007	8.9-007
225Ra	.74E+05	3.0-002	1.5-001	.0	.0	.0
210Po	.27E+06	2.5-002	1.0-001	1.1-010	1.1-010	1.1-010
233U	.74E+05	1.1-003	1.8-002	4.0-006	4.0-006	4.0-006
236U	.74E+05	7.9-004	1.3-002	1.1-007	1.1-007	1.7-007
99Tc	.10E+05	4.4-005	1.0-004	1.4-005	3.3-010	6.0-003
234U	.45E+05	3.1-004	5.0-003	1.5-006	1.5-006	4.1-004
129I	.11E+05	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
225Ac	.74E+05	8.4-004	1.1-003	8.2-004	8.2-004	8.2-004
227Ac	.74E+05	6.7-005	9.7-004	5.7-006	5.7-006	5.7-006
242Pu	.33E+06	4.2-005	8.7-004	1.2-007	1.2-007	2.3-004
230Th	.27E+06	2.5-005	8.5-004	6.0-008	6.0-008	6.0-008
238U	.74E+05	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
235U	.74E+05	7.2-005	6.2-004	3.7-005	3.7-005	1.0-004
231Pa	.74E+05	3.2-005	5.0-004	1.2-005	1.2-005	1.2-005
237Np	.27E+06	5.2-006	7.9-005	1.8-006	1.8-006	1.8-006
93mNb	.27E+06	1.3-006	1.5-005	6.1-008	6.1-008	6.1-008
210Bi	.27E+06	3.5-007	6.1-007	5.7-010	5.7-010	5.7-010

TABLE B.1.27 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT027

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.68E+06	3.2+000	4.2+000	4.7-003	4.7-003	4.7-003
210Pb	.68E+06	1.8-002	4.6-001	2.6-006	2.6-006	2.6-006
210Po	.68E+06	7.2-002	3.0-001	3.1-010	3.1-010	3.1-010
99Tc	.20E+05	4.2-004	9.9-004	1.4-004	3.2-009	5.9-002
129I	.20E+05	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
234U	.60E+06	1.1-003	1.8-002	5.3-006	5.3-006	1.5-003
238U	.60E+06	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.71E+06	7.7-005	2.6-003	1.8-007	1.8-007	1.8-007
93mNb	.46E+07	1.8-006	2.1-005	8.3-008	8.3-008	8.3-008
210Bi	.68E+06	1.0-006	1.8-006	1.6-009	1.6-009	1.6-009
228Ra	.12E+08	9.4-007	8.6-007	4.1-010	4.1-010	1.4-010
242Pu	.58E+07	2.5-008	5.1-007	6.9-011	6.9-011	1.4-007
93Zr	.46E+07	5.0-009	1.8-007	.0	.0	.0
227Ac	.60E+06	1.4-009	2.0-008	1.2-010	1.2-010	1.2-010
232Th	.12E+08	1.2-009	2.0-008	5.0-010	5.0-010	1.2-009
231Pa	.60E+06	6.8-010	1.0-008	2.4-010	2.4-010	2.4-010
224Ra	.12E+08	1.8-009	9.0-009	1.3-012	1.3-012	1.3-012
228Th	.12E+08	3.2-010	6.2-009	1.1-010	1.1-010	1.1-010
235U	.60E+06	3.4-012	2.9-011	1.7-012	1.7-012	4.7-012
239Pu	.60E+06	4.4-013	9.4-012	8.5-016	8.5-016	2.4-012

TABLE B.1.28 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT028

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04 yr; dispersion coefficient = 4.2E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.90E+05	9.7-002	2.3-001	3.1-002	7.2-007	1.3+001
129I	.90E+05	1.5-002	8.7-003	5.2-003	7.7+000	5.8-003
226Ra	.47E+07	2.4+000	3.1+000	3.4-003	3.4-003	3.4-003
210Pb	.47E+07	1.3-002	3.4-001	1.9-006	1.9-006	1.9-006
210Po	.47E+07	5.2-002	2.2-001	2.3-010	2.3-010	2.3-010
229Th	.90E+05	9.5-003	1.8-001	8.4-004	8.4-004	8.4-004
225Ra	.90E+05	2.2-002	1.1-001	.0	.0	.0
234U	.47E+07	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
238U	.47E+07	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
233U	.90E+05	9.0-004	1.5-002	3.2-006	3.2-006	3.2-006
236U	.90E+05	2.5-004	4.0-003	3.5-008	3.5-008	3.5-008
225Ac	.90E+05	6.2-004	8.1-004	6.1-004	6.1-004	6.1-004
227Ac	.90E+05	5.4-005	7.9-004	4.6-006	4.6-006	4.6-006
230Th	.56E+07	2.0-005	6.6-004	4.7-008	4.7-008	4.7-008
231Pa	.90E+05	2.6-005	4.1-004	9.5-006	9.5-006	9.5-006
235U	.90E+05	4.2-005	3.6-004	2.2-005	2.2-005	5.9-005
228Ra	.92E+08	2.4-007	2.2-007	1.1-010	1.1-010	1.1-010
210Bi	.47E+07	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
232Th	.92E+08	3.0-010	5.2-009	1.3-010	1.3-010	3.2-010
224Ra	.92E+08	4.7-010	2.3-009	3.4-013	3.4-013	3.4-013
228Th	.92E+08	8.3-011	1.6-009	2.9-011	2.9-011	2.9-011

TABLE B.1.29 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT029

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.32E+06	5.7+000	7.5+000	8.3-003	8.3-003	8.3-003
210Pb	.32E+06	3.2-002	8.3-001	4.6-006	4.6-006	4.6-006
210Po	.32E+06	1.3-001	5.3-001	5.5-010	5.5-010	5.5-010
229Th	.24E+06	1.3-002	2.5-001	1.2-003	1.2-003	1.2-003
225Ra	.24E+06	3.1-002	1.5-001	.0	.0	.0
99Tc	.40E+04	4.5-004	1.0-003	1.4-004	3.3-009	6.2-002
234U	.24E+06	2.0-003	3.2-002	9.5-006	9.5-006	2.7-003
129I	.40E+04	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
223U	.24E+06	1.2-003	1.9-002	4.3-006	4.3-006	4.3-006
238U	.28E+06	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.32E+06	1.3-004	4.4-003	3.1-007	3.1-007	3.1-007
225Ac	.24E+06	8.7-004	1.1-003	8.5-004	8.5-004	8.5-004
242Pu	.23E+07	1.2-005	2.5-004	3.5-008	3.5-008	6.8-005
93mNb	.19E+07	6.3-006	7.4-005	2.9-007	2.9-007	2.9-007
237Np	.28E+06	3.7-006	5.6-005	1.3-006	1.3-006	1.3-006
227Ac	.24E+06	3.1-006	4.6-005	2.7-007	2.7-007	2.7-007
231Pa	.24E+06	1.5-006	2.4-005	5.5-007	5.5-007	5.5-007
235U	.24E+06	4.7-007	4.0-006	2.4-007	2.4-007	6.5-007
210Bi	.32E+06	1.8-006	3.1-006	2.9-009	2.9-009	2.9-009
93Zr	.19E+07	1.7-008	6.5-007	.0	.0	.0

TABLE B.1.30 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT030

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.13E+07	2.6+000	3.5+000	3.9-003	3.9-003	3.9-003
210Pb	.13E+07	1.5-002	3.8-001	2.1-006	2.1-006	2.1-006
210Po	.13E+07	5.9-002	2.4-001	2.6-010	2.6-010	2.6-010
129I	.10E+07	5.2-005	3.0-005	1.8-005	2.6-002	2.0-005
234U	.13E+07	7.0-004	1.1-002	3.3-006	3.3-006	9.3-004
238U	.13E+07	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
99Tc	.10E+07	1.6-005	3.9-005	5.3-006	1.2-010	2.3-003
230Th	.13E+07	6.1-005	2.0-003	1.4-007	1.4-007	1.4-007
228Ra	.56E+07	1.2-004	1.1-004	5.4-008	5.4-008	5.4-008
93mNb	.29E+07	3.9-006	4.6-005	1.8-007	1.8-007	1.8-007
242Pu	.33E+07	1.9-006	4.0-005	5.5-009	5.5-009	1.1-005
232Th	.56E+07	1.5-007	2.6-006	6.5-008	6.5-008	1.6-007
210Bi	.13E+07	8.2-007	1.4-006	1.3-009	1.3-009	1.3-009
224Ra	.56E+07	2.3-007	1.2-006	1.7-010	1.7-010	1.7-010
228Th	.56E+07	4.1-008	8.0-007	1.4-008	1.4-008	1.4-008
93Zr	.29E+07	1.1-008	4.0-007	.0	.0	.0
79Se	.15E+07	4.8-010	4.1-018	4.1-018	4.1-018	4.1-018

TABLE B.1.31 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT031

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.47E+06	7.5-001	9.9-001	1.1-003	1.1-003	1.1-003
229Th	.24E+06	1.3-002	2.5-001	1.2-003	1.2-003	1.2-003
225Ra	.24E+06	3.1-002	1.5-001	.0	.0	.0
210Pb	.47E+06	4.2-003	1.1-001	6.0-007	6.0-007	6.0-007
210Po	.47E+06	1.7-002	6.9-002	7.2-011	7.2-011	7.2-011
99Tc	.40E+04	4.5-005	1.0-004	1.4-005	3.3-010	6.2-003
233U	.24E+06	1.2-003	1.9-002	4.3-006	4.3-006	4.3-006
234U	.24E+06	2.0-004	3.2-003	9.5-007	9.5-007	2.7-004
129I	.40E+04	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
225Ac	.24E+06	8.7-004	1.1-003	8.5-004	8.5-004	8.5-004
238U	.47E+06	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.47E+06	1.7-005	5.7-004	4.0-008	4.0-008	4.0-008
237Np	.28E+06	3.7-006	5.6-005	1.3-006	1.3-006	1.3-006
227Ac	.24E+06	3.1-006	4.6-005	2.7-007	2.7-007	2.7-007
242Pu	.23E+07	1.2-006	2.5-005	3.5-009	3.5-009	6.8-006
231Pa	.24E+06	1.5-006	2.4-005	5.5-007	5.5-007	5.5-007
93mNb	.19E+07	6.3-007	7.4-006	2.9-008	2.9-008	2.9-008
235U	.24E+06	4.7-007	4.0-006	2.4-007	2.4-007	6.5-007
210Bi	.47E+06	2.3-007	4.1-007	3.8-010	3.8-010	3.8-010
93Zr	.19E+07	1.8-009	6.5-008	.0	.0	.0

TABLE B.1.32 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT032

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.15E+07	3.8-001	5.0-001	5.6-004	5.6-004	5.6-004
210Pb	.15E+07	2.1-003	5.5-002	3.1-007	3.1-007	3.1-007
210Po	.15E+07	8.5-003	3.5-002	3.7-011	3.7-011	3.7-011
129I	.10E+07	5.2-006	3.0-006	1.8-006	2.7-003	2.0-006
234U	.13E+07	7.0-005	1.1-003	3.3-007	3.3-007	9.3-005
238U	.15E+07	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.15E+07	8.3-006	2.8-004	1.9-008	1.9-008	1.9-008
99Tc	.10E+07	1.6-006	3.9-006	5.3-007	1.2-011	2.3-004
228Ra	.56E+07	1.2-005	1.1-005	5.4-009	5.4-009	5.4-009
93mNb	.29E+07	3.9-007	4.6-006	1.8-008	1.8-008	1.8-008
242Pu	.33E+07	1.9-007	4.0-006	5.5-010	5.5-010	1.1-006
232Th	.56E+07	1.5-008	2.6-007	6.5-009	6.5-009	1.6-008
210Bi	.15E+07	1.2-007	2.1-007	1.9-010	1.9-010	1.9-010
224Ra	.56E+07	2.3-008	1.2-007	1.7-011	1.7-011	1.7-011
228Th	.56E+07	4.1-009	8.0-008	1.4-009	1.4-009	1.4-009
93Zr	.29E+07	1.1-009	4.0-008	.0	.0	.0
79Se	.15E+07	4.8-011	4.1-019	4.1-019	4.1-019	4.1-019

TABLE B.1.33 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT033

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.33E+06	5.7+000	7.5+000	8.3-003	8.3-003	8.3-003
210Pb	.33E+06	3.2-002	8.3-001	4.6-006	4.6-006	4.6-006
210Po	.33E+06	1.3-001	5.3-001	5.5-010	5.5-010	5.5-010
237Np	.25E+06	3.0-002	4.6-001	1.0-002	1.0-002	1.0-002
229Th	.25E+06	4.1-003	7.7-002	3.7-004	3.7-004	3.7-004
99Tc	.14E+05	4.3-004	1.0-003	1.4-004	3.2-009	6.0-002
225Ra	.25E+06	9.6-003	4.8-002	.0	.0	.0
234U	.25E+06	2.0-003	3.2-002	9.3-006	9.3-006	2.7-003
129I	.14E+05	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
238U	.29E+06	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
233U	.25E+06	3.7-004	6.0-003	1.3-006	1.3-006	1.3-006
230Th	.33E+06	1.3-004	4.4-003	3.1-007	3.1-007	3.1-007
225Ac	.25E+06	2.7-004	3.5-004	2.6-004	2.6-004	2.6-004
242Pu	.23E+07	1.2-005	2.5-004	3.5-008	3.5-008	6.8-005
93mNb	.19E+07	6.3-006	7.4-005	2.9-007	2.9-007	2.9-007
227Ac	.25E+06	2.5-006	3.7-005	2.1-007	2.1-007	2.1-007
231Pa	.25E+06	1.2-006	1.9-005	4.4-007	4.4-007	4.4-007
210Bi	.33E+06	1.8-006	3.1-006	2.9-009	2.9-009	2.9-009
235U	.25E+06	3.2-007	2.8-006	1.6-007	1.6-007	4.5-007
228Ra	.46E+07	9.4-007	8.6-007	4.1-010	4.1-010	4.1-010

TABLE B.1.34 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT034

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 4.03+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.48E+06	7.3-001	9.7-001	1.1-003	1.1-003	1.1-003
237Np	.25E+06	3.0-002	4.6-001	1.0-002	1.0-002	1.0-002
210Pb	.48E+06	4.1-003	1.1-001	5.9-007	5.9-007	5.9-007
229Th	.25E+06	4.1-003	7.7-002	3.7-004	3.7-004	3.7-004
210Po	.48E+06	1.6-002	6.8-002	7.1-011	7.1-011	7.1-011
225Ra	.25E+06	9.6-003	4.8-002	.0	.0	.0
99Tc	.40E+05	4.3-005	1.0-004	1.4-005	3.2-010	6.0-003
233U	.25E+06	3.7-004	6.0-003	1.3-006	1.3-006	1.3-006
234U	.25E+06	2.0-004	3.2-003	9.3-007	9.3-007	2.6-004
129I	.14E+05	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
238U	.48E+06	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.48E+06	1.7-005	5.5-004	3.9-008	3.9-008	3.9-008
225Ac	.25E+06	2.7-004	3.5-004	2.6-004	2.6-004	2.6-004
227Ac	.25E+06	2.5-006	3.7-005	2.1-007	2.1-007	2.1-007
242Pu	.23E+07	1.2-006	2.5-005	3.5-009	3.5-009	6.8-006
231Pa	.25E+06	1.2-006	1.9-005	4.4-007	4.4-007	4.4-007
93mNb	.19E+07	6.3-007	7.4-006	2.9-008	2.9-008	2.9-008
235U	.25E+06	3.2-007	2.8-006	1.6-007	1.6-008	4.5-007
210Bi	.48E+06	2.3-007	4.0-007	3.7-010	3.7-010	3.7-010
228Ra	.46E+07	9.4-008	8.6-008	4.2-011	4.2-011	4.2-011

TABLE B.1.35 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT035

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.40E+05	4.0-002	9.3-002	1.3-002	3.0-007	5.5+000
226Ra	.23E+07	2.6+000	3.3+000	3.7-003	3.7-003	3.7-003
129I	.40E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.23E+07	1.4-002	3.5-001	2.0-006	2.0-006	2.0-006
210Po	.23E+07	5.5-002	2.3-001	2.4-010	2.4-010	2.4-010
234U	.23E+07	6.8-003	1.1-001	3.2-005	3.2-005	9.0-003
238U	.23E+07	6.4-003	8.3-002	1.4-003	1.4-003	8.1-003
230Th	.28E+07	3.4-005	1.1-003	7.9-008	7.9-008	7.9-008
210Bi	.23E+07	5.5-007	9.6-007	8.9-010	8.9-010	8.9-010
93mNb	.18E+08	3.9-009	4.6-008	1.8-010	1.8-010	1.8-010
228Ra	.46E+08	1.9-009	9.4-010	4.6-013	4.6-013	4.6-013
93Zr	.18E+08	1.1-011	4.0-010	.0	.0	.0
232Th	.46E+08	1.3-012	2.2-011	5.5-013	5.5-013	1.3-012
224Ra	.46E+08	2.0-012	9.9-012	1.4-015	1.4-015	1.4-015
228Th	.46E+08	3.5-013	6.8-012	1.2-013	1.2-013	1.2-013
242Pu	.23E+08	1.1-021	2.3-020	3.1-024	3.1-024	6.1-021
79Se	.46E+07	5.1-024	4.3-032	4.3-032	4.3-032	4.3-032

TABLE B.1.36 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT036

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.33E+07	2.6+000	3.3+000	3.7-003	3.7-003	3.7-003
129I	.10E+07	5.2-003	3.0-003	1.8-003	2.7+000	2.0-003
210Pb	.33E+07	1.4-002	3.5-001	2.0-006	2.0-006	2.0-006
210Po	.33E+07	5.5-002	2.3-001	2.4-010	2.4-010	2.4-010
99Tc	.10E+07	1.5-003	3.4-003	4.7-004	1.1-008	2.0-001
234U	.33E+07	6.5-003	1.0-001	3.0-005	3.0-005	8.6-003
238U	.33E+07	6.4-003	8.3-002	1.4-003	1.4-003	8.1-003
230Th	.38E+07	3.4-005	1.1-003	7.9-008	7.9-008	7.9-008
228Ra	.47E+08	6.4-005	5.8-005	2.8-008	2.8-008	2.8-008
232Th	.47E+08	7.9-008	1.4-006	3.4-008	3.4-008	8.3-008
210Bi	.33E+07	5.5-007	9.6-007	8.9-010	8.9-010	8.9-010
224Ra	.47E+08	1.2-007	6.1-007	9.0-011	9.0-011	9.0-011
228Th	.47E+08	2.2-008	4.2-007	7.6-009	7.6-009	7.6-009
93mNb	.19+08	2.5-009	2.9-008	1.2-010	1.2-010	1.2-010
93Zr	.19E+08	6.9-012	2.6-010	.0	.0	.0
242Pu	.24E+08	1.8-022	3.6-021	4.9-025	4.9-025	9.7-022
79Se	.56E+07	1.2-028	1.0-036	1.0-036	1.0-036	1.0-036

TABLE B.1.37 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT037

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+06	8.9+000	1.2+001	1.3-002	1.3-002	1.3-002
210Pb	.12E+06	5.0-002	1.3+000	7.1-006	7.1-006	7.1-006
210Po	.12E+06	2.0-001	8.3-001	8.6-010	8.6-010	8.6-010
229Th	.18E+06	9.9-003	1.9-001	8.8-004	8.8-004	8.8-004
225Ra	.18E+06	2.3-002	1.2-001	.0	.0	.0
99Tc	.16E+04	4.5-004	1.1-003	1.4-004	3.4-009	6.2-002
234U	.36E+05	3.1-003	5.0-002	1.5-005	1.5-005	4.1-003
129I	.16E+04	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
236U	.65E+05	1.6-003	2.5-002	2.2-007	2.2-007	2.2-007
233U	.18E+06	9.5-004	1.5-002	3.4-006	3.4-006	3.4-006
242Pu	.32E+06	4.3-004	8.8-003	1.2-006	1.2-006	2.4-003
233U	.65E+05	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.12E+06	2.0-004	6.8-003	4.8-007	4.8-007	4.8-007
225Ac	.18E+06	6.5-004	8.4-004	6.3-004	6.3-004	6.3-004
235U	.65E+05	7.7-005	6.5-004	3.9-005	3.9-005	1.1-004
227Ac	.12E+06	3.3-005	4.9-004	2.8-006	2.8-006	2.8-006
231Pa	.12E+06	1.6-005	2.5-004	5.8-006	5.8-006	5.8-006
98mNb	.26E+06	1.3-005	1.5-004	6.1-007	6.1-007	6.1-007
237Np	.26E+06	6.7-006	1.0-004	2.3-006	2.3-006	2.3-006
210Bi	.12E+06	2.8-006	4.9-006	4.5-009	4.5-009	4.5-009

TABLE B.1.38 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT038

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.6E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+06	7.6+000	1.0+001	1.1-002	1.1-002	1.1-002
210Pb	.22E+06	4.3-002	1.1+000	6.1-006	6.1-006	6.1-006
210Po	.22E+06	1.7-001	7.0-001	7.4-010	7.4-010	7.4-010
229Th	.22E+06	1.1-002	2.0-001	9.5-004	9.5-004	9.5-004
225Ra	.22E+06	2.5-002	1.3-001	.0	.0	.0
99Tc	.10E+06	3.2-004	7.6-004	1.0-004	2.4-009	4.5-002
234U	.13E+06	2.5-003	4.1-002	1.2-005	1.2-005	3.4-003
129I	.10E+06	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
233U	.22E+06	1.0-003	1.7-002	3.7-006	3.7-006	3.7-006
238U	.16E+06	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
242Pu	.42E+06	3.6-004	7.3-003	1.0-006	1.0-006	2.0-003
230Th	.22E+06	1.7-004	5.7-003	4.0-007	4.0-007	4.0-007
225Ac	.22E+06	7.1-004	9.1-004	6.9-004	6.9-004	6.9-004
227Ac	.10E+06	4.6-005	6.7-004	3.9-006	3.9-006	3.9-006
236U	.10E+06	3.7-005	5.9-004	5.2-009	5.2-009	5.2-009
231Pa	.10E+06	2.2-005	3.5-004	8.1-006	8.1-006	8.1-006
235U	.10E+06	3.1-005	2.6-004	1.6-005	1.6-005	4.3-005
93mNb	.36E+06	1.3-005	1.5-004	6.1-007	6.1-007	6.1-007
237Np	.28E+06	4.5-006	6.8-005	1.6-006	1.6-006	1.6-006
228Ra	.74E+06	1.7-005	1.6-005	7.5-009	7.5-009	7.5-009

TABLE B.1.39 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT039

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
⁹⁹ Tc	.20E+05	4.2-002	9.9-002	1.4-002	3.2-007	5.9+000
²²⁶ Ra	.12E+07	3.2+000	4.2+000	4.6-003	4.6-003	4.6-003
¹²⁹ I	.20E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
²¹⁰ Pb	.12E+07	1.7-002	4.6-001	2.6-006	2.6-006	2.6-006
²³⁴ U	.12E+07	2.2-002	3.5-001	1.0-004	1.0-004	2.9-002
²¹⁰ Po	.12E+07	7.1-002	2.9-001	3.1-010	3.1-010	3.1-010
²³⁸ U	.12E+07	1.6-002	2.1-001	3.6-003	3.6-003	2.0-002
²³⁰ Th	.14E+07	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
^{93m} Nb	.92E+07	7.0-007	8.2-006	3.3-008	3.3-008	3.3-008
²¹⁰ Bi	.12E+07	6.9-007	1.2-006	1.1-009	1.1-009	1.1-009
⁹³ Zr	.92E+07	1.9-009	7.2-008	.0	.0	.0
²²⁸ Ra	.23E+08	2.5-009	2.3-009	1.1-012	1.1-012	1.1-012
²³² Th	.23E+08	3.2-012	5.4-011	1.4-012	1.4-012	3.3-012
²⁴² Pu	.11E+08	2.4-012	4.9-011	6.8-015	6.8-015	1.3-011
²²⁴ Ra	.23E+08	4.8-012	2.4-011	3.6-015	3.6-015	3.6-015
²²⁸ Th	.23E+08	8.6-013	1.7-011	3.0-013	3.0-013	3.0-013

TABLE B.1.40 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT040

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.6E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.36E+06	9.7-001	1.3+000	1.4-003	1.4-003	1.4-003
229Th	.16E+06	1.0-002	1.9-001	9.1-004	9.1-004	9.1-004
210Pb	.36E+06	5.4-003	1.4-001	7.7-007	7.7-007	7.7-007
225Ra	.16E+06	2.4-002	1.2-001	.0	.0	.0
210Po	.36E+06	2.2-002	8.9-002	9.4-011	9.4-011	9.4-011
233U	.16E+06	9.8-004	1.6-002	3.5-006	3.5-006	3.5-006
99Tc	.10E+06	3.2-005	7.6-005	1.0-005	2.4-010	4.5-003
234U	.13E+06	2.5-004	4.0-003	1.2-006	1.2-006	3.4-004
129I	.10E+06	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
225Ac	.16E+06	6.8-004	8.8-004	6.6-004	6.6-004	6.6-004
238U	.16E+06	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.36E+06	2.2-005	7.4-004	5.2-008	5.2-008	5.2-008
242Pu	.42E+06	3.6-005	7.3-004	1.0-007	1.0-007	2.0-004
227Ac	.10E+06	4.6-005	6.7-004	3.9-006	3.9-006	3.9-006
236U	.10E+06	3.7-005	5.9-004	5.2-009	5.2-009	5.2-009
231Pa	.10E+06	2.2-005	3.5-004	8.1-006	8.1-006	8.1-006
235U	.10E+06	3.1-005	2.6-004	1.6-005	1.6-005	4.3-005
237Np	.28E+06	4.5-006	6.8-005	1.6-006	1.6-006	1.6-006
93mNb	.36E+06	1.3-006	1.5-005	6.1-008	6.1-008	6.1-008
228Ra	.80E+06	1.8-006	1.6-006	7.9-010	7.9-010	7.9-010

TABLE B.1.41 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT041

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+07	2.7+000	3.4+000	3.8-003	3.8-003	3.8-003
99Tc	.20E+05	4.2-003	9.9-003	1.4-003	3.2-008	5.9-001
210Pb	.12E+07	1.5-002	3.8-001	2.2-006	2.2-006	2.2-006
129I	.20E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
210Po	.12E+07	6.0-002	2.3-001	2.5-010	2.5-010	2.5-010
234U	.12E+07	7.3-003	1.2-001	3.4-005	3.4-005	9.7-003
238U	.12E+07	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
230Th	.14E+07	5.0-005	1.7-003	1.2-007	1.2-007	1.2-007
93mNb	.92E+07	6.7-007	8.0-006	3.1-008	3.1-008	3.1-008
210Bi	.12E+07	4.6-007	8.0-007	7.5-010	7.5-010	7.5-010
93Zr	.92E+07	1.9-009	7.0-008	.0	.0	.0
228Ra	.23E+08	2.5-009	2.3-009	1.1-012	1.1-012	1.1-012
232Th	.23E+08	3.2-012	5.4-011	1.4-012	1.4-012	3.3-012
242Pu	.11E+08	2.3-012	4.8-011	6.6-015	6.6-015	1.3-011
224Ra	.23E+08	4.8-012	2.4-011	3.6-015	3.6-015	3.6-015
228Th	.23E+08	8.6-013	1.7-011	3.0-013	3.0-013	3.0-013

TABLE B.1.42 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT042

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.14E+07	2.9-001	3.9-001	4.3-004	4.3-004	4.3-004
210Pb	.14E+07	1.7-003	4.2-002	2.3-007	2.3-007	2.3-007
210Po	.14E+07	6.5-003	2.7-002	2.8-011	2.8-011	2.8-011
99Tc	.20E+05	4.2-005	9.9-005	1.4-005	3.2-010	5.9-003
129I	.20E+05	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
234U	.12E+07	7.3-005	1.2-003	3.4-007	3.4-007	9.6-005
238U	.14E+07	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.14E+07	6.6-006	2.2-004	1.5-008	1.5-008	1.5-008
93mNb	.92E+07	2.0-008	2.4-007	9.4-010	9.4-010	9.4-010
210Bi	.14E+07	9.2-008	1.6-007	1.5-010	1.5-010	1.5-010
93Zr	.92E+07	5.6-011	2.1-009	.0	.0	.0
228Ra	.23E+08	1.9-010	1.7-010	8.3-014	8.3-014	8.3-014
232Th	.23E+08	2.3-013	4.0-012	1.0-013	1.0-013	2.5-013
224Ra	.23E+08	3.6-013	1.8-012	2.6-016	2.6-016	2.6-016
242Pu	.12E+08	8.4-014	1.7-012	2.4-016	2.4-016	4.7-013
228Th	.23E+08	6.4-014	1.2-012	2.2-014	2.2-014	2.2-014

TABLE B.1.43 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT043

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.23E+07	2.5+000	3.3+000	3.7-003	3.7-003	3.7-003
99Tc	.40E+05	4.0-003	9.3-003	1.3-003	3.0-008	5.5-001
210Pb	.23E+07	1.4-002	3.5-001	2.0-006	2.0-006	2.0-006
129I	.40E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
210Po	.23E+07	5.5-002	2.3-001	2.3-010	2.3-010	2.3-010
234U	.23E+07	5.2-003	8.3-002	2.4-005	2.4-005	6.9-003
238U	.23E+07	5.1-003	6.6-002	1.2-003	1.2-003	6.5-003
230Th	.28E+07	3.3-005	1.1-003	7.8-008	7.8-008	7.8-008
210Pb	.23E+07	4.0-007	7.0-007	6.5-010	6.5-010	6.5-010
93mNb	.18E+08	3.9-009	4.6-008	1.8-010	1.8-010	1.8-010
228Ra	.46E+08	1.0-009	9.4-010	4.6-013	4.6-013	4.6-013
93Zr	.18E+08	1.1-011	4.0-010	.0	.0	.0
232Th	.46E+08	1.3-012	2.2-011	5.5-013	5.5-013	1.3-012
224Ra	.46E+08	2.0-012	9.9-012	1.4-015	1.4-015	1.4-015
228Th	.46E+08	3.5-013	6.8-013	1.2-013	1.2-013	1.2-013
242Pu	.23E+08	1.0-012	2.9-024	2.9-024	2.9-024	5.7-021
79Se	.46E+07	4.5-024	3.8-032	3.8-032	3.8-032	3.8-032

TABLE B.1.44 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT044

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+04yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.30E+05	4.1-002	9.6-002	1.3-002	3.1-007	5.7+000
226Ra	.12E+07	3.4+000	4.5+000	4.9-003	4.9-003	4.9-003
129I	.30E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.12E+07	1.9-002	4.9-001	2.8-006	2.8-006	2.8-006
234U	.12E+07	1.9-002	3.0-001	8.7-005	8.7-005	2.5-002
238U	.12E+07	1.6-002	2.1-001	3.6-003	3.6-003	2.0-002
210Po	.12E+07	7.6-002	3.0-001	3.2-010	3.2-010	3.2-010
230Th	.14E+07	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
93mNb	.92E+07	7.0-007	8.2-006	3.3-008	3.3-008	3.3-008
210Bi	.12E+07	6.9-007	1.2-006	1.1-009	1.1-009	1.1-009
228Ra	.23E+08	1.2-006	1.1-006	5.4-010	5.4-010	5.4-010
93Zr	.92E+07	1.9-009	7.2-008	.0	.0	.0
232Th	.23E+08	1.5-009	2.6-008	6.5-010	6.5-010	1.6-009
224Ra	.23E+08	2.3-009	1.2-008	1.7-012	1.7-012	1.7-012
228Th	.23E+08	4.1-010	8.0-009	1.4-010	1.4-010	1.4-010
242Pu	.11E+08	2.3-012	4.8-011	6.6-015	6.6-015	1.3-011

TABLE B.1.45 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT045

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+07	2.8+000	3.7+000	4.2-003	4.2-003	4.2-003
129I	.10E+07	5.2-003	3.0-003	1.8-003	2.7+000	2.0-003
210Pb	.22E+07	1.6-002	4.0-001	2.2-006	2.2-006	2.2-006
210Po	.22E+07	6.3-002	2.7-001	2.7-010	2.7-010	2.7-010
234U	.22E+07	1.6-002	2.6-001	7.6-005	7.6-005	2.2-002
99Tc	.10E+07	1.6-003	3.7-003	5.0-004	1.2-008	2.2-001
238U	.22E+07	1.6-002	2.1-001	3.6-003	3.6-003	2.0-002
230Th	.24E+07	4.5-005	1.5-003	1.1-007	1.1-007	1.1-007
228Ra	.24E+08	1.6-004	1.5-004	7.1-008	7.1-008	7.1-008
93mNb	.10E+08	4.4-007	5.2-006	2.0-008	2.0-008	2.0-008
232Th	.24E+08	2.0-007	3.4-006	8.5-008	8.5-008	2.1-007
224Ra	.24E+08	3.0-007	1.5-006	2.2-010	2.2-010	2.2-010
228Th	.24E+08	5.4-008	1.0-006	1.9-008	1.9-008	1.9-008
210Bi	.22E+07	6.0-007	1.0-006	9.7-010	9.7-010	9.7-010
93Zr	.10E+08	1.2-009	4.5-008	.0	.0	.0
242Pu	.12E+08	3.8-013	7.9-012	1.1-015	1.1-015	2.1-012
79Se	.33E+07	1.7-017	1.4-025	1.4-025	1.4-025	1.4-025

TABLE B.1.46 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT046

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+000 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.40E+05	2.2-001	5.2-001	7.1-002	1.7-006	3.1+001
129I	.40E+05	3.0-002	1.8-002	1.0-002	1.5+001	1.2-002
226Ra	.23E+07	2.6+000	3.4+000	3.7-003	3.7-003	3.7-003
210Pb	.23E+07	1.4-002	3.7-001	2.0-006	2.0-006	2.0-006
210Po	.23E+07	5.7-002	2.3-001	2.5-010	2.5-010	2.5-010
234U	.23E+07	6.5-003	1.0-001	3.0-005	3.0-005	8.6-003
238U	.23E+07	6.4-003	8.3-002	1.4-003	1.4-003	8.1-003
230Th	.28E+07	3.4-005	1.1-003	7.9-008	7.9-008	7.9-008
210Bi	.23E+07	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
93mNb	.18E+08	3.9-009	4.6-008	1.8-010	1.8-010	1.8-010
228Ra	.46E+08	1.0-009	9.4-010	4.6-013	4.6-013	4.6-013
93Zr	.18E+08	1.1-011	4.0-010	.0	.0	.0
232Th	.46E+08	1.3-012	2.2-011	5.5-013	5.5-013	1.3-012
224Ra	.46E+08	2.0-012	9.9-012	1.4-015	1.4-015	1.4-015
228Th	.46E+08	3.5-013	6.8-012	1.2-013	1.2-013	1.2-013
242Pu	.23E+08	1.1-021	2.3-020	3.1-024	3.1-024	6.1-021
79Se	.46E+07	5.1-024	4.3-032	4.3-032	4.3-032	4.3-032

TABLE B.1.47 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT047

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure (yr)	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
129I	.10E+07	2.8-002	1.6-002	9.7-003	1.4+001	1.1-002
226Ra	.33E+07	2.6+000	3.4+000	3.7-003	3.7-003	3.7-003
99Tc	.10E+07	8.3-003	1.9-002	2.6-003	6.2-008	1.1+000
210Pb	.33E+07	1.4-002	3.7-001	2.0-006	2.0-006	2.0-006
210Po	.33E+07	5.7-002	2.3-001	2.5-010	2.5-010	2.5-010
234U	.33E+07	6.5-003	1.0-001	3.0-005	3.0-005	8.6-003
238U	.33E+07	6.4-003	8.3-002	1.4-003	1.4-003	8.1-003
230Th	.38E+07	3.4-005	1.1-003	7.9-008	7.9-008	7.9-008
228Ra	.47E+08	6.4-005	5.8-005	2.8-008	2.8-008	2.8-008
232Th	.47E+08	7.9-008	1.4-006	3.4-008	3.4-008	8.3-008
224Ra	.47E+08	1.2-007	6.1-007	9.0-011	9.0-011	9.0-011
228Th	.47E+08	2.2-008	4.2-007	7.6-009	7.6-009	7.6-009
210Bi	.33E+07	1.0-007	1.8-007	1.7-010	1.7-010	1.7-010
93mNb	.19E+08	2.5-009	2.9-008	1.2-010	1.2-010	1.2-010
93Zr	.19E+08	6.9-012	2.6-010	.0	.0	.0
242Pu	.24E+08	1.8-022	3.6-021	4.9-025	4.9-025	9.7-022
79Se	.56E+07	1.2-028	1.0-036	1.0-036	1.0-036	1.0-036

TABLE B.1.48 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT048

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.8+000	2.3+000	2.6-003	2.6-003	2.6-003
129I	.37E+06	3.0-003	1.7-003	1.1-003	1.5+000	1.1-003
99Tc	.37E+06	7.8-003	1.8-002	2.5-003	5.8-008	1.1+000
210Pb	.22E+08	9.9-003	2.5-001	1.4-006	1.4-006	1.4-006
210Po	.22E+08	3.9-002	1.6-001	1.7-010	1.7-010	1.7-010
234U	.22E+08	6.8-004	1.1-002	3.1-006	3.1-006	9.0-004
238U	.22E+08	6.6-004	8.6-003	1.5-004	1.5-004	8.4-004
230Th	.22E+08	2.6-005	8.7-004	6.1-008	6.1-008	6.1-008
228Ra	.43E+09	1.0-010	9.4-011	4.6-014	4.6-014	4.6-014
232Th	.43E+09	1.3-013	2.2-012	5.5-014	5.5-014	1.3-013
224Ra	.43E+09	2.0-013	9.9-013	1.4-016	1.4-016	1.4-016
228Th	.43E+09	3.5-014	6.8-013	1.2-014	1.2-014	1.2-014

TABLE B.1.49 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT049

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.56E+03	4.5-001	1.1+000	1.4-001	3.3-006	6.2+001
129I	.56E+03	5.4-002	3.1-002	1.9-002	2.7+001	2.1-002
226Ra	.35E+05	1.6+001	2.1+001	2.3-002	2.3-002	2.3-002
210Pb	.35E+05	9.1-002	2.3+000	1.3-005	1.3-005	1.3-005
210Po	.35E+05	3.6-001	1.5+000	1.6-009	1.6-009	1.6-009
234U	.30E+05	8.1-002	1.3+000	3.8-004	3.8-004	1.1-001
238U	.30E+5	2.2-002	2.9-001	5.1-003	5.1-003	2.9-002
242Pu	.29E+06	1.7-003	3.5-002	4.8-006	4.8-006	9.3-003
230Th	.30E+05	3.8-004	1.3-002	8.9-007	8.9-007	8.9-007
93mNb	.23E+06	6.1-005	7.3-004	2.9-006	2.9-006	2.9-006
210Bi	.35E+05	5.0-006	8.8-006	8.2-009	8.2-009	8.2-009
93Zr	.23E+06	1.7-007	6.4-006	.0	.0	.0
228Ra	.58E+06	3.6-009	3.3-009	1.6-012	1.6-012	1.6-012
79Se	.59E+05	2.9-002	2.4-010	2.4-010	2.4-010	2.4-010
232Th	.58E+06	4.4-012	7.5-011	1.9-012	1.9-012	4.7-012
224Ra	.58E+06	6.8-012	3.4-011	5.0-015	5.0-015	5.0-015
228Th	.58E+06	1.2-012	2.3-011	4.3-013	4.3-013	4.3-013

TABLE B.1.50 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT050

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.40E+04	4.5-001	1.0+000	1.4-001	3.3-006	6.2+001
129I	.40E+04	5.4-002	3.1-002	1.9-002	2.7+001	2.1-002
226Ra	.28E+06	1.0+001	1.4+001	1.5-002	1.5-002	1.5-002
234U	.23E+06	5.2-001	8.3+000	2.4-003	2.4-003	6.9-001
210Pb	.28E+06	5.9-002	1.5+000	8.3-006	8.3-006	8.3-006
210Po	.28E+06	2.3-001	9.7-001	1.0-009	1.0-009	1.0-009
238U	.23E+06	6.6-002	8.7-001	1.5-002	1.5-002	8.4-002
230Th	.28E+06	1.9-004	6.4-003	4.5-007	4.5-007	4.5-007
242Pu	.23E+07	1.4-004	2.8-003	3.8-007	3.8-007	7.5-004
93mNb	.18E+07	8.7-005	1.0-003	4.1-006	4.1-006	4.1-006
93Zr	.18E+07	2.4-007	9.1-006	.0	.0	.0
210Bi	.28E+06	2.2-006	3.8-006	3.5-009	3.5-009	3.5-009
228Ra	.46E+07	1.0-008	9.5-009	4.6-012	4.6-012	4.6-012
232Th	.46E+07	1.3-011	2.2-010	5.5-012	5.5-012	1.3-011
224Ra	.46E+07	2.0-011	9.9-011	1.4-014	1.4-014	1.4-014
228Th	.46E+07	3.5-012	6.8-011	1.2-012	1.2-012	1.2-012
79Se	.46E+06	1.1-003	9.4-012	9.4-012	9.4-012	9.4-012

TABLE B.1.51 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT051

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.10E+05	4.6-001	1.1+000	1.5-001	3.4-006	6.4+001
129I	.10E+05	5.4-002	3.1-002	1.9-002	2.7+001	2.1-002
226Ra	.70E+06	5.5+000	7.3+000	8.1-003	8.1-003	8.1-003
234U	.58E+06	1.6-001	2.5+000	7.3-004	7.3-004	2.1-001
210Pb	.70E+06	3.2-002	7.8-001	4.4-006	4.4-006	4.4-006
210Po	.70E+06	1.2-001	5.2-001	5.2-010	5.2-010	5.2-010
238U	.58E+06	2.5-002	3.3-001	5.8-003	5.8-003	3.2-002
230Th	.70E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
93mNb	.46E+07	9.6-006	1.1-004	4.5-007	4.5-007	4.5-007
242Pu	.57E+07	1.2-007	2.4-006	3.3-010	3.3-010	6.5-007
210Bi	.70E+06	6.0-007	1.0-006	9.7-010	9.7-010	9.7-010
93Zr	.46E+07	2.7-008	9.9-007	.0	.0	.0
228Ra	.11E+08	4.2-009	3.9-009	1.9-012	1.9-012	1.9-012
232Th	.11E+08	5.3-012	8.9-011	2.3-012	2.3-012	5.5-012
224Ra	.11E+08	8.1-012	4.0-011	5.9-015	5.9-015	5.9-015
228Th	.11E+08	1.4-012	2.8-011	5.0-013	5.0-013	5.0-013
79Se	.12E+07	2.8-007	2.4-015	2.4-015	2.4-015	2.4-015

TABLE B.1.52 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT052

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.20E+05	4.0-001	9.4-001	1.3-001	3.0-006	5.6+001
129I	.20E+05	4.9-002	2.9-002	1.7-002	2.5+001	1.9-002
226Ra	.12E+07	3.4+000	4.5+000	5.0-003	5.0-003	5.0-003
234U	.12E+07	3.9-002	6.2-001	1.8-004	1.8-004	5.2-002
210Pb	.12E+07	1.9-002	4.9-001	2.8-006	2.8-006	2.8-006
210Po	.12E+07	7.6-002	3.2-001	3.4-010	3.4-010	3.4-010
238U	.12E+07	1.6-002	2.1-001	3.7-003	3.7-003	2.0-002
230Th	.14E+07	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
93mNb	.92E+07	7.0-007	8.2-006	3.3-008	3.3-008	3.3-008
210Bi	.12E+07	1.3-007	2.2-007	2.1-010	2.1-010	2.1-010
93Zr	.92E+07	1.9-009	7.2-008	.0	.0	.0
228Ra	.23E+08	2.5-009	2.3-009	1.1-012	1.1-012	1.1-012
232Th	.23E+08	3.2-012	5.4-011	1.4-012	1.4-012	3.3-012
242Pu	.11E+08	2.4-012	4.9-011	6.8-015	6.8-015	1.3-011
224Ra	.23E+08	4.8-012	2.4-011	3.6-015	3.6-015	3.6-015
228Th	.23E+08	8.6-013	1.7-011	3.0-013	3.0-013	3.0-013
79Se	.23E+07	7.2-013	6.0-021	6.0-021	6.0-021	6.0-021

TABLE B.1.53 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT053

Parametric Data

Release duration = 1.0E+07 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure (yr)	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.26E+06	1.1-001	1.5-001	1.6-004	1.6-004	1.6-004
210Pb	.26E+06	6.3-004	1.6-002	9.0-008	9.0-008	9.0-008
210Po	.26E+06	2.5-003	1.0-002	1.1-011	1.1-011	1.1-011
99Tc	.59E+03	4.5-006	1.1-005	1.4-006	3.4-011	6.3-004
234U	.35E+05	3.1-005	5.0-004	1.5-007	1.5-007	4.1-005
129I	.61E+03	5.4-007	3.1-007	1.9-007	2.7-004	2.1-007
242Pu	.32E+06	4.3-006	8.8-005	1.2-008	1.2-008	2.4-005
230Th	.26E+06	2.6-006	8.7-005	6.1-009	6.1-009	6.1-009
238U	.64E+05	6.1-006	8.0-005	1.4-006	1.4-006	7.8-006
93mNb	.26E+06	1.3-007	1.5-006	6.1-009	6.1-009	6.1-009
210Bi	.26E+06	3.5-008	6.2-008	5.7-011	5.7-011	5.7-011
93Zr	.26E+06	3.6-010	1.4-008	.0	.0	.0
228Ra	.70E+06	1.9-011	1.7-011	8.3-015	8.3-015	8.3-015
232Th	.70E+06	2.3-014	4.0-013	1.0-014	1.0-014	2.5-014
224Ra	.70E+06	3.6-014	1.8-013	2.6-017	2.6-017	2.6-017
79Se	.64E+05	1.5-005	1.2-013	1.2-013	1.2-013	1.2-013
228Th	.70E+06	6.4-015	1.2-013	2.2-015	2.2-015	2.2-015

TABLE B.1.54 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT054

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 6.03E-01 m/yr; groundwater pathlength = 4.83E+04 m;
groundwater travel time = 8.0E+04 yr; dispersion coefficient = 4.2E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.47E+07	1.7+000	2.2+000	2.6-003	2.6-003	2.6-003
210Pb	.47E+07	9.7-003	2.4-001	1.4-006	1.4-006	1.4-006
210Po	.47E+07	3.8-002	1.6-001	1.7-010	1.7-010	1.7-010
99Tc	.81E+05	3.5-004	8.2-004	1.1-004	2.6-009	4.8-002
129I	.81E+05	5.4-005	3.1-005	1.9-005	2.8-002	2.1-005
234U	.47E+07	6.2-004	9.9-003	2.9-006	2.9-006	8.3-004
238U	.47E+07	6.1-004	8.0-003	1.4-004	1.4-004	7.8-004
230Th	.47E+07	2.2-005	7.2-004	5.1-008	5.1-008	5.1-008
210Bi	.47E+07	2.9-007	5.1-007	4.8-010	4.8-010	4.8-010
228Ra	.92E+08	4.8-010	4.4-010	2.1-013	2.1-013	2.1-013
232Th	.92E+08	6.0-013	1.0-011	2.6-013	2.6-013	6.2-013
224Ra	.92E+08	9.1-013	4.6-012	6.7-016	6.7-016	6.7-016
93mNb	.37E+08	3.2-013	3.8-012	1.5-014	1.5-014	1.5-014
228Th	.92E+08	1.6-013	3.1-012	5.7-014	5.7-014	5.7-014
93Zr	.37E+08	8.9-016	3.3-014	.0	.0	.0

TABLE B.1.55 Seventy-Year Cumulative Dose Commitment (Maximum Individual)
Expanded Summary for Case SLT055

Parametric Data

Release duration = 1.0E+05 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.3+000	1.8+000	2.1-003	2.1-003	2.1-003
210Pb	.22E+08	7.8-003	2.0-001	1.1-006	1.1-006	1.1-006
210Po	.22E+08	3.1-002	1.3-001	1.3-010	1.3-010	1.3-010
129I	.37E+06	5.2-005	3.0-005	1.8-005	2.6-002	2.0-005
99Tc	.37E+06	1.4-004	3.5-004	4.3-005	1.1-009	1.9-002
234U	.22E+08	5.2-004	8.3-003	2.4-006	2.4-006	6.9-004
238U	.22E+08	5.1-004	6.6-003	1.2-004	1.2-004	6.5-004
236U	.22E+08	3.0-004	4.8-003	4.2-008	4.2-008	4.2-008
230Th	.22E+08	2.7-005	8.8-004	6.2-008	6.2-008	6.2-008
235U	.22E+08	8.1-005	6.9-004	4.1-005	4.1-005	1.1-004
227Ac	.22E+08	2.9-005	4.3-004	2.5-006	2.5-006	2.5-006
231Pa	.22E+08	1.4-005	2.2-004	5.1-006	5.1-006	5.1-006
228Ra	.43E+09	5.6-006	5.1-006	2.5-009	2.5-009	2.5-009
210Bi	.22E+08	3.6-007	6.2-007	5.8-010	5.8-010	5.8-010
232Th	.43E+09	6.9-009	1.2-007	2.9-009	2.9-009	7.2-009
224Ra	.43E+09	1.1-008	5.3-009	7.8-012	7.8-012	7.8-012
228Th	.43E+09	1.9-009	3.6-008	6.6-010	6.6-010	6.6-010
229Th	.86E+08	7.0-015	1.3-013	6.2-016	6.2-016	6.2-016
225Ra	.86E+08	1.6-014	8.2-014	.0	.0	.0
237Np	.86E+08	3.8-015	5.8-014	1.3-015	1.3-015	1.3-015
233U	.86E+08	6.3-016	1.0-014	2.3-018	2.3-018	2.3-018
27Rb	.47E+07	3.6-008	4.3-015	4.3-015	4.3-015	4.3-015
225Ac	.86E+08	4.6-016	6.0-016	4.5-016	4.5-016	4.5-016
14C	.37E+06	4.3-022	2.2-021	4.3-022	4.3-022	4.3-022

TABLE B.1.56 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT056

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.20E+05	4.0-001	9.4-001	1.3-001	3.0-006	5.6+001
129I	.20E+05	4.9-002	2.9-002	1.7-002	2.5+001	1.9-002
226Ra	.12E+07	3.4+000	4.5+000	5.0-003	5.0-003	5.0-003
234U	.12E+07	3.9-002	6.2-001	1.8-004	1.8-004	5.2-002
210Pb	.12E+07	1.9-002	4.9-001	2.8-006	2.8-006	2.8-006
210Po	.12E+07	7.6-002	3.2-001	3.4-010	3.4-010	3.4-010
238U	.12E+07	1.6-002	2.1-001	3.7-003	3.7-003	2.0-002
230Th	.14E+07	5.2-005	1.7-003	1.2-007	1.2-007	1.2-007
93mNb	.92E+07	7.0-007	8.2-006	3.3-008	3.3-008	3.3-008
210Bi	.12E+07	1.3-007	2.2-007	2.1-010	2.1-010	2.1-010
93Zr	.92E+07	1.9-009	7.2-008	.0	.0	.0
228Ra	.23E+08	2.5-009	2.3-009	1.1-012	1.1-012	1.1-012
232Th	.23E+08	3.2-012	5.4-011	1.4-012	1.4-012	3.3-012
242Pu	.11E+08	2.4-012	4.9-011	6.8-015	6.8-015	1.3-011
224Ra	.23E+08	4.8-012	2.4-011	3.6-015	3.6-015	3.6-015
228Th	.23E+08	8.6-013	1.7-011	3.0-013	3.0-013	3.0-013
79Se	.23E+07	7.2-013	6.0-021	6.0-021	6.0-021	6.0-021

TABLE B.1.57 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT057

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.12E+06	3.0-002	7.1-002	9.7-003	2.3-007	4.2+000
226Ra	.13E+07	3.2+000	4.0+000	4.4-003	4.4-003	4.4-003
129I	.12E+06	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.13E+07	1.7-002	4.4-001	2.3-006	2.3-006	2.3-006
210Po	.13E+07	6.7-002	2.9-001	2.9-010	2.9-010	2.9-010
234U	.13E+07	1.8-002	2.9-001	8.5-005	8.5-005	2.4-002
238U	.13E+07	1.6-002	2.1-001	3.6-003	3.6-003	2.0-002
229Th	.13E+07	1.2-003	2.2-002	1.1-004	1.1-004	1.1-004
225Ra	.13E+07	2.8-003	1.4-002	.0	.0	.0
237Np	.12E+06	1.6-004	2.4-003	5.6-005	5.6-005	5.6-005
233U	.13E+07	1.2-004	1.9-003	4.2-007	4.2-007	4.2-007
230Th	.15E+07	5.0-005	1.7-003	1.2-007	1.2-007	1.2-007
236U	.12E+06	1.5-005	2.3-004	2.1-009	2.1-009	2.1-009
225Ac	.13E+07	7.9-005	1.0-004	7.7-005	7.7-005	7.7-005
228Ra	.23E+08	2.3-005	2.2-005	1.0-008	1.0-008	1.0-008
93mNb	.93E+07	6.6-007	7.8-006	3.1-008	3.1-008	3.1-008
227Ac	.23E+08	3.6-007	5.2-006	3.0-008	3.0-008	3.0-008
231Pa	.23E+08	1.7-007	2.7-006	6.2-008	6.2-008	6.2-008
210Bi	.13E+07	4.0-007	7.0-007	6.6-010	6.6-010	6.6-010
232Th	.23E+08	2.9-008	5.0-007	1.3-008	1.3-008	3.1-008

TABLE B.1.58 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT058

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.60E+06	6.7+000	8.4+000	9.3-003	9.3-003	9.3-003
210Pb	.60E+06	3.6-002	9.3-001	4.9-006	4.9-006	4.9-006
210Po	.60E+06	1.4-001	6.2-001	6.2-010	6.2-010	6.2-010
99Tc	.20E+05	4.2-003	9.9-003	1.4-003	3.2-008	5.9-001
129I	.20E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
234U	.60E+06	1.1-002	1.8-001	5.3-005	5.3-005	1.5-002
238U	.60E+06	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
230Th	.71E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
229Th	.20E+05	9.1-005	1.7-003	8.1-006	8.1-006	8.1-006
225Ra	.20E+05	2.1-004	1.1-003	.0	.0	.0
227Ac	.60E+06	2.5-005	3.6-004	2.1-006	2.1-006	2.1-006
231Pa	.60E+06	1.2-005	1.9-004	4.4-006	4.4-006	4.4-006
93mNb	.46E+07	8.9-006	1.1-004	4.1-007	4.1-007	4.1-007
225Ac	.20E+05	6.0-006	7.7-006	5.8-006	5.8-006	5.8-006
228Ra	.20E+05	3.3-006	3.0-006	1.4-009	1.4-009	1.4-009
242Pu	.57E+07	1.1-007	2.3-006	3.1-010	3.1-010	6.1-007
210Bi	.60E+06	6.4-007	1.1-006	1.0-009	1.0-009	1.0-009
93Zr	.46E+07	2.5-008	9.2-007	.0	.0	.0
236U	.20E+05	1.8-008	2.8-007	2.5-012	2.5-012	2.5-012
233U	.20E+05	6.1-009	9.9-008	2.2-011	2.2-011	2.2-011

TABLE B.1.59 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT059

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+07	5.4+000	7.2+000	7.9-003	7.9-003	7.9-003
210Pb	.11E+07	3.1-002	7.8-001	4.3-006	4.3-006	4.3-006
210Po	.11E+07	1.2-001	5.1-001	5.3-010	5.3-010	5.3-010
129I	.10E+07	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
234U	.10E+07	7.8-003	1.2-001	3.6-005	3.6-005	1.0-002
238U	.10E+07	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
99Tc	.10E+07	1.7-004	3.9-004	5.3-005	1.2-009	2.3-002
242Pu	.13E+07	2.6-004	5.3-003	7.3-007	7.3-007	1.4-003
230Th	.11E+07	1.1-004	3.5-003	2.5-007	2.5-007	2.5-007
93mNb	.12E+07	3.7-005	4.3-004	1.7-006	1.7-006	1.7-006
228Ra	.16E+07	2.3-004	2.1-004	1.0-007	1.0-007	1.0-007
232Th	.16E+07	2.8-007	4.8-006	1.2-007	1.2-007	2.9-007
93Zr	.12E+07	1.0-007	3.8-006	.0	.0	.0
210Bi	.11E+07	1.4-006	2.4-006	2.2-009	2.2-009	2.2-009
224Ra	.16E+07	4.3-007	2.2-006	3.2-010	3.2-010	3.2-010
228Th	.16E+07	7.7-008	1.5-006	2.7-008	2.7-008	2.7-008
79Se	.11E+07	3.5-007	2.9-015	2.9-015	2.9-015	2.9-015
227Ac	.10E+07	1.5-022	2.2-021	1.3-023	1.3-023	1.3-023
231Pa	.10E+07	7.4-023	1.2-021	2.7-023	2.7-023	2.7-023

TABLE B.1.60 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT060

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+07	4.5+000	5.7+000	6.3-003	6.3-003	6.3-003
210Pb	.12E+07	2.5-002	6.3-001	3.3-006	3.3-006	3.3-006
129I	.10E+07	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
210Po	.12E+07	9.6-002	4.2-001	4.2-010	4.2-010	4.2-010
234U	.12E+07	7.0-003	1.1-001	3.3-005	3.3-005	9.3-003
238U	.12E+07	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
99Tc	.10E+07	1.6-004	3.9-004	5.3-005	1.2-009	2.3-002
230Th	.13E+07	8.3-005	2.8-003	1.9-007	1.9-007	1.9-007
228Ra	.56E+07	6.1-004	5.6-004	2.7-007	2.7-007	2.7-007
93mNb	.28E+07	3.7-005	4.3-004	1.7-006	1.7-006	1.7-006
242Pu	.33E+07	1.7-005	3.5-004	4.7-008	4.7-008	9.3-005
232Th	.56E+07	7.6-007	1.3-005	3.2-007	3.2-007	8.0-007
224Ra	.56E+07	1.2-006	5.8-006	8.6-010	8.6-010	8.6-010
228Th	.56E+07	2.1-007	4.0-006	7.3-008	7.3-008	7.3-008
93Zr	.28E+07	1.0-007	3.8-006	.0	.0	.0
210Bi	.12E+07	7.8-007	1.4-006	1.3-009	1.3-009	1.3-009
79Se	.15E+07	4.8-009	4.1-017	4.1-017	4.1-017	4.1-017
227Ac	.10E+07	1.1-022	1.6-021	9.4-024	9.4-024	9.4-024
231Pa	.10E+07	5.4-023	8.3-022	1.9-023	1.9-023	1.9-023
235U	.10E+07	7.2-030	6.2-029	3.7-030	3.7-030	1.0-029

TABLE B.1.61 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT061

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
129I	.10E+07	4.7-002	2.8-002	1.6-002	2.4+001	1.8-002
99Tc	.10E+07	1.5-002	3.5-002	4.7-003	1.1-007	2.1+000
226Ra	.22E+07	2.2-001	2.9-001	3.3-004	3.3-004	3.3-004
234U	.22E+07	1.7-002	2.6-001	7.8-005	7.8-005	2.2-002
238U	.22E+07	1.6-002	2.1-001	3.7-003	3.7-003	2.0-002
210Pb	.22E+07	1.2-003	3.1-002	1.8-007	1.8-007	1.8-007
210Po	.22E+07	5.0-003	2.0-002	2.1-011	2.1-011	2.1-011
230Th	.24E+07	4.5-005	1.5-003	1.1-007	1.1-007	1.1-007
228Ra	.24E+08	1.6-004	1.5-004	7.1-008	7.1-008	7.1-008
93mNb	.10E+08	4.4-007	5.2-006	2.0-008	2.0-008	2.0-008
232Th	.24E+08	2.0-007	3.4-006	8.5-008	8.5-008	2.1-007
224Ra	.24E+08	3.0-007	1.5-006	2.2-010	2.2-010	2.2-010
228Th	.24E+08	5.4-008	1.0-006	1.9-008	1.9-008	1.9-008
210Bi	.22E+07	2.9-008	5.0-008	4.7-011	4.7-011	4.7-011
93Zr	.10E+08	1.2-009	4.5-008	.0	.0	.0
242Pu	.12E+08	3.8-013	7.9-012	1.1-015	1.1-015	2.1-012
227Ac	.10E+07	3.3-024	4.9-023	2.9-025	2.9-025	2.9-025
231Pa	.10E+07	1.6-024	2.5-023	5.9-025	5.9-025	5.9-025
79Se	.33E+07	1.7-017	1.4-025	1.4-025	1.4-025	1.4-025
235U	.10E+07	2.2-031	1.8-030	1.1-031	1.1-031	3.0-031

TABLE B.1.62 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT062

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.18E+06	1.0+000	1.3+000	1.5-003	1.5-003	1.5-003
210Pb	.18E+06	5.8-003	1.5-001	8.2-007	8.2-007	8.2-007
210Po	.18E+06	2.3-002	9.5-002	9.9-011	9.9-011	9.9-011
229Th	.16E+04	8.7-004	1.6-002	7.7-005	7.7-005	7.7-005
225Ra	.16E+04	2.0-003	1.0-002	.0	.0	.0
99Tc	.16E+04	4.5-005	1.1-004	1.4-005	3.4-010	6.2-003
236U	.16E+04	3.7-004	6.0-003	5.2-008	5.2-008	5.2-008
234U	.36E+05	3.1-004	5.0-003	1.5-006	1.5-006	4.1-004
129I	.16E+04	5.4-006	3.1-006	1.9-006	2.8-003	2.1-006
223U	.16E+04	1.1-004	1.8-003	3.9-007	3.9-007	3.9-007
242Pu	.32E+06	4.3-005	8.8-004	1.2-007	1.2-007	2.4-004
230Th	.26E+06	2.6-005	8.7-004	6.1-008	6.1-008	6.1-008
238U	.65E+05	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
227Ac	.58E+06	2.9-005	4.3-004	2.5-006	2.5-006	2.5-006
231Pa	.58E+06	1.4-005	2.2-004	5.1-006	5.1-006	5.1-006
225Ac	.16E+04	5.7-005	7.4-005	5.6-005	5.6-005	5.6-005
93mNb	.26E+06	1.3-006	1.5-005	6.1-008	6.1-008	6.1-008
210Bi	.18E+06	3.2-007	5.6-007	5.2-010	5.2-010	5.2-010
93Zr	.26E+06	3.6-009	1.4-007	.0	.0	.0
228Ra	.16E+04	3.4-008	3.1-008	1.5-011	1.5-011	1.5-011

TABLE B.1.63 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT063

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.59E+06	5.4+000	6.9+000	7.7-003	7.7-003	7.7-003
210Pb	.59E+06	3.1-002	7.7-001	4.1-006	4.1-006	4.1-006
99Tc	.11E+05	4.4-003	1.0-002	1.4-003	3.3-008	6.0-001
237Np	.11E+05	3.1-002	4.7-001	1.1-002	1.1-002	1.1-002
210Po	.59E+06	1.2-001	4.9-001	5.1-010	5.1-010	5.1-010
129I	.11E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
234U	.59E+06	1.1-002	1.8-001	5.3-005	5.3-005	1.5-002
238U	.59E+06	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
229Th	.11E+05	3.3-003	6.1-002	2.9-004	2.9-004	2.9-004
225Ra	.11E+05	7.6-003	3.8-002	.0	.0	.0
236U	.11E+05	1.2-003	1.9-002	1.7-007	1.7-007	1.7-007
233U	.11E+05	3.2-004	5.1-003	1.1-006	1.1-006	1.1-006
230Th	.70E+06	9.4-005	3.1-003	2.2-007	2.2-007	2.2-007
227Ac	.59E+06	2.7-005	4.0-004	2.3-006	2.3-006	2.3-006
225Ac	.11E+05	2.1-004	2.8-004	2.1-004	2.1-004	2.1-004
231Pa	.59E+06	1.3-005	2.0-004	4.8-006	4.8-006	4.8-006
93mNb	.46E+07	8.9-006	1.1-004	4.1-007	4.1-007	4.1-007
242Pu	.57E+07	1.1-007	2.3-006	3.1-010	3.1-010	6.1-007
210Bi	.59E+06	6.4-007	1.1-006	1.0-009	1.0-009	1.0-009
93Zr	.46E+07	2.5-008	9.2-007	.0	.0	.0

TABLE B.1.64 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT064

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.41E+05	4.0-002	9.3-002	1.3-002	2.9-007	5.5+000
226Ra	.23E+07	2.7+000	3.4+000	3.6-003	3.6-003	3.6-003
129I	.41E+05	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.23E+07	1.4-002	3.6-001	2.1-006	2.1-006	2.1-006
210Po	.23E+07	5.6-002	2.3-001	2.7-010	2.7-010	2.7-010
234U	.23E+07	6.5-002	1.0-001	3.0-005	3.0-005	8.6-003
238U	.23E+07	6.4-003	8.3-002	1.4-003	1.4-003	8.1-003
230Th	.28E+07	3.4-005	1.1-003	7.9-008	7.9-008	7.9-008
228Ra	.46E+08	6.6-008	6.0-008	2.9-011	2.9-011	2.9-011
93mNb	.18E+08	3.9-009	4.6-008	1.8-010	1.8-010	1.8-010
210Bi	.23E+07	3.3-009	5.8-009	5.4-012	5.4-012	5.4-012
232Th	.46E+08	8.2-011	1.4-009	3.5-011	3.5-011	8.6-011
224Ra	.46E+08	1.2-010	6.3-010	9.2-014	9.2-014	9.2-014
228Th	.46E+08	2.2-011	4.3-010	7.8-012	7.8-012	7.8-012
93Zr	.18E+08	1.1-011	4.0-010	.0	.0	.0
242Pu	.23E+08	1.1-021	2.3-020	3.1-024	3.1-024	6.1-021
79Se	.46E+07	4.9-024	4.2-032	4.2-032	4.2-032	4.2-032

TABLE B.1.65 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT065

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.69E+06	5.0+000	6.3+000	7.2-003	7.2-003	7.2-003
210Pb	.69E+06	2.7-002	6.9-001	3.9-006	3.9-006	3.9-006
99Tc	.11E+06	3.1-003	7.4-003	1.0-003	2.3-008	4.4-001
210Po	.69E+06	1.1-001	4.4-001	4.7-010	4.7-010	4.7-010
129I	.11E+06	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
234U	.69E+06	1.0-002	1.6-001	4.7-005	4.7-005	1.3-002
238U	.69E+06	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
93mNb	.47E+07	8.5-006	1.0-004	4.0-007	4.0-007	4.0-007
228Ra	.12E+08	3.9-005	3.5-005	1.7-008	1.7-008	1.7-008
242Pu	.58E+07	9.1-008	1.9-006	2.6-010	2.6-010	5.0-007
210Bi	.69E+06	5.5-007	9.6-007	8.9-010	8.9-010	8.9-010
93Zr	.47E+07	2.4-008	8.8-007	.0	.0	.0
232Th	.12E+08	4.8-008	8.1-007	2.0-008	2.0-008	5.0-008
224Ra	.12E+08	7.3-008	3.7-007	5.4-011	5.4-011	5.4-011
228Th	.12E+08	1.3-008	2.5-007	4.6-009	4.6-009	4.6-009
79Se	.13E+07	4.2-008	3.5-016	3.5-016	3.5-016	3.5-016

TABLE B.1.66 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT066

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.14E+06	1.3+001	1.7+001	1.9-002	1.9-002	1.9-002
99Tc	.10E+06	3.2-002	7.6-002	1.0-002	2.4-007	4.5+000
129I	.10E+06	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.14E+06	7.4-002	1.9+000	1.1-005	1.1-005	1.1-005
234U	.13E+06	9.1-002	1.4+000	4.2-004	4.2-004	1.2-001
210Po	.14E+06	2.9-001	1.2+000	1.3-009	1.3-009	1.3-009
238U	.13E+06	2.2-002	2.8-001	4.9-003	4.9-003	2.8-002
242Pu	.39E+06	1.4-003	2.9-002	4.0-006	4.0-006	7.9-003
230Th	.14E+06	3.0-004	1.0-002	7.1-007	7.1-007	7.1-007
93mNb	.33E+06	5.9-005	7.0-004	2.8-006	2.8-006	2.8-006
228Ra	.68E+06	3.3-005	3.0-005	1.4-008	1.4-008	1.4-008
227Ac	.39E+06	1.5-006	2.2-005	1.3-007	1.3-007	1.3-007
231Pa	.39E+06	7.5-007	1.2-005	2.7-007	2.7-007	2.7-007
210Bi	.14E+06	4.1-006	7.2-006	6.7-009	6.7-009	6.7-009
93Zr	.33E+06	1.6-007	6.1-006	.0	.0	.0
232Th	.68E+06	4.1-008	6.9-007	1.7-008	1.7-008	4.3-008
224Ra	.68E+06	6.3-008	3.1-007	4.6-011	4.6-011	4.6-011
228Th	.68E+06	1.1-008	2.2-007	3.9-009	3.9-009	3.9-009
79Se	.16E+06	1.0-002	8.4-011	8.4-011	8.4-011	8.4-011
235U	.39E+06	1.9-013	1.6-012	9.5-014	9.5-014	2.6-013

TABLE B.1.67 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT067

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.36E+05	1.6+001	2.1+001	2.3-002	2.3-002	2.3-002
99Tc	.16E+04	4.5-002	1.1-001	1.4-002	3.4-007	6.2+000
129I	.16E+04	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.36E+05	9.1-002	2.3+000	1.3-005	1.3-005	1.3-005
234U	.31E+05	1.1-001	1.8+000	5.2-004	5.2-004	1.5-001
210Po	.36E+05	3.6-001	1.5+000	1.6+009	1.6-009	1.6-009
238U	.31E+05	2.2-002	2.8-001	4.9-003	4.9-003	2.8-002
242Pu	.29E+06	1.7-003	3.5-002	4.8-006	4.8-006	9.3-003
230Th	.36E+05	3.6-004	1.2-002	8.6-007	8.6-007	8.6-007
93mNb	.23E+06	6.1-005	7.3-004	2.9-006	2.9-006	2.9-006
210Bi	.36E+05	5.0-006	8.8-006	8.2-009	8.2-009	8.2-009
93Zr	.23E+06	1.7-007	6.4-006	.0	.0	.0
228Ra	.58E+06	2.3-007	2.1-007	1.0-010	1.0-010	1.0-010
232Th	.58E+06	2.8-010	4.8-009	1.2-010	1.2-010	2.9-010
224Ra	.58E+06	4.3-010	2.2-009	3.2-013	3.2-013	3.2-013
228Th	.58E+06	7.6-011	1.5-009	2.7-011	2.7-011	2.7-011
79Se	.60E+05	2.8-002	2.4-010	2.4-010	2.4-010	2.4-010

TABLE B.1.68 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT068

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.12E+06	3.0-002	7.1-002	9.7-003	2.3-007	4.2+000
226Ra	.13E+07	3.2+000	4.0+000	4.4-003	4.4-003	4.4-003
129I	.12E+06	5.4-003	3.1-003	1.9-003	2.7+000	2.1-003
210Pb	.13E+07	1.7-002	4.4-001	2.3-006	2.3-006	2.3-006
210Po	.13E+07	6.7-002	2.9-001	2.9-010	2.9-010	2.9-010
234U	.13E+07	1.8-002	2.9-001	8.5-005	8.5-005	2.4-002
238U	.13E+07	1.6-002	2.1-001	3.6-003	3.6-003	2.0-002
229Th	.13E+07	1.2-003	2.2-002	1.1-004	1.1-004	1.1-004
225Ra	.13E+07	2.8-003	1.4-002	.0	.0	.0
237Np	.12E+06	1.6-004	2.4-003	5.6-005	5.6-005	5.6-005
233U	.13E+07	1.2-004	1.9-003	4.2-007	4.2-007	4.2-007
230Th	.15E+07	5.0-005	1.7-003	1.2-007	1.2-007	1.2-007
236U	.12E+06	1.5-005	2.3-004	2.1-009	2.1-009	2.1-009
225Ac	.13E+07	7.9-005	1.0-004	7.7-005	7.7-005	7.7-005
228Ra	.23E+08	2.3-005	2.2-005	1.0-008	1.0-008	1.0-008
93mNb	.93E+07	6.6-007	7.8-006	3.1-008	3.1-008	3.1-008
227Ac	.23E+08	3.6-007	5.2-006	3.0-008	3.0-008	3.0-008
231Pa	.23E+08	1.7-007	2.7-006	6.2-008	6.2-008	6.2-008
210Bi	.13E+07	4.0-007	7.0-007	6.6-010	6.6-010	6.6-010
232Th	.23E+08	2.9-008	5.0-007	1.3-008	1.3-008	3.1-008

TABLE B.1.69 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT069

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	2.9-001	3.9-001	4.3-004	4.3-004	4.3-004
210Pb	.22E+08	1.6-003	4.3-002	2.4-007	2.4-007	2.4-007
210Po	.22E+08	6.5-003	2.8-002	2.9-011	2.9-011	2.9-011
99Tc	.37E+06	1.3-005	3.1-005	4.3-006	1.0-010	1.9-003
129I	.37E+06	5.2-006	3.0-006	1.8-006	2.7-003	2.0-006
234U	.22E+08	6.2-005	9.9-004	2.9-007	2.9-007	8.3-005
238U	.22E+08	6.1-005	8.0-004	1.4-005	1.4-005	7.8-005
230Th	.22E+08	5.3-006	1.8-004	1.2-008	1.2-008	1.2-008
210Bi	.22E+08	7.3-008	1.3-007	1.2-010	1.2-010	1.2-010
228Ra	.43E+09	9.4-011	8.6-011	4.2-014	4.2-014	4.2-014
232Th	.43E+09	1.2-013	2.0-012	5.0-014	5.0-014	1.2-013
224Ra	.43E+09	1.8-013	9.0-013	1.3-016	1.3-016	1.3-016
228Th	.43E+09	3.2-014	6.2-013	1.1-014	1.1-014	1.1-014

TABLE B.1.70 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT070

Parametric Data

Release duration = 1.0E+07 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.1E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.13E+07	4.7-002	6.2-002	6.8-005	6.8-005	6.8-005
210Pb	.13E+07	2.6-004	6.8-003	3.7-008	3.7-008	3.7-008
210Po	.13E+07	1.0-003	4.3-003	4.5-012	4.5-012	4.5-012
129I	.10E+07	5.2-007	3.0-007	1.8-007	2.6-004	2.0-007
234U	.10E+07	7.8-006	1.2-004	3.6-008	3.6-008	1.0-005
238U	.11E+07	6.1-006	8.0-005	1.4-006	1.4-006	7.8-006
230Th	.13E+07	1.0-006	3.5-005	2.5-009	2.5-009	2.5-009
99Tc	.10E+07	1.7-007	3.9-007	5.3-008	1.2-012	2.3-005
242Pu	.13E+07	7.1-007	1.5-005	2.0-009	2.0-009	4.0-006
228Ra	.17E+07	1.2-006	1.1-006	5.4-010	5.4-010	5.4-010
93mNb	.13E+07	8.2-008	9.6-007	3.8-009	3.8-009	3.8-009
232Th	.17E+07	1.5-009	2.6-008	6.5-010	6.5-010	1.6-009
210Bi	.13E+07	1.5-008	2.6-008	2.4-011	2.4-011	2.4-011
224Ra	.17E+07	2.3-009	1.2-008	1.7-012	1.7-012	1.7-012
93Zr	.13E+07	2.3-010	8.4-009	.0	.0	.0
228Th	.17E+07	4.1-010	8.0-009	1.4-010	1.4-010	1.4-010
79Se	.11E+07	3.5-010	2.9-018	2.9-018	2.9-018	2.9-018

TABLE B.1.71 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT071

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.64E+05	1.3+001	1.7+001	1.9-002	1.9-002	1.9-002
210Pb	.64E+05	7.2-002	1.8+000	1.0-005	1.0-005	1.0-005
210Po	.64E+05	2.8-001	1.2+000	1.2-009	1.2-009	1.2-009
99Tc	.59E+03	4.5-003	1.1-002	1.4-003	3.4-008	6.3-001
234U	.35E+05	3.1-002	5.0-001	1.5-004	1.5-004	4.1-002
129I	.61E+03	5.4-004	3.1-041	1.9-004	2.7-001	2.1-004
238U	.35E+05	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
242Pu	.30E+06	1.6-003	3.3-002	4.6-006	4.6-006	9.0-003
230Th	.64E+05	2.9-004	9.6-003	6.7-007	6.7-007	6.7-007
93mNb	.24E+06	5.8-005	6.8-004	2.7-006	2.7-006	2.7-006
210Bi	.64E+05	4.0-006	7.0-006	6.5-009	6.5-009	6.5-009
93Zr	.24E+06	1.6-007	6.0-006	.0	.0	.0
228Ra	.59E+06	3.6-009	3.3-009	1.6-012	1.6-012	1.6-012
79Se	.64E+05	1.5-002	1.2-010	1.2-010	1.2-010	1.2-010
232Th	.59E+06	4.4-012	7.5-011	1.9-012	1.9-012	4.7-012
224Ra	.59E+06	6.8-012	3.4-011	5.0-015	5.0-015	5.0-015
228Th	.59E+06	1.2-012	2.3-011	4.3-013	4.3-013	4.3-013

TABLE B.1.72 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT072

Parametric Data

Release duration = 2.6E+07 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.26E+06	4.4-002	5.8-002	6.4-005	6.4-005	6.4-005
210Pb	.26E+06	2.5-004	6.3-003	3.5-008	3.5-008	3.5-008
210Po	.26E+06	9.8-004	4.1-003	4.2-012	4.2-012	4.2-012
99Tc	.59E+03	1.7-006	4.1-006	5.6-007	1.3-011	2.4-004
234U	.33E+05	1.2-005	1.9-004	5.7-008	5.7-008	1.6-005
129I	.61E+03	2.0-007	1.2-007	7.1-008	1.1-004	7.8-008
242Pu	.32E+06	1.6-006	3.3-005	4.6-009	4.6-009	9.0-006
230Th	.26E+06	9.9-007	3.3-005	2.3-009	2.3-009	2.3-009
238U	.61E+06	2.3-006	3.1-005	5.3-007	5.3-007	3.0-006
93mNb	.26E+06	5.0-008	5.9-007	2.3-009	2.3-009	2.3-009
210Bi	.26E+06	1.4-008	2.4-008	2.2-011	2.2-011	2.2-011
93Zr	.26E+06	1.4-010	5.1-009	.0	.0	.0
228Ra	.70E+06	7.3-012	6.7-012	3.2-015	3.2-015	3.2-015
232Th	.70E+06	9.1-015	1.6-013	3.9-015	3.9-015	9.6-015
224Ra	.70E+06	1.4-014	7.0-014	1.0-017	1.0-017	1.0-017
228Th	.70E+06	2.5-015	4.8-014	8.7-016	8.7-016	8.7-016
79Se	.64E+05	5.6-006	4.7-014	4.7-014	4.7-014	4.7-014

TABLE B.1.73 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT073

Parametric Data

Release duration = 1.7E+07 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.47E+06	4.1-002	5.4-002	6.0-005	6.0-005	6.0-005
210Pb	.47E+06	2.3-004	5.9-003	3.3-008	3.3-008	3.3-008
210Po	.47E+06	9.1-004	3.8-003	4.0-012	4.0-012	4.0-012
99Tc	.40+04	2.6-006	6.2-006	8.4-007	2.0-011	3.6-004
234U	.24E+06	1.2-005	1.9-004	5.6-008	5.6-008	1.6-005
129I	.40E+04	3.2-007	1.9-007	1.1-007	1.6-004	1.2-007
238U	.47E+06	3.6-006	4.7-005	8.1-007	8.1-007	4.5-006
230Th	.47E+06	9.9-007	3.3-005	2.3-009	2.3-009	2.3-009
242Pu	.23E+07	7.1-008	1.5-006	2.0-010	2.0-010	4.0-007
93mNb	.19E+07	3.7-008	4.3-007	1.7-009	1.7-009	1.7-009
210Bi	.47E+06	1.3-008	2.2-008	2.1-011	2.1-011	2.1-011
93Zr	.19E+07	1.0-010	3.8-009	.0	.0	.0
228Ra	.46E+07	1.1-011	1.0-011	5.0-015	5.0-015	5.0-015
232Th	.46E+07	1.4-014	2.4-013	6.0-015	6.0-015	1.5-014
224Ra	.46E+07	2.1-014	1.1-013	1.6-017	1.6-017	1.6-017
228Th	.46E+07	3.8-015	7.4-014	1.3-015	1.3-015	1.3-015
79Se	.47E+06	1.2-007	1.0-015	1.0-015	1.0-015	1.0-015

TABLE B.1.74 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT074

Parametric Data

Release duration = 6.6E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 2.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 2.0E+04 yr; dispersion coefficient = 6.8E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.23E+07	4.5-002	6.0-002	6.6-005	6.6-005	6.6-005
210Pb	.23E+07	2.5-004	6.6-003	3.6-008	3.6-008	3.6-008
210Po	.23E+07	1.0-003	4.2-003	4.4-012	4.4-012	4.4-012
99Tc	.20E+05	6.4-006	1.5-005	2.1-006	4.8-011	8.9-004
129I	.20E+05	8.2-007	4.7-007	2.8-007	4.2-004	3.1-007
234U	.12E+07	1.1-005	1.7-004	5.1-008	5.1-008	1.5-005
238U	.23E+07	9.2-006	1.2-004	2.1-006	2.1-006	1.2-005
230Th	.23E+07	1.0-006	3.5-005	2.5-009	2.5-009	2.5-009
93mNb	.92E+07	3.1-009	3.6-008	1.4-010	1.4-010	1.4-010
210Bi	.23E+07	1.4-008	2.5-008	2.3-011	2.3-011	2.3-011
93Zr	.92E+07	8.6-012	3.2-010	.0	.0	.0
228Ra	.23E+08	2.9-011	2.7-011	1.3-014	1.3-014	1.3-014
232Th	.23E+08	3.6-014	6.2-013	1.5-014	1.5-014	3.8-014
224Ra	.23E+08	5.6-014	2.8-013	4.1-017	4.1-017	4.1-017
242Pu	.12E+08	1.2-014	2.5-013	3.5-017	3.5-017	6.8-014
228Th	.23E+08	9.9-015	1.9-013	3.5-015	3.5-015	3.5-015
79Se	.23E+07	7.5-016	6.3-024	6.3-024	6.3-024	6.3-024

TABLE B.1.75 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT075

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.74E+05	1.6+001	2.1+001	2.2-002	2.2-002	2.2-002
210Pb	.74E+05	8.6-002	2.2+000	1.2-005	1.2-005	1.2-005
210Po	.74E+05	3.4-001	1.5+000	1.5-009	1.5-009	1.5-009
99Tc	.11E+05	4.4-003	1.0-002	1.4-003	3.3-008	6.0-001
234U	.45E+05	3.1-002	5.0-001	1.5-004	1.5-004	4.1-002
129I	.11E+05	5.4-004	3.1-004	1.9-004	2.7-001	2.1-004
238U	.45E+05	6.1-003	8.0-002	1.4-003	1.4-003	7.8-003
242Pu	.31E+06	1.6-003	3.3-002	4.6-006	4.6-006	9.0-003
230Th	.74E+05	2.9-004	9.6-003	6.7-007	6.7-007	6.7-007
93mNb	.25E+06	5.8-005	6.8-004	2.7-006	2.7-006	2.7-006
210Bi	.74E+05	3.9-006	6.9-006	6.4-009	6.4-009	6.4-009
93Zr	.25E+06	1.6-007	6.0-006	.0	.0	.0
228Ra	.60E+06	1.8-006	1.6-006	7.9-010	7.9-010	7.9-010
232Th	.60E+06	2.2-009	3.8-008	9.5-010	9.5-010	2.3-009
224Ra	.60E+06	3.4-009	1.7-008	2.5-012	2.5-012	2.5-012
228Th	.60E+06	6.1-010	1.2-008	2.1-010	2.1-010	2.1-010
79Se	.74E+05	1.4-002	1.1-010	1.1-010	1.1-010	1.1-010

TABLE B.1.76 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT076

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.11E+05	4.3-001	1.0+000	1.4-001	3.2-006	6.0+001
129I	.11E+05	5.2-002	3.0-002	1.8-002	2.6+001	2.0-002
226Ra	.45E+05	1.6+001	2.1+001	2.3-002	2.3-002	2.3-002
210Pb	.45E+05	9.1-002	2.3+000	1.3-005	1.3-005	1.3-005
234U	.40E+05	1.1-001	1.8+000	5.3-004	5.3-004	1.5-001
210Po	.45E+05	3.6-001	1.5+000	1.6-009	1.6-009	1.6-009
238U	.40E+05	2.2-002	2.9-001	5.1-003	5.1-003	2.9-002
242Pu	.30E+06	1.7-003	3.5-002	4.8-006	4.8-006	9.3-003
230Th	.45E+05	3.6-004	1.2-002	8.4-007	8.4-007	8.4-007
93mNb	.24E+06	6.1-005	7.3-004	2.9-006	2.9-006	2.9-006
210Bi	.45E+05	5.0-006	8.8-006	8.2-009	8.2-009	8.2-009
93Zr	.24E+06	1.7-007	6.4-006	.0	.0	.0
228Ra	.59E+06	1.8-006	1.6-006	7.9-010	7.9-010	7.9-010
232Th	.59E+06	2.2-009	3.8-008	9.5-010	9.5-010	2.3-009
224Ra	.59E+06	3.4-009	1.7-008	2.5-012	2.5-012	2.5-012
228Th	.59E+06	6.1-010	1.2-008	2.1-010	2.1-010	2.1-010
79Se	.69E+05	2.6-002	2.2-010	2.2-010	2.2-010	2.2-010

TABLE B.1.77 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT077

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.6+000	2.1+000	2.3-003	2.3-003	2.3-003
129I	.38E+06	5.2-004	3.0-004	1.8-004	2.6-001	2.0-004
210Pb	.22E+08	8.9-003	2.2-001	1.3-006	1.3-006	1.3-006
99Tc	.38E+06	1.3-003	3.0-003	4.2-004	9.7-009	1.8-001
210Po	.22E+08	3.5-002	1.5-001	1.5-010	1.5-010	1.5-010
234U	.22E+08	6.8-004	1.1-002	3.1-006	3.1-006	9.0-004
238U	.22E+08	6.6-004	8.6-003	1.5-004	1.5-004	8.4-004
230Th	.22E+08	2.5-005	8.3-004	5.8-008	5.8-008	5.8-008
210Bi	.22E+08	3.3-007	5.8-007	5.4-010	5.4-010	5.4-010
228Ra	.43E+09	5.2-008	4.7-008	2.3-011	2.3-011	2.3-011
232Th	.43E+09	6.4-011	1.1-009	2.8-011	2.8-011	6.7-011
224Ra	.43E+09	9.9-011	4.9-010	7.2-014	7.2-014	7.2-014
228Th	.43E+09	1.7-011	3.4-010	6.1-012	6.1-012	6.1-012

TABLE B.1.78 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLT078

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	1.5+000	1.9+000	2.2-003	2.2-003	2.2-003
129I	.38E+06	3.2-003	1.9-003	1.1-003	1.7+000	1.2-003
99Tc	.38E+06	8.4-003	2.0-002	2.7-003	6.2-008	1.2+000
210Pb	.22E+08	8.3-003	2.1-001	1.2-006	1.2-006	1.2-006
210Po	.22E+08	3.3-002	1.4-001	1.4-010	1.4-010	1.4-010
234U	.22E+08	6.8-004	1.1-002	3.1-006	3.1-006	9.0-004
238U	.22E+08	6.6-004	8.6-003	1.5-004	1.5-004	8.4-004
230Th	.22E+08	2.5-005	8.3-004	5.8-008	5.8-008	5.8-008
210Bi	.22E+08	3.3-007	5.8-007	5.4-010	5.4-010	5.4-010
228Ra	.43E+09	5.2-008	4.7-008	2.3-011	2.3-011	2.3-011
232Th	.43E+09	6.4-011	1.1-009	2.8-011	2.8-011	6.7-011
224Ra	.43E+09	9.9-011	4.9-010	7.2-014	7.2-014	7.2-014
228Th	.43E+09	1.7-011	3.4-010	6.1-012	6.1-012	6.1-012

B.2 SUMMARY TABLES FOR INTRUSION WATER WELL SCENARIO

The following tables are expanded summaries of the consequence calculations for the intrusion water well scenario. The nuclides are listed in decreasing dose commitment to critical organs, along with the associated total body dose commitment and time of peak dose occurrence. Only Tables B.2.4, B.2.19 and B.2.35 contain complete lists of all dose causing nuclides for the respective parameter set. All other tables are arbitrarily cut off at the 20 most dose-significant isotopes in order to save space. Very little information is lost, since generally only a few isotopes dominate the dose and all others are orders of magnitude less significant.

TABLE B.2.1 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW01

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 3.22E+03 m;
groundwater travel time = 2.9E+02 yr; dispersion coefficient = 1.6E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.36E+05	7.1+002	9.4+002	.0	.0	.0
210Pb	.36E+05	8.4+000	2.1+002	.0	.0	.0
14C	.33E+03	1.9+001	9.7+001	1.9+001	1.9+001	1.9+001
99Tc	.33E+03	6.0-001	1.5+000	1.9-001	.0	8.1+001
234U	.20E+05	3.2+000	5.0+001	.0	.0	4.2+000
129I	.33E+03	4.5-002	1.6-002	.0	3.5+001	2.4-003
237Np	.72E+05	1.5+000	3.3+001	.0	.0	.0
239Pu	.17E+06	6.5-001	1.4+001	.0	.0	3.6+000
236U	.22E+05	6.1-001	9.7+000	.0	.0	.0
229Th	.36E+05	4.4-001	9.0+000	.0	.0	.0
238U	.20E+05	4.6-001	7.6+000	.0	.0	6.2-001
242Pu	.17E+06	3.2-001	6.5+000	.0	.0	1.7+000
225Ra	.36E+05	1.1+000	5.7+000	.0	.0	.0
59Ni	.22E+05	3.5-001	2.1+000	.0	.0	.0
233U	.36E+05	1.2-001	2.0+000	.0	.0	.0
210Po	.36E+05	3.3-001	1.4+000	.0	.0	.0
126Sn	.89E+05	2.3-002	8.1-001	.0	4.7-003	.0
235U	.20E+05	3.1-002	5.0-001	.0	.0	5.5-002
230Th	.36E+05	1.2-002	4.2-001	.0	.0	.0
135Cs	.21E+06	8.0-002	2.0-001	2.1-002	.0	.0

TABLE B.2.2 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW02

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+03 m;
groundwater travel time = 1.4E+02 yr; dispersion coefficient = 7.9E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.18E+05	7.9+002	1.0+003	.0	.0	.0
210Pb	.18E+05	9.3+000	2.4+002	.0	.0	.0
239Pu	.88E+05	9.2+000	2.0+002	.0	.0	5.1+001
14C	.16E+03	2.0+001	1.0+002	2.0+001	2.0+001	2.0+001
99Tc	.17E+03	6.0-001	1.5+000	1.9-001	.0	8.1+001
234U	.10E+05	3.4+000	5.5+001	.0	.0	4.5+000
129I	.17E+03	4.5-002	1.6-002	.0	3.5+001	2.4-003
237Np	.37E+05	1.5+000	3.4+001	.0	.0	.0
229Th	.18E+05	7.6-001	1.5+001	.0	.0	.0
242Pu	.88E+05	5.0-001	1.0+001	.0	.0	2.8+000
225Ra	.18E+05	2.0+000	9.8+000	.0	.0	.0
236U	.11E+05	5.3-001	8.5+000	.0	.0	.0
238U	.10E+05	4.6-001	7.6+000	.0	.0	6.2-001
233U	.18E+05	2.0-001	3.2+000	.0	.0	.0
59Ni	.11E+05	3.8-001	2.3+000	.0	.0	.0
210Po	.18E+05	3.6-001	1.5+000	.0	.0	.0
126Sn	.45E+05	3.3-002	1.2+000	.0	6.8-003	.0
230Th	.17E+06	3.2-002	1.1+000	.0	.0	.0
235U	.11E+05	3.1-002	5.0-001	.0	.0	5.5-002
240Pu	.88E+05	1.5-002	3.3-001	.0	.0	8.5-002

TABLE B.2.3 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW03

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.83E+05	1.0+003	1.3+003	.0	.0	.0
239Pu	.47E+05	3.2+001	6.9+002	.0	.0	1.7+002
210Pb	.83E+05	1.2+001	3.0+002	.0	.0	.0
14C	.86E+02	2.0+001	1.0+002	2.0+001	2.0+001	2.0+001
99Tc	.86E+02	6.0-001	1.5+000	1.9-001	.0	8.1+001
234U	.93E+04	3.4+000	5.5+001	.0	.0	4.5+000
129I	.86E+02	4.5-002	1.6-002	.0	3.5+001	2.4-003
237Np	.19E+05	1.5+000	3.5+001	.0	.0	.0
240Pu	.47E+05	1.3+000	2.8+001	.0	.0	7.3+000
242Pu	.47E+05	5.8-001	1.2+001	.0	.0	3.2+000
236U	.93E+04	6.1-001	9.7+000	.0	.0	.0
229Th	.93E+04	3.9-001	7.9+000	.0	.0	.0
238U	.93E+04	4.6-001	7.6+000	.0	.0	6.2-001
225Ra	.93E+04	1.0+000	5.0+000	.0	.0	.0
59Ni	.57E+04	4.0-001	2.4+000	.0	.0	.0
230Th	.88E+05	6.9-002	2.3+000	.0	.0	.0
210Po	.83E+05	4.6-001	1.9+000	.0	.0	.0
233U	.93E+04	1.1-001	1.8+000	.0	.0	.0
126Sn	.25E+05	3.9-002	1.4+000	.0	7.9-003	.0
235U	.93E+04	3.1-002	5.0-001	.0	.0	5.5-002

TABLE B.2.4 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW04

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 3.22E+02 m;
groundwater travel time = 2.9E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.37E+03	7.7+002	2.9+003	.0	.0	7.4+001
226Ra	.33E+05	1.6+003	2.1+003	.0	.0	.0
239Pu	.20E+05	6.5+001	1.4+003	.0	.0	3.6+002
210Pb	.33E+05	1.8+001	4.7+002	.0	.0	.0
240Pu	.20E+05	2.1+001	4.5+002	.0	.0	1.2+002
14C	.40E+02	2.0+001	1.0+002	2.0+001	2.0+001	2.0+001
99Tc	.40E+02	6.0-001	1.5+000	1.9-001	.0	8.1+001
234U	.40E+04	3.4+000	5.5+001	.0	.0	4.5+000
237Np	.82E+04	1.6+000	3.7+001	.0	.0	.0
129I	.40E+02	4.5-002	1.6-002	.0	3.5+001	2.4-002
243Am	.36E+05	4.9-001	1.2+001	.0	.0	.0
242Pu	.25E+05	5.8-001	1.2+001	.0	.0	3.2+000
236U	.10E+05	6.6-001	1.0+001	.0	.0	.0
229Th	.10E+05	5.0-001	1.0+001	.0	.0	.0
238U	.40E+04	4.6-001	7.6+000	.0	.0	6.2-001
225Ra	.10E+05	1.3+000	6.4+000	.0	.0	.0
230Th	.38E+05	1.1-001	3.6+000	.0	.0	.0
210Po	.33E+05	7.2-001	3.0+000	.0	.0	.0
159Ni	.24E+04	4.2-001	2.5+000	.0	.0	.0
233U	.10E+05	1.4-001	2.3+000	.0	.0	.0
126Sn	.10E+05	4.2-002	1.5+000	.0	8.7-003	.0
235U	.10E+05	3.5-002	5.7-001	.0	.0	6.3-002
135Cs	.25E+05	1.4-001	3.5-001	3.7-002	.0	.0
245Cm	.36E+05	1.2-002	2.9-001	.0	.0	.0
241Am	.36E+05	1.0-002	2.5-001	.0	.0	2.1-002
231Pa	.25E+05	8.8-003	2.1-001	.0	.0	.0
227Ac	.25E+05	6.4-003	1.0-001	.0	.0	.0
3H	.32E+02	1.5-002	.0	1.5-002	1.5-002	1.5-002
225Ac	.10E+05	2.7-004	4.1-003	.0	.0	.0
93Zr	.20E+05	4.9-005	1.8-003	.0	.0	.0
210Bi	.33E+05	1.0-003	1.8-003	.0	.0	.0
241Pu	.36E+05	6.5-005	1.7-003	.0	.0	4.0-004
93mNb	.20E+05	1.4-004	1.7-003	.0	.0	.0
63Ni	.20E+04	4.9-005	1.4-003	.0	.0	.0
228Ra	.38E+05	2.2-004	2.0-004	.0	.0	.0
126Sb	.10E+05	2.6-006	6.3-006	.0	1.3-007	.0
232Th	.38E+05	1.0-007	3.0-006	.0	.0	1.1-007
224Ra	.38E+05	2.0-007	1.0-006	.0	.0	.0
228Th	.38E+05	3.2-008	9.4-007	.0	.0	.0
232U	.20E+04	5.2-010	7.2-009	.0	.0	.0
87Rb	.53E+03	7.6-006	.0	.0	.0	.0
79Se	.40E+04	3.7+000	.0	.0	.0	.0
107Pd	.10E+05	2.0-022	.0	.0	.0	.0

TABLE B.2.5 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW05

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.30E+03	3.0+003	1.1+004	.0	.0	2.9+002
226Ra	.11E+05	1.7+003	2.2+003	.0	.0	.0
239Pu	.20E+05	7.1+001	1.5+003	.0	.0	3.0+002
240Pu	.15E+05	3.1+001	6.7+002	.0	.0	1.8+002
210Pb	.11E+05	2.0+001	5.2+002	.0	.0	.0
14C	.40E+02	2.0+001	1.0+002	2.0+001	2.0+001	2.0+001
99Tc	.40E+02	6.0-001	1.5+000	1.9-001	.0	8.1+001
234U	.37E+04	3.4+000	5.5+001	.0	.0	4.5+000
129I	.40E+02	4.5-002	1.6-002	.0	3.5+001	2.4-003
237Np	.83E+04	1.5+000	3.5+001	.0	.0	.0
243Am	.30E+05	7.5-001	1.9+001	.0	.0	.0
242Pu	.20E+05	5.8-001	1.2+001	.0	.0	3.2+000
236U	.92E+04	6.6-001	1.0+001	.0	.0	.0
229Th	.11E+05	5.1-001	1.0+001	.0	.0	.0
238U	.37E+04	4.6-001	7.6+000	.0	.0	6.2-001
225Ra	.11E+05	1.3+000	6.6+000	.0	.0	.0
230Th	.33E+05	1.1-001	3.8+000	.0	.0	.0
210Po	.11E+05	7.9-001	3.3+000	.0	.0	.0
59Ni	.23E+04	4.2-001	2.5+000	.0	.0	.0
233U	.11E+05	1.4-001	2.3+000	.0	.0	.0

TABLE B.2.6 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW06

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.30E+03	3.0+005	1.1+006	.0	.0	2.9+004
14C	.40E+02	2.0+003	1.0+004	2.0+003	2.0+003	2.0+003
99Tc	.40E+02	6.0+001	1.5+002	1.9+001	.0	8.1+003
239Pu	.14E+05	2.4+002	5.1+003	.0	.0	1.3+003
129I	.40E+02	4.5+000	1.6+000	.0	3.5+003	2.4+001
240Pu	.14E+05	1.3+002	2.7+003	.0	.0	7.0+002
234U	.14E+04	1.1+002	1.8+003	.0	.0	1.5+002
226Ra	.28E+04	4.5+002	5.9+002	.0	.0	.0
237Np	.56E+04	1.8+001	4.1+002	.0	.0	.0
238U	.14E+04	1.3+001	2.2+002	.0	.0	1.8+001
236U	.14E+04	1.2+001	1.9+002	.0	.0	.0
210Pb	.28E+04	5.3+000	1.3+002	.0	.0	.0
59Ni	.17E+04	9.9+000	5.8+001	.0	.0	.0
243Am	.28E+05	1.7+000	4.3+001	.0	.0	.0
242Pu	.14E+05	1.8+000	3.7+001	.0	.0	9.9+000
235U	.14E+04	7.7+001	1.3+001	.0	.0	1.4+000
229Th	.56E+04	4.7+001	9.6+000	.0	.0	.0
126Sn	.70E+04	2.6+001	9.0+000	.0	5.3+002	.0
225Ra	.56E+04	1.2+000	6.1+000	.0	.0	.0
233U	.56E+04	1.3+001	2.1+000	.0	.0	.0

TABLE B.2.7 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW07

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.30E+03	3.0+004	1.1+005	.0	.0	2.9+003
239Pu	.14E+05	2.3+002	5.0+003	.0	.0	1.3+003
240Pu	.14E+05	1.2+002	2.6+003	.0	.0	6.7+002
14C	.40E+02	2.0+002	1.0+003	2.0+002	2.0+002	2.0+002
99Tc	.40E+02	6.1+000	1.5+001	1.9+000	.0	8.1+002
226Ra	.33E+04	5.5+002	7.2+002	.0	.0	.0
234U	.17E+04	3.4+001	5.5+002	.0	.0	4.5+001
129I	.40E+02	4.5-001	1.6-001	.0	3.5+002	2.5-002
237Np	.60E+04	1.3+001	2.8+002	.0	.0	.0
210Pb	.33E+04	6.5+000	1.6+002	.0	.0	.0
238U	.19E+04	4.6+000	7.6+001	.0	.0	6.2+000
236U	.19E+04	4.6+000	7.3+001	.0	.0	.0
243Am	.28E+05	1.7+000	4.3+001	.0	.0	.0
242Pu	.14E+05	1.7+000	3.6+001	.0	.0	9.6+000
59Ni	.22E+04	4.0+000	2.4+001	.0	.0	.0
229Th	.33E+04	4.4-001	9.0+000	.0	.0	.0
126Sn	.74E+04	2.3-001	8.1+000	.0	4.7-002	.0
225Ra	.33E+04	1.1+000	5.7+000	.0	.0	.0
235U	.19E+04	2.9-001	4.7+000	.0	.0	5.2-001
233U	.22E+04	1.3-001	2.2+000	.0	.0	.0

TABLE B.2.8 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW08

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+05	4.3+003	5.6+003	.0	.0	.0
239Pu	.24E+05	1.7+002	3.7+003	.0	.0	9.5+002
210Pb	.12E+05	5.0+001	1.3+003	.0	.0	.0
240Pu	.24E+05	4.2+001	9.1+002	.0	.0	2.4+002
99Tc	.10E+05	5.9+000	1.5+001	1.8+000	.0	7.9+002
234U	.12E+05	3.4+001	5.5+002	.0	.0	4.5+001
129I	.10E+05	4.5-001	1.6-001	.0	3.5+002	2.5-002
14C	.10E+05	6.0+001	3.0+002	6.0+001	6.0+001	6.0+001
237Np	.16E+05	9.6+000	2.2+002	.0	.0	.0
236U	.12E+05	5.8+000	9.3+001	.0	.0	.0
238U	.12E+05	4.6+000	7.6+001	.0	.0	6.2+000
242Pu	.24E+05	1.7+000	3.6+001	.0	.0	9.6+000
159N	.12E+05	3.8+000	2.3+001	.0	.0	.0
243Am	.38E+05	6.7-001	1.7+001	.0	.0	.0
233U	.12E+05	1.0+000	1.7+001	.0	.0	.0
230Th	.38E+05	2.8-001	9.5+000	.0	.0	.0
210Po	.12E+05	2.0+000	8.1+000	.0	.0	.0
126Sn	.17E+05	2.2-001	7.7+000	.0	4.5-002	.0
235U	.12E+05	3.1-001	5.0+000	.0	.0	5.5-001
231Pa	.24E+05	3.5-002	8.4-001	.0	.0	.0

TABLE B.2.9 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW09

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+06	2.9+004	3.8+004	.0	.0	.0
210Pb	.10E+06	3.4+002	8.8+003	.0	.0	.0
99Tc	.10E+06	4.4+000	1.1+001	1.3+000	.0	5.9+002
234U	.10E+06	2.6+001	4.2+002	.0	.0	3.5+001
129I	.10E+06	4.5-001	1.6-001	.0	3.5+002	2.5-002
239Pu	.11E+06	1.4+001	2.9+002	.0	.0	7.4+001
237Np	.11E+06	9.2+000	2.1+002	.0	.0	.0
233U	.10E+06	7.6+000	1.2+002	.0	.0	.0
236U	.10E+06	6.6+000	1.0+002	.0	.0	.0
238U	.10E+06	4.6+000	7.6+001	.0	.0	6.2+000
210Po	.10E+06	1.3+001	5.6+001	.0	.0	.0
230Th	.13E+06	1.5+000	5.2+001	.0	.0	.0
242Pu	.11E+06	1.5+000	3.0+001	.0	.0	8.2+000
59Ni	.10E+06	1.7+000	1.0+001	.0	.0	.0
229Th	.13E+06	4.1-001	8.5+000	.0	.0	.0
235U	.10E+06	4.3-001	7.0+000	.0	.0	7.7-001
225Ra	.13E+06	1.1+000	5.3+000	.0	.0	.0
231Pa	.11E+06	2.0-001	4.7+000	.0	.0	.0
126Sn	.11E+06	1.1-001	3.8+000	.0	2.2-002	.0
227Ac	.11E+06	1.4-001	2.2+000	.0	.0	.0

TABLE B.2.10 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW10

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+07	1.4+004	1.9+004	.0	.0	.0
210Pb	.10E+07	1.7+002	4.3+003	.0	.0	.0
129I	.10E+07	4.3-001	1.6-001	.0	3.4+002	2.3-002
233U	.10E+07	1.7+001	2.8+002	.0	.0	.0
237Np	.10E+07	6.9+000	1.6+002	.0	.0	.0
234U	.10E+07	7.9+000	1.3+002	.0	.0	1.0+001
236U	.10E+07	6.6+000	1.0+002	.0	.0	.0
238U	.10E+07	4.6+000	7.6+001	.0	.0	6.2+000
99Tc	.10E+07	2.3-001	5.6-001	7.1-002	.0	3.0+001
210Po	.10E+07	6.6+000	2.7+001	.0	.0	.0
230Th	.10E+07	7.9-001	2.6+001	.0	.0	.0
229Th	.10E+07	1.0+000	2.1+001	.0	.0	.0
225Ra	.10E+07	2.6+000	1.3+001	.0	.0	.0
235U	.10E+07	4.3-001	7.0+000	.0	.0	7.7-001
242Pu	.10E+07	2.8-001	5.7+000	.0	.0	1.5+000
231Pa	.10E+07	2.4-001	5.7+000	.0	.0	.0
227Ac	.10E+07	1.7-001	2.7+000	.0	.0	.0
135Cs	.10E+07	2.8-001	6.7-001	7.1-002	.0	.0
228Ra	.10E+07	8.4-002	7.6-002	.0	.0	.0
210Bi	.10E+07	9.3-003	1.6-002	.0	.0	.0

TABLE B.2.11 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW11

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.68+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.46E+05	2.1+002	2.7+002	.0	.0	.0
90Sr	.30E+03	3.0+001	1.1+002	.0	.0	2.9+000
210Pb	.46E+05	2.4+000	6.2+001	.0	.0	.0
239Pu	.20E+05	7.1-001	1.5+001	.0	.0	3.9+000
240Pu	.15E+05	3.2-001	6.7+000	.0	.0	1.8+000
14C	.40E+02	2.0-001	1.0+000	2.0-001	2.0-001	2.0-001
99Tc	.40E+02	6.1-003	1.5-002	1.9-003	.0	8.1-001
234U	.37E+04	3.4-002	5.5-001	.0	.0	4.5-002
210Po	.46E+05	9.5-002	3.9-001	.0	.0	.0
129I	.40E+02	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.83E+04	1.5-002	3.5-001	.0	.0	.0
229Th	.46E+05	1.7-002	3.4-001	.0	.0	.0
225Ra	.46E+05	4.3-002	2.1-001	.0	.0	.0
243Am	.30E+05	7.5-003	1.9-001	.0	.0	.0
230Th	.46E+05	3.6-003	1.2-001	.0	.0	.0
242Pu	.24E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.24E+05	6.9-003	1.1-001	.0	.0	.0
238U	.37E+04	4.6-003	7.6-002	.0	.0	6.2-003
233U	.46E+05	4.3-003	7.0-002	.0	.0	.0
159N	.23E+04	4.2-003	2.5-002	.0	.0	.0

TABLE B.2.12 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW12

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.47E+05	2.1+002	2.8+002	.0	.0	.0
210Pb	.47E+05	2.5+000	6.4+001	.0	.0	.0
239Pu	.21E+05	6.5-001	1.4+001	.0	.0	3.6+000
240Pu	.16E+05	2.8-001	6.1+000	.0	.0	1.6+000
14C	.10E+04	1.8-001	8.9-001	1.8-001	1.8-001	1.8-001
99Tc	.10E+04	6.1-003	1.5-002	1.9-003	.0	8.1-001
234U	.47E+04	3.4-002	5.5-001	.0	.0	4.5-002
210Po	.47E+05	9.8-002	4.1-001	.0	.0	.0
129I	.10E+04	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.93E+04	1.5-002	3.4-001	.0	.0	.0
243Am	.31E+05	6.7-003	1.7-001	.0	.0	.0
230Th	.47E+05	3.6-003	1.2-001	.0	.0	.0
242Pu	.25E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.25E+05	6.9-003	1.1-001	.0	.0	.0
229Th	.47E+05	4.3-003	8.7-002	.0	.0	.0
238U	.47E+04	4.6-003	7.6-002	.0	.0	6.2-003
233U	.47E+05	4.3-003	7.0-002	.0	.0	0
225Ra	.47E+05	1.1-002	5.5-002	.0	.0	.0
59Ni	.47E+04	4.0-003	2.4-002	.0	.0	.0
126Sn	.10E+05	4.2-004	1.5-002	.0	8.7-005	.0

TABLE B.2.13 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW13

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.56E+05	2.5+002	3.3+002	.0	.0	.0
210Pb	.56E+05	2.9+000	7.5+001	.0	.0	.0
239Pu	.25E+05	5.2-001	1.1+001	.0	.0	2.8+000
240Pu	.25E+05	1.1-001	2.4+000	.0	.0	6.4-001
99Tc	.10E+05	5.9-003	1.5-002	1.8-003	.0	7.9-001
234U	.14E+05	3.4-002	5.5-001	.0	.0	4.5-002
210Po	.56E+05	1.2-001	4.8-001	.0	.0	.0
129I	.10E+05	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.18E+05	1.5-002	3.4-001	.0	.0	.0
14C	.10E+05	6.0-002	3.0-001	6.0-002	6.0-002	6.0-002
230Th	.56E+05	4.8-003	1.6-001	.0	.0	.0
242Pu	.34E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.34E+05	6.9-003	1.1-001	.0	.0	.0
233U	.56E+05	5.1-003	8.4-002	.0	.0	.0
243Am	.40E+05	3.1-003	7.7-002	.0	.0	.0
238U	.14E+05	4.6-003	7.6-002	.0	.0	6.2-003
229Th	.56E+05	1.7-003	3.4-002	.0	.0	.0
59Ni	.12E+05	3.8-003	2.3-002	.0	.0	.0
225Ra	.56E+05	4.3-003	2.1-002	.0	.0	.0
126Sn	.19E+05	4.0-004	1.4-002	.0	8.1-005	.0

TABLE B.2.14 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW14

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+07	2.1+002	2.8+002	.0	.0	.0
210Pb	.10E+07	2.5+000	6.4+001	.0	.0	.0
210Po	.10E+07	9.8-002	4.1-001	.0	.0	.0
129I	.10E+07	4.3-004	1.6-004	.0	3.4-001	2.3-005
233U	.10E+07	1.7-002	2.8-001	.0	.0	.0
237Np	.10E+07	1.1-002	2.5-001	.0	.0	.0
230Th	.10E+07	5.7-003	1.9-001	.0	.0	.0
229Th	.10E+07	8.7-003	1.8-001	.0	.0	.0
234U	.10E+07	7.9-003	1.3-001	.0	.0	1.0-002
225Ra	.10E+07	2.2-002	1.1-001	.0	.0	.0
236U	.10E+07	6.6-003	1.1-001	.0	.0	.0
238U	.10E+07	4.6-003	7.6-002	.0	.0	6.2-003
99Tc	.10E+07	2.3-004	5.7-004	7.1-005	.0	3.1-002
231Pa	.10E+07	8.3-004	2.0-002	.0	.0	.0
242Pu	.10E+07	9.4-004	1.9-002	.0	.0	5.2-003
227Ac	.10E+07	6.0-004	9.4-003	.0	.0	.0
235U	.10E+07	4.3-004	7.0-003	.0	.0	7.7-004
135Cs	.10E+07	1.2-003	2.8-003	3.0-004	.0	.0
228Ra	.10E+07	5.7-004	5.2-004	.0	.0	.0
210Bi	.10E+07	1.4-004	2.4-004	.0	.0	.0

TABLE B.2.15 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW15

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.99E+05	3.4+002	4.4+002	.0	.0	.0
210pb	.99E+05	4.0+000	1.0+002	.0	.0	.0
239Pu	.47E+05	3.2-001	6.7+000	.0	.0	1.7+000
14C	.86E+02	2.0-001	1.0+000	2.0-001	2.0-001	2.0-001
99Tc	.86E+02	6.1-003	1.5-002	1.9-003	.0	8.1-001
229Th	.99E+05	3.2-002	6.5-001	.0	.0	.0
210Po	.99E+05	1.5-001	6.4-001	.0	.0	.0
234U	.93E+04	3.4-002	5.5-001	.0	.0	4.5-002
225Ra	.99E+05	8.2-002	4.1-001	.0	.0	.0
129I	.86E+02	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.19E+05	1.5-002	3.5-001	.0	.0	.0
240Pu	.47E+05	1.2-002	2.7-001	.0	.0	7.0-002
233U	.99E+05	8.6-003	1.4-001	.0	.0	.0
242Pu	.57E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.25E+05	7.1-003	1.1-001	.0	.0	.0
230Th	.99E+05	2.4-003	8.1-002	.0	.0	.0
238U	.93E+04	4.6-003	7.6-002	.0	.0	6.2-003
159N	.57E+04	4.0-003	2.4-002	.0	.0	.0
126Sn	.25E+05	3.9-004	1.4-002	.0	7.9-005	.0
231Pa	.99E+05	3.3-004	7.9-003	.0	.0	.0

TABLE B.2.16 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW16

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+06	3.4+002	4.5+002	.0	.0	.0
210Pb	.10E+06	4.0+000	1.0+002	.0	.0	.0
239Pu	.48E+05	3.1-001	6.6+000	.0	.0	1.7+000
14C	.11E+04	1.8-001	8.9-001	1.8-001	1.8-001	1.8-001
99Tc	.11E+04	6.1-003	1.5-002	1.9-003	.0	8.1-001
210Po	.10E+06	1.6-001	6.5-001	.0	.0	.0
234U	.10E+05	3.4-002	5.5-001	.0	.0	4.5-002
129I	.11E+04	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.20E+05	1.5-002	3.4-001	.0	.0	.0
240Pu	.48E+05	1.1-002	2.3-001	.0	.0	6.1-002
229Th	.10E+06	8.2-003	1.7-001	.0	.0	.0
233U	.10E+06	8.9-003	1.4-001	.0	.0	.0
242Pu	.58E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.26E+05	6.9-003	1.1-001	.0	.0	.0
225Ra	.10E+06	2.1-002	1.1-001	.0	.0	.0
230Th	.10E+06	2.6-003	8.8-002	.0	.0	.0
238U	.10E+05	4.6-003	7.6-002	.0	.0	6.2-003
159N	.67E+04	4.0-003	2.4-002	.0	.0	.0
126Sn	.26E+05	3.9-004	1.4-002	.0	7.9-005	.0
231Pa	.10E+06	3.4-004	8.0-003	.0	.0	.0

TABLE B.2.17 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW17

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+06	3.8+002	5.0+002	.0	.0	.0
210Pb	.11E+06	4.5+000	1.1+002	.0	.0	.0
239Pu	.57E+05	2.4-001	5.1+000	.0	.0	1.3+000
99Tc	.10E+05	5.9-003	1.5-002	1.8-003	.0	7.9-001
210Po	.11E+06	1.7-001	7.2-001	.0	.0	.0
234U	.19E+05	3.4-002	5.5-001	.0	.0	4.5-002
129I	.10E+05	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.35E+05	1.5-002	3.4-001	.0	.0	.0
14C	.10E+05	6.0-002	3.0-001	6.0-002	6.0-002	6.0-002
233U	.11E+06	9.4-003	1.5-001	.0	.0	.0
242Pu	.57E+05	5.8-003	1.2-001	.0	.0	3.2-002
236U	.35E+05	6.9-003	1.1-001	.0	.0	.0
230Th	.11E+06	3.2-003	1.1-001	.0	.0	.0
240Pu	.57E+05	4.4-003	9.4-002	.0	.0	2.5-002
238U	.19E+05	4.6-003	7.6-002	.0	.0	6.2-003
229Th	.11E+06	2.2-003	4.5-002	.0	.0	.0
225Ra	.11E+06	5.7-003	2.9-002	.0	.0	.0
159N	.16E+05	3.6-003	2.2-002	.0	.0	.0
126Sn	.35E+05	3.6-004	1.3-002	.0	7.4-005	.0
231Pa	.11E+06	3.6-004	8.6-003	.0	.0	.0

TABLE B.2.18 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW18

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.19E+03	6.6+004	2.4+005	.0	.0	6.3+003
226Ra	.10E+05	2.0+003	2.6+003	.0	.0	.0
240Pu	.10E+05	6.5+001	1.4+003	.0	.0	3.6+002
210Pb	.10E+05	2.4+001	6.0+002	.0	.0	.0
14C	.21E+02	2.0+001	1.0+002	2.0+001	2.0+001	2.0+001
99Tc	.21E+02	6.1-001	1.5+000	1.8-001	.0	8.2+001
243Am	.18E+05	2.6+000	6.6+001	.0	.0	.0
234U	.11E+04	3.7+000	5.9+001	.0	.0	4.9+000
237Np	.42E+04	1.6+000	3.7+001	.0	.0	.0
129I	.21E+02	4.5-002	1.6-002	.0	3.5+001	2.4-003
242Pu	.13E+05	6.3-001	1.3+001	.0	.0	3.5+000
236U	.84E+04	6.6-001	1.0+001	.0	.0	.0
229Th	.10E+05	4.3-001	8.7+000	.0	.0	.0
238U	.20E+04	4.6-001	7.6+000	.0	.0	6.2-001
225Ra	.10E+05	1.1+000	5.5+000	.0	.0	.0
230Th	.22E+05	1.4-001	4.7+000	.0	.0	.0
210Po	.10E+05	9.2-001	3.8+000	.0	.0	.0
233U	.10E+05	1.2-001	2.0+000	.0	.0	.0
126Sn	.51E+04	4.4-002	1.5+000	.0	8.9-003	.0
245Cm	.18E+05	5.3-002	1.3+000	.0	.0	.0

TABLE B.2.19 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW19

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.19E+03	6.6+006	2.4+007	.0	.0	6.3+005
240Pu	.83E+04	6.0+002	1.3+004	.0	.0	3.3+003
14C	.21E+02	2.0+003	1.0+004	2.0+003	2.0+003	2.0+003
99Tc	.21E+02	6.1+001	1.5+002	1.8+001	.0	8.2+003
234U	.90E+03	2.3+002	3.6+003	.0	.0	3.0+002
129I	.21E+02	4.5+000	1.6+000	.0	3.5+003	2.4-001
238U	.90E+03	3.0+001	5.1+002	.0	.0	4.1+001
236U	.90E+03	3.0+001	4.9+002	.0	.0	.0
237Np	.34E+04	2.0+001	4.5+002	.0	.0	.0
226Ra	.17E+04	3.2+002	4.2+002	.0	.0	.0
243Am	.17E+05	1.3+001	3.4+002	.0	.0	.0
242Am	.83E+04	4.9+000	1.0+002	.0	.0	2.7+001
210Pb	.17E+04	3.8+000	9.7+001	.0	.0	.0
126Sn	.42E+04	7.1-001	2.5+001	.0	1.4-001	.0
229Th	.34E+04	4.4-001	9.0+000	.0	.0	.0
245Cm	.17E+05	2.7-001	6.4+000	.0	.0	.0
225Ra	.34E+04	1.1+000	5.7+000	.0	.0	.0
241Am	.17E+05	2.2-001	5.5+000	.0	.0	4.6-001
135Cs	.10E+05	9.5-001	2.3+000	2.4-001	.0	.0
233U	.34E+04	1.1-001	1.8+000	.0	.0	.0
210Po	.17E+04	1.5-001	6.1-001	.0	.0	.0
230Th	.17E+04	1.5-002	5.0-001	.0	.0	.0
239Pu	.17E+05	2.2-002	4.7-001	.0	.0	1.2-001
241Pu	.17E+05	1.4-003	3.8-002	.0	.0	8.8-003
93Zr	.67E+04	4.9-004	1.8-002	.0	.0	.0
93mNb	.67E+04	1.4-003	1.7-002	.0	.0	.0
225Ac	.34E+04	2.4-004	3.6-003	.0	.0	.0
210Bi	.17E+04	2.1-004	3.6-004	.0	.0	.0
231Pa	.28E+06	1.5-005	3.6-004	.0	.0	.0
227Ac	.28E+06	1.1-005	1.7-004	.0	.0	.0
126Sb	.42E+04	4.4-005	1.0-004	.0	2.1-006	.0
228Ra	.83E+04	2.6-005	2.4-005	.0	.0	.0
235U	.28E+06	1.2-006	1.9-005	.0	.0	2.1-006
232Th	.83E+04	1.2-008	3.5-007	.0	.0	1.3-008
224Ra	.83E+04	2.4-008	1.2-007	.0	.0	.0
228Th	.83E+04	3.8-009	1.1-007	.0	.0	.0
238Pu	.70E+04	6.4-023	1.3-021	.0	.0	4.2-022
79Se	.17E+04	1.5+002	.0	.0	.0	.0

TABLE B.2.20 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW20

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.19E+03	6.6+002	2.4+003	.0	.0	6.3+001
226Ra	.30E+06	3.6+002	4.7+002	.0	.0	.0
210Pb	.30E+06	4.2+000	1.1+002	.0	.0	.0
240Pu	.10E+05	6.5-001	1.4+001	.0	.0	3.6+000
229Th	.95E+06	6.9-002	1.4+000	.0	.0	.0
14C	.21E+02	2.0-001	1.0+000	2.0-001	2.0-001	2.0-001
225Ra	.95E+06	1.8-001	8.9-001	.0	.0	.0
210Po	.30E+06	1.6-001	6.8-001	.0	.0	.0
243Am	.18E+05	2.6-002	6.6-001	.0	.0	.0
234U	.11E+04	3.7-002	5.9-001	.0	.0	4.9-002
230Th	.30E+06	1.6-002	5.4-001	.0	.0	.0
237Np	.42E+04	1.6-002	3.7-001	.0	.0	.0
129I	.21E+02	4.5-004	1.6-004	.0	3.6-001	2.5-005
233U	.95E+06	1.8-002	2.9-001	.0	.0	.0
242Pu	.13E+05	6.3-003	1.3-001	.0	.0	3.5-002
236U	.13E+05	6.6-003	1.1-001	.0	.0	.0
238U	.20E+04	4.6-003	7.6-002	.0	.0	6.2-003
126Sn	.51E+04	4.4-004	1.5-002	.0	8.9-005	.0
245Cm	.18E+05	5.3-004	1.3-002	.0	.0	.0
241Am	.18E+05	4.4-004	1.1-002	.0	.0	9.3-004

TABLE B.2.21 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW21

Parametric Data

Release duration = 1.0E+08 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.19E+03	6.6+000	2.4+001	.0	.0	6.3-001
226Ra	.30E+06	3.1+000	4.0+000	.0	.0	.0
210Pb	.30E+06	3.6-002	9.2-001	.0	.0	.0
240Pu	.10E+05	6.5-003	1.4-001	.0	.0	3.6-002
14C	.21E+02	2.0-003	1.0-002	2.0-003	2.0-003	2.0-003
229Th	.30E+06	4.1-004	8.4-003	.0	.0	.0
99Tc	.21E+02	6.1-005	1.5-004	1.8-005	.0	8.2-003
243Am	.18E+05	2.6-004	6.6-003	.0	.0	.0
234U	.11E+04	3.7-004	5.9-003	.0	.0	4.9-004
210Po	.30E+06	1.4-003	5.8-003	.0	.0	.0
225Ra	.30E+06	1.1-003	5.3-003	.0	.0	.0
230Th	.30E+06	1.3-004	4.3-003	.0	.0	.0
237Np	.42E+04	1.6-004	3.7-003	.0	.0	.0
129I	.21E+02	4.5-006	1.6-006	.0	3.5-003	2.4-007
233U	.30E+06	9.4-005	1.5-003	.0	.0	.0
242Pu	.13E+05	6.3-005	1.3-003	.0	.0	3.5-004
236U	.13E+05	6.6-005	1.1-003	.0	.0	.0
238U	.20E+04	4.6-005	7.6-004	.0	.0	6.2-005
126Sn	.51E+04	4.4-006	1.5-004	.0	8.9-007	.0

TABLE B.2.22 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW22

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 3.0E+02 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
240Pu	.86E+04	6.0+002	1.3+004	.0	.0	3.3+003
14C	.32E+03	1.9+003	9.7+003	1.9+003	1.9+003	1.9+003
99Tc	.32E+03	6.1+001	1.5+002	1.8+001	.0	8.2+003
234U	.12E+04	2.3+002	3.6+003	.0	.0	3.0+002
129I	.32E+03	4.5+000	1.6+000	.0	3.5+003	2.4-001
90Sr	.49E+03	3.5+002	1.3+003	.0	.0	3.4+001
226Ra	.14E+04	4.2+002	5.5+002	.0	.0	.0
237Np	.37E+04	2.3+001	5.3+002	.0	.0	.0
238U	.12E+04	3.0+001	5.1+002	.0	.0	4.1+001
236U	.12E+04	3.0+001	4.9+002	.0	.0	.0
243Am	.17E+05	1.3+001	3.2+002	.0	.0	.0
210Pb	.14E+04	5.0+000	1.3+002	.0	.0	.0
242Pu	.86E+04	4.9+000	1.0+002	.0	.0	2.7+001
126Sn	.45E+04	7.1-001	2.5+001	.0	1.4-001	.0
245Cm	.17E+05	2.5-001	6.0+000	.0	.0	.0
241Am	.17E+05	2.0-001	5.1+000	.0	.0	4.3-001
229Th	.37E+04	2.3-001	4.8+000	.0	.0	.0
233U	.12E+04	1.9-001	3.1+000	.0	.0	.0
225Ra	.37E+04	6.0-001	3.0+000	.0	.0	.0
135Cs	.10E+05	9.5-001	2.3+000	2.4-001	.0	.0

TABLE B.2.23 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW23

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
240Pu	.93E+04	5.4+002	1.2+004	.0	.0	3.0+003
14C	.10E+04	1.8+003	8.9+003	1.8+003	1.8+003	1.8+003
99Tc	.10E+04	6.0+001	1.5+002	1.8+001	.0	8.2+003
234U	.19E+04	2.3+002	3.7+003	.0	.0	3.1+002
129I	.10E+04	4.5+000	1.6+000	.0	3.5+003	2.4-001
226Ra	.21E+04	1.0+003	1.3+003	.0	.0	.0
237Np	.44E+04	2.7+001	6.2+002	.0	.0	.0
238U	.19E+04	3.0+001	5.1+002	.0	.0	4.1+001
236U	.19E+04	3.0+001	4.9+002	.0	.0	.0
243Am	.18E+05	1.2+001	3.1+002	.0	.0	.0
210Pb	.21E+04	1.2+001	3.0+002	.0	.0	.0
242Pu	.93E+04	4.9+000	1.0+002	.0	.0	2.7+001
126Sn	.52E+04	7.1-001	2.5+001	.0	1.4-001	.0
233U	.19E+04	5.1-001	8.4+000	.0	.0	.0
245Cm	.18E+05	2.3-001	5.5+000	.0	.0	.0
241Am	.18E+05	1.9-001	4.7+000	.0	.0	4.0-001
230Th	.18E+05	8.7-002	2.9+000	.0	.0	.0
135Cs	.11E+05	9.5-001	2.3+000	2.4-001	.0	.0
210Po	.21E+04	4.6-001	1.9+000	.0	.0	.0
229Th	.44E+04	8.7-002	1.8+000	.0	.0	.0

TABLE B.2.24 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW24

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+05	2.4+004	3.2+004	.0	.0	.0
99Tc	.10E+05	5.9+001	1.5+002	1.8+001	.0	7.9+003
210Pb	.11E+05	2.9+002	7.3+003	.0	.0	.0
240Pu	.18E+05	2.2+002	4.8+003	.0	.0	1.2+003
234U	.11E+05	2.3+002	3.7+003	.0	.0	3.0+002
129I	.10E+05	4.5+000	1.6+000	.0	3.5+003	2.4+001
14C	.10E+05	6.0+002	3.0+003	6.0+002	6.0+002	6.0+002
237Np	.13E+05	2.9+001	6.6+002	.0	.0	.0
236U	.11E+05	4.1+001	6.5+002	.0	.0	.0
238U	.11E+05	3.0+001	5.1+002	.0	.0	4.1+001
243Am	.27E+05	5.4+000	1.3+002	.0	.0	.0
233U	.11E+05	6.2+000	1.0+002	.0	.0	.0
242Pu	.18E+05	4.9+000	1.0+002	.0	.0	2.7+001
210Po	.11E+05	1.1+001	4.6+001	.0	.0	.0
230Th	.27E+05	7.7+001	2.6+001	.0	.0	.0
126Sn	.14E+05	6.7+001	2.3+001	.0	1.4+001	.0
229Th	.27E+05	1.4+001	2.8+000	.0	.0	.0
245Cm	.27E+05	1.1+001	2.7+000	.0	.0	.0
135Cs	.20E+05	9.5+001	2.3+000	2.4+001	.0	.0
241Am	.27E+05	9.3+002	2.3+000	.0	.0	2.0+001

TABLE B.2.25 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW25

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+06	1.9+005	2.5+005	.0	.0	.0
210Pb	.10E+06	2.3+003	5.8+004	.0	.0	.0
99Tc	.10E+06	4.4+001	1.1+002	1.3+001	.0	5.9+003
129I	.10E+06	4.5+000	1.6+000	.0	3.5+003	2.4+001
234U	.10E+06	1.9+002	3.0+003	.0	.0	2.5+002
233U	.10E+06	5.1+001	8.4+002	.0	.0	.0
236U	.10E+06	4.6+001	7.3+002	.0	.0	.0
237Np	.10E+06	2.9+001	6.6+002	.0	.0	.0
238U	.10E+06	3.0+001	5.1+002	.0	.0	4.1+001
229Th	.12E+06	3.0+000	6.2+001	.0	.0	.0
225Ra	.12E+06	7.8+000	3.9+001	.0	.0	.0
126Sn	.10E+06	3.2+001	1.1+001	.0	6.6+002	.0
135Cs	.11E+06	9.5+001	2.3+000	2.4+001	.0	.0
240Pu	.11E+06	2.2+002	4.7+001	.0	.0	1.2+001
210Bi	.10E+06	1.3+001	2.2+001	.0	.0	.0
14C	.10E+06	1.1+002	5.7+002	1.1+002	1.1+002	1.1+002
243Am	.12E+06	1.5+003	3.9+002	.0	.0	.0
228Ra	.12E+06	3.3+002	3.0+002	.0	.0	.0
225Ac	.12E+06	1.7+003	2.5+002	.0	.0	.0
93Zr	.11E+06	4.9+004	1.8+002	.0	.0	.0

TABLE B.2.26 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW26

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+07	9.3+004	1.2+005	.0	.0	.0
210Pb	.10E+07	1.1+003	2.8+004	.0	.0	.0
129I	.10E+07	4.3+000	1.6+000	.0	3.4+003	2.3-001
233U	.10E+07	1.2+002	1.9+003	.0	.0	.0
234U	.10E+07	5.5+001	8.8+002	.0	.0	7.3+001
236U	.10E+07	4.6+001	7.3+002	.0	.0	.0
238U	.10E+07	3.0+001	5.1+002	.0	.0	4.1+001
237Np	.10E+07	2.2+001	4.9+002	.0	.0	.0
99Tc	.10E+07	2.2+000	5.7+000	6.8-001	.0	3.0+002
210Po	.10E+07	4.3+001	1.8+002	.0	.0	.0
229Th	.10E+07	7.6+000	1.5+002	.0	.0	.0
225Ra	.10E+07	2.0+001	9.8+001	.0	.0	.0
230Th	.10E+07	2.4+000	8.1+001	.0	.0	.0
242Pu	.10E+07	7.9-001	1.6+001	.0	.0	4.4+000
135Cs	.10E+07	8.0-001	2.0+000	2.1-001	.0	.0
228Ra	.10E+07	2.2-001	2.0-001	.0	.0	.0
210Bi	.10E+07	6.0-002	1.1-001	.0	.0	.0
225Ac	.10E+07	4.2-003	6.2-002	.0	.0	.0
126Sn	.10E+07	7.0-004	2.4-002	.0	1.4-004	.0
93Zr	.10E+07	3.3-004	1.2-002	.0	.0	.0

TABLE B.2.27 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW27

Parametric Data

Release duration = 1.0E+06 yr; delay prior to release = 3.0E+02 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.30E+06	3.9+002	5.1+002	.0	.0	.0
210Pb	.30E+06	4.6+000	1.2+002	.0	.0	.0
240Pu	.96E+04	6.5-001	1.4+001	.0	.0	3.6+000
14C	.32E+03	2.0-001	9.7-001	2.0-001	2.0-001	2.0-001
229Th	.95E+06	4.6-002	9.3-001	.0	.0	.0
99Tc	.32E+03	6.1-003	1.5-002	1.8-003	.0	8.2-001
210Po	.30E+06	1.8-001	7.3-001	.0	.0	.0
243Am	.19E+05	2.6-002	6.6-001	.0	.0	.0
225Ra	.95E+06	1.2-001	5.9-001	.0	.0	.0
234U	.23E+04	3.4-002	5.5-001	.0	.0	4.5-002
230Th	.30E+06	1.6-002	5.3-001	.0	.0	.0
129I	.32E+03	4.5-004	1.6-004	.0	3.6-001	2.5-005
237Np	.45E+04	1.5-002	3.4-001	.0	.0	.0
233U	.95E+06	1.7-002	2.7-001	.0	.0	.0
90Sr	.49E+03	3.5-002	1.3-001	.0	.0	3.4-003
242Pu	.13E+05	6.3-003	1.3-001	.0	.0	3.5-002
236U	.13E+05	6.6-003	1.1-001	.0	.0	.0
238U	.23E+04	4.6-003	7.6-002	.0	.0	6.2-003
231Pa	.95E+06	2.2-003	5.3-002	.0	.0	.0
227Ac	.95E+06	1.6-003	2.5-002	.0	.0	.0

TABLE B.2.28 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW28

Parametric Data

Release duration = 1.0E+08 yr; delay prior to release = 3.0E+02 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.30E+06	3.4+000	4.4+000	.0	.0	.0
210Pb	.30E+06	4.0-002	1.0+000	.0	.0	.0
240Pu	.96E+04	6.5-003	1.4-001	.0	.0	3.6-002
14C	.32E+03	2.0-003	9.7-003	2.0-003	2.0-003	2.0-003
99Tc	.32E+03	6.1-005	1.5-004	1.8-005	.0	8.2-003
243Am	.19E+05	2.6-004	6.6-003	.0	.0	.0
210Po	.30E+06	1.5-003	6.4-003	.0	.0	.0
229Th	.30E+06	2.8-004	5.6-003	.0	.0	.0
234U	.23E+04	3.4-004	5.5-003	.0	.0	4.5-004
230Th	.30E+06	1.3-004	4.2-003	.0	.0	.0
225Ra	.30E+06	7.1-004	3.6-003	.0	.0	.0
129I	.32E+03	4.5-006	1.6-006	.0	3.5-003	2.4-007
237Np	.45E+04	1.5-004	3.4-003	.0	.0	.0
90Sr	.49E+03	3.5-004	1.3-003	.0	.0	3.4-005
242Pu	.13E+05	6.3-005	1.3-003	.0	.0	3.5-004
233U	.30E+06	7.8-005	1.3-003	.0	.0	.0
236U	.13E+05	6.6-005	1.1-003	.0	.0	.0
238U	.23E+04	4.6-005	7.6-004	.0	.0	6.2-005
231Pa	.35E+07	2.2-005	5.3-004	.0	.0	.0
227Ac	.35E+07	1.6-005	2.5-004	.0	.0	.0

TABLE B.2.29 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW29

Parametric Data

Release duration = 1.0E+09 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
90Sr	.19E+03	6.6-001	2.4+000	.0	.0	6.3-002
226Ra	.30E+06	3.4-001	4.5-001	.0	.0	.0
210Pb	.30E+06	4.0-003	1.0-001	.0	.0	.0
240Pu	.10E+05	6.5-004	1.4-002	.0	.0	3.6-003
14C	.21E+02	2.0-004	1.0-003	2.0-004	2.0-004	2.0-004
229Th	.30E+06	4.1-005	8.5-004	.0	.0	.0
99Tc	.21E+02	6.1-006	1.5-005	1.8-006	.0	8.2-004
243Am	.18E+05	2.6-005	6.6-004	.0	.0	.0
210Po	.30E+06	1.6-004	6.5-004	.0	.0	.0
225Ra	.30E+06	1.1-004	5.3-004	.0	.0	.0
234U	.20E+04	2.3-005	3.7-004	.0	.0	3.1-005
129I	.21E+02	4.5-007	1.6-007	.0	3.6-004	2.5-008
242Pu	.13E+05	6.3-006	1.3-004	.0	.0	3.5-005
233U	.30E+06	6.7-006	1.1-004	.0	.0	.0
237Np	.13E+05	4.5-006	1.0-004	.0	.0	.0
238U	.20E+04	4.6-006	7.6-005	.0	.0	6.2-006
236U	.20E+04	4.3-006	6.9-005	.0	.0	.0
126Sn	.51E+04	4.4-007	1.5-005	.0	8.9-008	.0
245Cm	.18E+05	5.3-007	1.3-005	.0	.0	.0
241Am	.18E+05	4.4-007	1.1-005	.0	.0	9.3-007
135Cs	.13E+05	1.4-006	3.5-006	3.7-007	.0	.0

TABLE B.2.30 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW30

Parametric Data

Release duration = 1.0E+08 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 6.68E+00 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 2.4E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
⁹⁰ Sr	.19E+03	6.6+000	2.4+001	.0	.0	6.3-001
²²⁶ Ra	.23E+05	7.9-001	1.0+000	.0	.0	.0
²¹⁰ Pb	.23E+05	9.3-003	2.4-001	.0	.0	.0
²⁴⁰ Pu	.11E+05	6.0-003	1.3-001	.0	.0	3.3-002
¹⁴ C	.18E+02	2.0-003	1.0-002	2.0-003	2.0-003	2.0-003
⁹⁹ Tc	.18E+02	6.1-005	1.5-004	1.9-005	.0	8.2-003
²⁴³ Am	.18E+05	2.6-004	6.6-003	.0	.0	.0
²³⁴ U	.20E+04	3.4-004	5.5-003	.0	.0	4.5-004
²³⁷ Np	.50E+04	1.6-004	3.6-003	.0	.0	.0
¹²⁹ I	.18E+02	4.5-006	1.6-006	.0	3.5-003	2.4-007
²²⁹ Th	.23E+05	8.6-005	1.7-003	.0	.0	.0
²¹⁰ Po	.23E+05	3.6-004	1.5-003	.0	.0	.0
²⁴² Pu	.13E+05	6.3-005	1.3-003	.0	.0	3.5-004
²²⁵ Ra	.23E+05	2.2-004	1.1-003	.0	.0	.0
²³⁶ U	.13E+05	6.6-005	1.1-003	.0	.0	.0
²³⁸ U	.20E+04	4.6-005	7.6-004	.0	.0	6.2-005
²³⁰ Th	.23E+05	1.1-005	3.6-004	.0	.0	.0
²³³ U	.23E+05	2.0-005	3.2-004	.0	.0	.0
⁵⁹ Ni	.20E+04	4.2-005	2.5-004	.0	.0	.0

TABLE B.2.31 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW31

Parametric Data

Release duration = 1.0E+07 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+07	1.6+001	2.1+001	.0	.0	.0
210pb	.10E+07	1.9-001	4.7+000	.0	.0	.0
229Th	.10E+07	1.8-003	3.7-002	.0	.0	.0
129I	.10E+07	4.3-005	1.6-005	.0	3.4-002	2.3-006
210Po	.10E+07	7.2-003	3.0-002	.0	.0	.0
233U	.10E+07	1.7-003	2.8-002	.0	.0	.0
237Np	.10E+07	1.1-003	2.5-002	.0	.0	.0
225Ra	.10E+07	4.6-003	2.3-002	.0	.0	.0
230Th	.10E+07	5.9-004	2.0-002	.0	.0	.0
234U	.10E+07	7.9-004	1.3-002	.0	.0	1.1-003
236U	.10E+07	6.6-004	1.1-002	.0	.0	.0
238U	.10E+07	4.6-004	7.6-003	.0	.0	6.2-004
99Tc	.10E+07	2.3-005	5.7-005	7.1-006	.0	3.1-003
242Pu	.10E+07	1.0-004	2.1-003	.0	.0	5.5-004
135Cs	.10E+07	1.2-004	2.8-004	3.0-005	.0	.0
228Ra	.10E+07	5.7-005	5.2-005	.0	.0	.0
210Bi	.10E+07	1.0-005	1.8-005	.0	.0	.0
225Ac	.10E+07	9.9-007	1.5-005	.0	.0	.0
126Sn	.10E+07	4.4-008	1.5-006	.0	8.9-009	.0
93Zr	.10E+07	3.2-008	1.2-006	.0	.0	.0

TABLE B.2.32 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW32

Parametric Data

Release duration = 1.0E+07 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m,
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.33E+05	1.2+001	1.6+001	.0	.0	.0
210Pb	.33E+05	1.4-001	3.7+000	.0	.0	.0
240Pu	.21E+05	2.1-002	4.5-001	.0	.0	1.2-001
99Tc	.10E+05	5.9-004	1.5-003	1.8-004	.0	7.9-002
234U	.12E+05	3.4-003	5.5-002	.0	.0	4.5-003
129I	.10E+05	4.5-005	1.6-005	.0	3.6-002	2.5-006
237Np	.15E+05	1.5-003	3.4-002	.0	.0	.0
14C	.10E+05	6.0-003	3.0-002	6.0-003	6.0-003	6.0-003
243Am	.28E+05	1.1-003	2.7-002	.0	.0	.0
210Po	.33E+05	5.6-003	2.3-002	.0	.0	.0
242Pu	.23E+05	5.8-004	1.2-002	.0	.0	3.2-003
236U	.23E+05	6.6-004	1.1-002	.0	.0	.0
230Th	.33E+05	2.8-004	9.5-003	.0	.0	.0
238U	.12E+05	4.6-004	7.6-003	.0	.0	6.2-004
233U	.33E+05	2.1-004	3.4-003	.0	.0	.0
229Th	.33E+05	1.3-004	2.7-003	.0	.0	.0
159N	.12E+05	3.8-004	2.3-003	.0	.0	.0
225Ra	.33E+05	3.3-004	1.7-003	.0	.0	.0
126Sn	.15E+05	4.1-005	1.4-003	.0	8.4-006	.0
245Cm	.28E+05	2.3-005	5.5-004	.0	.0	.0

TABLE B.2.33 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW33

Parametric Data

Release duration = 1.0E+07 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 3.22E+02 m;
groundwater travel time = 2.9E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.44E+05	1.9+001	2.5+001	.0	.0	.0
210Pb	.44E+05	2.3-001	5.8+000	.0	.0	.0
90Sr	.37E+03	7.7-001	2.9+000	.0	.0	7.4-002
240Pu	.20E+05	2.1-002	4.5-001	.0	.0	1.2-001
14C	.40E+02	2.0-002	1.0-001	2.0-002	2.0-002	2.0-002
99Tc	.40E+02	6.1-004	1.5-003	1.9-004	.0	8.2-002
234U	.40E+04	3.4-003	5.5-002	.0	.0	4.5-003
210Po	.44E+05	8.8-003	3.7-002	.0	.0	.0
237Np	.82E+04	1.6-003	3.6-002	.0	.0	.0
129I	.40E+02	4.5-005	1.6-005	.0	3.6-002	2.5-006
229Th	.44E+05	1.5-003	3.1-002	.0	.0	.0
225Ra	.44E+05	3.9-003	2.0-002	.0	.0	.0
243Am	.36E+05	4.9-004	1.2-002	.0	.0	.0
242Pu	.25E+05	5.8-004	1.2-002	.0	.0	3.2-003
236U	.25E+05	6.8-004	1.1-002	.0	.0	.0
238U	.40E+04	4.6-004	7.6-003	.0	.0	6.2-004
233U	.44E+05	3.8-004	6.2-003	.0	.0	.0
230Th	.44E+05	1.6-004	5.4-003	.0	.0	.0
159N	.24E+04	4.2-004	2.5-003	.0	.0	.0
126Sn	.10E+05	4.2-005	1.5-003	.0	8.7-006	.0

TABLE B.2.34 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW34

Parametric Data

Release duration = 1.3E+07 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.26E+06	4.2+000	5.5+000	.0	.0	.0
210Pb	.26E+06	5.0-002	1.3+000	.0	.0	.0
229Th	.55E+06	6.9-003	1.4-001	.0	.0	.0
225Ra	.55E+06	1.8-002	8.9-002	.0	.0	.0
14C	.61E+03	1.5-002	7.3-002	1.5-002	1.5-002	1.5-002
99Tc	.59E+03	4.7-004	1.2-003	1.4-004	.0	6.3-002
234U	.33E+05	2.5-003	3.9-002	.0	.0	3.3-003
233U	.70E+06	1.8-003	3.0-002	.0	.0	.0
129I	.61E+03	3.4-005	1.2-005	.0	2.7-002	1.9-006
237Np	.13E+06	1.1-003	2.5-002	.0	.0	.0
236U	.64E+05	5.3-004	8.5-003	.0	.0	.0
210Po	.26E+06	1.9-003	8.0-003	.0	.0	.0
238U	.64E+05	3.4-004	5.7-003	.0	.0	4.7-004
242Pu	.32E+06	2.7-004	5.5-003	.0	.0	1.5-003
230Th	.26E+06	7.3-005	2.4-003	.0	.0	.0
126Sn	.16E+06	1.2-005	4.0-004	.0	2.3-006	.0
228Ra	.10E+08	3.7-004	3.4-004	.0	.0	.0
135Cs	.39E+06	1.0-004	2.5-004	2.6-005	.0	.0
225Ac	.55E+06	3.8-006	5.7-005	.0	.0	.0
232Th	.10E+08	1.7-007	5.0-006	.0	.0	1.9-007

TABLE B.2.35 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW35

Parametric Data

Release duration = 1.6E+06 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.74E-01 m/yr; groundwater pathlength = 6.44E+04 m;
groundwater travel time = 3.7E+05 yr; dispersion coefficient = 1.6E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.22E+08	9.0+000	1.2+001	.0	.0	.0
210Pb	.22E+08	1.0-001	2.7+000	.0	.0	.0
129I	.37E+06	2.7-004	9.7-005	.0	2.1-001	1.5-005
99Tc	.37E+06	1.1-003	2.9-003	3.4-004	.0	1.5-001
234U	.22E+08	4.0-003	6.3-002	.0	.0	5.2-003
238U	.22E+08	2.9-003	4.8-002	.0	.0	3.9-003
210Po	.22E+08	4.0-003	1.6-002	.0	.0	.0
230Th	.43E+08	1.4-004	4.5-003	.0	.0	.0
210Bi	.22E+08	4.6-006	8.0-006	.0	.0	.0
228Ra	.43E+09	4.1-009	3.7-009	.0	.0	.0
232Th	.43E+09	1.9-012	5.5-011	.0	.0	2.1-012
224Ra	.43E+09	3.7-012	1.8-011	.0	.0	.0
228Th	.43E+09	5.9-013	1.7-011	.0	.0	.0

TABLE B.2.36 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW 36

Parametric Data

Release duration = 1.0E+08 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+03 m/yr; groundwater pathlength = 8.05E+00 m;
groundwater travel time = 7.2E-03 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
⁹⁰ Sr	.22E+01	7.7+002	2.9+003	.0	.0	7.4+001
¹³⁷ Cs	.85E+01	1.5+001	1.5+001	1.7+001	.0	5.0-001
²⁴¹ Am	.12E+02	3.8-001	9.4+000	.0	.0	7.9-001
²³⁸ Pu	.85E+01	5.4-002	1.1+000	.0	.0	3.6-001
²⁴⁰ Pu	.85E+01	1.9-002	4.0-001	.0	.0	1.0-001
²⁴⁴ Cm	.12E+02	1.6-002	3.7-001	.0	.0	.0
⁶³ Ni	.43E+01	1.2-002	3.6-001	.0	.0	.0
²⁴¹ Pu	.85E+01	1.1-002	3.0-001	.0	.0	6.9-002
²⁴³ Am	.12E+02	1.5-003	3.9-002	.0	.0	.0
^{242m} Am	.12E+02	1.0-003	2.5-002	.0	.0	.0
¹⁴ C	.21E+01	2.0-003	1.0-002	2.9-003	2.0-003	2.0-003
⁹⁹ Tc	.21E+01	6.1-005	1.5-004	1.9-005	.0	8.2-003
²³⁴ U	.12E+02	2.4-004	3.9-003	.0	3.5-003	2.4-007
¹²⁹ I	.21E+01	4.5-006	1.6-006	.0	3.5-003	2.4-007
²⁴³ Cm	.12E+02	1.3-004	3.0-003	.0	.0	.0
²⁴² Pu	.85E+01	6.3-005	1.3-003	.0	.0	3.5-004
²³⁷ Np	.12E+02	4.9-005	1.1-003	.0	.0	.0
¹⁵⁴ Eu	.76E+01	9.1-005	1.0-003	.0	.0	.0
²³⁸ U	.43E+01	4.6-005	7.6-004	.0	.0	6.2-005
²³⁶ U	.43E+01	4.3-005	6.9-004	.0	.0	.0

TABLE B.2.37 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW37

Parametric Data

Release duration = 1.0E+08 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E+03 m/yr; groundwater pathlength = 8.05E+00 m;
groundwater travel time = 7.2E-03 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.10E+06	4.9-001	6.4-001	.0	.0	.0
210Pb	.10E+06	5.7-003	1.5-001	.0	.0	.0
229Th	.10E+06	3.6-004	7.3-003	.0	.0	.0
99Tc	.10E+06	4.4-005	1.1-004	1.4-005	.0	5.9-003
234U	.10E+06	2.9-004	4.6-003	.0	.0	3.8-004
225Ra	.10E+06	9.3-004	4.6-003	.0	.0	.0
230Th	.10E+06	1.4-004	4.5-003	.0	.0	.0
129I	.10E+06	4.5-006	1.6-006	.0	3.5-003	2.4-007
237Np	.10E+06	1.4-004	3.3-003	.0	.0	.0
233U	.10E+06	7.6-005	1.2-003	.0	.0	.0
242Pu	.10E+06	5.2-005	1.1-003	.0	.0	2.9-004
236U	.10E+06	6.6-005	1.1-003	.0	.0	.0
210Po	.10E+06	2.2-004	9.2-004	.0	.0	.0
238U	.10E+06	4.6-005	7.6-004	.0	.0	6.2-005
59Ni	.10E+06	1.8-005	1.1-004	.0	.0	.0
126Sn	.10E+06	2.1-006	7.2-005	.0	4.2-007	.0
135Cs	.10E+06	1.5-005	3.5-005	3.7-006	.0	.0
240Pu	.10E+06	6.5-007	1.4-005	.0	.0	3.6-006
243Am	.10E+06	1.8-007	4.6-006	.0	.0	.0
225Ac	.10E+06	2.0-007	2.9-006	.0	.0	.0

TABLE B.2.38 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW38

Parametric Data

Release duration = 5.4E+06 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.13E+07	4.9+000	6.4+000	.0	.0	.0
210Pb	.13E+07	5.8-002	1.5+000	.0	.0	.0
233U	.12E+07	4.0-003	6.6-002	.0	.0	.0
129I	.10E+07	8.0-005	2.9-005	.0	6.3-002	4.3-006
237Np	.12E+07	2.0-003	4.5-002	.0	.0	.0
234U	.10E+07	1.4-003	2.3-002	.0	.0	1.9-003
229Th	.12E+07	1.1-003	2.1-002	.0	.0	.0
236U	.11E+07	1.2-003	1.9-002	.0	.0	.0
238U	.11E+07	8.4-004	1.4-002	.0	.0	1.1-003
225Ra	.12E+07	2.7-003	1.4-002	.0	.0	.0
210Po	.13E+07	2.2-003	9.3-003	.0	.0	.0
99Tc	.10E+07	4.2-005	1.1-004	1.3-005	.0	5.6-003
230Th	.13E+07	7.3-005	2.4-003	.0	.0	.0
242Pu	.13E+07	1.1-004	2.2-003	.0	.0	5.8-004
135Cs	.14E+07	1.9-004	4.6-004	4.9-005	.0	.0
228Ra	.45E+07	4.0-004	3.6-004	.0	.0	.0
225Ac	.12E+07	5.8-007	8.6-006	.0	.0	.0
232Th	.45E+07	1.9-007	5.4-006	.0	.0	2.0-007
210Bi	.13E+07	2.7-006	4.8-006	.0	.0	.0
93Zr	.13E+07	5.3-008	2.0-006	.0	.0	.0

TABLE B.2.39 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW39

Parametric Data

Release duration = 8.3E+07 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.31E+06	4.3+000	5.6+000	.0	.0	.0
210Pb	.31E+06	5.0-002	1.3+000	.0	.0	.0
240Pu	.19E+05	2.9-003	6.2-002	.0	.0	1.6-002
99Tc	.10E+05	6.9-005	1.8-004	2.1-005	.0	9.4-003
210Po	.31E+06	2.0-003	8.1-003	.0	.0	.0
234U	.12E+05	4.0-004	6.3-003	.0	.0	5.2-004
229Th	.31E+06	2.3-004	4.8-003	.0	.0	.0
129I	.10E+05	5.4-006	2.0-006	.0	4.3-003	2.9-007
230Th	.31E+06	1.3-004	4.3-003	.0	.0	.0
237Np	.23E+05	1.8-004	4.1-003	.0	.0	.0
14C	.10E+05	7.3-004	3.6-003	7.3-004	7.3-004	7.3-004
243Am	.28E+05	1.3-004	3.3-003	.0	.0	.0
225Ra	.31E+06	6.1-004	3.0-003	.0	.0	.0
233U	.31E+06	9.4-005	1.5-003	.0	.0	.0
242Pu	.23E+05	7.3-005	1.5-003	.0	.0	4.1-004
236U	.23E+05	8.1-005	1.3-003	.0	.0	.0
238U	.12E+05	5.5-005	9.2-004	.0	.0	7.5-005
231Pa	.35E+07	2.7-005	6.4-004	.0	.0	.0
227Ac	.35E+07	2.0-005	3.1-004	.0	.0	.0
126Sn	.15E+05	5.0-006	1.8-004	.0	1.0-006	.0

TABLE B.2.40 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW40

Parametric Data

Release duration = $3.3\text{E}+06$ yr; delay prior to release = $1.0\text{E}+00$ yr;
groundwater velocity = $1.74\text{E}-01$ m/yr; groundwater pathlength = $6.44\text{E}+04$ m;
groundwater travel time = $3.7\text{E}+05$ yr; dispersion coefficient = $1.6\text{E}-02$ m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
²²⁶ Ra	.22E+08	4.3+000	5.7+000	.0	.0	.0
²¹⁰ Pb	.22E+08	5.1-002	1.3+000	.0	.0	7.3-006
¹²⁹ I	.37E+06	1.3-004	4.8-005	.0	1.1-001	7.3-006
⁹⁹ Tc	.37E+06	5.5-004	1.4-003	1.7-004	.0	7.4-002
²³⁴ U	.22E+08	1.9-003	3.0-002	.0	.0	2.5-003
²³⁸ U	.22E+08	1.4-003	2.3-002	.0	.0	1.9-003
²³⁶ U	.22E+08	1.1-003	1.7-002	.0	.0	.0
²¹⁰ Po	.22E+08	2.0-003	8.2-003	.0	.0	.0
²³⁹ Th	.43E+08	6.7-005	2.2-003	.0	.0	.0
²²⁸ Ra	.43E+09	2.7-004	2.5-004	.0	.0	.0
²¹⁰ Bi	.22E+08	2.2-006	3.9-006	.0	.0	.0
²³² Th	.43E+09	1.3-007	3.7-006	.0	.0	1.4-007
²²⁴ Ra	.43E+09	2.5-007	1.2-006	.0	.0	.0
²²⁸ Th	.43E+09	4.0-008	1.2-006	.0	.0	.0
²³⁷ Np	.37E+06	4.3-008	9.9-007	.0	.0	.0
²²⁹ Th	.86E+08	8.4-014	1.7-012	.0	.0	.0
²²⁵ Ra	.86E+08	2.2-013	1.1-012	.0	.0	.0
²³³ U	.86E+08	2.3-014	3.7-013	.0	.0	.0
²²⁵ Ac	.86E+08	4.6-017	6.9-016	.0	.0	.0
¹⁴ C	.37E+06	1.7-021	8.5-021	1.7-021	1.7-021	1.7-021

TABLE B.2.41 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW41

Parametric Data

Release duration = 1.1E+07 yr; delay prior to release = 1.0E+05 yr;
groundwater velocity = 1.11E +01m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.36E+06	4.3+000	5.6+000	.0	.0	.0
210Pb	.36E+06	5.0-002	1.3+000	.0	.0	.0
99Tc	.10E+06	4.0-004	1.0-003	1.2-004	.0	5.4-002
234U	.13E+06	2.3-003	3.8-002	.0	.0	3.1-003
233U	.80E+06	2.2-003	3.6-002	.0	.0	.0
129I	.10E+06	4.0-005	1.4-005	.0	3.1-002	2.2-006
237Np	.23E+06	1.3-003	2.9-002	.0	.0	.0
229Th	.49E+06	5.8-004	1.2-002	.0	.0	.0
236U	.16E+06	6.1-004	9.7-003	.0	.0	.0
210Po	.36E+06	2.0-003	8.1-003	.0	.0	.0
225Ra	.49E+06	1.5-003	7.5-003	.0	.0	.0
238U	.16E+06	4.2-004	7.0-003	.0	.0	5.7-004
242Pu	.42E+06	2.6-004	5.4-003	.0	.0	1.5-003
230Th	.36E+06	7.3-005	2.4-003	.0	.0	.0
228Ra	.10E+08	4.4-004	4.0-004	.0	.0	.0
135Cs	.49E+06	1.2-004	2.8-004	3.0-005	.0	.0
126Sn	.26E+06	6.3-006	2.2-004	.0	1.3-006	.0
232Th	.10E+08	2.1-007	6.0-006	.0	.0	2.2-007
210Bi	.36E+06	2.8-006	4.9-006	.0	.0	.0
225Ac	.49E+06	3.2-007	4.7-006	.0	.0	.0

TABLE B.2.42 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW42

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+00yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
²²⁶ Ra	.64E+05	7.5+002	1.0+003	.0	.0	.0
²¹⁰ Pb	.64E+05	8.9+000	2.3+002	.0	.0	.0
⁹⁹ Tc	.11E+05	6.1-001	1.5+000	1.8-001	.0	8.2+001
¹⁴ C	.61E+03	1.9+001	9.3-001	1.9+001	1.9+001	1.9+001
²³⁴ U	.35E+05	3.2+000	5.0+001	.0	.0	4.2+000
¹²⁹ I	.61E+03	4.5-002	1.6-002	.0	3.5+001	2.4-003
²³⁷ Np	.12E+06	1.1+000	2.5+001	.0	.0	.0
²²⁹ Th	.37E+05	5.1-001	1.0+001	.0	.0	.0
²³⁶ U	.36E+05	6.3-001	1.0+001	.0	.0	.0
²³⁸ U	.35E+05	4.6-001	7.6+000	.0	.0	6.2-001
²²⁵ Ra	.37E+05	1.3+000	6.6+000	.0	.0	.0
²⁴² Pu	.30E+06	1.3-001	2.7+000	.0	.0	7.3-001
²³³ U	.37E+05	1.4-001	2.3+000	.0	.0	.0
²¹⁰ Po	.64E+05	3.5-001	1.5+000	.0	.0	.0
¹²⁶ Sn	.15E+06	1.0-002	3.7-001	.0	2.1-003	.0
²³⁰ Th	.64E+05	1.0-002	3.5-001	.0	.0	.0
²³⁰ Th	.64E+05	1.0-002	3.5-001	.0	.0	.0
¹³⁵ Cs	.36E+06	3.9-002	9.6-002	1.0-002	.0	.0
²²⁵ Ac	.37E+05	2.8-004	4.2-003	.0	.0	.0
⁹³ Zr	.24E+06	2.0-005	7.4-004	.0	.0	.0

TABLE B.2.43 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW43

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+3 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
129I	.10E+07	4.3+000	1.6+000	.0	3.4+003	2.3-001
226Ra	.10E+07	2.9+002	3.8+002	.0	.0	.0
99Tc	.10E+07	2.2+000	5.6+000	6.7-001	.0	3.0+002
233U	.10E+07	5.7+000	9.2-001	.0	.0	.0
210Pb	.10E+07	3.4+000	8.6+001	.0	.0	.0
234U	.10E+07	2.9+000	4.6+001	.0	.0	3.8+00
236U	.10E+07	2.4+000	3.8+001	.0	.0	.0
238U	.10E+07	1.7+000	2.8+001	.0	.0	2.3+000
237Np	.11E+07	9.8-001	2.2-001	.0	.0	.0
229Th	.10E+07	2.5-001	5.1+000	.0	.0	.0
225Ra	.10E+07	6.4-001	3.2+000	.0	.0	.0
210Po	.10E+07	1.3-001	5.4-001	.0	.0	.0
242Pu	.13E+07	2.2-002	4.5-001	.0	.0	1.2-001
230Th	.10E+07	4.8-003	1.6-001	.0	.0	.0
135Cs	.14E+07	3.2-002	7.8-002	8.2-003	.0	.0
228Ra	.16E+07	1.1-002	9.6-003	.0	.0	.0
225Ac	.10E+07	1.4-004	2.0-003	.0	.0	.0
93Ar	.12E+07	1.4-005	5.0-004	.0	.0	.0
93mNB	.12E+07	3.8-005	4.7-004	.0	.0	.0
126Sn	.11E+07	1.2-005	4.3-004	.0	2.5-006	.0

TABLE B.2.44 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW44

Parametric Data

Release duration = 1.0E+03 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.45E+05	7.9+002	1.0+003	.0	.0	.0
99Tc	.11E+05	5.9+000	1.5+001	1.8+000	.0	7.9+002
129I	.11E+05	4.5-001	1.6-001	.0	3.5+002	2.5-002
14C	.11E+05	5.7+001	2.8+002	5.7+001	5.7+001	5.7+001
210Pb	.45E+05	9.3+000	2.4+002	.0	.0	.0
234U	.40E+05	1.1+001	1.8+002	.0	.0	1.5+001
236U	.40E+05	2.1+000	3.4+001	.0	.0	.0
237Np	.13E+06	1.3+000	3.0+001	.0	.0	.0
238U	.40E+05	1.6+000	2.7+001	.0	.0	2.2+000
233U	.40E+05	3.5-001	5.7+000	.0	.0	.0
242Pu	.30E+06	1.4-001	2.8+000	.0	.0	7.6-001
210Po	.45E+05	3.6-001	1.5+000	.0	.0	.0
229Th	.69E+05	3.2-002	6.5-001	.0	.0	.0
230Th	.45E+05	1.3-002	4.4-001	.0	.0	.0
225Ra	.69E+05	8.2-002	4.1-001	.0	.0	.0
126Sn	.16E+06	1.2-002	4.1-001	.0	2.4-003	.0
135Cs	.36E+06	4.0-002	9.8-002	1.0-002	.0	.0
210Bi	.45E+05	5.1-004	8.9-004	.0	.0	.0
93Zr	.24E+06	2.1-005	7.9-004	.0	.0	.0
93mNb	.24E+06	6.0-005	7.4-004	.0	.0	.0

TABLE B.2.45 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW45

Parametric Data

Release duration = 1.0E+02 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.01E+00 m/yr; groundwater pathlength = 4.02E+04 m;
groundwater travel time = 4.0E+04 yr; dispersion coefficient = 5.3E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
99Tc	.40E+05	3.0+001	7.6+001	9.0+000	.0	4.0+003
129I	.40E+05	2.5+000	9.1-001	.0	2.0+003	1.4-001
226Ra	.23E+07	1.2+002	1.6+002	.0	.0	.0
14C	.40E+05	9.0+000	4.5+001	9.0+000	9.0+000	9.0+000
210Pb	.23E+07	1.4+000	3.6+001	.0	.0	.0
234U	.23E+07	6.9-001	1.1+001	.0	.0	9.1-001
236U	.23E+07	5.1-001	8.1+000	.0	.0	.0
238U	.23E+07	4.8-001	8.0+000	.0	.0	6.5-001
237Np	.92E+07	2.0-002	4.5-001	.0	.0	.0
229Th	.92E+07	1.2-002	2.5-001	.0	.0	.0
225Ra	.92E+07	3.1-002	1.6-001	.0	.0	.0
210Po	.23E+07	5.5-002	2.4-001	.0	.0	.0
233U	.92E+07	3.2-003	5.3-002	.0	.0	.0
230Th	.28E+07	1.2-003	4.1-002	.0	.0	.0
225Ac	.92E+07	6.7-006	9.9-005	.0	.0	.0
210Bi	.23E+07	4.0-005	7.0-005	.0	.0	.0
228Ra	.28E+08	3.0-005	2.7-005	.0	.0	.0
135Cs	.28E+08	2.8-006	6.9-006	7.3-007	.0	.0
232Th	.28E+08	1.4-008	4.1-007	.0	.0	1.5-008
224Ra	.28E+08	2.7-008	1.4-007	.0	.0	.0

TABLE B.2.46 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW46

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+03 yr;
groundwater velocity = 3.22E+00 m/yr; groundwater pathlength = 3.22E+04 m;
groundwater travel time = 1.0E+04 yr; dispersion coefficient = 1.3E-01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.59E+06	2.5+002	3.5+002	.0	.0	.0
99Tc	.11E+05	5.9-001	1.5+000	1.8-001	.0	7.9+001
210Pb	.59E+06	3.0+000	7.7+001	.0	.0	.0
129I	.11E+05	4.5-002	1.6-002	.0	3.5+001	2.4-003
14C	.11E+05	5.4+000	2.7+001	5.4+000	5.4+000	5.4+000
234U	.59E+06	1.2+000	1.8+001	.0	.0	1.5+000
237NP	.59E+06	6.3-001	1.0+001	.0	.0	.0
238U	.59E+06	4.6-001	7.6+000	.0	.0	6.2-001
229Th	.23E+07	3.3-002	6.8-001	.0	.0	.0
233U	.23E+07	3.0-002	4.8-001	.0	.0	.0
225Ra	.23E+07	8.5-002	4.3-001	.0	.0	.0
210Po	.59E+06	1.2-001	4.9-001	.0	.0	.0
230Th	.70E+06	3.4-003	1.2-001	.0	.0	.0
135Cs	.70E+07	6.2-003	1.5-002	1.6-003	.0	.0
225Ac	.23E+07	1.8-005	2.7-004	.0	.0	.0
210Bi	.59E+06	1.1-004	1.9-004	.0	.0	.0
242Pu	.57E+07	8.9-006	1.8-004	.0	.0	5.0-005
93Zr	.46E+07	3.1-006	1.1-004	.0	.0	.0
93mNb	.46E+07	8.7-006	1.1-004	.0	.0	.0

TABLE B.2.47 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW47

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
⁹⁰ Sr	.19E+03	3.5+005	1.4+006	.0	.0	.0
¹⁴ C	.21E+02	6.8+001	3.4+002	6.8+001	6.8+001	6.8+001
²⁴⁰ Pu	.30E+05	1.6+001	3.4+002	.0	.0	8.8+001
⁹⁹ Tc	.30E+04	2.0+000	5.1+000	6.1-001	.0	2.7+002
²³⁴ U	.54E+04	1.1+001	1.8+002	.0	.0	1.5+001
²³⁷ Np	.11E+05	5.4+000	1.2+002	.0	.0	.0
¹²⁹ I	.21E+02	1.5-001	5.4-002	.0	1.2+002	8.1-003
²²⁶ Ra	.24E+06	3.0+001	3.9+001	.0	.0	.0
²³⁶ U	.65E+04	1.7+000	2.8+001	.0	.0	.0
²³⁸ U	.54E+04	1.5+000	2.5+001	.0	.0	2.1+000
²⁴² Pu	.30E+05	1.2+000	2.5+001	.0	.0	6.7+000
²²⁹ Th	.65E+04	7.2-001	1.5+001	.0	.0	.0
²³⁹ Pu	.30E+05	4.9-001	1.1+001	.0	.0	2.7+000
²²⁵ Ra	.65E+04	1.8+000	9.2+000	.0	.0	.0
²¹⁰ Pb	.24E+06	3.5-001	9.0+000	.0	.0	.0
²³³ U	.65E+04	2.1-001	3.4+000	.0	.0	.0
¹²⁶ Sn	.49E+05	4.4-002	1.5+000	.0	8.9-003	.0
²³⁰ Th	.11E+05	4.2-003	1.4-001	.0	.0	.0
²³⁵ U	.54E+04	6.3-003	1.0-001	.0	.0	1.1-002
²¹⁰ Po	.24E+06	1.4-002	5.7-002	.0	.0	.0

TABLE B.2.48 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW48

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = 3.0E+02 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
²³⁹ Pu	.30E+05	1.0+002	2.2+003	.0	.0	5.6+002
¹⁴ C	.32E+03	6.4+001	3.2+002	6.4+001	6.4+001	6.4+001
²⁴⁰ Pu	.30E+05	1.5+001	3.1+002	.0	.0	8.2+001
⁹⁹ Tc	.32E+03	2.0+000	5.1+000	6.1-001	.0	2.7+002
²³⁴ U	.51E+04	1.1+001	1.8+002	.0	.0	1.5+001
¹²⁹ I	.32E+03	1.5-001	5.4-002	.0	1.2+002	8.1-003
²³⁷ Np	.11E+05	4.9+000	1.1+002	.0	.0	.0
⁹⁰ Sr	.49E+03	1.8+001	7.2+001	.0	.0	.0
²²⁶ Ra	.24E+06	4.1+001	5.4+001	.0	.0	.0
²³⁶ U	.68E+04	1.8+000	2.8+001	.0	.0	.0
²³⁸ U	.57E+04	1.5+000	2.5+001	.0	.0	2.1+000
²⁴² Pu	.30E+05	1.2+000	2.5+001	.0	.0	6.7+000
²¹⁰ Pb	.24E+06	4.9-001	1.3+001	.0	.0	.0
²²⁹ Th	.68E+04	3.7-001	7.6+000	.0	.0	.0
²²⁵ Ra	.68E+04	9.6-001	4.8+000	.0	.0	.0
²³³ U	.68E+04	2.1-001	3.4+000	.0	.0	.0
²³⁵ U	.57E+04	9.6-002	1.6+000	.0	.0	1.7-001
¹²⁶ Sn	.50E+05	4.4-002	1.5+000	.0	8.9-003	.0
²³⁰ Th	.11E+05	4.2-003	1.4-001	.0	.0	.0
²¹⁰ Po	.24E+06	1.9-002	7.9-002	.0	.0	.0

TABLE B.2.49 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW49

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = .30E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 1.61E+02 m;
groundwater travel time = 1.4E+01 yr; dispersion coefficient = 3.2E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
²³⁹ Pu	.33E+05	9.8+001	2.1+003	.0	.0	5.3+002
⁹⁹ Tc	.30E+04	2.0+000	5.1+000	6.0-001	.0	2.7+002
²⁴⁰ Pu	.33E+05	1.1+001	2.4+002	.0	.0	6.4+001
¹⁴ C	.30E+04	4.7+001	2.3+002	4.7+001	4.7+001	4.7+001
²³⁴ U	.84E+04	1.1+001	1.8+002	.0	.0	1.5+001
²²⁶ Ra	.24E+06	1.1+002	1.5+002	.0	.0	.0
¹²⁹ I	.30E+04	1.5-001	5.4-002	.0	1.2+002	8.1-003
²³⁷ Np	.14E+05	4.5+000	1.0-002	.0	.0	.0
²¹⁰ Pb	.24E+06	1.3+000	3.4+001	.0	.0	.0
²³⁶ U	.95E+04	1.8+000	2.9+001	.0	.0	.0
²³⁸ U	.84E+04	1.5+000	2.5+001	.0	.0	2.1+000
²⁴² Pu	.33E+05	1.2+000	2.5+001	.0	.0	6.7+000
²³³ U	.95E+04	2.6-001	4.2+000	.0	.0	.0
²³⁵ U	.84E+04	9.8-002	1.6+000	.0	.0	1.8-001
¹²⁶ Sn	.52E+05	4.2-002	1.5+000	.0	8.7-003	.0
²¹⁰ Po	.24E+06	5.2-002	2.2-001	.0	.0	.0
²²⁹ Th	.14E+05	8.8-003	1.8-001	.0	.0	.0
²³⁰ Th	.14E+05	4.2-003	1.4-001	.0	.0	.0
²²⁵ Ra	.14E+05	2.3-002	1.1-001	.0	.0	.0
¹³⁵ Cs	.80E+06	9.5-003	2.3-002	2.4-003	.0	.0

TABLE B.2.50 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW50

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = 1.0E+00 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.14E+06	7.9+002	1.0+003	.0	.0	.0
14C	.57E+03	6.3+001	3.2+002	6.3+001	6.3+001	6.3+001
99Tc	.59E+03	2.0+000	5.1+000	6.1-001	.0	2.7+002
210Pb	.14E+06	9.3+000	2.4+002	.0	.0	.0
129I	.61E+03	1.5-001	5.4-002	.0	1.2+002	8.1-003
234U	.14E+06	1.4+000	2.2+001	.0	.0	1.8+000
236U	.14E+06	4.3-001	6.9+000	.0	.0	.0
238U	.14E+06	3.6-001	6.1+000	.0	.0	4.9-001
237Np	.34E+06	1.3-001	3.0+000	.0	.0	.0
230Th	.14E+06	1.4-002	4.5-001	.0	.0	.0
233U	.34E+06	2.3-002	3.7-001	.0	.0	.0
242Pu	.10E+07	1.1-002	2.3-001	.0	.0	6.1-002
229Th	.34E+06	3.0-003	6.2-002	.0	.0	.0
225Ra	.34E+06	7.8-003	3.9-002	.0	.0	.0
235U	.14E+06	1.5-003	2.5-002	.0	.0	2.8-003
210Po	.14E+06	2.3-003	9.5-003	.0	.0	.0
210Bi	.14E+06	5.1-004	9.0-004	.0	.0	.0
231Pa	.14E+06	1.3-005	3.1-004	.0	.0	.0
227Ac	.14E+06	9.4-006	1.5-004	.0	.0	.0
225Ac	.34E+06	1.7-006	2.5-005	.0	.0	.0

TABLE B.2.51 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW51

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = 3.0E+02 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.14E+06	7.8+002	1.0+003	.0	.0	.0
14C	.91E+03	6.0+001	3.2+002	6.0+001	6.0+001	6.0+001
99Tc	.88E+03	2.0+000	5.1+000	6.1-001	.0	2.7+002
210Pb	.14E+06	9.3+000	2.4+002	.0	.0	.0
129I	.91E+03	1.5-001	5.4-002	.0	1.2+002	8.1-003
234U	.14E+06	1.9+000	3.0+001	.0	.0	2.5+000
236U	.14E+06	4.6-001	7.3+000	.0	.0	.0
238U	.14E+06	3.6-001	6.1+000	.0	.0	4.9-001
237Np	.34E+06	2.5-001	5.8+000	.0	.0	.0
230Th	.14E+06	1.3-002	4.3-001	.0	.0	.0
233U	.34E+06	4.3-002	7.0-001	.0	.0	.0
242Pu	.10E+07	1.1-002	2.3-001	.0	.0	6.1-002
229Th	.34E+06	5.4-003	1.1-001	.0	.0	.0
225Ra	.34E+06	1.4-002	6.9-002	.0	.0	.0
235U	.14E+06	2.5-002	4.0-001	.0	.0	4.4-002
210Po	.14E+06	2.2-003	9.2-003	.0	.0	.0
210Bi	.14E+06	5.1-004	8.9-004	.0	.0	.0
231Pa	.14E+06	2.0-004	4.8-008	.0	.0	.0
227Ac	.14E+06	1.5-004	2.3-003	.0	.0	.0
225Ac	.34E+06	3.0-006	4.4-005	.0	.0	.0

TABLE B.2.52 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW52

Parametric Data

Release duration = 3.0E+03 yr; delay prior to release = 3.0E+03 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLT
226Ra	.39E+05	7.8+002	1.0+003	.0	.0	.0
99Tc	.36E+04	2.0+000	5.1+000	6.0-001	.0	2.7+002
210Pb	.39E+05	9.3+000	2.4+002	.0	.0	.0
14C	.36E+04	4.4+001	2.2+002	4.4+001	4.4+001	4.4+001
129I	.36E+04	1.5-001	5.4-002	.0	1.2+002	8.1-003
234U	.14E+06	2.0+000	3.2+001	.0	.0	2.6+000
237Np	.34E+06	4.0-001	9.1+000	.0	.0	.0
236U	.14E+06	4.6-001	7.3+000	.0	.0	.0
238U	.14E+06	3.6-001	6.1+000	.0	.0	4.9-001
210Po	.39E+05	3.6-001	1.5+000	.0	.0	.0
233U	.34E+06	6.7-002	1.1+000	.0	.0	.0
235U	.14E+06	2.5-002	4.0-001	.0	.0	4.4-002
242Pu	.10E+07	1.1-002	2.3-001	.0	.0	6.1-002
229Th	.34E+06	8.3-003	1.7-001	.0	.0	.0
225Ra	.34E+06	2.1-002	1.1-001	.0	.0	.0
230Th	.14E+06	1.6-003	5.4-002	.0	.0	.0
231Pa	.14E+06	2.1-004	4.9-003	.0	.0	.0
227Ac	.14E+06	1.5-004	2.4-003	.0	.0	.0
225Ac	.34E+06	4.6-006	6.8-005	.0	.0	.0
228Ra	.10E+07	6.6-006	6.0-006	.0	.0	.0

TABLE B.2.53 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW53

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.93E+05	2.2+003	2.9+003	.0	.0	.0
210Pb	.93E+05	2.6+001	6.7+002	.0	.0	.0
99Tc	.10E+05	5.9-001	1.5+000	1.8-001	.0	7.9+001
234U	.33E+05	3.2+000	5.0+001	.0	.0	4.2+000
129I	.10E+05	4.5-002	1.6-002	.0	3.5+001	2.4-003
237Np	.63E+05	1.5+000	3.3+001	.0	.0	.0
14C	.10E+05	6.0+000	3.0+001	6.0+000	6.0+000	6.0+000
239Pu	.16E+06	8.7-001	1.9+001	.0	.0	4.8+000
236U	.38E+05	6.6-001	1.0+001	.0	.0	.0
238U	.33E+05	4.6-001	7.6+000	.0	.0	6.2-001
242Pu	.16E+06	3.2-001	6.6+000	.0	.0	1.8+000
233U	.38E+05	2.7-001	4.4+000	.0	.0	.0
210Po	.93E+05	1.0+000	4.2+000	.0	.0	.0
235U	.38E+05	3.7-002	6.0-001	.0	.0	6.6-002
229Th	.63E+05	1.2-002	2.5-001	.0	.0	.0
225Ra	.63E+05	3.2-002	1.6-001	.0	.0	.0
126Sn	.25E+06	3.6-003	1.3-001	.0	7.4-004	.0
230Th	.63E+05	3.4-003	1.2-001	.0	.0	.0
231Pa	.38E+05	3.9-004	9.4-003	.0	.0	.0
227Ac	.38E+05	2.8-004	4.5-003	.0	.0	.0
135Cs	.40E+07	1.2-003	3.0-003	3.2-004	.0	.0

TABLE B.2.54 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW54

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 8.05E+02 m;
groundwater travel time = 7.2E+01 yr; dispersion coefficient = 5.3E+00 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+07	4.3+003	5.6+003	.0	.0	.0
210pb	.11E+07	5.0+001	1.3+003	.0	.0	.0
233U	.10E+07	1.6+000	2.7+001	.0	.0	.0
237Np	.11E+07	1.1+000	2.4+001	.0	.0	.0
234U	.10E+07	7.9-001	1.3+001	.0	.0	.0
236U	.10E+07	6.6-001	1.0+001	.0	.0	.0
210Po	.11E+07	2.0+000	8.1+000	.0	.0	.0
238U	.10E+07	4.6-001	7.6+000	.0	.0	6.2-001
99Tc	.10E+07	2.2-002	5.7-002	6.8-003	.0	3.0+000
229Th	.10E+07	7.5-002	1.5+000	.0	.0	.0
242Pu	.11E+07	5.2-002	1.1+000	.0	.0	2.9-001
225Ra	.10E+07	1.9-001	9.6-001	.0	.0	.0
235U	.10E+07	4.3-002	7.0-001	.0	.0	7.7-002
230Th	.10E+07	1.3-003	4.3-002	.0	.0	.0
231Pa	.10E+07	5.0-004	1.2-002	.0	.0	.0
227Ac	.10E+07	3.6-004	5.7-003	.0	.0	.0
228Ra	.22E+07	5.3-003	4.8-003	.0	.0	.0
135Cs	.50E+07	1.0-003	2.5-003	2.6-004	.0	.0
225Ac	.10E+07	4.1-005	6.1-004	.0	.0	.0
126Sn	.12E+07	3.7-006	1.3-004	.0	7.6-007	.0

TABLE B.2.55 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW55

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.74E+05	7.4+002	9.8+002	.0	.0	.0
210pb	.74E+05	8.7+000	2.3+002	.0	.0	.0
99Tc	.11E+05	5.9-001	1.5+000	1.8-001	.0	7.9+001
129I	.11E+05	4.5-002	1.6-002	.0	3.5+001	2.4-003
14C	.11E+05	5.7+000	2.8+001	5.7+000	5.7+000	5.7+000
234U	.15E+06	1.7+000	2.7+001	.0	.0	2.2+000
237Np	.35E+06	4.2-001	9.5+000	.0	.0	.0
236U	.15E+06	4.3-001	6.9+000	.0	.0	.0
238U	.15E+06	3.1-001	5.1+000	5.1+000	.0	4.1-001
233U	.15E+06	9.7-002	1.6+000	.0	.0	.0
210Po	.74E+05	3.4-001	1.5+000	.0	.0	.0
235U	.15E+06	2.5-002	4.0-001	.0	.0	4.4-002
242Pu	.10E+07	1.0-002	2.2-001	.0	.0	5.8-002
229Th	.35E+06	8.8-003	1.8-001	.0	.0	.0
225Ra	.35E+06	2.3-002	1.1-001	.0	.0	.0
230Th	.15E+06	1.6-003	5.4-002	.0	.0	.0
231Pa	.15E+06	2.3-004	5.6-003	.0	.0	.0
227Ac	.15E+06	1.7-004	2.7-003	.0	.0	.0
225Ac	.35E+06	4.8-006	7.2-005	.0	.0	.0
228Ra	.84E+07	1.3-005	1.2-005	.0	.0	.0

TABLE B.2.56 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW56

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 1.11E+01 m/yr; groundwater pathlength = 5.63E+03 m;
groundwater travel time = 5.0E+02 yr; dispersion coefficient = 4.2E+01 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.11E+07	2.7+002	3.6+002	.0	.0	.0
210Pb	.11E+07	3.2+000	8.2+001	.0	.0	.0
129I	.10E+07	4.3-002	1.6-002	.0	3.4+001	2.3-003
233U	.11E+07	6.7-001	1.1+001	.0	.0	.0
234U	.11E+07	5.0-001	8.0+000	.0	.0	6.6-001
236U	.11E+07	4.6-001	7.3+000	.0	.0	.0
237Np	.13E+07	3.1-001	7.0+000	.0	.0	.0
238U	.11E+07	3.1-001	5.1+000	.0	.0	4.1-001
99Tc	.10E+07	2.2-002	5.7-002	6.7-003	.0	3.0+000
229Th	.11E+07	2.6-002	5.3-001	.0	.0	.0
210Po	.11E+07	1.2-001	5.1-001	.0	.0	.0
235U	.11E+07	2.9-002	4.7-001	.0	.0	5.2-002
225Ra	.11E+07	6.8-002	3.4-001	.0	.0	.0
242Pu	.20E+07	1.7-003	3.6-002	.0	.0	9.6-003
230Th	.11E+07	6.5-004	2.2-002	.0	.0	.0
231Pa	.11E+07	3.0-004	7.0-003	.0	.0	.0
227Ac	.11E+07	2.1-004	3.4-003	.0	.0	.0
228Ra	.94E+07	7.5-004	6.8-004	.0	.0	.0
225Ac	.11E+07	1.4-005	2.2-004	.0	.0	.0
232Th	.94E+07	3.5-007	1.0-005	.0	.0	3.8-007
224Ra	.94E+07	6.8-007	3.4-006	.0	.0	.0

TABLE B.2.57 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW57

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+04 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure, yr	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.27E+07	4.8+002	6.3+002	.0	.0	.0
210Pb	.27E+07	5.6+000	1.5+002	.0	.0	.0
99Tc	.14E+05	5.8-001	1.5+000	1.7-001	.0	7.8+001
129I	.14E+05	4.5-002	1.6-002	.0	3.5+001	2.4-003
14C	.14E+05	3.8+000	1.9+001	3.8+000	3.8+000	3.8+000
234U	.11E+07	7.7-001	1.2+001	.0	.0	1.0+000
237Np	.27E+07	4.9-001	1.1+001	.0	.0	.0
236U	.11E+07	6.3-001	1.0+001	.0	.0	.0
238U	.11E+07	4.6-001	7.6+000	.0	.0	6.2-001
210Po	.27E+07	2.2-001	9.1-001	.0	.0	.0
233U	.27E+07	3.5-002	5.7-001	.0	.0	.0
235U	.11E+07	3.5-002	5.7-001	.0	.0	6.3-002
229Th	.27E+07	4.8-003	9.9-002	.0	.0	.0
225Ra	.27E+07	1.2-002	6.2-002	.0	.0	.0
230Th	.11E+07	4.4-004	1.5-002	.0	.0	.0
231Pa	.11E+07	2.3-004	5.6-003	.0	.0	.0
227Ac	.11E+07	1.7-004	2.7-003	.0	.0	.0
225Ac	.27E+07	2.6-006	4.0-005	.0	.0	.0
228Ra	.67E+08	3.2-005	2.9-005	.0	.0	.0
242Pu	.80E+07	1.1-007	2.4-006	.0	.0	6.4-007
210Bi	.27E+07	8.8-007	1.5-006	.0	.0	.0

TABLE B.2.58 Seventy-Year Cumulative Dose Commitment (Maximum-Individual)
Expanded Summary for Case SLTW58

Parametric Data

Release duration = 1.0E+04 yr; delay prior to release = 1.0E+06 yr;
groundwater velocity = 4.03E+00 m/yr; groundwater pathlength = 1.61E+04 m;
groundwater travel time = 4.0E+03 yr; dispersion coefficient = 7.9E-02 m²/yr.

Nuclide	Time After Closure (yr)	Seventy-year dose, rem				
		Total Body	Bone	Lungs	Thyroid	GI-LLI
226Ra	.12E+07	1.7+002	2.3+002	.0	.0	.0
210Pb	.12E+07	2.0+000	5.2+001	.0	.0	.0
129I	.10E+07	4.3-002	1.6-002	.0	3.4+001	2.3-003
234U	.21E+07	6.3-001	1.0+001	.0	.0	8.4-001
236U	.21E+07	6.3-001	1.0+001	.0	.0	.0
237Np	.37E+07	3.4-001	7.8+000	.0	.0	.0
238U	.21E+07	4.6-001	7.6+000	.0	.0	6.2-001
99Tc	.10E+07	2.2-002	5.6-002	6.7-003	.0	3.0+000
235U	.21E+07	4.3-002	7.0-001	.0	.0	7.7-002
233U	.37E+07	2.5-002	4.1-001	.0	.0	.0
210Po	.12E+07	7.8-002	3.3-001	.0	.0	.0
229Th	.37E+07	3.6-003	7.3-002	.0	.0	.0
225Ra	.37E+07	9.3-003	4.6-002	.0	.0	.0
230Th	.21E+07	3.6-004	1.2-002	.0	.0	.0
231Pa	.21E+07	3.0-004	7.2-003	.0	.0	.0
227Ac	.21E+07	2.2-004	3.4-003	.0	.0	.0
228Ra	.68E+08	2.2-003	2.0-003	.0	.0	.0
225Ac	.37E+07	2.0-006	2.9-005	.0	.0	.0
232Th	.68E+08	1.0-006	2.9-005	.0	.0	1.1-006
224Ra	.68E+08	2.0-006	9.8-006	.0	.0	.0

APPENDIX C

SAMPLE CALCULATIONS

APPENDIX C

SAMPLE CALCULATIONS

C.1 SAMPLE OUTPUT FROM THE GETOUT GEOSPHERE TRANSPORT MODEL

The first set of sample output shows typical results from the groundwater transport calculations utilizing the GETOUT model.

C.1.1 PROGRAM ONE

Three example migration profile reports from program ONE of the GETOUT code are shown for three of the individual members of the $4N+2$ decay chain that will also be the bases for the example outputs from programs TWO and THREE.

65 U234

RUN MADE 070379 125923
XAMPL1

RADIONUCLIDE DISCHARGE RATE FROM AN AQUIFER AFTER
A LEACH INCIDENT IN AN UNDERGROUND REPOSITORY
CONTAINING YEAR 2050 NUCLEAR POWER ECONOMY WASTE

TIME OF LEACH INCIDENT: 1 YEARS

*NUCLIDE: U234

HALF LIFE: 2.44+005 YEARS
NUCLIDE VELOCITY/WATER VELOCITY: .017100
INVENTORY IN WASTE AT YEAR 2050: 8.80+004 CURIES
INVENTORY IN WASTE AT BEGINNING OF LEACH INCIDENT: 8.80+004 CURIES
NUCLIDE FLOW RATE INTO AQUIFER: 8.80+000 CURIES/YR

NUCLIDE DISCHARGE RATE FROM AQUIFER WITH NO DISPERSION
INITIAL: 7.41+000 CURIES/YR AT 60426. YEARS
FINAL: 7.20+000 CURIES/YR AT 70426. YEARS

LEACH RATE: .100000-003 FRACTION PER YEAR
LEACH DURATION: 10000. YRS
LENGTH OF AQUIFER: 10.00 MILES

WATER VELOCITY: .140000+000 FT/DAY
WATER TRAVEL TIME: .1033268+004 YEARS
AXIAL DISPERSION COEFFICIENT: .01000 SQ CM / MIN

NUCLIDE DISCHARGE RATE FROM AQUIFER,
RELEASE MECHANISM: BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 58896. YEARS
PEAK DISCHARGE RATE: 7.40+000 CURIES/YR AT 60891. YEARS
BAND WIDTH: 11530. YEARS WITH TAIL END AT 70426. YEARS
DISPERSION PEAK/NO-DISPERSION PEAK: 9.99-001

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
2.100-0358	.000	2.194-0328	.000	.56790488+002	.58680799+005
2.100-035	.000	2.194-032	.000	.56998882+002	.58896127+005
2.249-027	.000	2.054-024	.000	.57181684+002	.59085010+005
3.243-021	.000	2.591-018	.000	.57342037+002	.59250697+005
1.738-016	.000	1.216-013	.000	.57482697+002	.59396037+005
7.502-013	.000	4.603-010	.000	.57606083+002	.59523528+005
4.712-010	.000	2.539-007	.000	.57714317+002	.59635362+005
6.750-008	.000	3.203-005	.000	.57809258+002	.59733462+005
3.128-006	.000	1.306-003	.000	.57892540+002	.59819515+005
6.075-005	.000	2.239-002	.000	.57965595+002	.59895000+005
6.061-004	.000	1.978-001	.000	.58029678+002	.59961215+005
3.625-003	.000	1.050+000	.000	.58085891+002	.60019298+005
1.463-002	.000	3.774+000	.000	.58135201+002	.60070248+005
4.359-002	.000	1.006+001	.000	.58178455+002	.60114941+005
1.028-001	.000	2.131+001	.000	.58216397+002	.60154146+005
2.025-001	.000	3.785+001	.000	.58249680+002	.60188536+005
3.465-001	.000	5.876+001	.000	.58278875+002	.60218702+005
5.321-001	.000	8.226+001	.000	.58304485+002	.60245164+005
7.504-001	.000	1.064+002	.000	.58326950+002	.60268377+005
9.902-001	.000	1.294+002	.000	.58346656+002	.60288738+005
1.240+000	.000	1.503+002	.000	.58363942+002	.60306599+005
1.490+000	.000	1.685+002	.000	.58379105+002	.60322267+005
1.732+000	.000	1.838+002	.000	.58392406+002	.60336010+005
1.961+000	.000	1.963+002	.000	.58404073+002	.60348066+005
2.174+000	.000	2.064+002	.000	.58414308+002	.60358641+005
2.369+000	.000	2.143+002	.000	.58423286+002	.60367918+005
2.546+000	.000	2.205+002	.000	.58431161+002	.60376055+005
2.705+000	.000	2.253+002	.000	.58438069+002	.60383193+005
2.847+000	.000	2.290+002	.000	.58444129+002	.60389454+005
2.974+000	.000	2.317+002	.000	.58449444+002	.60394947+005
3.066+000	.000	2.338+002	.000	.58454107+002	.60399764+005
3.185+000	.000	2.353+002	.000	.58458197+002	.60403991+005
3.273+000	.000	2.365+002	.000	.58461785+002	.60407698+005
3.350+000	.000	2.373+002	.000	.58464933+002	.60410950+005
3.417+000	.000	2.379+002	.000	.58467693+002	.60413802+005
3.477+000	.000	2.383+002	.000	.58470115+002	.60416305+005
3.529+000	.000	2.386+002	.000	.58472239+002	.60418500+005
3.575+000	.000	2.389+002	.000	.58474103+002	.60420425+005
3.615+000	.000	2.389+002	.000	.58475737+002	.60422114+005
3.651+000	.000	2.389+002	.000	.58477171+002	.60423596+005
3.682+000	.000	2.390+002	7.412+004R	.58478429+002	.60424895+005
3.709+000	.000	2.390+002	7.412+004	.58479532+002	.60426045+005

3.709+000	7.412+000B	2.390+002	7.412+004	.58479532+002	.60426035+005
3.767+000	7.412+000	2.389+002	7.412+004T	.58481893+002	.60428475+005
3.803+000	7.412+000	2.388+002	.000	.58483327+002	.60429956+005
3.843+000	7.412+000	2.387+002	.000	.58484962+002	.60431645+005
3.889+000	7.412+000	2.385+002	.000	.58486825+002	.60433571+005
3.941+000	7.412+000	2.382+002	.000	.58488949+002	.60435766+005
4.001+000	7.412+000	2.377+002	.000	.58491371+002	.60438268+005
4.068+000	7.412+000	2.371+002	.000	.58494132+002	.60441121+005
4.145+000	7.412+000	2.362+002	.000	.58497279+002	.60444372+005
4.233+000	7.412+000	2.351+002	.000	.58500867+002	.60448080+005
4.332+000	7.411+000	2.335+002	.000	.58504957+002	.60452306+005
4.444+000	7.411+000	2.313+002	.000	.58509620+002	.60457124+005
4.570+000	7.411+000	2.285+002	.000	.58514935+002	.60462616+005
4.712+000	7.411+000	2.248+002	.000	.58520995+002	.60468878+005
4.870+000	7.411+000	2.200+002	.000	.58527903+002	.60476016+005
5.047+000	7.411+000	2.137+002	.000	.58535779+002	.60484153+005
5.241+000	7.411+000	2.057+002	.000	.58544756+002	.60493429+005
5.453+000	7.410+000	1.956+002	.000	.58554991+002	.60504004+005
5.681+000	7.410+000	1.830+002	.000	.58566659+002	.60516060+005
5.922+000	7.410+000	1.677+002	.000	.58579960+002	.60529804+005
6.171+000	7.409+000	1.496+002	.000	.58595123+002	.60545471+005
6.419+000	7.409+000	1.288+002	.000	.58612409+002	.60563332+005
6.657+000	7.409+000	1.059+002	.000	.58632115+002	.60583694+005
6.874+000	7.408+000	8.196+001	.000	.58654579+002	.60606906+005
7.059+000	7.408+000	5.866+001	.000	.58680189+002	.60633368+005
7.202+000	7.407+000	3.790+001	.000	.58709385+002	.60663535+005
7.302+000	7.406+000	2.145+001	.000	.58742667+002	.60697924+005
7.361+000	7.405+000	1.021+001	.000	.58780610+002	.60737129+005
7.389+000	7.404+000	3.885+000	.000	.58823864+002	.60781822+005
7.400+000	7.403+000	1.104+000	.000	.58873173+002	.60832772+005
7.402+000	7.402+000	2.149+001	.000	.58929387+002	.60890855+005
7.401+000	7.401+000	2.557+002	.000	.58993469+002	.60957070+005
7.399+000	7.399+000	1.607+003	.000	.59066524+002	.61032555+005
7.397+000	7.397+000	4.415+005	.000	.59149806+002	.61118608+005
7.395+000	7.395+000	4.147+007	.000	.59244748+002	.61216708+005
7.393+000	7.393+000	9.694+010	.000	.59352981+002	.61328542+005
7.390+000	7.390+000	3.743+013	.000	.59476367+002	.61456033+005
7.387+000	7.387+000	1.405+017	.000	.59617028+002	.61601373+005
7.384+000	7.384+000	2.588+023	.000	.59777380+002	.61767060+005
7.380+000	7.380+000	9.694+031	.000	.59960182+002	.61955944+005
7.375+000	7.375+000	9.694+031T	.000	.60168577+002	.62171271+005
7.370+000	7.370+000	.000	.000	.60406146+002	.62416744+005
7.364+000	7.364+000	.000	.000	.60676975+002	.62696583+005
7.358+000	7.358+000	.000	.000	.60985721+002	.63015600+005
7.350+000	7.350+000	.000	.000	.61337691+002	.63379279+005
7.341+000	7.341+000	.000	.000	.61738936+002	.63793873+005
7.332+000	7.332+000	.000	.000	.62196356+002	.64266511+005
7.320+000	7.320+000	.000	.000	.62717814+002	.64805317+005
7.308+000	7.308+000	.000	.000	.63312277+002	.65419557+005
7.293+000	7.293+000	.000	.000	.63989965+002	.66119790+005
7.277+000	7.277+000	.000	.000	.64762529+002	.66918055+005
7.258+000	7.258+000	.000	.000	.65643252+002	.67828078+005
7.236+000	7.236+000	.000	.000	.66647276+002	.68865504+005
7.204+000	7.212+000	.000	.000	.67791863+002	.70048170+005
3.599+000	7.204+000	.000	.000	.68157562+002	.70426035+005
3.599+000T	7.204+000T	.000	.000	.70584198+002	.72933401+005

@ED,R 69%.
NO CORRECTIONS APPLIED.
READ-ONLY MODE
ED 15R2-TUE-07/03/79-13:14:56-(0,)
EDIT

69 TH230

RUN MADE 070379 125923
XAMPL1

RADIONUCLIDE DISCHARGE RATE FROM AN AQUIFER AFTER
A LEACH INCIDENT IN AN UNDERGROUND REPOSITORY
CONTAINING YEAR 2050 NUCLEAR POWER ECONOMY WASTE

TIME OF LEACH INCIDENT: 1 YEARS

**NUCLIDE: TH230

HALF LIFE: 7.70+004 YEARS
NUCLIDE VELOCITY/WATER VELOCITY: .000869
INVENTORY IN WASTE AT YEAR 2050: 2.94+001 CURIES
INVENTORY IN WASTE AT BEGINNING OF LEACH INCIDENT: 2.94+001 CURIES
NUCLIDE FLOW RATE INTO AQUIFER: 2.94-003 CURIES/YR

NUCLIDE DISCHARGE RATE FROM AQUIFER WITH NO DISPERSION
INITIAL: 6.60-008 CURIES/YR AT 1189032. YEARS
FINAL : 6.04-008 CURIES/YR AT 1199032. YEARS

LEACH RATE: .100000-003 FRACTION PER YEAR
LEACH DURATION: 10000. YRS
LENGTH OF AQUIFER: 10.00 MILES

WATER VELOCITY: .140000+000 FT/DAY
WATER TRAVEL TIME: .1033268+004 YEARS
AXIAL DISPERSION COEFFICIENT: .01000 SQ CM / MIN

NUCLIDE DISCHARGE RATE FROM AQUIFER.
RELEASE MECHANISM: BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 1164943. YEARS
PEAK DISCHARGE RATE: 6.06-008 CURIES/YR AT 1194026. YEARS
BAND WIDTH: 59783. YEARS WITH TAIL END AT 1224726. YEARS
DISPERSION PEAK/NO-DISPERSION PEAK: 9.18-001

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
6.652-031B	.000	2.814-029R	.000	.11241692+004	.11615691+007
6.652-031	.000	2.814-029	.000	.11274342+004	.11649428+007
8.161-026	.000	3.026-024	.000	.11302983+004	.11679021+007
6.677-022	.000	2.172-020	.000	.11328106+004	.11704981+007
6.873-019	.000	1.964-017	.000	.11350144+004	.11727752+007
1.445-016	.000	3.635-015	.000	.11369476+004	.11747727+007
8.993-015	.000	1.995-013	.000	.11386433+004	.11765248+007
2.199-013	.000	4.310-012	.000	.11401308+004	.11780618+007
2.624-012	.000	4.557-011	.000	.11414357+004	.11794101+007
1.805-011	.000	2.784-010	.000	.11425802+004	.11805927+007
8.122-011	.000	1.117-009	.000	.11435843+004	.11816301+007
2.636-010	.000	3.245-009	.000	.11444650+004	.11825402+007
6.651-010	.000	7.356-009	.000	.11452376+004	.11833384+007
1.381-009	.000	1.379-008	.000	.11459152+004	.11840387+007
2.464-009	.000	2.233-008	.000	.11465097+004	.11846529+007
3.911-009	.000	3.232-008	.000	.11470312+004	.11851917+007
5.662-009	.000	4.292-008	.000	.11474886+004	.11856643+007
7.631-009	.000	5.336-008	.000	.11478898+004	.11860789+007
9.718-009	.000	6.305-008	.000	.11482418+004	.11864426+007
1.184-008	.000	7.165-008	.000	.11485505+004	.11867616+007
1.391-008	.000	7.902-008	.000	.11488214+004	.11870415+007
1.590-008	.000	8.519-008	.000	.11490589+004	.11872870+007
1.775-008	.000	9.021-008	.000	.11492673+004	.11875023+007
1.946-008	.000	9.426-008	.000	.11494501+004	.11876912+007
2.102-008	.000	9.747-008	.000	.11496105+004	.11878568+007
2.243-008	.000	9.999-008	.000	.11497512+004	.11880022+007
2.369-008	.000	1.020-007	.000	.11498745+004	.11881297+007
2.481-008	.000	1.035-007	.000	.11499828+004	.11882415+007
2.581-008	.000	1.047-007	.000	.11500777+004	.11883396+007
2.670-008	.000	1.056-007	.000	.11501610+004	.11884257+007
2.748-008	.000	1.062-007	.000	.11502340+004	.11885012+007
2.817-008	.000	1.068-007	.000	.11502981+004	.11885674+007
2.877-008	.000	1.072-007	.000	.11503543+004	.11886255+007
2.931-008	.000	1.075-007	.000	.11504037+004	.11886764+007
2.978-008	.000	1.077-007	.000	.11504469+004	.11887211+007
3.019-008	.000	1.078-007	.000	.11504849+004	.11887603+007
3.055-008	.000	1.080-007	.000	.11505181+004	.11887947+007
3.087-008	.000	1.080-007	.000	.11505473+004	.11888249+007
3.114-008	.000	1.081-007	.000	.11505729+004	.11888513+007
3.139-008	.000	1.082-007	.000	.11505954+004	.11888745+007
3.160-008	.000	1.082-007	.000	.11506151+004	.11888949+007
3.179-008	.000	1.082-007	.000	.11506324+004	.11889128+007

3.196-008	.000	1.082-007	.000	.11506476+004	.11889284+007
3.210-008	.000	1.082-007	.000	.11506609+004	.11889422+007
3.223-008	.000	1.082-007	.000	.11506725+004	.11889542+007
3.234-008	.000	1.082-007	.000	.11506828+004	.11889648+007
3.244-008	.000	1.082-007	.000	.11506917+004	.11889741+007
3.252-008	.000	1.082-007	.000	.11506996+004	.11889822+007
3.260-008	.000	1.082-007	.000	.11507065+004	.11889893+007
3.266-008	.000	1.082-007	.000	.11507126+004	.11889956+007
3.272-008	.000	1.082-007	.000	.11507179+004	.11890011+007
3.277-008	.000	1.082-007	.000	.11507226+004	.11890059+007
3.282-008	.000	1.082-007	.000	.11507267+004	.11890101+007
3.286-008	.000	1.082-007	.000	.11507302+004	.11890139+007
3.289-008	.000	1.082-007	.000	.11507334+004	.11890171+007
3.292-008	.000	1.082-007	.000	.11507361+004	.11890200+007
3.295-008	.000	1.082-007	.000	.11507386+004	.11890225+007
3.297-008	.000	1.082-007	.000	.11507407+004	.11890247+007
3.299-008	.000	1.082-007	.000	.11507426+004	.11890266+007
3.301-008	.000	1.082-007	.000	.11507442+004	.11890283+007
3.302-008	.000	1.082-007	.000	.11507456+004	.11890297+007
3.304-008	.000	1.082-007	6.605-004B	.11507469+004	.11890310+007
3.305-008	.000	1.082-007	6.605-004	.11507480+004	.11890322+007
3.305-008	6.605-008B	1.082-007	6.605-004	.11507480+004	.11890322+007
3.307-008	6.605-008	1.082-007	6.605-004T	.11507503+004	.11890346+007
3.309-008	6.604-008	1.082-007	.000	.11507518+004	.11890361+007
3.311-008	6.604-008	1.082-007	.000	.11507534+004	.11890378+007
3.313-008	6.604-008	1.082-007	.000	.11507553+004	.11890397+007
3.315-008	6.604-008	1.082-007	.000	.11507574+004	.11890419+007
3.318-008	6.604-008	1.082-007	.000	.11507598+004	.11890444+007
3.321-008	6.604-008	1.082-007	.000	.11507626+004	.11890473+007
3.324-008	6.604-008	1.082-007	.000	.11507657+004	.11890505+007
3.328-008	6.603-008	1.082-007	.000	.11507693+004	.11890542+007
3.333-008	6.603-008	1.082-007	.000	.11507734+004	.11890585+007
3.338-008	6.603-008	1.082-007	.000	.11507781+004	.11890633+007
3.343-008	6.603-008	1.082-007	.000	.11507834+004	.11890688+007
3.350-008	6.602-008	1.081-007	.000	.11507894+004	.11890750+007
3.357-008	6.602-008	1.081-007	.000	.11507964+004	.11890822+007
3.366-008	6.601-008	1.081-007	.000	.11508042+004	.11890903+007
3.376-008	6.601-008	1.081-007	.000	.11508132+004	.11890996+007
3.387-008	6.600-008	1.081-007	.000	.11508234+004	.11891102+007
3.400-008	6.599-008	1.080-007	.000	.11508351+004	.11891222+007
3.414-008	6.599-008	1.080-007	.000	.11508484+004	.11891360+007
3.430-008	6.598-008	1.079-007	.000	.11508636+004	.11891516+007
3.449-008	6.597-008	1.079-007	.000	.11508809+004	.11891695+007
3.470-008	6.595-008	1.078-007	.000	.11509006+004	.11891898+007
3.495-008	6.594-008	1.077-007	.000	.11509230+004	.11892131+007
3.522-008	6.592-008	1.076-007	.000	.11509486+004	.11892395+007
3.554-008	6.591-008	1.074-007	.000	.11509778+004	.11892697+007
3.590-008	6.589-008	1.072-007	.000	.11510111+004	.11893041+007
3.630-008	6.586-008	1.070-007	.000	.11510491+004	.11893433+007
3.677-008	6.584-008	1.067-007	.000	.11510923+004	.11893880+007
3.729-008	6.581-008	1.063-007	.000	.11511416+004	.11894389+007
3.789-008	6.577-008	1.058-007	.000	.11511978+004	.11894970+007
3.856-008	6.573-008	1.051-007	.000	.11512619+004	.11895632+007
3.933-008	6.569-008	1.043-007	.000	.11513350+004	.11896387+007
4.019-008	6.564-008	1.032-007	.000	.11514183+004	.11897248+007
4.116-008	6.558-008	1.018-007	.000	.11515132+004	.11898229+007
4.224-008	6.551-008	1.001-007	.000	.11516214+004	.11899347+007

4.345-008	6.544-008	9.792-008	.000	.11517448+004	.11900622+007
4.480-008	6.535-008	9.517-008	.000	.11518855+004	.11902075+007
4.628-008	6.525-008	9.173-008	.000	.11520458+004	.11903732+007
4.788-008	6.514-008	8.747-008	.000	.11522286+004	.11905621+007
4.961-008	6.502-008	8.224-008	.000	.11524370+004	.11907774+007
5.143-008	6.487-008	7.595-008	.000	.11526746+004	.11910229+007
5.331-008	6.471-008	6.850-008	.000	.11529454+004	.11913027+007
5.517-008	6.453-008	5.993-008	.000	.11532542+004	.11916218+007
5.695-008	6.431-008	5.041-008	.000	.11536061+004	.11919854+007
5.852-008	6.407-008	4.027-008	.000	.11540074+004	.11924000+007
5.977-008	6.380-008	3.011-008	.000	.11544648+004	.11928727+007
6.054-008	6.349-008	2.065-008	.000	.11549863+004	.11934115+007
6.062-008	6.314-008	1.266-008	.000	.11555807+004	.11940257+007
5.973-008	6.275-008	6.718-009	.000	.11562584+004	.11947259+007
5.740-008	6.230-008	2.952-009	.000	.11570310+004	.11955242+007
5.288-008	6.179-008	1.016-009	.000	.11579117+004	.11964342+007
4.522-008	6.122-008	2.550-010	.000	.11589157+004	.11974717+007
3.399-008	6.057-008	4.244-011	.000	.11600603+004	.11986543+007
3.015-008	6.036-008	2.280-011	.000	.11604260+004	.11990322+007
8.945-009	6.036-008T	2.037-013	.000	.11628527+004	.12015395+007
2.341-009	.000	4.093-015	.000	.11645484+004	.12032917+007
2.952-010	.000	2.588-017	.000	.11664816+004	.12052892+007
1.333-011	.000	3.664-020	.000	.11686854+004	.12075663+007
1.460-013	.000	7.478-024	.000	.11711977+004	.12101622+007
2.326-016	.000	1.248-028	.000	.11740618+004	.12131216+007
2.769-020	.000	8.185-035	.000	.11773268+004	.12164952+007
1.031-025	.000	8.185-035T	.000	.11810490+004	.12203412+007
3.871-033	.000	.000	.000	.11852922+004	.12247256+007
3.871-033T	.000	.000	.000	.11901295+004	.12297238+007

@ED,R 745.
NO CORRECTIONS APPLIED.
READ-ONLY MODE
ED 15R2-TUE-07/03/79-13:15:12-(0.)
EDIT

74 RA226

RUN MADE 070379 125923
XAMPL1

RADIONUCLIDE DISCHARGE RATE FROM AN AQUIFER AFTER
A LEACH INCIDENT IN AN UNDERGROUND REPOSITORY
CONTAINING YEAR 2050 NUCLEAR POWER ECONOMY WASTE

TIME OF LEACH INCIDENT: 1 YEARS

**NUCLIDE: RA226

HALF LIFE: 1.60+003 YEARS
NUCLIDE VELOCITY/WATER VELOCITY: .014300
INVENTORY IN WASTE AT YEAR 2050: 2.86-001 CURIES
INVENTORY IN WASTE AT BEGINNING OF LEACH INCIDENT: 2.86-001 CURIES
NUCLIDE FLOW RATE INTO AQUIFER: 2.86-005 CURIES/YR

NUCLIDE DISCHARGE RATE FROM AQUIFER WITH NO DISPERSION
INITIAL: 7.27-019 CURIES/YR AT 72258. YEARS
FINAL : 9.56-021 CURIES/YR AT 82258. YEARS

LEACH RATE: .100000-003 FRACTION PER YEAR
LEACH DURATION: 10000. YRS
LENGTH OF AQUIFER: 10.00 MILES

WATER VELOCITY: .140000+000 FT/DAY
WATER TRAVEL TIME: .1033268+004 YEARS
AXIAL DISPERSION COEFFICIENT: .01000 SQ CM / MIN

NUCLIDE DISCHARGE RATE FROM AQUIFER.
RELEASE MECHANISM: BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 71082. YEARS
PEAK DISCHARGE RATE: 6.25-019 CURIES/YR AT 72529. YEARS
BAND WIDTH: 11175. YEARS WITH TAIL END AT 82258. YEARS
DISPERSION PEAK/NO-DISPERSION PEAK: 8.59-001

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
.000	.000	2.425-035R	.000	.68449420+002	.70727602+005
7.090-0348	.000	2.425-035	.000	.68632222+002	.70916486+005
7.090-034	.000	3.959-031	.000	.68792574+002	.71082173+005
1.355-030	.000	6.639-028	.000	.68933235+002	.71227513+005
4.532-028	.000	1.951-025	.000	.69056621+002	.71355004+005
3.991-026	.000	1.513-023	.000	.69164854+002	.71466838+005
1.265-024	.000	4.227-022	.000	.69259796+002	.71564938+005
1.830-023	.000	5.406-021	.000	.69343078+002	.71650991+005
1.451-022	.000	3.800-020	.000	.69416133+002	.71726476+005
7.252-022	.000	1.689-019	.000	.69480216+002	.71792690+005
2.542-021	.000	5.281-019	.000	.69536429+002	.71850774+005
6.781-021	.000	1.262-018	.000	.69585738+002	.71901724+005
1.465-020	.000	2.454-018	.000	.69628992+002	.71946417+005
2.692-020	.000	4.076-018	.000	.69666935+002	.71985621+005
4.359-020	.000	5.999-018	.000	.69700217+002	.72020011+005
6.400-020	.000	8.050-018	.000	.69729413+002	.72050178+005
8.708-020	.000	1.007-017	.000	.69755023+002	.72076640+005
1.116-019	.000	1.193-017	.000	.69777487+002	.72099852+005
1.365-019	.000	1.356-017	.000	.69797193+002	.72120214+005
1.608-019	.000	1.494-017	.000	.69814479+002	.72138075+005
1.839-019	.000	1.607-017	.000	.69829643+002	.72153742+005
2.055-019	.000	1.697-017	.000	.69842944+002	.72167486+005
2.252-019	.000	1.768-017	.000	.69854611+002	.72179541+005
2.432-019	.000	1.823-017	.000	.69864846+002	.72190117+005
2.593-019	.000	1.864-017	.000	.69873824+002	.72199393+005
2.736-019	.000	1.895-017	.000	.69881699+002	.72207530+005
2.864-019	.000	1.917-017	.000	.69888607+002	.72214668+005
2.976-019	.000	1.934-017	.000	.69894667+002	.72220930+005
3.076-019	.000	1.945-017	.000	.69899982+002	.72226422+005
3.163-019	.000	1.954-017	.000	.69904645+002	.72231240+005
3.240-019	.000	1.959-017	.000	.69908735+002	.72235466+005
3.307-019	.000	1.962-017	.000	.69912323+002	.72239173+005
3.366-019	.000	1.964-017	.000	.69915470+002	.72242425+005
3.418-019	.000	1.965-017	.000	.69918231+002	.72245278+005
3.464-019	.000	1.965-017	.000	.69920653+002	.72247780+005
3.504-019	.000	1.965-017	.000	.69922777+002	.72249975+005
3.538-019	.000	1.965-017	.000	.69924640+002	.72251901+005
3.569-019	.000	1.964-017	.000	.69926275+002	.72253589+005
3.596-019	.000	1.963-017	.000	.69927709+002	.72255071+005
3.619-019	.000	1.962-017	7.274-0158	.69928967+002	.72256371+005
3.640-019	7.270-0198	1.961-017	7.274-015	.69930070+002	.72257511+005
3.660-019	7.270-019	1.960-017	7.274-0157	.69931173+002	.72258651+005

3.684-019	7.266-019	1.959-017	.000	.69932431+002	.72259950+005
3.710-019	7.261-019	1.957-017	.000	.69933865+002	.72261432+005
3.741-019	7.256-019	1.955-017	.000	.69935499+002	.72263121+005
3.775-019	7.250-019	1.952-017	.000	.69937363+002	.72265046+005
3.814-019	7.243-019	1.948-017	.000	.69939487+002	.72267241+005
3.859-019	7.235-019	1.944-017	.000	.69941909+002	.72269743+005
3.909-019	7.226-019	1.938-017	.000	.69944570+002	.72272596+005
3.967-019	7.216-019	1.930-017	.000	.69947817+002	.72275848+005
4.032-019	7.205-019	1.920-017	.000	.69951405+002	.72279555+005
4.105-019	7.191-019	1.908-017	.000	.69955495+002	.72283781+005
4.188-019	7.176-019	1.891-017	.000	.69960158+002	.72288599+005
4.281-019	7.159-019	1.871-017	.000	.69965473+002	.72294092+005
4.386-019	7.140-019	1.844-017	.000	.69971533+002	.72300353+005
4.503-019	7.118-019	1.811-017	.000	.69978441+002	.72307491+005
4.632-019	7.093-019	1.768-017	.000	.69986316+002	.72315628+005
4.775-019	7.064-019	1.715-017	.000	.69995294+002	.72324905+005
4.930-019	7.032-019	1.648-017	.000	.70005529+002	.72335480+005
5.098-019	6.995-019	1.565-017	.000	.70017196+002	.72347536+005
5.275-019	6.954-019	1.464-017	.000	.70030497+002	.72361279+005
5.459-019	6.907-019	1.342-017	.000	.70045660+002	.72376947+005
5.643-019	6.854-019	1.199-017	.000	.70062946+002	.72394808+005
5.820-019	6.793-019	1.036-017	.000	.70082652+002	.72415169+005
5.980-019	6.726-019	8.574-018	.000	.70105117+002	.72438381+005
6.112-019	6.649-019	6.707-018	.000	.70130727+002	.72464843+005
6.205-019	6.563-019	4.876-018	.000	.70159922+002	.72495010+005
6.251-019	6.465-019	3.225-018	.000	.70193205+002	.72529400+005
6.243-019	6.357-019	1.886-018	.000	.70231147+002	.72568604+005
6.184-019	6.235-019	9.400-019	.000	.70274402+002	.72613297+005
6.080-019	6.099-019	3.809-019	.000	.70323711+002	.72664248+005
5.942-019	5.947-019	1.180-019	.000	.70379924+002	.72722331+005
5.778-019	5.779-019	2.579-020	.000	.70444007+002	.72788546+005
5.593-019	5.593-019	3.589-021	.000	.70517062+002	.72864031+005
5.388-019	5.388-019	2.781-022	.000	.70600344+002	.72950083+005
5.164-019	5.164-019	1.009-023	.000	.70695286+002	.73048183+005
4.920-019	4.920-019	1.369-025	.000	.70803519+002	.73160018+005
4.656-019	4.656-019	5.200-028	.000	.70926905+002	.73287509+005
4.371-019	4.371-019	3.802-031	.000	.71067565+002	.73432848+005
4.069-019	4.069-019	3.297-035	.000	.71227918+002	.73598536+005
3.749-019	3.749-019	3.297-035T	.000	.71410720+002	.73787419+005
3.415-019	3.415-019	.000	.000	.71619114+002	.74002746+005
3.071-019	3.071-019	.000	.000	.71856684+002	.74248219+005
2.720-019	2.720-019	.000	.000	.72127513+002	.74528059+005
2.369-019	2.369-019	.000	.000	.72436259+002	.74847075+005
2.024-019	2.024-019	.000	.000	.72788228+002	.75210754+005
1.691-019	1.691-019	.000	.000	.73189474+002	.75625349+005
1.378-019	1.378-019	.000	.000	.73646894+002	.76097986+005
1.091-019	1.091-019	.000	.000	.74168352+002	.76636792+005
8.361-020	8.361-020	.000	.000	.74762815+002	.77251032+005
6.173-020	6.173-020	.000	.000	.75440503+002	.77951265+005
4.368-020	4.368-020	.000	.000	.76213067+002	.78749531+005
2.945-020	2.945-020	.000	.000	.77093789+002	.79659553+005
1.879-020	1.879-020	.000	.000	.78097813+002	.80696979+005
1.120-020	1.126-020	.000	.000	.79242401+002	.81879645+005
4.775-021	9.557-021	.000	.000	.79608100+002	.82257511+005
4.775-021T	9.557-021T	.000	.000	.82034736+002	.84764876+005

C.1.2 PROGRAM TWO

Two examples of 2-member-chain migration profile reports from program TWO are shown for three members of the $4N+2$ decay chain.

#ED,R 705.
NO CORRECTIONS APPLIED.
READ-ONLY MODE
ED 15R2-TUE-07/03/79-13:30:43-(0.)
EDIT

70 TH230

RUN MADE 070379 131634
XAMPL1

MIGRATION OF RADIONUCLIDE CHAINS THROUGH AN ADSORBING MEDIUM
FOR IMPULSE AND BAND RELEASE OF ALL THE YEAR 2050 NUCLEAR
POWER ECONOMY WASTE FROM AN UNDERGROUND REPOSITORY

TIME OF LEACH INCIDENT: 1 YEARS

**NUCLIDE: TH230 FROM U234

	U234	TH230
HALF-LIFE,YR	2.44+005	7.70+004
DECAY NUMBER	2.94+003	9.30+003
DISTRIB COEFF	5.85+001	1.15+003
YR 2050 CURIES	8.80+004	.00
PULSE G-ATOMS	6.00+004	.00
NUCL VEL,MI/YR	1.65+004	8.41+006
DISCH TIME,YR	6.04+004	1.19+006
DIM DISC TIME	5.85+001	1.15+003

LEACH RATE .000100 FRACTION PER YEAR
LEACH DURATION 10000. YEARS
PATH LENGTH 10.00 MILES
DIMENSIONLESS DISTANCE 1.00
WATER VELOCITY .1400000+000 FT /DAY
WATER TRAVEL TIME .10332681+004 YEARS
AXIAL DISPERSION COEFFICIENT .0100 SQ CM / MIN
PECLET NUMBER 476902.27

NUCLIDE DISCHARGE RATE FROM AQUIFER.
RELEASE MECHANISM: BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 60492. YEARS
PEAK DISCHARGE RATE= 3.345+002 CURIES PER YR AT 70426. YEARS
BAND WIDTH= 1138540. YEARS WITH TAIL END AT 1199032. YEARS

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
3.109-032B	.000	2.398-033	.000	.57095407+002	.58995863+005
3.109-032	.000	2.840-029	.000	.57191932+002	.59095599+005
1.998-028	.000	1.688-025	.000	.57288458+002	.59195336+005
6.512-025	.000	5.061-022	.000	.57384983+002	.59295072+005
1.082-021	.000	7.684-019	.000	.57481508+002	.59394809+005
9.228-019	.000	5.937-016	.000	.57578033+002	.59494545+005
4.064-016	.000	2.347-013	.000	.57674559+002	.59594282+005
9.317-014	.000	4.775-011	.000	.57771084+002	.59694018+005
1.122-011	.000	5.032-009	.000	.57867609+002	.59793755+005
7.178-010	.000	2.769-007	.000	.57964134+002	.59893491+005
2.475-008	.000	8.035-006	.000	.58060650+002	.59993227+005
4.690-007	.000	1.247-004	.000	.58157185+002	.60092964+005
5.016-006	.000	1.054-003	.000	.58253710+002	.60192700+005
3.146-005	.000	5.005-003	.000	.58350235+002	.60292437+005
1.763-004	2.352-004B	1.786-002	3.570-002B	.58479532+002	.60426035+005
3.183-004	2.352-004	2.509-002	3.570-002	.58543286+002	.60491910+005
6.035-004	5.910-004	3.243-002	3.567-002	.58639811+002	.60591646+005
9.487-004	9.464-004	3.506-002	3.563-002	.58734336+002	.60691383+005
1.301-003	1.301-003	3.554-002	3.560-002	.58832861+002	.60791119+005
1.656-003	1.656-003	3.556-002	3.557-002	.58929387+002	.60890855+005
3.344-003	3.344-003	3.541-002	3.541-002	.59390795+002	.61367614+005
5.023-003	5.023-003	3.525-002	3.525-002	.59852204+002	.61844373+005
6.692-003	6.692-003	3.510-002	3.510-002	.60313613+002	.62321132+005
8.351-003	8.352-003	3.494-002	3.494-002	.60775022+002	.62797891+005
1.000-002	1.000-002	3.479-002	3.479-002	.61236431+002	.63274650+005
1.164-002	1.164-002	3.463-002	3.463-002	.61697839+002	.63751409+005
1.327-002	1.327-002	3.448-002	3.448-002	.62159248+002	.64228168+005
1.489-002	1.489-002	3.432-002	3.432-002	.62620657+002	.64704927+005
1.650-002	1.650-002	3.417-002	3.417-002	.63082066+002	.65181686+005
1.811-002	1.811-002	3.402-002	3.402-002	.63543475+002	.65658445+005
1.970-002	1.970-002	3.387-002	3.387-002	.64004883+002	.66135204+005
2.128-002	2.128-002	3.372-002	3.372-002	.64466292+002	.66611963+005
2.286-002	2.286-002	3.357-002	3.357-002	.64927701+002	.67088722+005
2.442-002	2.442-002	3.342-002	3.342-002	.65389110+002	.67565481+005
2.598-002	2.598-002	3.327-002	3.327-002	.65850518+002	.68042240+005
2.752-002	2.752-002	3.312-002	3.312-002	.66311927+002	.68518999+005
2.906-002	2.906-002	3.298-002	3.298-002	.66773336+002	.68995758+005
3.059-002	3.059-002	3.283-002	3.283-002	.67234745+002	.69472517+005
3.211-002	3.211-002	3.269-002	3.269-002	.67696154+002	.69949276+005
3.345-002	3.362-002	3.254-002	3.254-002	.68157562+002	.70426035+005
2.017-002	2.017-002	1.953-002	1.953-002	.12112139+003	.12515187+006
1.211-002	1.211-002	1.172-002	1.172-002	.17408523+003	.17987771+006
7.265-003	7.265-003	7.031-003	7.031-003	.22704906+003	.23460355+006
4.359-003	4.359-003	4.219-003	4.219-003	.28001289+003	.28932939+006
2.616-003	2.616-003	2.532-003	2.532-003	.33297672+003	.34405522+006
1.570-003	1.570-003	1.519-003	1.519-003	.38594055+003	.39878106+006
9.420-004	9.420-004	9.118-004	9.118-004	.43890438+003	.45350690+006

5.653-004	5.653-004	5.471-004	5.471-004	.49186822+003	.50823274+006
3.392-004	3.392-004	3.283-004	3.283-004	.54483205+003	.56295857+006
2.036-004	2.036-004	1.970-004	1.970-004	.59779588+003	.61768441+006
1.222-004	1.222-004	1.182-004	1.182-004	.65075971+003	.67241025+006
7.330-005	7.330-005	7.095-005	7.095-005	.70372354+003	.72713609+006
4.399-005	4.399-005	4.257-005	4.257-005	.75668737+003	.78186193+006
2.640-005	2.640-005	2.555-005	2.555-005	.80965120+003	.83658776+006
1.584-005	1.584-005	1.533-005	1.533-005	.86261504+003	.89131360+006
9.505-006	9.505-006	9.200-006	9.200-006	.91557887+003	.94603944+006
5.704-006	5.704-006	5.521-006	5.521-006	.96854270+003	.10007653+007
3.423-006	3.423-006	3.313-006	3.313-006	.10215065+004	.10554911+007
2.054-006	2.054-006	1.988-006	1.988-006	.10744704+004	.11102170+007
1.233-006	1.233-006	1.193-006	1.193-006	.11274342+004	.11649428+007
1.216-006	1.216-006	1.177-006	1.177-006	.11288415+004	.11663969+007
1.200-006	1.200-006	1.161-006	1.161-006	.11302488+004	.11678511+007
1.183-006	1.183-006	1.145-006	1.145-006	.11316562+004	.11693052+007
1.167-006	1.167-006	1.130-006	1.130-006	.11330635+004	.11707594+007
1.152-006	1.152-006	1.115-006	1.115-006	.11344708+004	.11722135+007
1.136-006	1.136-006	1.100-006	1.100-006	.11358782+004	.11736677+007
1.121-006	1.121-006	1.085-006	1.085-006	.11372855+004	.11751218+007
1.106-006	1.106-006	1.070-006	1.070-006	.11386928+004	.11765760+007
1.091-006	1.091-006	1.056-006	1.056-006	.11401001+004	.11780301+007
1.076-006	1.076-006	1.042-006	1.042-006	.11415075+004	.11794842+007
1.062-006	1.062-006	1.027-006	1.028-006	.11429148+004	.11809384+007
1.051-006	1.047-006	1.011-006	1.014-006	.11443221+004	.11823925+007
1.059-006	1.033-006	9.836-007	1.000-006	.11457294+004	.11838467+007
1.135-006	1.019-006	9.249-007	9.866-007	.11471368+004	.11853008+007
1.401-006	1.006-006	8.033-007	9.733-007	.11485441+004	.11867550+007
2.636-006	9.844-007	4.763-007	9.528-007	.11507480+004	.11890322+007
3.211-006	2.038-006	3.767-007	9.528-007T	.11513588+004	.11896633+007
4.890-006	4.435-006	1.832-007	.000	.11527661+004	.11911174+007
6.876-006	6.791-006	6.757-008	.000	.11541734+004	.11925716+007
8.789-006	9.106-006	1.850-008	.000	.11555807+004	.11940257+007
1.007-005	1.151-005	3.359-009	.000	.11570663+004	.11955607+007
9.758-006	1.386-005	4.263-010	.000	.11585519+004	.11970957+007
7.586-006	1.618-005	3.757-011	.000	.11600375+004	.11986307+007
6.805-006	1.678-005	1.873-011	.000	.11604260+004	.11990322+007
1.969-006	1.678-005T	9.623-014	.000	.11630086+004	.12017007+007
6.176-007	.000	2.787-015	.000	.11644942+004	.12032357+007
1.368-007	.000	5.554-017	.000	.11659797+004	.12047707+007
2.118-008	.000	7.620-019	.000	.11674653+004	.12063057+007
2.275-009	.000	7.195-021	.000	.11689509+004	.12078407+007
1.690-010	.000	4.679-023	.000	.11704365+004	.12093757+007
8.653-012	.000	2.096-025	.000	.11719220+004	.12109107+007
3.050-013	.000	6.478-028	.000	.11734076+004	.12124456+007
7.398-015	.000	1.381-030	.000	.11748932+004	.12139806+007
1.234-016	.000	2.035-033	.000	.11763788+004	.12155156+007
1.416-018	.000	2.035-033T	.000	.11778643+004	.12170506+007
1.118-020	.000	.000	.000	.11793499+004	.12185856+007
6.082-023	.000	.000	.000	.11808355+004	.12201206+007
2.279-025	.000	.000	.000	.11823210+004	.12216556+007
5.991-028	.000	.000	.000	.11838066+004	.12231906+007

RED,R 75%.
NO CORRECTIONS APPLIED.
READ-ONLY MODE
ED 15R2-TUE-07/03/79-13:30:47-(0,)
EDIT

75 RA226

RUN MADE 070379 131634
XAMPL1

MIGRATION OF RADIONUCLIDE CHAINS THROUGH AN ADSORRING MEDIUM
FOR IMPULSE AND BAND RELEASE OF ALL THE YEAR 2050 NUCLEAR
POWER ECONOMY WASTE FROM AN UNDERGROUND REPOSITORY

TIME OF LEACH INCIDENT: 1 YEARS

**NUCLIDE: RA226 FROM TH230

	TH230	RA226
HALF-LIFE,YR	7.70+004	1.60+003
DECAY NUMBER	9.30+003	4.48+001
DISTRIB COEFF	1.15+003	6.99+001
YR 2050 CURIES	2.94+001	.00
PULSE G-ATOMS	6.33+000	.00
NUCL VEL,MI/YR	8.41+006	1.38+004
DISCH TIME,YR	1.19+006	7.23+004
DIM DISC TIME	1.15+003	6.99+001

LEACH RATE .000100 FRACTION PER YEAR
LEACH DURATION 10000. YEARS
PATH LENGTH 10.00 MILES
DIMENSIONLESS DISTANCE 1.00
WATER VELOCITY .1400000+000 FT /DAY
WATER TRAVEL TIME .10332681+004 YEARS
AXIAL DISPERSION COEFFICIENT .0100 SQ CM / MIN
PECLET NUMBER 476902.27

NUCLIDE DISCHARGE RATE FROM AQUIFER.
RELEASE MECHANISM: BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 72258. YEARS
PEAK DISCHARGE RATE= 2.664+007 CURIES PER YR AT 1189032. YEARS
BAND WIDTH= 1126373. YEARS WITH TAIL END AT 1198631. YEARS

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
6.031-032	.000	1.652-029	.000	.68862606+002	.71154534+005
2.452-030	.000	6.291-028	.000	.68932638+002	.71226895+005
7.831-029	.000	1.875-026	.000	.69002669+002	.71299257+005
1.969-027	.000	4.381-025	.000	.69072701+002	.71371618+005
3.905-026	.000	8.032-024	.000	.69142732+002	.71443980+005
6.125-025	.000	1.158-022	.000	.69212764+002	.71516341+005
7.615-024	.000	1.314-021	.000	.69282795+002	.71588702+005
7.532-023	.000	1.178-020	.000	.69352827+002	.71661064+005
5.948-022	.000	8.357-020	.000	.69422858+002	.71733425+005
3.767-021	.000	4.708-019	.000	.69492890+002	.71805786+005
1.924-020	.000	2.114-018	.000	.69562921+002	.71878148+005
7.983-020	.000	7.609-018	.000	.69632953+002	.71950509+005
2.712-019	.000	2.209-017	.000	.69702984+002	.72022870+005
7.629-019	.000	5.220-017	.000	.69773016+002	.72095232+005
1.800-018	4.383-032B	1.016-016	3.449-016B	.69843047+002	.72167593+005
4.700-018	4.383-032	1.822-016	3.449-016	.69913070+002	.72239954+005
6.339-018	3.645-018	2.316-016	3.452-016	.69983111+002	.72312316+005
9.855-018	8.394-018	2.851-016	3.457-016	.70053142+002	.72384677+005
1.393-017	1.307-017	3.197-016	3.462-016	.70123174+002	.72457038+005
1.830-017	1.769-017	3.375-016	3.466-016	.70193205+002	.72529400+005
4.764-017	4.711-017	3.505-016	3.497-016	.70263236+002	.72601761+005
7.473-017	7.416-017	3.537-016	3.529-016	.70333267+002	.72674122+005
9.991-017	9.930-017	3.569-016	3.561-016	.70403298+002	.72746483+005
1.236-016	1.229-016	3.601-016	3.593-016	.70473329+002	.72818844+005
1.460-016	1.453-016	3.633-016	3.625-016	.70543360+002	.72891205+005
1.675-016	1.668-016	3.666-016	3.658-016	.70613391+002	.72963566+005
1.882-016	1.874-016	3.699-016	3.691-016	.70683422+002	.73035927+005
2.083-016	2.075-016	3.732-016	3.724-016	.70753453+002	.73108288+005
2.279-016	2.271-016	3.766-016	3.758-016	.70823484+002	.73180649+005
2.471-016	2.463-016	3.800-016	3.792-016	.70893515+002	.73253010+005
2.661-016	2.652-016	3.834-016	3.826-016	.70963546+002	.73325371+005
2.849-016	2.840-016	3.869-016	3.860-016	.71033577+002	.73397732+005
3.035-016	3.025-016	3.904-016	3.895-016	.71103608+002	.73470093+005
3.220-016	3.210-016	3.939-016	3.930-016	.71173639+002	.73542454+005
3.405-016	3.394-016	3.974-016	3.965-016	.71243670+002	.73614815+005
3.589-016	3.578-016	4.010-016	4.001-016	.71313701+002	.73687176+005
3.773-016	3.762-016	4.046-016	4.037-016	.71383732+002	.73759537+005
3.958-016	3.946-016	4.083-016	4.074-016	.71453763+002	.73831898+005
4.142-016	4.130-016	4.120-016	4.110-016	.71523794+002	.73904259+005
3.945-016	4.315-016	4.157-016	4.147-016	.71593825+002	.73976620+005
9.866-016	9.844-016	1.128-015	1.126-015	.71663856+002	.74048981+005
2.678-015	2.672-015	3.062-015	3.055-015	.71733887+002	.74121342+005
7.269-015	7.253-015	8.312-015	8.293-015	.71803918+002	.74193703+005
1.973-014	1.969-014	2.253-014	2.251-014	.71873949+002	.74266064+005
5.355-014	5.343-014	6.124-014	6.110-014	.71943980+002	.74338425+005
1.454-013	1.450-013	1.662-013	1.658-013	.72014011+002	.74410786+005
3.945-013	3.936-013	4.511-013	4.501-013	.72084042+002	.74483147+005

1.071-012	1.068-012	1.225-012	1.222-012	.49873854+003	.51533162+006
2.907-012	2.900-012	3.324-012	3.316-012	.55112984+003	.56946589+006
7.889-012	7.871-012	9.021-012	9.001-012	.60352115+003	.62360015+006
2.141-011	2.137-011	2.449-011	2.443-011	.65591245+003	.67773441+006
5.812-011	5.799-011	6.646-011	6.631-011	.70830376+003	.73186869+006
1.578-010	1.574-010	1.804-010	1.800-010	.76069506+003	.78600294+006
4.282-010	4.272-010	4.896-010	4.885-010	.81308637+003	.84013721+006
1.162-009	1.160-009	1.329-009	1.326-009	.86547767+003	.89427147+006
3.155-009	3.148-009	3.607-009	3.599-009	.91786898+003	.94840573+006
8.562-009	8.543-009	9.791-009	9.769-009	.97026028+003	.10025400+007
2.324-008	2.319-008	2.658-008	2.652-008	.10226516+004	.10566743+007
6.308-008	6.294-008	7.213-008	7.197-008	.10750429+004	.11108085+007
1.712-007	1.708-007	1.958-007	1.954-007	.11274342+004	.11649428+007
1.759-007	1.755-007	2.011-007	2.007-007	.11288415+004	.11663969+007
1.807-007	1.802-007	2.066-007	2.061-007	.11302488+004	.11678511+007
1.856-007	1.851-007	2.122-007	2.117-007	.11316562+004	.11693052+007
1.906-007	1.902-007	2.180-007	2.175-007	.11330635+004	.11707594+007
1.958-007	1.954-007	2.239-007	2.234-007	.11344708+004	.11722135+007
2.011-007	2.007-007	2.300-007	2.295-007	.11358782+004	.11736677+007
2.066-007	2.061-007	2.362-007	2.357-007	.11372855+004	.11751218+007
2.122-007	2.117-007	2.426-007	2.421-007	.11386928+004	.11765760+007
2.180-007	2.175-007	2.492-007	2.487-007	.11401001+004	.11780301+007
2.239-007	2.234-007	2.560-007	2.554-007	.11415075+004	.11794842+007
2.300-007	2.295-007	2.626-007	2.624-007	.11429148+004	.11809384+007
2.362-007	2.357-007	2.691-007	2.695-007	.11443221+004	.11823925+007
2.422-007	2.421-007	2.721-007	2.769-007	.11457294+004	.11838467+007
2.471-007	2.487-007	2.647-007	2.844-007	.11471368+004	.11853008+007
2.487-007	2.555-007	2.364-007	2.921-007	.11485441+004	.11867550+007
2.361-007	2.664-007	1.444-007	3.046-007	.11507480+004	.11890322+007
2.283-007	2.502-007	1.149-007	3.046-007T	.11513588+004	.11896633+007
2.031-007	2.127-007	5.644-008	.000	.11527661+004	.11911174+007
1.705-007	1.747-007	2.097-008	.000	.11541734+004	.11925716+007
1.342-007	1.362-007	5.771-009	.000	.11555807+004	.11940257+007
9.538-008	9.512-008	1.052-009	.000	.11570663+004	.11955607+007
5.985-008	5.343-008	1.339-010	.000	.11585519+004	.11970957+007
3.170-008	1.116-008	1.183-011	.000	.11600375+004	.11986307+007
2.595-008	1.116-008T	5.899-012	.000	.11604260+004	.11990322+007
4.463-009	.000	3.039-014	.000	.11630086+004	.12017007+007
1.103-009	.000	8.811-016	.000	.11644942+004	.12032357+007
1.991-010	.000	1.758-017	.000	.11654797+004	.12047707+007
2.584-011	.000	2.414-019	.000	.11674653+004	.12063057+007
2.380-012	.000	2.281-021	.000	.11689509+004	.12078407+007
1.543-013	.000	1.484-023	.000	.11704365+004	.12093757+007
6.997-015	.000	6.653-026	.000	.11719220+004	.12109107+007
2.212-016	.000	2.057-028	.000	.11734076+004	.12124456+007
4.860-018	.000	4.388-031	.000	.11748932+004	.12139806+007
7.407-020	.000	6.467-034	.000	.11763788+004	.12155156+007
7.823-022	.000	6.467-034T	.000	.11778643+004	.12170506+007
5.722-024	.000	.000	.000	.11793499+004	.12185856+007
2.898-026	.000	.000	.000	.11808355+004	.12201206+007
1.016-028	.000	.000	.000	.11823210+004	.12216556+007
2.468-031	.000	.000	.000	.11838066+004	.12231906+007

C.1.3 PROGRAM THREE

One example of a 3-member-chain migration report from program THREE is shown for three of the members of the $4N+2$ decay chain.

ED,R 765.
NO CORRECTIONS APPLIED.
READ-ONLY MODE
ED 15R2-TUE-07/03/79-13:44:21-(0,)
EDIT

76 RA226

RUN MADE 070379 133103
XAMPL1

MIGRATION OF RADIONUCLIDE CHAINS THROUGH AN ADSORBING MEDIUM
FOR IMPULSE AND BAND RELEASE OF ALL THE YEAR 2050 NUCLEAR
POWER ECONOMY WASTE FROM AN UNDERGROUND REPOSITORY

TIME OF LEACH INCIDENT: 1 YEARS

••NUCLIDE: RA226 VIA TH230 FROM U234

	U234	TH230	RA226
HALF-LIFE,YR	2.44+005	7.70+004	1.60+003
DECAY NUMBER	2.94+003	9.30+003	4.48+001
DISTRIB COEFF	5.85+001	1.15+003	6.99+001
YR 2050 Curies	8.80+004	.00	.00
PULSE G-ATOMS	6.00+004	.00	.00
NUCL VEL,MI/YR	1.65+004	8.41+006	1.38+004
DISCH TIME,YR	6.04+004	1.19+006	7.23+004
DIM DISC TIME	5.85+001	1.15+003	6.99+001

LEACH RATE .100000+003 FRACTION PER YEAR
LEACH DURATION 10000. YEARS
PATH LENGTH 10.00 MILES
DIMENSIONLESS DISTANCE 1.00
WATER VELOCITY .140000+000 FT /DAY
WATER TRAVEL TIME .10332681+004 YEARS
AXIAL DISPERSION COEFFICIENT .0100 SQ CM / MIN
PECLET NUMBER 476902.27

NUCLIDE DISCHARGE RATE FROM AQUIFER.
RELEASE MECHANISM BAND WITHOUT DISPERSION
INITIAL BREAKTHROUGH AT 60592. YEARS
PEAK DISCHARGE RATE=5.514+001 Curies PER YR AT 71299. YEARS
BAND WIDTH= 1136039. YEARS WITH TAIL END AT 1198631. YEARS

DISCHARGE RATE, CI/YR.

BAND WITH DISP.	BAND W/O DISP.	PULSE WITH DISP.	PULSE W/O DISP.	THETA (DIMENSIONLESS)	TIME (YEARS)
1.430-032B	.000	1.035-033	.000	.57095407+002	.58995863+005
1.430-032	.000	1.316-029	.000	.57191932+002	.59095599+005
9.896-029	.000	8.439-026	.000	.57288458+002	.59195336+005
3.492-025	.000	2.743-022	.000	.57384983+002	.59295072+005
6.323-022	.000	4.545-019	.000	.57481508+002	.59394809+005
5.914-019	.000	3.862-016	.000	.57578033+002	.59494545+005
2.880-016	.000	1.694-013	.000	.57674559+002	.59594282+005
7.371-014	.000	3.863-011	.000	.57771084+002	.59694018+005
1.902-011	.000	4.622-009	.000	.57867609+002	.59793755+005
7.332-010	.000	2.932-007	.000	.57964134+002	.59893491+005
2.938-008	.000	1.000-005	.000	.58060660+002	.59993227+005
6.588-007	.000	1.869-004	.000	.58157185+002	.60092964+005
8.514-006	.000	1.960-003	.000	.58253710+002	.60192700+005
6.598-005	.000	1.196-002	.000	.58350235+002	.60292437+005
3.232-004	.000	4.477-002	.000	.58446760+002	.60392173+005
5.053-004	1.853-003B	6.346-002	2.086-001B	.58479532+002	.60426035+005
2.596-003	1.853-003	1.971-001	2.086-001	.58639811+002	.60591646+005
4.993-003	4.391-003	2.818-001	2.966-001	.58736336+002	.60691383+005
8.165-003	7.699-003	3.519-001	3.642-001	.58832861+002	.60791119+005
1.196-002	1.160-002	4.065-001	4.160-001	.58929387+002	.60890855+005
3.502-002	3.492-002	5.355-001	5.382-001	.59390795+002	.61367614+005
6.150-002	6.147-002	5.704-001	5.712-001	.59852204+002	.61844373+005
8.084-002	8.883-002	5.785-001	5.787-001	.60313613+002	.62321132+005
1.163-001	1.163-001	5.790-001	5.790-001	.60775022+002	.62797891+005
1.437-001	1.437-001	5.773-001	5.773-001	.61236431+002	.63274650+005
1.710-001	1.710-001	5.750-001	5.750-001	.61697839+002	.63751409+005
1.981-001	1.981-001	5.725-001	5.725-001	.62159248+002	.64228168+005
2.250-001	2.250-001	5.700-001	5.700-001	.62620657+002	.64704927+005
2.518-001	2.518-001	5.674-001	5.674-001	.63082066+002	.65181686+005
2.784-001	2.784-001	5.649-001	5.649-001	.63543475+002	.65658445+005
3.049-001	3.049-001	5.624-001	5.624-001	.64004883+002	.66135204+005
3.312-001	3.312-001	5.599-001	5.599-001	.64466292+002	.66611963+005
3.574-001	3.574-001	5.574-001	5.574-001	.64927701+002	.67088722+005
3.834-001	3.834-001	5.550-001	5.550-001	.65389110+002	.67565481+005
4.093-001	4.093-001	5.525-001	5.525-001	.65850518+002	.68042240+005
4.350-001	4.350-001	5.500-001	5.500-001	.66311927+002	.68518999+005
4.605-001	4.605-001	5.476-001	5.476-001	.66771336+002	.68995758+005
4.860-001	4.860-001	5.452-001	5.452-001	.67234745+002	.69472517+005
5.112-001	5.112-001	5.427-001	5.427-001	.67696154+002	.69949276+005
5.358-001	5.363-001	5.403-001	5.403-001	.68157562+002	.70426035+005
5.373-001	5.380-001	5.402-001	5.402-001	.68189313+002	.70458842+005
5.387-001	5.395-001	5.400-001	5.400-001	.68221064+002	.70491649+005
5.401-001	5.408-001	5.398-001	5.398-001	.68252814+002	.70524456+005
5.413-001	5.420-001	5.397-001	5.397-001	.68284565+002	.70557263+005
5.424-001	5.432-001	5.395-001	5.395-001	.68316315+002	.70590070+005
5.435-001	5.442-001	5.393-001	5.393-001	.68348066+002	.70622876+005
5.444-001	5.451-001	5.392-001	5.392-001	.68379817+002	.70655683+005

5.453-001	5.459-001	5.390-001	5.390-001	.68411567+002	.70688490+005
5.461-001	5.466-001	5.388-001	5.388-001	.68443318+002	.70721297+005
5.468-001	5.473-001	5.387-001	5.387-001	.68475068+002	.70754104+005
5.474-001	5.479-001	5.385-001	5.385-001	.68506819+002	.70786911+005
5.480-001	5.484-001	5.384-001	5.384-001	.68538570+002	.70819718+005
5.485-001	5.489-001	5.382-001	5.382-001	.68570320+002	.70852525+005
5.490-001	5.493-001	5.380-001	5.380-001	.68602071+002	.70885332+005
5.494-001	5.497-001	5.379-001	5.379-001	.68633821+002	.70918138+005
5.497-001	5.500-001	5.377-001	5.377-001	.68665572+002	.70950945+005
5.500-001	5.503-001	5.375-001	5.375-001	.68697323+002	.70983752+005
5.503-001	5.506-001	5.374-001	5.374-001	.68729073+002	.71016559+005
5.505-001	5.508-001	5.372-001	5.372-001	.68760824+002	.71049366+005
5.507-001	5.509-001	5.370-001	5.370-001	.68792574+002	.71082173+005
5.511-001	5.512-001	5.367-001	5.367-001	.68862606+002	.71154534+005
5.513-001	5.514-001	5.363-001	5.363-001	.68932638+002	.71226895+005
5.514-001	5.515-001	5.360-001	5.360-001	.69002669+002	.71299257+005
5.514-001	5.515-001	5.356-001	5.356-001	.69072701+002	.71371618+005
5.514-001	5.515-001	5.352-001	5.352-001	.69142732+002	.71443980+005
5.513-001	5.514-001	5.349-001	5.349-001	.69212764+002	.71516341+005
5.511-001	5.512-001	5.345-001	5.345-001	.69282795+002	.71588702+005
5.510-001	5.510-001	5.341-001	5.341-001	.69352827+002	.71661064+005
5.507-001	5.508-001	5.338-001	5.338-001	.69422858+002	.71733425+005
5.505-001	5.505-001	5.334-001	5.334-001	.69492890+002	.71805786+005
5.502-001	5.503-001	5.331-001	5.331-001	.69562921+002	.71878148+005
5.500-001	5.500-001	5.327-001	5.327-001	.69632953+002	.71950509+005
5.497-001	5.497-001	5.323-001	5.323-001	.69702984+002	.72022870+005
5.493-001	5.494-001	5.320-001	5.320-001	.69773016+002	.72095232+005
5.490-001	5.490-001	5.316-001	5.316-001	.69843047+002	.72167593+005
5.487-001	5.487-001	5.313-001	5.313-001	.69913079+002	.72239954+005
5.486-001	5.486-001	5.312-001	5.312-001	.69930070+002	.72257511+005
5.480-001	5.480-001	5.305-001	5.305-001	.70053142+002	.72384677+005
5.477-001	5.477-001	5.302-001	5.302-001	.70123174+002	.72457038+005
5.473-001	5.473-001	5.298-001	5.298-001	.70193205+002	.72529400+005
5.449-001	5.449-001	5.274-001	5.274-001	.70663950+002	.73015805+005
5.425-001	5.425-001	5.250-001	5.250-001	.71134695+002	.73502211+005
5.400-001	5.400-001	5.227-001	5.227-001	.71605439+002	.73988616+005
5.376-001	5.376-001	5.203-001	5.203-001	.72076184+002	.74475022+005
5.351-001	5.351-001	5.179-001	5.179-001	.72546929+002	.74961427+005
5.327-001	5.327-001	5.156-001	5.156-001	.73017674+002	.75447833+005
5.303-001	5.303-001	5.133-001	5.133-001	.73488418+002	.75934239+005
5.279-001	5.279-001	5.109-001	5.109-001	.73959163+002	.76420644+005
5.255-001	5.255-001	5.086-001	5.086-001	.74429908+002	.76907050+005
5.231-001	5.231-001	5.063-001	5.063-001	.74900653+002	.77393455+005
5.207-001	5.207-001	5.040-001	5.040-001	.75371397+002	.77879861+005
5.184-001	5.184-001	5.017-001	5.017-001	.75842142+002	.78366266+005
5.160-001	5.160-001	4.995-001	4.995-001	.76312887+002	.78852672+005
5.137-001	5.137-001	4.972-001	4.972-001	.76783632+002	.79339077+005
5.114-001	5.114-001	4.950-001	4.950-001	.77254376+002	.79825483+005
5.091-001	5.091-001	4.927-001	4.927-001	.77725121+002	.80311888+005
5.068-001	5.068-001	4.905-001	4.905-001	.78195866+002	.80798294+005
5.045-001	5.045-001	4.883-001	4.883-001	.78666611+002	.81284700+005
5.022-001	5.022-001	4.861-001	4.861-001	.79137355+002	.81771105+005
4.999-001	4.999-001	4.839-001	4.839-001	.79608100+002	.82257511+005
4.999-001	4.999-001	4.839-001	4.839-001	.79608100+002	.82257511+005
1.820-001	1.820-001	1.762-001	1.762-001	.18439071+003	.19052604+006
1.098-001	1.098-001	1.063-001	1.063-001	.23678201+003	.24466030+006
6.627-002	6.627-002	6.414-002	6.414-002	.28917332+003	.29879457+006

3.999-002	3.999-002	3.870-002	3.870-002	.34156462+003	.35292883+006
2.413-002	2.413-002	2.335-002	2.335-002	.39395593+003	.40706309+006
1.456-002	1.456-002	1.409-002	1.409-002	.44634723+003	.46119736+006
8.785-003	8.785-003	8.503-003	8.503-003	.49873854+003	.51533162+006
5.301-003	5.301-003	5.131-003	5.131-003	.55112984+003	.56946589+006
3.199-003	3.199-003	3.096-003	3.096-003	.60352115+003	.62360015+006
1.930-003	1.930-003	1.868-003	1.868-003	.65591245+003	.67773441+006
1.165-003	1.165-003	1.127-003	1.127-003	.70830376+003	.73186868+006
7.027-004	7.027-004	6.802-004	6.802-004	.76069506+003	.78600294+006
4.241-004	4.241-004	4.104-004	4.104-004	.81308637+003	.84013721+006
2.560-004	2.560-004	2.476-004	2.476-004	.86547767+003	.89427147+006
1.546-004	1.546-004	1.492-004	1.492-004	.91786898+003	.94840573+006
9.382-005	9.382-005	8.966-005	8.966-005	.97026028+003	.10025400+007
5.802-005	5.801-005	5.303-005	5.303-005	.10226516+004	.10566743+007
3.882-005	3.881-005	2.908-005	2.909-005	.10750429+004	.11108085+007
3.377-005	3.374-005	9.641-006	9.664-006	.11274342+004	.11649428+007
3.385-005	3.382-005	9.098-006	9.121-006	.11288415+004	.11663969+007
3.395-005	3.392-005	8.551-006	8.574-006	.11302488+004	.11678511+007
3.407-005	3.403-005	7.999-006	8.024-006	.11316562+004	.11693052+007
3.419-005	3.416-005	7.443-006	7.468-006	.11330635+004	.11707594+007
3.434-005	3.430-005	6.883-006	6.908-006	.11344708+004	.11722135+007
3.449-005	3.446-005	6.317-006	6.344-006	.11358782+004	.11736677+007
3.466-005	3.463-005	5.746-006	5.774-006	.11372855+004	.11751218+007
3.485-005	3.481-005	5.170-006	5.198-006	.11386928+004	.11765760+007
3.505-005	3.501-005	4.588-006	4.617-006	.11401001+004	.11780301+007
3.526-005	3.523-005	4.000-006	4.029-006	.11415075+004	.11794842+007
3.550-005	3.546-005	3.405-006	3.435-006	.11429148+004	.11809384+007
3.574-005	3.570-005	2.805-006	2.835-006	.11443221+004	.11823925+007
3.600-005	3.597-005	2.202-006	2.228-006	.11457294+004	.11838467+007
3.624-005	3.625-005	1.611-006	1.613-006	.11471368+004	.11853008+007
3.638-005	3.654-005	1.062-006	9.906-007	.11485441+004	.11867550+007
3.622-005	3.686-005	6.080-007	3.604-007	.11499514+004	.11882091+007
3.589-005	3.704-005	4.098-007	2.997-022	.11507480+004	.11890322+007
3.369-005	3.584-005	1.109-007	2.997-022T	.11527661+004	.11911174+007
3.062-005	3.300-005	3.309-008	.000	.11541734+004	.11925716+007
2.612-005	2.850-005	7.511-009	.000	.11555807+004	.11940257+007
2.003-005	2.192-005	1.146-009	.000	.11570663+004	.11955607+007
1.337-005	1.344-005	1.248-010	.000	.11585519+004	.11970957+007
7.421-006	3.040-006	9.604-012	.000	.11600375+004	.11986307+007
6.138-006	3.040-006T	4.633-012	.000	.11604260+004	.11990322+007
1.111-006	.000	1.954-014	.000	.11630086+004	.12017007+007
2.797-007	.000	5.122-016	.000	.11644942+004	.12032357+007
5.124-008	.000	9.325-018	.000	.11659797+004	.12047707+007
6.722-009	.000	1.176-019	.000	.11674653+004	.12063057+007
6.244-010	.000	9.608-022	.000	.11689509+004	.12078407+007
4.075-011	.000	9.608-022T	.000	.11704365+004	.12093757+007
1.858-012	.000	.000	.000	.11719220+004	.12109107+007
5.901-014	.000	.000	.000	.11734076+004	.12124456+007
1.301-015	.000	.000	.000	.11748932+004	.12139806+007
1.990-017	.000	.000	.000	.11763788+004	.12155156+007
2.200-019	.000	.000	.000	.11778643+004	.12170506+007
2.200-019T	.000	.000	.000	.11793499+004	.12185856+007

C.1.4 PROGRAM FOUR

The output from program FOUR is a file representing the composite of all discharges calculated by the model, including the assemblage of 4-member and longer chains based on the 2- and 3-member chain results. The peak discharge rate and the time of the peak rate are reported for 26 key nuclides. Immediately following the peak rate and time for each key nuclide is an array of 117 values representing the inventory, in curies, for each nuclide that is discharging at the time of the peak. The example shown below is a portion of the output file showing the discharge summary for all nuclides discharging at the ^{226}Ra peak at 7.3×10^4 yr after the base year (year of repository closure).

A map showing the nuclide label associated with each value in the array is given in Figure C.1. For example, the map in Figure C.1 shows the position of ^{226}Ra in the discharge summary to be in the fourth column, twelfth row. Looking at this position on the discharge summary, the discharge of ^{226}Ra from all sources (parent nuclides plus the original ^{226}Ra inventory) is .99E+00 (9.9×10^{-1}) curies/yr. The discharge rate of other nuclides are found in a like manner.

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####
RA226      PEAK DISCHARGE RATE      .63E-18 CI/YR AT  .73E+05 YR  070379
FRESH
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.12E+02  .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .99E+00 .99E+00 .99E+00 .99E+00
.00      .62E-07 .40E+00 .99E+00 .62E-07 .40E+00 .32E-02
.32E-02  .62E-07 .40E+00 .60E-01 .62E-07 .12E+01 .32E-02
.00      .00      .51E+00 .38E+01 .84E-01 .12E+01 .00
.12E+01  .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00
.00      .00      .00      .00      .00      .00      .00

```

^3H	^{10}Be	^{14}C	^{22}Na	^{24}Na	^{32}P	^{41}Ca
^{51}Cr	^{54}Mn	^{55}Fe	^{59}Fe	^{57}Co	^{58}Co	^{60}Co
^{59}Ni	^{63}Ni	^{65}Zn	^{79}Se	^{82}Br	^{85}Kr	^{87}Rb
^{89}Sr	^{90}Sr	$^{90}\text{D}_{\text{Sr}}$	^{91}Sr	^{90}Y	$^{91}\text{M}_{\text{Y}}$	^{91}Y
$^{93+\text{D}}\text{Zr}$	^{95}Zr	$^{95}\text{D}_{\text{Zr}}$	$^{93}\text{M}_{\text{Nb}}$	^{95}Nb	^{93}Mo	$^{99+\text{D}}\text{Mo}$
$^{99}\text{D}_{\text{Mo}}$	$^{99}\text{M}_{\text{Tc}}$	^{99}Tc	$^{103+\text{D}}\text{Ru}$	$^{106+\text{D}}\text{Ru}$	^{107}Pd	$^{110\text{M}+\text{D}}\text{Ag}$
$^{113}\text{M}_{\text{Cd}}$	$^{126+\text{D}}\text{Sn}$	^{125}Sb	^{126}Sb	$^{125}\text{M}_{\text{Te}}$	$^{127}\text{M}_{\text{Te}}$	^{127}Te
^{129}I	^{130}I	^{131}I	^{132}I	^{133}I	^{134}I	^{135}I
^{134}Cs	^{135}Cs	^{136}Cs	^{137}Cs	^{138}Cs	^{140}Ba	$^{140}\text{D}_{\text{Ba}}$
^{141}Ce	$^{144+\text{D}}\text{Ce}$	^{144}Pr	^{147}Pm	^{148}Pm	^{151}Sm	^{152}Eu
^{154}Eu	^{155}Eu	$^{166}\text{M}_{\text{Ho}}$	$^{210+\text{D}}\text{Pb}$	$^{210+\text{D}}\text{Bi}$	^{210}Po	$^{222+\text{D}}\text{Rn}$
$^{223+\text{D}}\text{Ra}$	$^{224+\text{D}}\text{Ra}$	$^{225+\text{D}}\text{Ra}$	$^{226+\text{D}}\text{Ra}$	$^{228+\text{D}}\text{Ra}$	^{225}Ac	$^{227+\text{D}}\text{Ac}$
$^{227+\text{D}}\text{Th}$	$^{228+\text{D}}\text{Th}$	^{229}Th	$^{230+\text{D}}\text{Th}$	$^{232+\text{D}}\text{Th}$	^{234}Th	$^{231+\text{D}}\text{Pa}$
^{233}Pa	^{232}U	^{233}U	^{234}U	$^{235}\text{D}_{\text{U}}$	^{236}U	^{237}U
$^{238+\text{D}}\text{U}$	$^{237+\text{D}}\text{Np}$	^{239}Np	^{239}Pu	^{239}Pu	^{240}Pu	^{241}Pu
^{242}Pu	^{244}Pu	^{241}Am	$^{242\text{M}+\text{D}}\text{Am}$	$^{243+\text{D}}\text{Am}$	^{242}Cm	^{243}Cm
^{244}Cm	$^{245+\text{D}}\text{Cm}$	^{246}Cm	$^{247+\text{D}}\text{Cm}$	^{248}Cm		

FIGURE C.1. Nuclide Inventory Location Format for Program FOUR Output

C.2 SAMPLE OUTPUT FROM THE PABLM BIOSPHERE TRANSPORT/DOSE MODEL

The following set of sample output shows a typical result of inputting the resultant data from GETOUT for one peak release time (as shown in the sample of Section C.1.4) to PABLM. The result of PABLM is a dose commitment breakdown by pathway and by nuclide with total dose for each organ, plus the associated total body dose equivalent. The sample shown is for the intrusion well scenario.

PARLM, VERSION 2.0, APRIL 1979

CASE TITLE: COMBINED FOOD/WATER PARLM PATHWAYS TEST (GETOUT INPUT: BST001)

RUN ON 092580

TYPE OF DOSE CALCULATED: CHRONIC INGESTION AND EXTERNAL EXPOSURE
FOR WATER PATHWAY, MAX. IND.

*** DATA LIBRARIES USED:
 RADIONUCLIDE LIBRARY: RADIONUCLIDE MASTER DATA LIBRARY, 15 MARCH 78, RA NAPIER
 FOOD TRANSFER FACTOR LIBRARY: *** FOOD TRANSFER COEFFICIENT LIBRARY 2/27/78 RA NAPIER ***
 ORGAN DATA LIBRARY: *** ORGAN DATA LIBRARY UPDATED BY RAN 9/8/78 ***
 EXTERNAL DOSE FACTOR LIBRARY: *** GDFELIB FOR FOOD, 15 MARCH 1978, RA NAPIER ***
 BIOACCUMULATION LIBRARY: ELMT SALT WATER FACTORS FRESH WATER FACTORS D.

RA226 PEAK DISCHARGE RATE .63E-18 CI/YR AT .73E+05 YR 080180

FOOD TYPE	X/Q (SEC/M**3)	GROWING PERIOD (DAYS)	YIELD (KG/M**3)	IRR. RATE (L/M**2/MONTH)	HOLDUP (DAYS)	CONSUMPTION (KG/YR)	TRANSLLOCATION
LEAFY VEG.	2.10E-08	9.00E+01	1.50E+00	1.50E+02	1.00E+00	2.10E+01	1.00E+00
O.A.G.VEG.	2.10E-08	6.00E+01	7.00E-01	1.60E+02	1.00E+00	3.30E+01	1.00E-01
OT. RT. VEG.	2.10E-08	9.00E+01	4.00E+00	1.70E+02	1.00E+01	1.80E+02	1.00E-01
ORCH. FRUIT	2.10E-08	9.00E+01	2.00E+00	1.50E+02	1.00E+01	1.15E+02	1.00E-01
OT. GRAIN	2.10E-08	9.00E+01	1.00E+00	1.50E+02	1.00E+00	1.25E+02	1.00E-01
EGGS	2.10E-08	9.00E+01	8.40E-01	1.50E+02	1.00E+00	3.00E+01	1.00E-01
MILK	2.10E-08	3.00E+01	1.30E+00	2.00E+02	1.00E+00	1.81E+02	1.00E+00
BEEF	2.10E-08	9.00E+01	8.40E-01	1.40E+02	1.50E+00	4.40E+01	1.00E-01
PORK	2.10E-08	9.00E+01	8.40E-01	1.40E+02	1.50E+00	4.40E+01	1.00E-01
POULTRY	2.10E-08	9.00E+01	8.40E-01	1.40E+02	1.00E+00	2.20E+01	1.00E-01

PATHWAY	MIXING RATIO	HOLDUP (DAYS)	USAGE	UNITS
DRINK. H2O	1.00+000	2.00+000	7.30+002	(L/YR)

ORGANS CONSIDERED:	BONE	LUNGS	THYROID	LOWER LARG
TOTAL BODY				

NUCLIDE	RELEASE	NUCLIDE	RELEASE	NUCLIDE	RELEASE
FLT. WT.	(CI/YR)	FLT. WT.	(CI/YR)	FLT. WT.	(CI/YR)
NI 59	1.20E+01	PR 210+D	9.90E-01	RI 210+D	9.90E-01
RA 224+D	6.20E-08	RA 225+D	4.00E-01	RA 226+D	9.90E-01
RA 228+D	6.20E-08	AC 227+D	3.20E-03	TH 227+D	3.20E-03
TH 228+D	6.20E-08	TH 230+D	6.00E-02	TH 232+D	6.20E-08
PA 231+D	3.20E-03	U 234	3.80E+00	U 235+D	8.40E-02
U 236	1.20E+00	U 238+D	1.20E+00	PO 210	9.90E-01
U 233	5.10E-01	TH 229	4.00E-01	RA 225	.00
AC 225	4.00E-01	TH 234	1.20E+00	PA 234M	.00
PA 234	.00				

*** TIMES CONSIDERED (YEARS): EXTERNAL EXPOSURE TIME (HOURS) = 4.40E+03
 DOSE COMMITMENT TIME = 70
 FACILITY LIFE = 1.00E+02
 POPULATION: 1.00E+00
 RECONCENTRATION MODEL USED: 3
 INVENTORY MODIFICATION FACTOR: 1.00E+00
 COOLANT FLOW RATE: 3.21E+01

COMBINED PATHWAY SUMMARY TOTALS PARLM VERSION2 092580
 TOTALS BY PATHWAY FOR SPECIFIED ORGANS (INTERNAL DOSES ONLY)
 CASE TITLE: COMBINED FOOD/ARRRG PARLM PATHWAYS TEST (GETOUT INPUT: RST001)
 *** DOSE COMMITMET SUMMARY FOR DOSE-YEAR 1 OF 100. YEAR PLANT LIFE ***

IRRIGATION CROP PATHWAY: ON
 AIR DEPOSITION CROP PATH: OFF
 AQUATIC FOODS PATHWAY: ON

DOSES AND TOTALS REPORTED IN REM

EXPOSURE PATHWAY	TOTAL BODY	BONE	LUNGS	THYROID	GI=LLI
-----	-----	-----	-----	-----	-----
LEAFY VEG.	3.0E+00	4.7E+00	.0	.0	5.2E-03
O.A.G. VEG	1.0E+00	1.6E+00	.0	.0	1.8E-03
OT.PT.VEG.	1.1E+00	1.8E+00	.0	.0	1.8E-03
ORCH.FRUIT	1.2E+00	2.0E+00	.0	.0	2.1E-03
OT. GRAIN	2.7E+00	4.3E+00	.0	.0	4.7E-03
EGGS	8.5E-05	1.3E-03	.0	.0	7.9E-05
MILK	3.6E-01	5.6E-01	.0	.0	1.5E-03
BEFF	8.9E-02	1.6E-01	.0	.0	8.0E-04
PORK	8.1E-03	1.4E-02	.0	.0	4.5E-05
POULTRY	1.2E-04	2.0E-04	.0	.0	4.3E-07
DRINK.H2O	4.4E+00	7.1E+00	.0	.0	8.6E-03
-----	-----	-----	-----	-----	-----
TOTALS	1.4E+01	2.2E+01	.0	.0	2.7E-02

COMBINED PATHWAY SUMMARY TOTALS PARIM VERSION2 092580
 TOTALS BY NUCLIDE FOR SPECIFIED ORGANS (INTERNAL DOSES ONLY)
 CASE TITLE: COMBINED FOOD/ARRRG PAHLM PATHWAYS TEST (GETOUT INPUT: RST001)
 *** DOSE COMMITMET SUMMARY FOR DOSE-YEAR 1 OF 100. YEAR PLANT LIFE ***

IRRIGATION CROP PATHWAY: ON
 AIR DEPOSITION CROP PATH: OFF
 AQUATIC FOODS PATHWAY: ON

RADIONUCLIDE		TOTAL BODY		DOSES AND TOTALS REPORTED IN REM		BONE		LUNGS		THYROID		GIT=LLI	
			%		%		%		%		%		%
NI	59	1.4E-03	0	8.1E-03	0	.0	0	.0	0	.0	0	.0	0
PR	210+D	3.7E-02	0	1.1E+00	4	.0	0	.0	0	.0	0	.0	0
RI	210+D	6.6E-06	0	1.1E-05	0	.0	0	.0	0	.0	0	.0	0
RA	224+D	3.6E-10	0	1.8E-09	0	.0	0	.0	0	.0	0	.0	0
RA	225+D	1.8E-02	0	8.9E-02	0	.0	0	.0	0	.0	0	.0	0
RA	226+D	1.4E+01	99	2.1E+01	92	.0	0	.0	0	.0	0	.0	0
RA	228+D	4.2E-07	0	3.9E-07	0	.0	0	.0	0	.0	0	.0	0
AC	227+D	2.2E-05	0	3.5E-04	0	.0	0	.0	0	.0	0	.0	0
TH	227+D	4.6E-08	0	1.6E-06	0	.0	0	.0	0	.0	0	.0	0
TH	228+D	5.8E-11	0	1.7E-09	0	.0	0	.0	0	.0	0	.0	0
TH	230+D	2.6E-04	0	8.5E-03	0	.0	0	.0	0	.0	0	.0	0
TH	232+D	3.4E-10	0	9.7E-09	0	.0	0	.0	0	.0	0	.0	0
PA	231+D	3.8E-05	0	9.0E-04	0	.0	0	.0	0	.0	0	.0	0
U	234	1.2E-02	0	1.9E-01	0	.0	0	.0	0	.0	0	1.6E-02	59
U	235+D	2.5E-04	0	4.1E-03	0	.0	0	.0	0	.0	0	4.4E-04	1
U	236	3.6E-03	0	5.8E-02	0	.0	0	.0	0	.0	0	.0	0
U	238+D	3.3E-03	0	5.5E-02	0	.0	0	.0	0	.0	0	4.4E-03	16
PD	210	4.6E-03	0	1.9E-02	0	.0	0	.0	0	.0	0	.0	0
U	233	1.6E-03	0	2.7E-02	0	.0	0	.0	0	.0	0	.0	0
TH	229	1.2E-02	0	2.5E-01	1	.0	0	.0	0	.0	0	.0	0
RA	225	.0	0	.0	0	.0	0	.0	0	.0	0	.0	0
AC	225	3.5E-06	0	5.1E-05	0	.0	0	.0	0	.0	0	.0	0
TH	234	1.1E-07	0	3.8E-06	0	.0	0	.0	0	.0	0	6.0E-03	22
PA	234M	.0	0	.0	0	.0	0	.0	0	.0	0	.0	0
PA	234	.0	0	.0	0	.0	0	.0	0	.0	0	.0	0
TOTALS		1.4E+01	100	2.2E+01	100	.0	100	.0	100	.0	100	2.7E-02	100

COMBINED PATHWAY SUMMARY TOTALS PARIM VERSION2 092580
 TOTALS BY PATHWAY FOR SPECIFIED ORGANS (INTERNAL DOSES ONLY)
 CASE TITLE: COMBINED FOOD/ARRRG PARIM PATHWAYS TEST (GETOUT INPUT: RST001)
 *** DOSE COMMITTEE SUMMARY FOR DOSE-YEAR 70 OF 100. YEAR PLANT LIFE ***

IRRIGATION CROP PATHWAY: ON
 AIR DEPOSITION CROP PATH: OFF
 AQUATIC FOODS PATHWAY: ON

DOSES AND TOTALS REPORTED IN REM

EXPOSURE PATHWAY	TOTAL BODY	BONE	LUNGS	THYROID	GI=LLI
-----	-----	-----	-----	-----	-----
LEAFY VEG.	1.4E+02	2.1E+02	.0	.0	3.7E-01
O.A.G. VEG	5.3E+01	8.7E+01	.0	.0	1.4E-01
OT.PT.VEG.	7.9E+01	1.7E+02	.0	.0	2.2E-01
ORCH.FRUIT	7.3E+01	1.4E+02	.0	.0	1.9E-01
OT. GRAIN	1.4E+02	2.4E+02	.0	.0	3.8E-01
EGGS	6.5E-03	1.0E-01	.0	.0	6.1E-03
MILK	1.7E+01	2.5E+01	.0	.0	1.1E-01
BEEF	4.6E+00	8.3E+00	.0	.0	6.2E-02
PORK	4.1E-01	6.9E-01	.0	.0	3.2E-03
POULTRY	5.9E-03	9.5E-03	.0	.0	3.1E-05
DRINK.H2O	2.1E+02	3.1E+02	.0	.0	6.0E-01
-----	-----	-----	-----	-----	-----
TOTALS	7.2E+02	1.2E+03	.0	.0	2.1E+00

COMBINED PATHWAY SUMMARY TOTALS PARLIM VERSION2 092580
 TOTALS BY NUCLIDE FOR SPECIFIED ORGANS (INTERNAL DOSES ONLY)
 CASE TITLE: COMBINED FOOD/ARRRG PARLIM PATHWAYS TEST (GETOUT INPUT: RST001)
 *** DOSE COMMITTEE SUMMARY FOR DOSE-YEAR 70 OF A100. YEAR PLANT LIFE ***

IRRIGATION CROP PATHWAY: ON
 AIR DEPOSITION CROP PATH: OFF
 AQUATIC FOODS PATHWAY: ON

RADIONUCLIDE	DOSES AND TOTALS REPORTED IN REM									
	TOTAL BODY	%	BONE	%	LUNGS	%	THYROID	%	GI=LLI	%
NI 59	2.2E-01	0	1.3E+00	0	.0	0	.0	0	.0	0
PR 210+D	8.3E+00	1	2.1E+02	17	.0	0	.0	0	.0	0
RI 210+D	4.6E-04	0	8.0E-04	0	.0	0	.0	0	.0	0
RA 224+D	2.5E-08	0	1.2E-07	0	.0	0	.0	0	.0	0
RA 225+D	1.2E+00	0	6.2E+00	0	.0	0	.0	0	.0	0
RA 226+D	7.1E+02	98	9.3E+02	78	.0	0	.0	0	.0	0
RA 228+D	2.7E-05	0	2.5E-05	0	.0	0	.0	0	.0	0
AC 227+D	1.2E-03	0	1.9E-02	0	.0	0	.0	0	.0	0
TH 227+D	3.2E-06	0	1.1E-04	0	.0	0	.0	0	.0	0
TH 228+D	4.0E-09	0	1.2E-07	0	.0	0	.0	0	.0	0
TH 230+D	1.2E-02	0	4.0E-01	0	.0	0	.0	0	.0	0
TH 232+D	1.3E-08	0	3.7E-07	0	.0	0	.0	0	.0	0
PA 231+D	1.7E-03	0	3.9E-02	0	.0	0	.0	0	.0	0
U 234	1.0E+00	0	1.6E+01	1	.0	0	.0	0	1.3E+00	63
U 235+D	1.7E-02	0	2.8E-01	0	.0	0	.0	0	3.1E-02	1
U 236	3.0E-01	0	4.8E+00	0	.0	0	.0	0	.0	0
U 238+D	2.3E-01	0	3.8E+00	0	.0	0	.0	0	3.1E-01	14
PO 210	3.2E-01	0	1.3E+00	0	.0	0	.0	0	.0	0
U 233	1.4E-01	0	2.2E+00	0	.0	0	.0	0	.0	0
TH 229	5.5E-01	0	1.1E+01	0	.0	0	.0	0	.0	0
QA 225	.0	0	.0	0	.0	0	.0	0	.0	0
AC 225	2.4E-04	0	3.6E-03	0	.0	0	.0	0	.0	0
TH 234	7.7E-06	0	2.7E-04	0	.0	0	.0	0	4.2E-01	20
PA 234M	.0	0	.0	0	.0	0	.0	0	.0	0
PA 234	.0	0	.0	0	.0	0	.0	0	.0	0
TOTALS	7.2E+02	100	1.2E+03	100	.0	100	.0	100	2.1E+00	100

1-YEAR DOSE BY NUCLIDE FOR AN INDIVIDUAL

NUCLIDE	DATE	TOTAL BODY	BONE	LUNGS	THYROID	GI-LLI
RA226	.73E+05	3.0-001	4.5-001	8.7-006	8.7-006	8.7-006
PO210	.73E+05	4.6-004	1.4-002	1.7-011	1.7-011	1.7-011
PR210	.73E+05	5.7-004	1.6-002	8.6-009	8.6-009	8.6-009
TH229	.73E+05	3.9-004	7.9-003	6.0-007	6.0-007	6.0-007
RA225	.73E+05	5.3-004	3.7-003	.0	.0	.0
U234	.73E+05	1.2-004	2.0-003	1.9-008	1.9-008	1.6-004
U236	.73E+05	3.7-005	6.0-004	1.7-010	1.7-010	1.7-010
U238	.73E+05	3.4-005	5.7-004	2.8-007	2.8-007	4.6-005
U233	.73E+05	1.7-005	2.8-004	2.0-009	2.0-009	2.0-009
TH230	.73E+05	8.4-005	2.7-004	3.2-010	3.2-010	3.2-010
NI59	.73E+05	2.1-005	1.2-004	1.1-009	1.1-009	1.1-009
U235	.73E+05	2.6-006	2.2-005	7.4-008	7.4-008	4.6-006
AC227	.73E+05	1.2-006	1.9-005	4.3-009	4.3-009	4.3-009
PA231	.73E+05	5.1-007	1.2-005	4.8-009	4.8-009	4.4-009
AC225	.73E+05	7.6-007	5.3-006	4.4-007	4.3-007	4.3-007
BI210	.73E+05	6.5-008	1.1-007	1.1-010	1.1-010	1.1-010
RA228	.73E+05	9.1-009	8.4-009	4.8-013	4.8-013	4.8-013
TH232	.73E+05	1.1-011	3.1-010	1.3-013	1.3-013	6.6-012
RA224	.73E+05	1.6-011	7.9-011	1.2-014	1.2-014	1.2-014
TH228	.73E+05	2.2-012	5.6-011	3.2-013	3.2-013	3.2-013

70-YEAR DOSE BY NUCLIDE FOR AN INDIVIDUAL

NUCLIDE	DATE	TOTAL BODY	BONE	LUNGS	THYROID	GI-LLI
RA226	.73E+05	1.5-001	1.9-001	2.1-002	2.1-002	2.1-002
PR210	.73E+05	3.2-002	2.1-000	1.2-005	1.2-005	1.2-005
PO210	.73E+05	3.2-001	1.3-000	1.4-009	1.4-009	1.4-009
TH229	.73E+05	1.7-002	3.1-001	1.5-003	1.5-003	1.5-003
RA225	.73E+05	3.9-002	1.9-001	.0	.0	.0
U234	.73E+05	9.9-003	1.6-001	4.6-005	4.6-005	1.3-002
U236	.73E+05	3.0-003	4.8-002	4.2-007	4.2-007	4.2-007
U238	.73E+05	3.1-003	4.0-002	7.0-004	7.0-004	3.9-003
U233	.73E+05	1.3-003	2.2-002	4.8-006	4.8-006	4.8-006
NI59	.73E+05	2.4-003	1.4-002	7.6-008	7.6-008	7.6-008
TH230	.73E+05	3.3-004	1.1-002	7.8-007	7.8-007	7.8-007
U235	.73E+05	3.6-004	3.1-003	1.8-004	1.8-004	5.0-004
AC225	.73E+05	1.1-003	1.4-003	1.1-003	1.1-003	1.1-003
AC227	.73E+05	6.7-005	5.7-004	5.7-006	5.7-006	5.7-006
PA231	.73E+05	3.2-005	5.0-004	1.2-005	1.2-005	1.2-005
BI210	.73E+05	4.5-006	7.9-005	7.4-009	7.4-009	7.4-009
RA228	.73E+05	5.8-007	5.3-007	2.6-010	2.6-010	2.6-010
TH232	.73E+05	7.2-010	1.2-008	3.1-010	3.1-010	7.6-010
RA224	.73E+05	1.1-009	5.6-009	8.2-013	8.2-013	8.2-013
TH228	.73E+05	2.0-010	3.8-009	6.9-011	6.9-011	6.9-011

APPENDIX D

DISPERSIVE EFFECTS EVALUATION

APPENDIX D

DISPERSIVE EFFECTS EVALUATION

There are many complex interrelationships to consider in describing the effects of various dispersive phenomena on biosphere discharge rates. The dispersive phenomena described here are flow field geometry, distribution of the source in the hydrologic system, geometry and character of the discharge site, type and time period of release, and hydrodynamic dispersion. The distribution coefficient (K_d) has a complicating role in the above phenomena because nuclide retardation (sorption) amplifies the effect of any of these dispersive phenomena. In any given situation any one of the above dispersive phenomena can control the peak discharge rate for any one of the radionuclides being transported. The purpose of this study is to show if and when these dispersive effects are important to the analysis of engineered barriers. The first section is a general discussion of these dispersive phenomena and their effects on the isolation effectiveness of the geohydrology. In the second section, the parametric analysis is performed to characterize and evaluate the effects of these phenomenon.

D.1 EFFECTS OF DISPERSIVE PHENOMENA

D.1.1 Hydrodynamic Dispersion

Hydrodynamic dispersion in a groundwater system is a spreading phenomenon. A contaminant tracer placed in a flowing groundwater system gradually spreads and, with time, occupies an ever-increasing portion of the flow field. The volume occupied extends beyond the region it would be expected to occupy with only the average flow alone (Bear 1972). The complicated system of interconnected passages comprising a groundwater system causes a continuous division of the tracer into finer offshoots. Variations in the local velocity (both magnitude and direction) along and between these tortuous flow paths give rise to this ever-increasing spreading on the microscopic scale. On a larger or macroscopic scale, nonhomogeneity due to variations in permeability and porosity also cause further spreading. On a megascopic scale the effects of layering and differences in permeabilities and porosities can give rise to further spreading (Pickens, Cherry, Gilham and Merritt 1977). Figures D.1 and D.2 (Pickens, Cherry, Gilham and Merritt 1977) illustrate some of these effects on different scales. Because the actual spread of the tracer depends on inhomogeneity on various scales in addition to the variations in the tortuosity and local velocity on a microscopic scale, the selection and measurement of the dispersion parameter should be related to the scale and detail of the modeling effort.

In relation to the nuclear waste isolation problem, the primary effects of hydrodynamic dispersion are to attenuate the peak discharge rate and to spread the discharge arrival curve over time. This can be shown for small amounts of relative dispersion ($D/VL \ll 1.0$) by

FIGURE D.1. Mechanisms of Hydrodynamic Dispersion(a)

(a) Taken from Pickens, Cherry, Gilham and Merritt 1977.

FIGURE D.2. Schematic Representation of Scales Within a Layered Porous Medium(a)

(a) Taken from Pickens, Cherry, Gilham and Merritt 1977.

considering the spread and attenuation of a pulse release in a one-dimensional, porous media column with water flowing at a constant velocity. The equation for peak relative concentration is

$$\frac{C}{C_0 \max} = 2 \sqrt{\pi D / (VL)}^{-1} \quad (1)$$

and the relative time spread at $0.61 (C/C_0)_{\max}$ is

$$2 \sqrt{2 D / VL}, \quad (2)$$

where

D = hydrodynamic dispersion constant

V = convective velocity

L = column or path length.

From the two equations above it can be seen that as dispersion increases with respect to velocity and path length, the peak decreases and the curve spreads. The effect of hydrodynamic dispersion on the peak arrival concentration is illustrated in Figure D.3 (Bond and Kaszeta 1979). The release rate curve used for this particular analysis for this study (Bond and Kaszeta 1979) is shown in Figure D.4.

D.1.2 Combined Effects of Hydrodynamic Dispersion and Retardation

With respect to the peak discharge rate of a radionuclide, hydrodynamic dispersion can have varying effects depending on release duration and nuclide retardation factor. The extremes can be seen by comparing a pulse release with a continuous, constant release (long leach time with respect to the dispersion forces). In the first case dispersion controls the peak discharge rate, and in the latter the leach time controls the peak rate, with peak discharge rate only a function of the constant release rate and nuclide decay. Release duration becomes more significant and begins to dominate when the release distance calculated by the product of release duration (for a constant release rate) and the nuclide velocity approaches the spreading in distance caused by the hydrodynamic dispersion. When the release distance is equal to or greater than the dispersion distance, the constant release rate and nuclide decay control the peak discharge rate. Figures D.5 and D.6 (Cole and Bond 1980) illustrate this effect. The distance spread due to hydrodynamic dispersion can be estimated as $2 \sqrt{2Dt}$ (Ahlgren, Foote, Arnett, Cole and Serne 1977). For this study (Cole and Bond 1980) $2 \sqrt{2Dt} = 13,680$ ft. For the ^{129}I isotope (retardation factor = 1), the release distance is 2.4×10^6 ft (nuclide velocity * release time = $14.78 \text{ ft/yr} * 164,000 \text{ yr}$). As shown in Figure 5, the arrival concentration curve is simply a square type curve with rounded leading and trailing edges and a slight slope due to decay and the peak discharge concentration is simply a function of release rate. However, for ^{135}Cs , which has a retardation factor of 261, the release distance is 9,300 ft. In this case, as shown in Figure D.6, the arrival concentration curve has a Gaussian shape, which is characteristic of releases where hydrodynamic dispersion forces dominate the arrival distribution. It is important to note that both these nuclides were

FIGURE D.3. Influence of Dispersion Length on ^{129}I Base Case Concentration Distribution(a)

(a) Bond and Kaszeta 1979; retardation factor = 18.5.

FIGURE D.4. Release Rate Curve Used for Figure D.3(a)

(a) Bond and Kaszeta 1979.

FIGURE D.5. WISAP Predicted Malaga Bend Arrival Curve for ^{129}I (a)

(a) Cole and Bond 1980.

FIGURE D.6. Predicted Malaga Bend Arrival Curve for ^{135}Cs (a)

(a) Cole and Bond 1980.

subjected to the same hydrologic flow system and leaching forces. Only the retardation factor changes; and yet we passed from the realm where leach time dominates arrival distribution to the realm where hydrodynamic dispersion forces dominate the arrival distribution.

This interaction between dispersion and retardation changes the effective biosphere release interval. Both ^{129}I and ^{135}Cs were released into the hydrologic system at a constant rate for 165,000 yr. The ^{129}I (retardation factor = 1) arrived at the biosphere spread in time over essentially this same 164,000 yr period. The ^{135}Cs (retardation factor = 261), however, arrived in various amounts over approximately 1×10^6 yr. Figure D.7 (Bond and Kaszeta 1979) illustrates this amplification of dispersion effect for ^{129}I released as indicated in Figure D.4. Figure D.7 shows the change in ^{129}I arrival spread in time as well as the decrease in peak arrival concentration resulting simply from an increase in retardation. Figure D.8 (Bond and Kaszeta 1979) illustrates the amplification effect in a slightly different way. From Figure D.8 it can be seen that increasing the retardation from none ($K = 1.0$) to 67.5 that the peak concentration in the arrival curve is decreased in the same manner as increasing the dispersion length from 0.2 to 100 for a nonretarded nuclide. All of the above discussion have related to the movement of a single nuclide not involved in chain decay and the effects and interactions of hydrodynamic dispersion and retardation in reducing peak arrival concentration.

FIGURE D.7. Influences of Retardation Factor (K) on ^{129}I Base Case Concentration Distribution(a)

(a) Bond and Kaszeta 1979.

FIGURE D.8. Sensitivity of Peak Concentration as a Function of Dispersion Length for ^{129}I with Different Retardation Factors (a)

(a) Bond and Kaszeta 1979.

These discussions have illustrated that increases in retardation amplify the effects of any hydrodynamic dispersion that exist in the hydrologic system and that hydrodynamic dispersion, alone or in conjunction with retardation, produces the same effect on peak arrival concentration (or rate) as an increase in leach time and a change in the shape of the release curve. Retardation alone for one-dimensional column flow with no hydrodynamic dispersion, although not discussed above, only delays the entry of the contaminant into the biosphere. The shape of the biosphere release curve and peak value as well as total spread in time are the same as that of the contaminant release curve except for the effects of decay resulting from the delayed entry. For a contaminant like ^{129}I which has a 1.59×10^7 yr half time, the biosphere release curve and the repository release curve would be essentially equivalent since little or no decay would occur during normal ^{129}I geosphere transport travel times. The

exception to this equivalency would occur only if effects of source geometry or distribution, discharge geometry or distribution, or the nonuniformity of the flow field are accounted for. The effects of nonuniform flow fields and these other geometry factors on contaminant arrival have been previously described (Nelson 1978; Nelson 1978; Nelson 1978; Nelson 1978) and will be further described in later sections of this appendix. It is important to note that they produce effects of the same general type as caused by hydrodynamic dispersion but typically many times greater. A complete analysis of the transport problem would indicate that all the spreading effects:

- hydrodynamic dispersion
- nonuniform flow field
- source character including geometry and distribution
- discharge geometry, character, and distribution

have one thing in common. They all give rise to a distribution in the groundwater arrival time at the discharge site for waters that left the source location at the same time. For nuclides that are not retarded, this distribution in arrival time (unless it approaches the total release time, assuming a constant rate) will have little effect on the peak discharge rate. For nuclides that are retarded, however, the spread in arrival time must be multiplied by the retardation factor before it is compared to the effective release time to determine if it is important in reducing the peak arrival value.

D.1.3 Chain Decay Spreading Effects and Hydrodynamic Dispersion

Assessing the effects of hydrodynamic dispersion, or the other spreading forces discussed above on nuclides that are daughter products of a chain decay scheme is a more complex problem; however, there are some general effects and relationships that can be identified. The effects caused by chain decay can be best understood by realizing that the difference between the single nuclide (either fission or activation product nuclides or top-of-the-chain nuclide) transport problem and the daughter of a chain decay transport problem is actually only the difference between a stationary source and a moving source.

All the generalizations made for single nuclides regarding the effects of travel time variation and retardation apply to the top chain members and to the daughter products that are released directly from the repository. Figure D.9 (Burkholder and Rosinger 1979) shows the arrival distribution for ^{226}Ra , which was released from the repository, and for ^{226}Ra , which was produced via chain decay from parents during the transport process. It should be noted that the fact that hydrodynamic dispersion does not influence the peak arrival of ^{226}Ra released from the repository is consistent with the hydrologic parameters used in this study (Burkholder and Rosinger 1979). The 2σ $2Dt$ value for this study accounts for a 22-m spreading of the contaminant resulting from the 16-km migration to the discharge. This spread in distance in turn results in an arrival time variation for water (velocity = 110 m/yr) of 0.2 yr in the 145.45 yr travel time and a variation in ^{226}Ra arrival of 110 yr due to the retardation factor of 500. This 100-yr spread in ^{226}Ra arrival time is less than the 333-yr constant release time; therefore, release rate and simple nuclide decay dominates biosphere arrival distribution and peak value for the ^{226}Ra , which was released from the repository.

FIGURE D.9. Sample Calculation for the $^{234}\text{U} \rightarrow ^{230}\text{Th} \rightarrow ^{226}\text{Ra}$ Decay Chain Using the Dispersion and No-Dispersion Solutions^(a)

(a) Burkholder and Rosinger 1979.

Now concentrate on the arrival of nuclide daughters resulting from chain decay of moving parents. In the special case where all parents and daughters move with the water or at the same retarded velocity, the problem reduces to that of the single nuclide--release rates for daughters being simply a function of the chain decay calculations and the released inventories of the parents. For the simple uniform velocity chain, the buildup effect due to chain decay in conjunction with the nuclide travel time can influence the isolation effectiveness as shown in Figure D.10. This is a simple relative-hazard plot for the Uranium Series based on the once-through spent fuel inventories of parents and daughters versus time. Inventories of the various chain members versus time have been multiplied by a ratio of the nuclide Maximum Permissible Concentration (MPC) to the ^{238}U MPC values. This figure is only presented to illustrate that delayed entry will not always insure lower biosphere arrival rates.

In addition to hydrodynamic dispersion and the other hydrologic spreading phenomena, there is a spreading phenomenon that occurs for daughter nuclides involved in chain decay when the various chain members move at different velocities. This process is easiest to visualize for a two-member chain. Assume that no other spreading phenomena are operating and that there is one-day constant release of only the parent nuclide from the repository; let the parent and the daughter have different velocities; and for this example, let the parent be moving faster and let the daughter have a long half-life compared to its geosphere transport time. If they

FIGURE D.10. Relative Hazard of the Uranium Series Chain as a Function of Time^(a)

(a) Based on one metric ton of once-through spent fuel and MPC guidelines for uncontrolled water.)

both moved at the same velocity, the parent nuclide along with the entire buildup of daughter nuclides would arrive at the biosphere over the same one-day interval. However, since they are moving at different rates, the parent will arrive at the biosphere over a one-day interval and the daughter will arrive over a period of time determined by the absolute difference between the parent and daughter travel times. Actual shape and arrival rate of the daughter will be governed by the relative decay rates of the parent and daughter and the time required for each daughter atom to exit the hydrologic system.

Figures D.11 and D.12 (Cole and Bond 1980) show a parent-daughter pair that illustrates this kind of spreading phenomenon due to differential velocities. Other spreading forces and decay interactions are also present, but the main difference in shape between the two curves is due to differential velocities. The parent ^{236}U arrives at an essentially constant rate over a 2×10^8 -yr interval as could have been estimated from the product of the water travel time and the difference between the retardation factors $[(5,277 \text{ yr} \times (38,061 - 174) = 2.02 \times 10^8 \text{ yr})]$. The slightly increasing arrival value with time results from the slightly decreasing production of daughter due to decay of the parent inventory.

Our last example is for a parent moving faster than the daughter and the daughter long-lived with respect to the parent and geosphere transport time. If the velocity relationship were only reversed, the curves would be similar but somewhat different in shape and magnitude. The ^{232}Th would still arrive over the 2×10^8 -yr time frame, but the magnitude would be higher because the 10^8 -yr travel time for ^{236}U would now allow for much more parent decay than the previous 10^6 -yr travel time. The slope of the ^{232}Th curve would be reversed (highest rate of

FIGURE D.11. Predicted Malaga Bend Arrival for Actinide Chain 1(a)

(a) Cole and Bond 1980.

FIGURE D.12. WISAP Predicted Malaga Bend Arrival for Actinide Chain 1(a)

(a) Cole and Bond 1980.

arrival would now be early in time) and steepened due to the more significant decay of ^{236}U . The ^{236}U would arrive spread over a longer interval and at a reduced rate as a result of the amplified hydrodynamic dispersion resulting from the greater retardation.

Now for the same two-member chain, let the parent become long lived with respect to its geosphere transport time and the daughter short lived with respect to its geosphere transport time. For this case, the spread in arrival and rate of arrival is governed by the decay rate of the daughter and the time required for decay equilibrium to be reached between parent and daughter. For the long-lived daughter the peak arrival was spread in time according to the difference in the parent and daughter geosphere transport times from the repository. For this case of a fast-decaying daughter and slow-decaying parent (fast-moving parent, slow-moving daughter), the parent must reach a point in the hydrologic system where decay of the daughter created by the parent will not be significant over the daughter geosphere transport time from this point. Figures D.13 and D.14 illustrate for $^{233}\text{U} \rightarrow ^{229}\text{Th}$ chain an extreme example of this effect in that the daughter arrives over much the same interval as the parent rather than being spread over the differential geosphere transport time as in Figure D.12. The peak spread in the ^{229}Th arrival time for this example is instead governed by the relationship between the differential daughter-parent transport velocity and daughter-parent decay equilibrium time.

Multimember chains illustrate much the same behavior as discussed for the two-member chains, and this will be illustrated with some figures from the Paradox sensitivity study (Bond and Kaszeta 1979). Figure D.15 shows groundwater concentrations versus distance 2×10^6 yr after release from the repository for the Uranium Series chain members. At this point in time, inventories initially released from the repository, except for ^{238}U , have essentially

FIGURE D.13. Arrival Curve of a Faster-Moving, Longer-Lived Parent of a Two-Member Chain

FIGURE D.14. Arrival Curve of a Slower-Moving, Shorter-Lived Daughter of a Two-Member Chain

FIGURE D.15. Base Case Concentration Distributions at Two Million Years for a Three-Member Actinide Chain^(a)

(a) Bond and Kaszeta 1979.

decayed. The release distributions then are the result of parent sources decaying as they move. The uraniums (238-234) are in essentially equilibrium and have the same distribution as expected. The apparently inconsistent result illustrated is related to the total amounts of ^{230}Th and ^{226}Ra activity in relationship to ^{238}U and ^{235}U . We have indicated that the ^{230}Th and ^{226}Ra released from the repository have decayed at this point in time; so one would expect the total activity of each member to be essentially equal to that of the parent ^{238}U (similar to ^{234}U but may be spread in space differently due to the differential velocities of U-Th-Ra). There is much more ^{226}Ra activity in the groundwaters than one would expect and much less ^{230}Th . This is because the equilibrium is between the total soil-water inventories which can be obtained by multiplying the water concentration curves in Figure D.15 by the nuclide retardation factors. This reconcentration effect is discussed in detail by Burkholder and Cloninger (Burkholder and Cloninger 1978). Figure D.16 shows that the effect of spreading due to differential velocity is important even for multimember chains. All parameters are the same except that over the range of retardation factors thought to be applicable, the minimum U retardation and maximum Th and Ra were selected. This selection, if we used the product of the ratios of retardation factors between chain members as an index, increases from approximately 3000 for the run in Figure D.15 to approximately 5500 for the run in Figure D.16. As can be seen, the ^{226}Ra concentration falls by just about this ratio when the level in

FIGURE D.16. Base Case Concentration Distributions at Two Million Years with Altered Retardation Factors for Three-Membered Chain^(a)

(a) Bond and Kaszeta 1979.

Figure D.16 is adjusted to account for the portion of its total drop resulting from the change in the soil-water equilibrium ratio.

We have discussed the spreading phenomenon due to differential velocities between chain members in a brief way, some of the effects related to decay and parent-daughter decay equilibrium times and their interrelationships with this differential spreading. Now we must discuss what effects, if any, hydrodynamic dispersion has on these chains and try to formulate a means for determining when those effects are important. In addition, we must address how release duration interacts with all these phenomena. As discussed previously, release time and hydrodynamic dispersion (and really, as we will later demonstrate, any of the other spreading phenomena) really produce the same kind of effect on biosphere arrival distributions. Increases in release duration or any of the other hydrologic or retardation characteristics of the geosphere system generally tend to reduce the rate of arrival of nuclides to the biosphere. The relative dominance of one over the other only changes from one situation to another. In order to understand the relationship between release duration, (for simplicity, assume a constant release rate since almost any release can be approximated as a sum of a finite number of constant release rates of varying levels and durations), hydrodynamic dispersion and retardation, we need only to visualize the mapping from time to space or distance which occurs as the nuclide leaves the repository and enters the geosphere transport system.

Hydrodynamic dispersion accounts for a characteristic spreading in distance dependent only on the length of media traversed and not the contaminants nor its velocity. The map from time to distance is controlled by the nuclide velocity and leach time. When this mapped distance for a single nuclide is less than the distance associated with the hydrodynamic dispersion distance $\sqrt{2D \cdot (\text{water travel time})}$, then hydrodynamic dispersion will be effective in reducing the biosphere release rate. Otherwise, leach rate along with decay (which occurs in either case) will determine the biosphere release rate. It is important to note that in either case biosphere arrival rate can be reduced only by changing the phenomena responsible for the reduction. For chain nuclides, such as those shown in Figures D.11 and D.12, that have tremendous differential velocities, release duration and other hydrologic dispersion phenomena can influence the arrival rate of the parent as for any single nuclide; but neither leach time nor dispersion forces will have any great effect on the daughter arrival rate unless the distance spread due to dispersion forces approaches that determined by the difference in velocity between the parent and the daughter times the sum of the parent release duration and the daughter geosphere transport time. For chains such as these (long daughter half life and large differential parent-daughter velocity), hydrodynamic dispersion is likely to have little effect on the biosphere arrival rate of the daughter. The importance of leach time for these kinds of chains is also evident. Not until leach duration of the parent becomes significant with respect to the geosphere transport time difference between the parent and the daughter will it have any great effect on biosphere arrival rate of the daughter. For this chain the daughter geosphere transport time is 2.01×10^8 yr and the effective leach duration of the parent has been increased somewhat from the actual leach duration of 164,000 yr by hydrodynamic dispersion. The effects are not entirely as simple as outlined because decay also enters into the picture in determining biosphere arrival rate, but these simple relationships help us to determine whether dispersion or other hydrodynamic spreading phenomena, leach duration, or differential velocity spreading is dominant. Reversal of the parent and daughter velocities for this kind of chain produces the effects discussed earlier and gives rise to the same arguments for leach duration and hydrodynamic dispersion interactions with the differential velocity spreading phenomena.

For chains like those discussed in Figures D.13 and D.14 where daughter decay and the parent-daughter decay equilibrium time constant controls the effect of the differential velocity spreading phenomena, leach duration and hydrodynamic dispersion become dominant at much lower values. In multimember chains, such as illustrated in Figures D.15 and D.16, the same generalizations with regard to dominance reversal between differential velocity spreading, leach duration and hydrodynamic dispersion exist when the chain is examined by pairs starting at the top of the chain. In the example, (skipping the U's which travel at the same rate), differential velocity spreading dominates arrival rate of ^{230}Th and, as a result of this ^{230}Th daughter spreading, indirectly provides for a reduced arrival of ^{226}Ra . This portion (U $\rightarrow$ Th) of the multimember chain represents a chain midway between the chains illustrated in Figures D.11 and D.12, where total geosphere transport time for the daughter controls the differential velocity spreading phenomena, and Figures D.13 and D.14, where the parent-daughter equilibrium decay time constant and daughter decay dominates to the point where the differential

velocity spreading is somewhat nullified. The last portion (^{230}Th ^{226}Ra) of this multi-member chain is of the Figure D.13 and D.14 kind, so that the differential velocity spreading effect which has already spread the ^{230}Th parent dominates the ^{226}Ra arrival. For this multi-member chain then, the U parents can be considered as a single nuclide with respect to the effects of leach duration and hydrodynamic dispersion. Since the rest of the chain is, to a great extent, dominated by the ^{230}Th differential velocity spreading, leach duration and hydrodynamic dispersion must attain large values before they can influence biosphere arrival rates.

Experience on the INFCE study (INFCE/DEP/WG.7/21) on a repository in hard rock illustrated that even a seemingly meaningless hydrodynamic dispersion constant of $2.5 \times 10^{-9} \text{ m}^2/\text{sec}$ (equivalent to a dispersion length of 0.08 m) can produce significant reduction in the biosphere arrival rate of nuclide chain members which were leached at a constant release rate over a 2×10^5 yr time period. For the $^{239}\text{Pu} \rightarrow ^{235}\text{U} \rightarrow ^{231}\text{Pa}$ chain, Pu decayed before exit; ^{235}U arrival was reduced from the no-dispersion case by a factor of 13; and ^{231}Pa was reduced by a factor of 37. For runs with this same chain and a more realistic dispersion constant of $8.7 \text{ E-7 m}^2/\text{yr}$ (equivalent to a dispersion length of 45 m), the ^{235}U arrival was reduced by a factor 245 and the ^{231}Pa was reduced by a factor of 590.

D.1.4 Effects of Flow Field Geometry, Distribution and Geometry of the Discharge, Site and Distribution and Geometry of the Source

So far we have discussed the interactions between hydrodynamic dispersion, nuclide retardation and leach time, both for single nuclides and nuclide chains. We have also discussed how these interact with the spreading phenomena in chains that arises when the chain members have different velocities. All of the above phenomena are accounted for in the parametric analysis in the main text of this report. We have also indicated that there are hydrologic spreading phenomena, which are not accounted for in the analysis in the main text, that give rise to effects similar to hydrodynamic dispersion, but generally of a larger magnitude. These hydrologic spreading phenomena are:

- flow field geometry
- source character including geometry and distribution
- discharge geometry, character and distribution.

For the most part, all the interactions and effects discussed in the previous section on hydrodynamic dispersion are equally valid for these hydrologic spreading phenomena. The similarity between these additional hydrologic spreading phenomena and hydrodynamic dispersion arises because they all give rise to a variation in biosphere arrival time for water, and it is this variation in arrival time that significantly reduces the peak in the arrival rate (or concentration) curve. An example of the importance of these other hydrologic spreading forces shown in Figure D.17, which is a plot of the ^3H distribution within the Hanford groundwater system (Ahlstrom, Foote, Arnett, Cole and Serne 1977). The major spread in this plume arises from the flow field geometry and the character, geometry and distribution of the source. It can also be seen that biosphere arrival distribution will also be affected by the discharge site geometry and distribution. The importance of these additional hydrologic spreading phenomena can be appreciated by comparing the spread of the plume in Figure D.17, which must be measured in

FIGURE D.17. Interpreted Contours for the ^3H Contaminant Plumes in the Hanford Unconfined Groundwater System^(a)

(a) Ahlstrom, Foote, Arnett, Cole and Serne 1977.

kilometers over the 15- to 20-km path, with the 22-m spread over a 16-km path resulting from hydrodynamic dispersion, shown in Figure D.9.

D.1.4.1 Flow Field Geometry and Discharge Geometry and Distribution

The effect of flow field geometry on peak discharge rate can either be significant or can have little effect, as was the case for hydrodynamic dispersion. The dispersive effect of

flow field geometry depends on the variation in water (or nuclide) travel time from source to discharge point and the time required for leaching. There are conditions where the leach time controls the peak discharge rate and conditions where the flow geometry controls the peak discharge rate. For example, the flow field pictured in Figure D.18 has a 7000-yr variation in water travel time, and the travel time varies linearly from the shortest travel time to the longest travel time.

The upper curve in Figure D.19 shows the ratio of peak discharge rate to peak release rate as a function of leach time for a square wave release of a long-lived radionuclide such as ^{129}I with no hydrodynamic dispersion. For leach times longer than the variation in travel time, flow geometry has no effect on the peak discharge rate. Thus, leach rate controls the maximum discharge rate. However, for leach times shorter than the travel time variation, the flow field geometry controls the peak discharge rate. The lower curve illustrates the effect of sorption. In the lower curve, flow field geometry controls the peak discharge rate when the leach times are less than 70,000 yr. This leads to the following relationships:

$T_L \leq (T_{\max} - T_{\min}) K$, flow field geometry controls peak discharge rate, and

$T_L > (T_{\max} - T_{\min}) K$, leach rate controls peak discharge rate, where

FIGURE D.18. Distributed-Source, General Discharge Flow Case for Curved Boundary

FIGURE D.19. Ratio of Peak Biosphere Discharge Rate to Peak Leach Rate as a Function of Leach Time for a Case of Linear Travel Time Variation and Square Wave Release

T_L is the leach time, $(T_{\max} - T_{\min})$ is the variation in water travel time, and K is the retardation coefficient. The above equations show that in the event that no variation in travel time exists, leach rate controls the peak biosphere discharge rate for single nuclides. For decay chain transport, the relationships are:

$$T_L \leq T_{\max} K_S - T_{\min} K_f$$

flow geometry controls peak discharge rate, and

$$T_L > T_{\max} K_S - T_{\min} K_f,$$

K_S is the retardation coefficient of the slowest-moving chain member and K_f is the retardation coefficient of the fastest-moving member. Note that when $K_S = K_f$ (say both members of a two-member chain are retarded equally) the inequality relationships for decay chain transport break down into the prior inequalities for single nuclides. However, when there is no flow field

distribution, $T_{\max} = T_{\min}$, the leach time must still be greater than the dispersion in time due to the different travel times of the chain members. This is seen where the above relationships for decay chains for $T_{\max} = T_{\min} = T_{\text{avg}}$ break down to:

$T_L \leq T_{\text{avg}} (K_S - K_f)$, sorption effects control peak discharge rate, and

$T_L > T_{\text{avg}} (K_S - K_f)$, leach rate controls peak discharge rate.

It is important to note that the effects of radioactive decay and hydrodynamic dispersion have been excluded in these relationships.

For this simple case of a linear variation in water arrival time due to flow field geometry, an effective hydrodynamic dispersion coefficient and an average water travel time can be determined to represent this flow field geometry effect. In general, for more complicated arrival time distributions due to flow field geometry, there is no equivalent, one-dimensional, convective-dispersion system that will give rise to the actual arrival time distribution. However, these more complicated flow systems will give rise to the same general kinds of reduction in the peak rate of nuclide arrival and will interact similarly with leach time, nuclide retardation, and differential velocity spreading for chains.

D.1.4.2 Source Distribution, Character, and Geometry

The effects of source distribution on the peak discharge rate can vary from none for a line source perpendicular to the gradient in a uniform flow field to potentially significant for a uniformly distributed source over the 10,000 ft x 10,000 ft area of a repository. The distribution of the source in the flow field, as with all the other spreading phenomena, gives rise to a variation in travel time to the discharge site. For a 10-mi water path to the biosphere from the closest repository boundary, the waste leaving the front of the repository has 10,000 ft (~2 mi) or 20% less distance to travel than the waste leaving the back of the repository at the same point in time.

As in the previous discussion of the effects of travel time variation due to flow geometry, there is a region in which nuclide travel time across the entire distributed source controls the peak discharge rate and a region in which leach time controls the peak discharge rate. To illustrate this, let us examine the effect of source distribution for a one-dimensional uniform flow problem with no hydrodynamic dispersion and a square wave leach function with no decay. Figure D.20 shows the resultant ratio of peak rate across the downstream boundary to peak leach rate for various ratios of nuclide travel time across the distributed source to the leach time. Figure D.20 shows that for the foregoing conditions when:

$\frac{T_n}{T_L} > 1$, nuclide travel time controls peak rate, and when

$\frac{T_n}{T_L} \leq 1$, leach time controls peak rate, where

T_n is the nuclide travel time across the distributed source and T_L is the leach time.

FIGURE D.20. Ratio of Peak Biosphere Discharge Rate to Peak Leach Rate Versus the Ratio of Leach Time to Nuclide Travel Time Across a Distributed Source

As with the spreading effects due to hydrodynamic dispersion, flow field geometry, and discharge site geometry and distribution, the effects of a distributed source on the peak discharge rate result because it spreads the arrival time of contaminants that left the repository at the same time.

D.1.5 Summary of the Dispersive Effects Discussion

We have discussed the effect of various dispersive phenomena on the peak discharge rate, which include:

1. hydrodynamic dispersion
2. flow field geometry
3. source character including geometry and distribution
4. discharge geometry and distribution
5. velocity differences between chain members.

We have also discussed how these spreading phenomena interact with each other and with nuclide retardation and leach time. We have shown that (1) through (4) are important for many retarded nuclides in reducing biosphere arrival rate even for extremely long leach times. More importantly, however, we have shown that when these effects are considered, they can be used to

determine minimum effective leach time regardless of how the waste form actually leaches. Take the distributed source case since it is easiest to visualize. A pulse release of a contaminant over an interval for certain circumstances is equivalent to a square wave release over a specific time. The two are equivalent when the pulse is uniformly distributed over the interval and when the release time is equal to the water (or nuclide) travel time for one end of the interval to the other. Also, travel times from the downstream end of the interval must be equal to travel times from the point source. The foregoing is only for the special case of no hydrodynamic dispersion.

These spreading phenomena act as natural backup units in a sense. If leach times are extremely long, the effects of these backup units go unnoticed, but as leach time decreases and the threshold limit is reached for one of these spreading phenomena, then their effects dominate biosphere arrival rate regardless of the actual release rate at the source. For the same repository and hydrologic system, different phenomena will dominate the biosphere arrival rate of individual isotopes depending on the leach time, isotope retardation, and whether it is a member of a chain, and which member it is. Peak biosphere arrival rate for ^{129}I , for long leach times with respect to flow field or source distribution arrival time variation, will be controlled by leach time. Peak arrival rate of ^{135}Cs , which is typically greatly retarded, will probably be controlled by one of the hydrologic spreading forces 1-4 unless extremely long leach times are postulated. Peak arrival rates for certain chain members (recall Figure D.12) will probably be dominated by velocity differences between chain members. Peak arrival of actinide parent chain members, which are typically greatly retarded, are probably controlled by spreading forces 1-4 unless extremely long leach times are postulated.

Thus, for a given spectrum of radionuclides, a given release scenario and set of hydrologic conditions, leach time or any one of these dispersive phenomena, 1-5, may control peak discharge rates or the rate may be controlled by radioactive decay. At this time there is no simple, straightforward way to factor in all the complex interactions. This is one reason for computer models. To show the effect of combining variables, the following section describes several cases that were modeled. The results of the modeling show the effect of consideration of these dispersive phenomena and of not considering them. The above discussions and the following example modeling efforts may shed some light on the design of a repository and engineered barrier systems.

D.2 DESCRIPTION OF PARAMETRIC ANALYSIS

The following parametric analysis characterizes the interactive effects of the dispersive phenomena described in the previous section on the release to the biosphere. Three basic flow situations were used to characterize the effects of variations in travel time from the source to the sink. Those three base cases were:

- flow from a source to a water-supply well,
- flow from a source to a natural discharge boundary such as a river, where the boundary was straight and normal to aquifer flow, and
- flow from a source to a natural discharge boundary where the boundary was curved or not normal to the ground-water gradient.

Superimposed on these base cases was either a distributed source or a point source--thus bringing the total flow cases analyzed to six. For each of the six flow cases, the effect of two different leach times on peak discharge rate were evaluated. The leach times used were 100 and 10^6 yr. Two single nuclides, ^{129}I and ^{135}Cs , and the $^{234}\text{U} \rightarrow ^{226}\text{Ra}$ chain were used as examples.

D.2.1 Point-Source Flow Cases

The point-source cases simulate the results of a repository shaft failure and were treated as an injection well with a discharge of 50 g/min (189 L/min). Except in the case of a water-supply well discharge to the biosphere, this resulted in significant travel time variations. Since potability was a constraint of the water-well scenario for a salt repository, there was less than 0.1% variation in water travel time. Figures D.21, D.22, and D.23 show the resulting point source flow systems for each of the base flow systems. An exception to these flow cases was a point-source/point-discharge case used for comparison with the transport model GETOUT. In that case there was no travel time variation and a travel time of 30,000 yr was used.

FIGURE D.21. Point-Release, Well Discharge Flow Case^(a)

(a) Square indicates repository boundary

FIGURE D.22. Point-Release, Natural Discharge Flow Case for a Boundary Normal to the Gradient

Figures D.24 and D.25 show water travel time as a function of percent of flow arriving at the biosphere discharge points for Figures D.22 and D.23, respectively. This travel time distribution is the result of either variation in velocity or travel distance or both. It can be seen from Figure D.23 that little or no travel time variation occurs for the point source water-well discharge case.

D.2.2 Distributed-Source Flow Cases

The distributed-source cases assume that within the bounds of the repository the entire inventory is leached uniformly into the adjacent aquifer. This could be the result of the overburden being rubbelized and water passing vertically through the repository to the adjacent aquifer. Furthermore, it is assumed that the flow from the repository does not significantly disrupt flow in the transporting aquifer. Figures D.18, D.26, and D.27 show the resulting flow systems for the three base distributed-source cases.

Figures D.28 and D.29 show the travel time variation as a function of percent of flow arriving at the biosphere discharge point or boundary for the flow systems shown in Figures D.27 and D.18, respectively. No travel time variation resulted in the distributed-source case that was parallel to the natural discharge boundary and perpendicular to the groundwater flow (shown in Figure D.27).

FIGURE D.23. Point-Release, Natural Discharge Flow Case for a Curved Boundary

FIGURE D.24. Arrival Time Distribution at River for Flow System Shown in Figure 22

FIGURE D.25. Water Arrival Time Distribution for Flow System Shown in Figure D.23

FIGURE D.26. Distributed Source, Point Discharge Flow Case

FIGURE D.27. Distributed-Source, Natural Discharge Flow Case for a Boundary Normal to the Gradient

FIGURE D.28. Water Arrival Time Distribution for Flow System Shown in Figure D.26

FIGURE D.29. Water Arrival Time Distribution for Flow System Shown in Figure D.18

D.3 RESULTS OF PARAMETRIC ANALYSIS

Neglecting radioactive decay for a moment, the 10^6 -yr leach time obscured dispersive effects for ^{129}I and ^{234}U in all flow cases. This was because the travel time variation, distributed source, and hydrodynamic dispersion effects were negated by the long leach time for the particular retardation factors used in this run. The maximum travel time variation for ^{129}I was the same as the water travel time variation, and ^{234}U had a maximum variation of 7.4×10^5 yr. Therefore, the ratio of leach time to nuclide travel time was greater than one. Consulting Figure D.19 for values of this ratio greater than one shows that leach time (for square waves and linear travel time variation) controls the peak biosphere discharge rate.

The 10^6 -yr leach time did not control the peak discharge for ^{135}Cs for any of the natural discharge cases because for the cases with significant travel time variation, the minimum ^{135}Cs travel time variation was 4.9×10^6 ; and for the distributed source cases, the ^{135}Cs travel time across the repository was 1.4×10^6 yr. Both are larger than the 10^6 -yr leach time; and in either case (see Figures D.19 and D.20) leach time does not control peak biosphere discharge rate. In both well discharge cases the 10^6 -yr leach time controlled the peak discharge rate of ^{135}Cs .

The 100-yr leach-time-controlled peak discharge rate for the point source, water-well discharge case for ^{129}I in the distributed-source, water-well discharge case, and for the GETOUT comparison case. In all other situations travel time variation and/or the source distribution controlled the peak biosphere discharge rate.

D.3.1 Results of Modeling

Peak discharge rates (Ci/yr) for each nuclide, leach time, and flow field are shown in Table D.1. The items in the first column in Tables D.1 through D.4 correspond to the following flow cases:

- PS-ND-P--point source, natural discharge, and perpendicular boundary (Figure D.22)
- DS-ND-P--distributed source, natural discharge, and perpendicular boundary (Figure D.27)
- PS-ND-C--point source, natural discharge, and curved boundary (Figure D.23)
- DS-ND-C--distributed source, natural discharge, and curved boundary (Figure D.28)
- PS-WD--point source and well discharge (Figure D.21)
- DS-WD--distributed source and well discharge (Figure D.26)

The PS-PND system corresponds to a one-dimensional flow system and corresponds to the results that would be obtained by a single run of the GETOUT code. This flow case used a hydrodynamic dispersivity of 1.0 ft. The comparisons made show the effects of:

- increasing leach time
- point source versus distributed source
- changing flow field geometry.

The following is a discussion of each of these effects and an explanation of the results obtained.

D.3.1.1 Effects of Increasing Leach Duration

In general, the results show that increasing the leach duration decreases the peak biosphere discharge rate but not in direct relation with the decrease in leach rate. The peak leach rate for the 100-yr leach duration is one hundredth of the inventory per year, while in the 10^6 -yr leach duration it is 10^{-6} of the inventory--a decrease of 10^{-4} . Table D.2 shows the resulting ratio of peak biosphere discharge rate of the 10^6 -yr leach time to the 100-yr leach time for each flow case. For the most part, increasing leach time had only a marginal effect, especially for the ^{234}U daughters, ^{230}Th , and ^{226}Ra . The greatest effect was for the point-source, point-natural discharge and for each of the water-well discharge cases. These cases showed the greatest effect because they showed essentially no travel time variation and no distributed source effects, and they represent the effects of only hydrodynamic dispersion.

The daughters of ^{234}U are relatively insensitive to the increased leach time. This is due to the differential velocity spreading phenomenon discussed in Section II for daughter nuclides. ^{230}Th and ^{226}Ra are in decay equilibrium with ^{234}U . While the peak rate for ^{234}U may be affected greatly by increased leach time, the daughters' peak rate is, for the most part, being dominated by the spread caused by velocity differences. At leach times of

TABLE D.1. Peak Biosphere Discharge Rates for Each Flow Case and Each Leach Time (Ci/yr)

Case	Leach Time, yr	Radionuclide				
		¹²⁹ I	¹³⁵ Cs	²³⁴ U	²³⁰ Th	²²⁶ Ra
PS-ND-P	100	8.34×10^{-1}	5.86×10^{-5}	1.62×10^{-2}	2.06×10^{-4}	1.13×10^{-3}
DS-ND-P		1.24	3.18×10^{-5}	8.59×10^{-3}	2.15×10^{-4}	1.98×10^{-3}
PS-ND-C		8.34×10^{-1}	1.69×10^{-5}	4.88×10^{-3}	9.90×10^{-5}	9.97×10^{-4}
DS-ND-C		3.55×10^{-1}	9.08×10^{-6}	2.47×10^{-3}	9.77×10^{-5}	9.13×10^{-3}
PS-WD		3.66×10^{-2}	9.62×10^{-4}	7.30×10^{-2}	6.24×10^{-5}	6.52×10^{-4}
DS-WD		3.1×10^{-2}	2.25×10^{-3}	1.96×10^{-1}	8.32×10^{-5}	1.22×10^{-3}
PS-PND		11.00	2.44×10^{-4}	7.35×10^{-2}	4.07×10^{-4}	1.98×10^{-3}
PS-ND-P	10 ⁶	2.47×10^{-3}	2.33×10^{-5}	6.00×10^{-4}	3.08×10^{-5}	3.09×10^{-4}
DS-ND-P		2.48×10^{-3}	2.24×10^{-5}	6.62×10^{-4}	2.62×10^{-5}	2.47×10^{-4}
PS-ND-C		2.48×10^{-3}	1.17×10^{-5}	3.69×10^{-4}	2.07×10^{-5}	1.82×10^{-4}
DS-ND-C		2.48×10^{-3}	7.60×10^{-6}	3.73×10^{-4}	1.85×10^{-5}	1.80×10^{-4}
PS-WD		2.48×10^{-3}	1.58×10^{-2}	1.46×10^{-4}	2.95×10^{-6}	1.19×10^{-5}
DS-WD		3.05×10^{-6}	2.36×10^{-5}	1.80×10^{-4}	3.96×10^{-5}	7.26×10^{-4}
PS-PND		2.48×10^{-3}	3.38×10^{-5}	8.08×10^{-4}	2.90×10^{-5}	2.79×10^{-4}

TABLE D.2. Ratios of Peak Biosphere Discharge Rate for 10⁶-yr Leach Time to Peak Rate for 100-yr Leach Time

Case	Radionuclide				
	¹²⁹ I	¹³⁵ Cs	²³⁴ U	²³⁰ Th	²²⁶ Ra
PS-ND-P	2.97×10^{-3}	3.96×10^{-1}	3.70×10^{-2}	1.50×10^{-1}	2.73×10^{-1}
DS-ND-P	2.00×10^{-3}	7.04×10^{-1}	7.71×10^{-2}	1.22×10^{-1}	1.25×10^{-1}
PS-ND-C	2.97×10^{-3}	6.92×10^{-1}	7.56×10^{-2}	2.09×10^{-1}	1.83×10^{-1}
DS-ND-C	6.99×10^{-3}	8.37×10^{-1}	1.51×10^{-1}	1.89×10^{-1}	1.97×10^{-1}
PS-WD	6.78×10^{-2}	6.09×10^{-2}	2.00×10^{-3}	4.73×10^{-2}	1.83×10^{-2}
DS-WD	9.84×10^{-5}	1.05×10^{-2}	9.18×10^{-4}	4.76×10^{-1}	5.95×10^{-1}
PS-PND	2.25×10^{-4}	1.39×10^{-1}	4.12×10^{-3}	7.13×10^{-2}	1.41×10^{-1}

10⁶ yr, the leach time spread of the ²³⁴U parent is now becoming significant with respect to the differential ²³⁰Th - ²³⁴U velocity spread.

¹²⁹I is most affected because lack of retardation decreases all the spreading effects, and the 10⁶-yr leach time is the controlling effect. However, ¹³⁵Cs has a retardation coefficient of 700; therefore, it amplifies the other dispersive effects, and the 10⁶-yr leach time is only a fraction of all the resulting spreading.

D.3.1.3 Effects of Different Flow Geometries

The effect of different flow geometries is quite dramatic in some cases and marginal in others. Table D.3 shows the ratio of peak discharge rate for each of the natural discharge

TABLE D.3. Ratios of Peak Discharge Rates for Each Natural Discharge Flow Case to Peak Discharge Rate for a Point Source/Point Discharge for a One-Dimensional Streamtube with Water Travel Time of 30,000 Years

Case	Leach Time, yr	Radionuclide				
		^{129}I	^{135}Cs	^{234}U	^{230}Th	^{226}Ra
PS-ND-P	100	7.58×10^{-2}	2.40×10^{-1}	2.20×10^{-1}	5.06×10^{-1}	5.71×10^{-1}
DS-ND-P		1.13×10^{-1}	1.30×10^{-1}	1.17×10^{-1}	5.28×10^{-1}	1.0
PS-ND-C		7.58×10^{-2}	6.93×10^{-2}	6.64×10^{-2}	2.43×10^{-1}	5.04×10^{-1}
DS-ND-C		3.23×10^{-1}	3.72×10^{-2}	3.36×10^{-2}	2.40×10^{-1}	4.61×10^{-1}
PS-ND-P	10^6	0.996	6.89×10^{-1}	7.43×10^{-1}	1.06	1.11
DS-ND-P		1.0	6.63×10^{-1}	8.19×10^{-1}	9.03×10^{-1}	8.85×10^{-1}
PS-ND-C		1.00	3.46×10^{-1}	4.57×10^{-1}	7.14×10^{-1}	6.52×10^{-1}
DS-ND-C		1.00	2.25×10^{-1}	4.62×10^{-1}	6.38×10^{-1}	6.45×10^{-1}

TABLE D.4. Ratios of Distributed Source Peak Discharge Rates to Point Source Peak Discharge Rates

Case	Leach Time, yr	Radionuclide				
		^{129}I	^{135}Cs	^{234}U	^{230}Th	^{226}Ra
ND P	100	1.49	0.543	0.364	1.04	1.75
ND C		0.426	0.537	0.506	0.987	0.916
ND P	10^6	0.996	0.961	1.10	0.851	0.799
ND C		1.00	0.650	0.506	0.894	0.989

flow cases to the peak discharge rate of the nuclides for the point-source, point-natural discharge for each leach time. For ^{129}I and a 100-yr leach time, the flow system was very effective in reducing peak biosphere discharge rates. The same is true for ^{135}Cs and ^{234}U . For the 10^6 -yr leach time, the different flow geometries had no effect on ^{129}I and little effect on ^{234}U , but had a greater effect on ^{135}Cs . The differing importance of the flow fields is due to the amplification effect of the retardation coefficient. For all nuclides except ^{135}Cs , the leach time was the dominant spreading factor. However, for ^{135}Cs the dominant spreading factor was either source distribution, travel time variation, or both. In the case of ^{135}Cs a leach time of greater than 1.4 M yr for the point source, parallel natural discharge case would be necessary for leach time to begin reduction of peak discharge rates. ^{129}I and ^{234}U both have travel time variations for the natural discharge cases less than 10^6 yr; therefore, leach time was affecting peak discharge rate more than any other dispersive effect.

D.3.1.3 Effects of Source Distribution

In all but a few instances, the distribution of the source over the size of the repository, as compared to a point source, reduced the peak discharge rate. Table D.4 shows the ratio of peak discharge rates for the distributed source versus the point source. One of the cases was for the 100-yr leach of ^{129}I and the parallel natural discharge flow case. This was due to less net travel time variation caused by the distributed source and the uniform

travel time variation distribution as compared to the travel time variation of the point source. The important phenomenon here is the difference in travel time distribution. The travel time distribution for the distributed source allowed the peak to rise higher for a shorter period of time as compared to the point source for poorly sorbed nuclides. It may also be that the point source allowed the peak to rise higher, but in-transit hydrodynamic dispersion was effective in reducing the peak.

The other case in which the differences were significant was for ^{226}Ra for the same flow case. The reason for this large ratio (1.75) is discussed by Burkholder and Cloninger (Burkholder and Cloninger 1978).

D.4 SUMMARY

In light of the results obtained from this study, the following observations are made:

- If the flow system in the region of the repository is such that it produces significant amounts of travel time variation, either because of source distribution or the hydrologic variation then the leach time must be greater than the nuclide travel time variation before it begins to have an effect upon the peak biosphere discharge rate.
- Since a repository has a wide spectrum of nuclides and distribution coefficients, it may be important to concentrate engineered barrier design on those nuclides which are both very mobile and dose significant (e.g., ^{129}I), since the most mobile nuclides will have the least travel time variation.
- The natural geologic barrier can have three benefits: providing enough retardation to reduce discharge rates by decay, providing significant amounts of travel time variation, hydrodynamic dispersion, etc., and, best of all, providing absolute containment of the nuclear waste by preventing initiation of leaching.
- It may be important to insure that if a repository fails, that it fails in such a fashion so it provides a distributed source to an aquifer rather than a point source. This may be important not only to geologic media chosen for disposal but also to engineered barrier design and access shaft sealing.
- It is important to guard against a situation in which a point-source/point-discharge flow situation occurs. This situation forces dependence on leach time to reduce peak discharge rates.
- It is important to factor geology, geohydrology, and geochemistry into repository siting, repository design, and engineered barrier design. Geologic nonhomogeneity is important because it should provide significant amounts of dispersive sources for the geohydrology. Geochemistry is important in that it is necessary to insure significant retardation to migration of radionuclides.

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