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CVP-2004-00004
Rev. 0

Cleanup Verification Package for the 118-B-10 Burial Ground

Prepared for the U.S. Department of Energy by Bechtel Hanford, Inc.

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EXECUTIVE SUMMARY

E1.0 INTRODUCTION

This cleanup verification package documents completion of remedial action for the 118-B-10 Burial Ground, also know as the 118-B-10 Ball 3X Storage Vault Burial Ground. The burial ground was located approximately 23 m (75 ft) north of the 115-B Gas Recirculation Building and 24 m (80 ft) south of the 105-B Reactor Building in the 100-BC-1 Operable Unit of the 100-B/C Area. Historical records indicated that the site contained a metal tank used to store highly radioactive boron-steel and carbon-steel balls. However, excavation of the site found only boron-steel balls mixed with soil. The site was believed to be approximately 15 m (50 ft) long, 6.1 m (20 ft) wide, and 6.1 m (20 ft) deep. The 118-B-10 Burial Ground was approximately 820 m (2,690 ft) south of the Columbia River. Operational dates of this burial ground are unknown.

Remedial action objectives and goals for the 118-B-10 Burial Ground were established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. For the 118-B-10 Burial Ground, these goals and objectives are documented in the *Interim Remedial Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units* (100 Area Burial Grounds ROD) (EPA 2000) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2002).

The selected remedial action for the 118-B-10 Burial Ground included (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) treatment as necessary and disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to average adjacent grade elevation. Excavation was driven by remedial action objectives for direct exposure, protection of groundwater, and protection of the Columbia River. For the respective points of compliance, remedial action goals (RAGs) were established to identify radionuclide and nonradionuclide contaminants of

concern (COCs). Waste site COCs identified through process knowledge are listed in Appendix A of the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (DOE-RL 2001). Although lead is not a COC for the burial ground, lead solids were found during the excavation effort and a focused sampling effort was performed to demonstrate that underlying soil had not been impacted. The focused sampling included analyses for several additional contaminants of potential concern (COPCs): arsenic, barium, cadmium, total chromium, mercury, selenium and silver. None of these COPCs were encountered at concentrations above the RAGs. Therefore, they were not added to the list of COCs for the site. The COCs identified in the sampling and analysis plan for this site consist of the following:

- Cobalt-60
- Nickel-63.

E2.0 RESULTS

Site excavation and waste disposal are complete, and the exposed surfaces (including an area used for staging of excavated waste) have been sampled and analyzed to verify attainment of the RAGs. At the completion of remedial action, the excavation was approximately 137 m^2 (1,475 ft^2) in area with an average depth of approximately 3.21 m (10.5 ft). Approximately 266 metric tons (293 tons) of material, including soil and burial ground debris, were removed from the site and disposed of at the Environmental Restoration Disposal Facility.

Results of the sampling, laboratory analyses, and data evaluations for the site indicate that all remedial action objectives and goals for direct exposure, protection of groundwater, and protection of the Columbia River have been met (see Table ES-1). The following sections discuss these results.

Table ES-1. Summary of Cleanup Verification Results for the 118-B-10 Burial Ground.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?	Ref.
Direct Exposure – Radionuclides	1. Attain 15 mrem/yr dose rate above background over 1,000 years.	1. Maximum dose rate calculated by RESRAD for the burial ground site is 2.79 mrem/yr and 0.504 mrem/yr for the staging pile area.	Yes	a
Groundwater/River Protection – Radionuclides	1. Attain single-COC groundwater and river protection RAGs.	1. All single-COC groundwater and river RAGs have been attained.	Yes	b
	2. Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.	2. All organ-specific dose rates are below the 4 mrem/yr dose rate limit.		b
	3. Meet drinking water standards for alpha emitters: the more stringent of 15 pCi/L MCL or 1/25th of the derived concentration guide from DOE Order 5400.5.	3. There are no alpha-emitting COCs at this site.		b
	4. Meet total uranium standard of 30 μg/L (21.2 pCi/L).[c]	4. Uranium is not a COC for this site.		
Other Supporting Information	1. 95% UCL calculation (Appendix C).			d, e
	2. Sample location design (Appendix C).			

NOTE: There are no nonradionuclide COCs associated with the 118-B-10 Burial Ground.
[a] *118-B-10 Burial Ground RESRAD Calculation Brief*, 0100B-CA-V0229, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[b] *118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)*, 0100B-CA-V0230, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[c] Based on the isotopic distribution of uranium in the 100 Areas, the 30 μg/L maximum contaminant level (MCL) corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Bechtel Hanford, Inc., Richland, Washington (BHI 2001).
[d] *118-B-10 Burial Ground 95% UCL Calculation*, 0100B-CA-V0228, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
[e] *Verification Sample Design for 118-B-10 Burial Ground*, 0100B-CA-V0206, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit

E2.1 DIRECT EXPOSURE SOIL CLEANUP STANDARDS

E2.1.1 Radionuclides

The 100 Area Burial Grounds ROD (EPA 2000), developed in compliance with the "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300), expresses the RAG for direct exposure to radionuclides in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The total dose rate above background, considering all radionuclide COCs and pathways, was predicted from the RESidual RADioactivity (RESRAD) dose assessment model (ANL 2002). The results indicate that at present (2004), the maximum dose rate above background for the site is 2.79 mrem/yr and for the staging pile area is 0.504 mrem/yr. The dose is predicted to decrease to 3.88×10^{-5} mrem/yr for the site and to 4.26×10^{-6} mrem/yr for the staging pile area in 1,000 years.

The estimated total dose rate in the year 2018 from the site is 0.462 mrem/yr and for the staging pile area is 0.0825 mrem/yr. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). Total dose rate estimates never exceed the direct exposure RAG of 15 mrem/yr above background.

Although the RAG for radionuclides is expressed in terms of radiation dose, this cleanup verification package also includes radionuclide excess lifetime cancer risk estimates as additional information. The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 *Code of Federal Regulations* 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. The RESRAD model calculated the total excess cancer risk for radionuclides using the U.S. Environmental Protection Agency's Health Effects Assessment Summary Tables (dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast).

Because of radioactive decay, the risk associated with radionuclides decreases over time. The estimated cancer risk is largest for the site (1.70×10^{-5}) and for the staging pile area (3.02×10^{-6}) at present (2004), and decreases to 1.42×10^{-9} for the site and 1.63×10^{-10} for the staging pile area in 1,000 years. The estimated excess cancer risk in 2018 is 3.70×10^{-6} for the site and 5.96×10^{-7} for the staging pile area.

E2.1.2 Nonradionuclides

No nonradionuclide COCs were identified for the 118-B-10 Burial Ground.

E2.2 PROTECTION OF GROUNDWATER AND THE RIVER

E2.2.1 Radionuclides

The estimated radionuclide dose rate via the groundwater and river pathways is below the RAG of 4 mrem/yr for beta and gamma emitters. There are no alpha-emitting COCs for this site. In summary, all radionuclide RAGs for protection of groundwater and the river have been met.

E2.2.2 Nonradionuclides

No nonradionuclide COCs were identified for the 118-B-10 Burial Ground.

E3.0 WASTE SITE RECLASSIFICATION

The site meets cleanup standards and has been reclassified as "interim closed out" in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998) and the Waste Site Reclassification Guideline TPA-MP-14 (RL-TPA-90-0001) (DOE-RL 1998). A copy of the waste site reclassification form is included as Attachment ES-1.

Attachment ES-1
Waste Site Reclassification Form

Date Submitted: 05/12/04 **Originator:** R. A. Carlson **Phone:** 372-9632	**Operable Unit(s):** 100-BC-1 **Waste Site ID:** 118-B-10 Burial Ground **Type of Reclassification Action:** Rejected ☐ Closed Out ☐ Interim Closed Out ☒ No Action ☐	**Control Number:** 2004-018 **Lead Agency:** EPA

This form documents agreement among the parties listed below authorizing classification of the subject unit as rejected, closed out, interim closed out, or no action and authorizing backfill of the site, if appropriate. Final removal from the National Priorities List of no action, interim closed out, or closed-out sites will occur at a future date.

Description of current waste site condition:

Remedial action at this site has been performed in accordance with remedial action objectives and goals established by the U.S. Environmental Protection Agency and the U.S. Department of Energy, Richland Operations Office, in concurrence with the Washington State Department of Ecology. The selected remedial action involves (1) excavating the site to the extent required to meet specified soil cleanup levels, (2) treatment as required with disposal of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site, and (3) backfilling the site with clean soil to adjacent grade elevations. The excavation and disposal activities have been completed.

Basis for reclassification:

The 118-B-10 Storage Vault Burial Ground has been remediated to meet the cleanup standards specified in the *Interim Remedial Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington. Remedial actions were performed so as to allow rural-residential use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep) and to protect groundwater and the Columbia River. The cleanup verification package demonstrates the acceptability of unrestricted access to deep zone soils (i.e., below 4.6 m [15 ft]); therefore, deep zone institutional controls are not required. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 118-B-10 Burial Ground* (CVP-2004-00004), Bechtel Hanford, Inc., Richland, Washington.

H. E. Bilson DOE-RL Manager	Signature	5/14/04 Date
NA Ecology Project Manager	Signature	Date
Dennis A. Faulk EPA Project Manager	Signature	5-24-04 Date

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ACRONYMS AND ABBREVIATIONS

CFR	*Code of Federal Regulations*
COC	contaminant of concern
CVP	cleanup verification package
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
MDA	minimum detectable activity
MS	matrix spike
NaI	sodium iodide
PARCC	precision, accuracy, representativeness, completeness, and comparability
PQL	practical quantitation limit
QA	quality assurance
QC	quality control
RAG	remedial action goal
RAO	remedial action objective
RDL	required detection limit
RDR/RAWP	Remedial Design Report/Remedial Action Work Plan
RESRAD	RESidual RADioactivity (dose assessment model)
ROD	Record of Decision
RPD	relative percent difference
SAP	sampling and analysis plan
SDG	sample delivery group
UCL	upper confidence limit
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this cleanup verification package (CVP) is to document that the 118-B-10 Burial Ground was remediated in accordance with the *Interim Remedial Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-2, 100-HR-2, and 100-KR-2 Operable Units* (100 Area Burial Grounds ROD) (EPA 2000) and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002). The 100 Area Burial Grounds ROD provides the U.S. Department of Energy, Richland Operations Office the authority, guidelines, and objectives to conduct this remedial action. The preferred remedy specified in the 100 Area Burial Grounds ROD and conducted for the 118-B-10 Burial Ground was excavation, treatment as necessary, and disposal of contaminated materials at the Environmental Restoration Disposal Facility (ERDF).

1.2 DOCUMENT ORGANIZATION

The cleanup verification evaluation is presented in the following sections:.

- Section 2.0 Site Description and Supporting Information
- Section 3.0 Summary of Remedial Action Objectives and Goals
- Section 4.0 Remedial Action Field Activities
- Section 5.0 Cleanup Verification Data Evaluation
- Section 6.0 Evaluation of Remedial Action Goal Attainment
- Section 7.0 Radionuclide Risk Information
- Section 8.0 Statement of Protectiveness
- Section 9.0 References
- Section 10.0 Bibliography.

The main text is supported by the following appendices:

- Appendix A Summary of Verification Soil Sampling and Analytical Results
- Appendix B Data Quality Assessment
- Appendix C RESRAD Input Parameters and Calculation Brief Excerpts.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

2.1 SITE HISTORY

The 118-B-10 Burial Ground was located approximately 23 m (75 ft) north of the 115-B Gas Recirculation Building and 24 m (80 ft) south of the 105-B Reactor Building in the 100-BC-1 Operable Unit of the 100-B/C Area (Figure 1). Historical records indicated that the site contained a metal tank used to store highly radioactive boron-steel and carbon-steel balls. However, excavation of the site found only boron-steel balls mixed with soil. The site was believed to be approximately 15 m (50 ft) long, 6.1 m (20 ft) wide, and 6.1 m (20 ft) deep. The 118-B-10 Burial Ground was approximately 820 m (2,690 ft) south of the Columbia River. Operational dates of this burial ground are unknown.

2.2 SUBSURFACE CONDITIONS

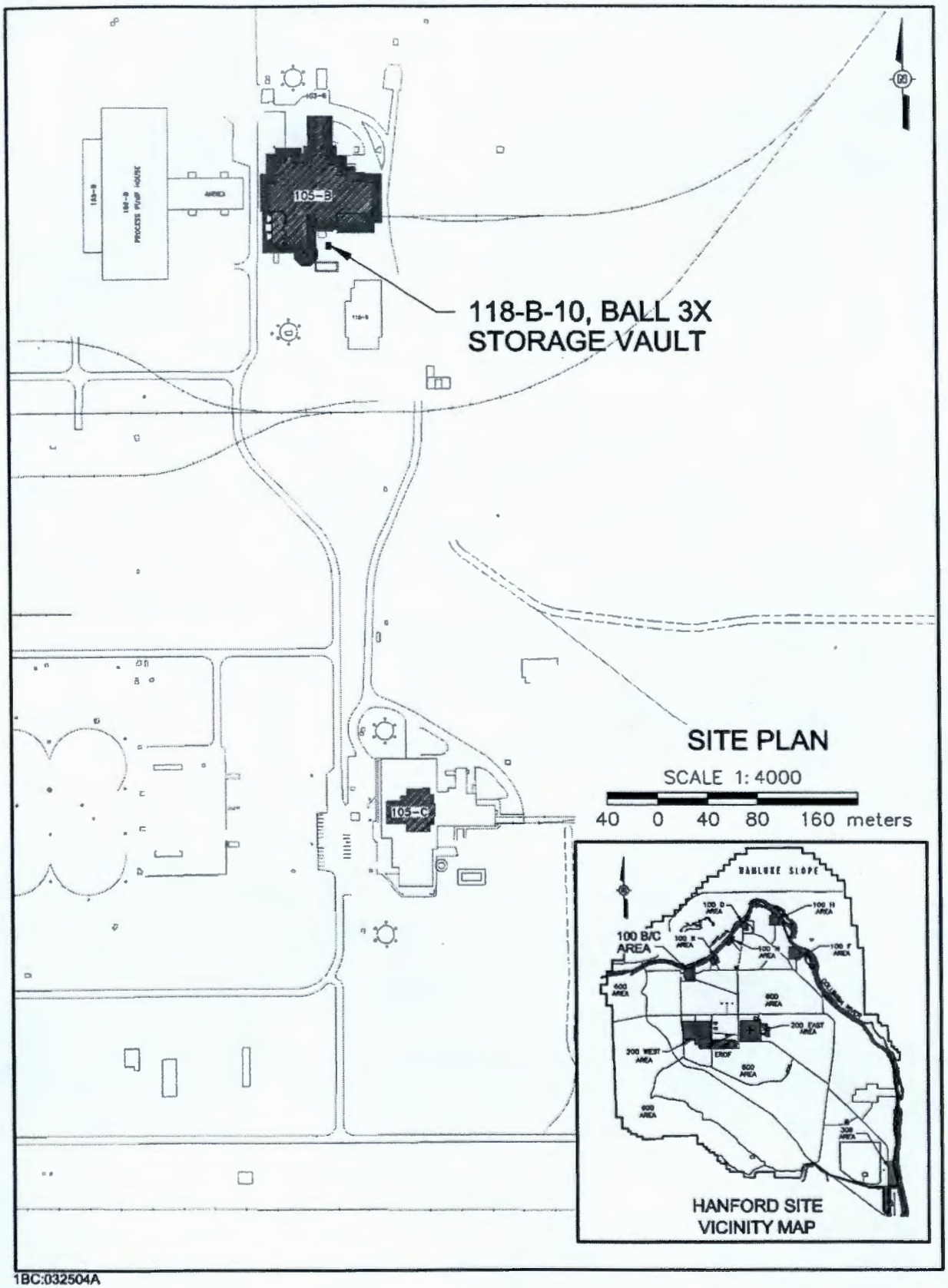
The soil column underlying the waste site and extending to groundwater consists of materials belonging to the Hanford formation. The Hanford formation consists predominantly of medium-dense to dense sand and gravel, with varying amounts of silt and cobble. The average long-term groundwater level beneath the site is estimated at El. 115.8 m (379.9 ft) for analysis purposes, based on historical and current information from adjacent groundwater wells. The average depth to groundwater is estimated to be 25.5 m (83.6 ft) beneath the floor of the excavation and approximately 28.7 m (94.2 ft) beneath surface grade level. Groundwater elevations in adjacent wells are influenced by the nearby Columbia River and other factors such as atmospheric pressure.

2.3 CONTAMINANTS OF CONCERN

Waste site contaminants of concern (COCs) identified through process knowledge are listed in the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The focused sampling performed at this site included analyses for several additional contaminants of potential concern (COPCs): arsenic, barium, cadmium, total chromium, mercury, selenium and silver. None of these COPCs were encountered at concentrations above the RAGs. Therefore, they were not added to the list of COCs for the site. The COCs identified in Appendix A of the SAP for this site consist of the following:

- Cobalt-60
- Nickel-63.

Figure 1. Hanford Site Map and 118-B-10 Burial Ground.



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3.0 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

3.1 REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAOs) for the 118-B-10 Burial Ground were established in the 100 Area Burial Grounds ROD (EPA 2000). The RAOs are narrative statements that define the extent to which waste sites require cleanup to protect human health and the environment. For a detailed discussion of the RAOs, see the RDR/RAWP (DOE-RL 2002) and the 100 Area Burial Grounds ROD.

3.2 REMEDIAL ACTION GOALS

Remedial action goals (RAGs) are the specific numeric goals against which the cleanup verification data are evaluated in order to demonstrate attainment of the RAOs. The RAGs were developed to support a rural-residential exposure scenario. This scenario addresses exposure only to soils less than 4.6 m (15 ft) deep. In the rural-residential scenario, an individual is assumed to live for 30 years in a residence built on the waste site and to spend 60% of his or her time indoors, 20% outdoors, and 20% offsite. The scenario assumes a portion of the resident's time is spent in the basement of the home. It further assumes that he or she consumes crops, meat, and milk from plants and animals raised on the waste site, and consumes fish from a pond downgradient from the waste site. Residual (post-cleanup) contaminant concentrations in the shallow zone (i.e., less than 4.6 m [15 ft]) are assumed for the soils in which crops are raised and on which animals providing meat and milk are raised. Water used by the resident for drinking, showering, watering livestock, and for fish production is assumed to be taken from groundwater derived from surface water that has infiltrated through the soil column at the site. A more detailed description of the rural-residential scenario, and how it is applied, is provided in the RDR/RAWP (DOE-RL 2002).

The contaminant-specific RAGs that are applicable to the 118-B-10 Burial Ground are listed in Table 1.

3.2.1 Direct Exposure RAGs

Under the rural-residential scenario, direct exposure RAGs are applicable to soils that are less than 4.6 m (15 ft) below ground surface (shallow zone soils). Direct exposure RAGs are listed in Table 1 and summarized below.

- **Radionuclide COCs:** For radionuclide COCs in the shallow zone (all pathways) and in the deep zone (water-dependent pathways), meet a 15 mrem/yr above background total dose rate (this RAG must be met for 1,000 years).

- **Nonradionuclide COCs:** No nonradionuclide COCs were identified for the 118-B-10 Burial Ground. Focused sampling (see Section 4.3) did not indicate any nonradionuclide COCs.

Table 1. Summary of Remedial Action Goals.

COCs	Direct Exposure RAG[a]	Groundwater Protection RAG[b] (pCi/L)	Columbia River Protection RAG[b] (pCi/L)
Radionuclides			
Cobalt-60	15 mrem/yr (cumulative)[a]	4 mrem/yr (cumulative)[b]	4 mrem/yr (cumulative)[b]
Nickel-63			

[a]Lookup values that correspond to the 15 mrem/yr dose rate are based on a generic site model and are presented in the RDR/RAWP (DOE-RL 2002).
[b]Lookup values that correspond to the individual radionuclide 4 mrem/yr dose rate equivalent for beta- and gamma-emitter RAGs per National Drinking Water Standards are presented in the RDR/RAWP (DOE-RL 2002), and in Table 3 of this CVP.

3.2.2 Groundwater and River Protection

Groundwater and river protection RAGs are applicable to all vadose zone soils (shallow and deep zone soils). For this CVP, river protection and surface water protection are synonymous since the Columbia River is the only surface water in proximity to the Hanford Site. The term river protection is used throughout this CVP. The groundwater and river protection RAGs are listed in Table 1 and summarized below.

- **Beta- and gamma-emitting radionuclide COCs:** Meet "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* [CFR] 141.66) dose rate standards (4 mrem/yr total body or organ dose rate) for a period of 1,000 years starting from site cleanup. Meet individual COC RAGs, as applicable.

- **Alpha-emitting radionuclide COCs:** Meet drinking water standards for nonuranium alpha-emitting radionuclides based on the more stringent of 15 pCi/L or 1/25th of the derived concentration guide per DOE Order 5400.5. The maximum contaminant level for uranium is 30 μg/L as promulgated by the U.S. Environmental Protection Agency (EPA) on December 7, 2000 (65 *Federal Register* 76708). For the 118-B-10 Burial Ground there are no alpha-emitting COCs or uranium.

- **Nonradionuclide COCs:** No nonradionuclide COCs were identified for the 118-B-10 Burial Ground.

4.0 REMEDIAL ACTION FIELD ACTIVITIES

4.1 EXCAVATION AND DISPOSAL

Remedial action at the 118-B-10 Burial Ground began on December 1, 2003. Excavation of the site involved removing the overburden materials and burial ground site materials. Based on field screening (discussed in Section 4.2), excavated waste was temporarily staged adjacent to the site excavation prior to disposal at ERDF.

The excavation was completed on December 2, 2003. Pre- and post-remediation action boundaries are shown in Figure 2. The elevation at the bottom of the excavation was approximately 141.3 m (463.6 ft) on completion. The excavation was approximately 137 m^2 (1,475 ft^2) in area with an average depth of approximately 3.21 m (10.5 ft). Approximately 266 metric tons (293 tons) of material was removed from the 118-B-10 Burial Ground and disposed of at ERDF.

4.2 FIELD SCREENING

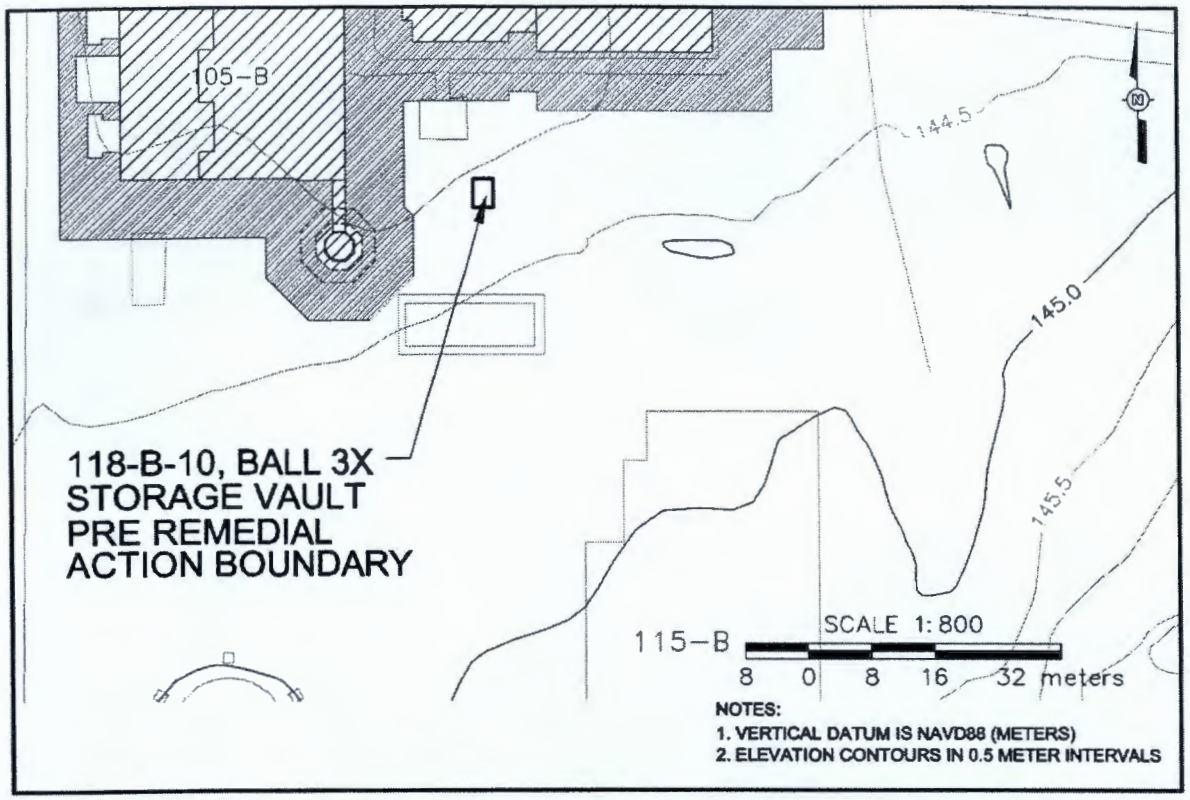
Field screening was conducted during the site remedial action as specified in the SAP (DOE-RL 2001). Field screening was used to guide the excavation to quickly assess for the presence and level of radiological contamination. Field screening for the 118-B-10 Burial Ground included using a radiological data mapping system survey, hand-held sodium iodide (NaI) detectors, and gamma energy analyses. The radiological mapping survey is performed over more than 50% of the site excavation surface area.

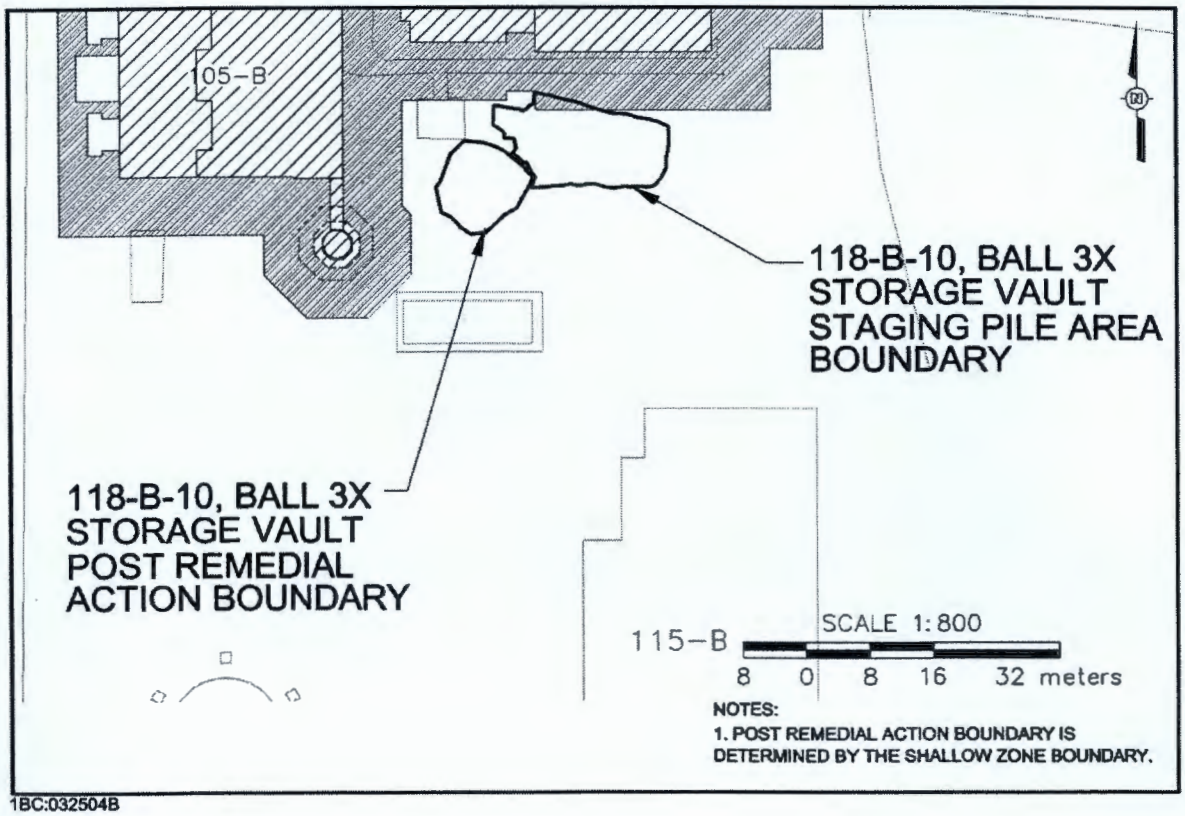
The hand-held NaI detectors are used to screen excavated waste material and to screen for potential excavation wall and floor hot spots. Gamma energy analyses were used to support waste characterization and to corroborate the radiological mapping survey and hand-held NaI detector data.

4.3 FOCUSED SAMPLING AND ANALYSIS

A focused soil sample (J01750) was collected in an excavation area where waste with potentially leachable metals (i.e., lead) was removed. Lead paint chips mixed with soil were identified in the field by visual inspection and were segregated. In addition, a soil sample (J01764) was collected from beneath the area where the lead paint chips mixed with soil were staged during the 118-B-10 remediation. These two focused samples were collected on January 19, 2004. The purpose of focused sampling and analysis was to verify that the excavated waste had not adversely impacted soil underlying the lead-containing solids. Results for the focused samples are included in Appendix A, Table A-4. The lead analysis of 16.2 mg/kg for the focused soil sample collected from the excavation area (J01750) is well below the direct exposure, but is above the Hanford Site background level of 10.2 mg/kg. Therefore, the elevated lead soil concentration was calculated using the RESidual RADioactivity (RESRAD) dose model to determine that it is protective of groundwater and the Columbia River. The RESRAD modeling determined that lead is not predicted to reach groundwater from the site within 1,000 years.

Figure 2. Pre- and Post-Remediation Action Boundaries for the 118-B-10 Burial Ground.





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4.4 CLEANUP VERIFICATION SAMPLING AND ANALYSIS

Cleanup verification sampling began on January 14, 2004, and was concluded on the same day. The final verification samples were submitted to offsite laboratories for analysis using EPA-approved analytical methods as required per the SAP (DOE-RL 2001). Each verification sample was a composite formed by combining samples collected at four randomly selected nodes within each sampling area. The sample design methodology and sample location figures are presented in the sample design calculation brief in Appendix C.

The division of the site excavation into decision units (e.g., shallow zone and staging pile area), as shown in the sample design figures, is a function of the applicable RAGs (Section 3.2, "Remedial Action Goals"). The direct exposure, groundwater protection, and river protection RAGs are applicable to soils within 4.6 m (15 ft) of the ground surface, referred to as the shallow zone. The groundwater protection and river protection RAGs are applicable to soils greater than 4.6 m (15 ft) below the ground surface, referred to as the deep zone. For the 118-B-10 site, because excavation greater than 4.6 m (15 ft) below the ground surface was not necessary, a separate deep zone unit was not established.

The shallow zone decision unit contained one decision subunit, which was divided into four sampling areas. The staging pile area contained one decision subunit, which was also divided into four sampling areas. One composite cleanup verification sample was collected from each shallow zone and staging pile area sample area. The sample design for this site is documented in the sample design calculation brief included in Appendix C.

5.0 CLEANUP VERIFICATION DATA EVALUATION

This section presents the evaluation and modeling of the 118-B-10 Burial Ground cleanup verification data for comparison with the data quality criteria and RAGs.

5.1 DATA QUALITY ASSESSMENT PROCESS

The data quality assessment (DQA) process provides a comprehensive evaluation of the cleanup verification sampling and analytical data to the requirements of the sampling and analysis document and the project goals and objectives. The data evaluations are presented in Sections 4.0 through 7.0 and in the calculation briefs included in Appendix C. The DQA results are summarized in Appendix B.

The DQA for the 118-B-10 site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The data evaluation verified that the cleanup verification data is of suitable quality and quantity for its intended use to support waste site reclassification. The cleanup verification sample

analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

5.2 CONTAMINANTS OF CONCERN 95% UPPER CONFIDENCE LIMIT

The primary statistical calculation used to support cleanup verification is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each COC are calculated for each decision unit (e.g., for the shallow zone and staging pile area, as appropriate). Prior to calculating the 95% UCL, the individual sample results are reviewed and, as appropriate, adjusted per the SAP (DOE-RL 2001). This process is summarized below.

Verification sampling summary statistics (95% UCL values) are listed in Table 2. Individual sample cleanup verification results are presented in Appendix A.

- **Radionuclides:** The laboratory-reported value is used in the calculation of the 95% UCL. In cases where the laboratory does not report a value for data qualified with a "U" (i.e., less than the detection limit), half of the minimum detectable activity is used in the calculation of the 95% UCL.

- **Nonradionuclides:** No nonradionuclide COCs were identified for the 118-B-10 Burial Ground. Focused sampling (see Section 4.3) did not indicate any nonradionuclide COCs. In addition, statistical 95% UCL values are not calculated for focused sampling.

Table 2. Cleanup Verification Data.

Radionuclide COCs	95% UCL Statistical Values		Hanford Site Background[a]	Cleanup Verification Data Set[b]	
	Shallow Zone	Staging Pile Area		Shallow Zone	Staging Pile Area
Radionuclides (pCi/g)[c]					
Cobalt-60	3.1E-01	6.1E-02	0.008	3.1E-01	5.3E-02
Nickel-63	8.11E+01	4.8E+00	NA	8.11E+01	4.8E+00

[a]Represents the 90th percentile of the lognormal distribution (DOE-RL 1995, 1996).
[b]For the staging pile area, anthropogenic background (DOE-RL 1996) and naturally occurring background is subtracted from all radionuclides. Refer to the 95% UCL calculation brief in Appendix C for additional details on determination of statistical values.
[c]Laboratory data including the minimum detectable activity or practical quantitation limit for the individual cleanup verification samples are included in Appendix A and the 95% UCL calculation brief in Appendix C.
NA = not applicable

Statistical calculations are presented in the 118-B-10 cleanup verification 95% UCL calculation brief (Appendix C). The columns on the left side of Table 2 are the 95% statistical values before subtraction of background, if appropriate. The columns on the right side of the table present statistical values adjusted for background. These values

constitute the cleanup verification data set and are used for RESRAD modeling. Because the staging pile area is a ground surface decision unit, anthropogenic background (DOE-RL 1996) and naturally occurring background are subtracted from all radionuclides for the staging pile area. For other decision units (e.g., shallow and deep zones), only naturally occurring background (uranium) is subtracted. Otherwise, nonradionuclide and radionuclide statistical values are not adjusted for background.

5.3 SITE-SPECIFIC CLEANUP VERIFICATION MODEL

The statistical values summarized in Table 2 were evaluated and used to develop a site-specific cleanup verification model. The 118-B-10 Burial Ground model assumes the worst case described in the RDR/RAWP (DOE-RL 2002), where the excavation as well as the staging pile area cleanup verification concentrations continue at the same concentrations to groundwater. A schematic cross section of the site-specific verification model is included in the RESRAD calculation brief in Appendix C. The elements of the model are described in Section 5.4.

5.4 RESRAD MODELING

The individual radionuclide cleanup verification values (Table 2) were entered into the RESRAD computer code, Version 6.21 (ANL 2002), to estimate the dose rate and to estimate the impact on groundwater and the river from residual COC concentrations. The direct radiation exposure dose rate to the resident living in his or her basement (rural-residential scenario) was conservatively estimated by substituting (for analysis purposes) a case where the resident is standing on level ground with the soil containing concentrations representative of residual (i.e., post-cleanup) shallow zone soils. This is conservative because it ignores the potential shielding effects of concrete basement walls and any clean backfill between residual soils and the basement walls.

The RESRAD modeling methodologies, results, input values, and the site-specific cleanup verification model are included in the RESRAD calculation brief (Appendix C). The drinking water dose rate calculations based on the RESRAD estimated groundwater radionuclide concentrations are shown in the comparison to drinking water standards calculation brief (Appendix C). Specific results from the calculations are discussed in the RAG evaluation section (Section 6.0).

6.0 EVALUATION OF REMEDIAL ACTION GOAL ATTAINMENT

This section demonstrates that remedial actions at the 118-B-10 Burial Ground have achieved the applicable RAGs. Sections 6.1, 6.2, and 6.3 address attainment of direct exposure RAGs, groundwater protection RAGs, and Columbia River protection RAGs, respectively.

6.1 DIRECT EXPOSURE SOIL REMEDIAL ACTION GOALS ATTAINED

6.1.1 Radionuclides

The results of the RESRAD dose rate estimate for the site all-pathways scenarios are presented in Figures 3 and 4. This dose rate represents the dose contributions from soils at relevant time periods. The dose rates from the shallow zone (Figure 3) and the staging pile area (Figure 4) are largest (2.79 mrem/yr and 0.504 mrem/yr, respectively) at present (2004), and decrease to 3.88×10^{-5} mrem/yr for the shallow zone and to 4.26×10^{-6} mrem/yr for the staging pile area in 1,000 years. The estimated dose rate in 2018 is 0.462 mrem/yr for the shallow zone and 0.0825 mrem/yr for the staging pile area. The 2018 date corresponds to the 30-year site cleanup schedule of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998). All dose rate estimates are less than the 15 mrem/yr RAG. The RESRAD computations are presented in detail in the RESRAD calculation brief in Appendix C.

Figure 3. RESRAD Analysis – All Radionuclides, Summed Shallow Zone All-Pathways Dose Rate Estimate, with Corresponding Risk Values.

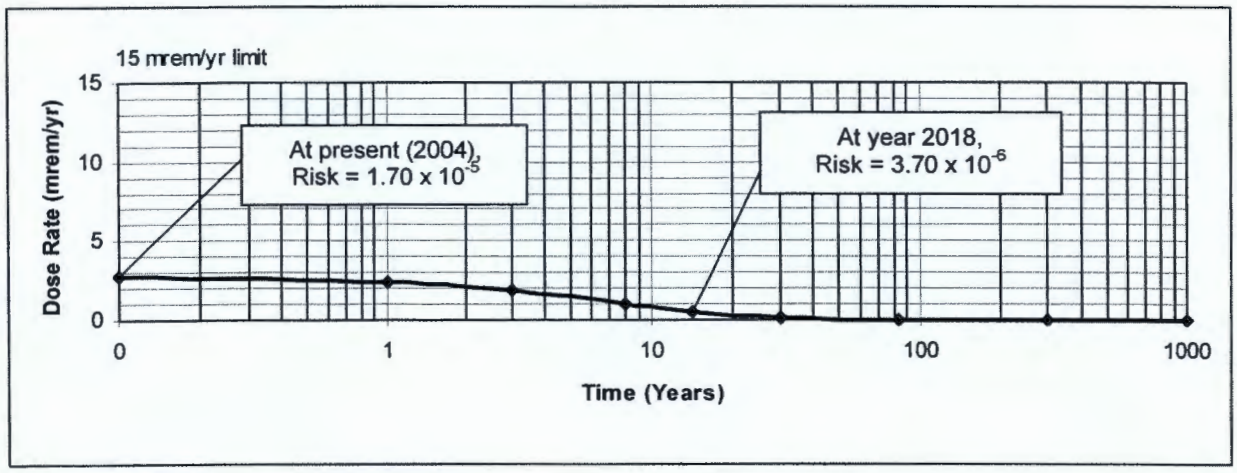
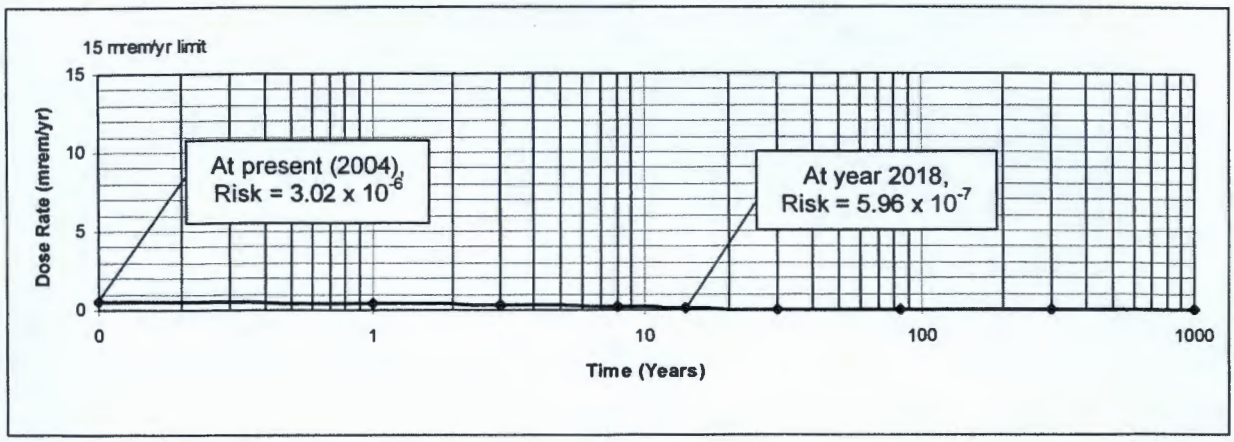


Figure 4. RESRAD Analysis – All Radionuclides, Staging Pile Area All-Pathways Dose Rate Estimate, with Corresponding Risk Values.



6.1.2 Nonradionuclides

Nonradionuclide COCs were not identified for the 118-B-10 Burial Ground; therefore, they are not discussed further.

6.2 GROUNDWATER REMEDIAL ACTION GOALS ATTAINED

6.2.1 Radionuclides

The estimated groundwater concentrations for all of the radionuclide COCs contributed by the site soils are shown in the RESRAD calculation brief (Appendix C). Table 3 shows the total peak concentrations predicted for each radionuclide COC and provides the individual RAGs for comparison. No COC is predicted to exceed the RAGs.

Table 3. Estimated Peak Radionuclide Groundwater Concentrations Compared to RAGs.

Radionuclide	Peak Concentration (pCi/L)	RAG (pCi/L)	RAGS Attained? (Yes/No)
Shallow Zone			
Cobalt-60	0.00223	100[a]	Yes
Nickel-63	44.1	50[a]	Yes
Staging Pile Area			
Cobalt-60	0.000381	100[a]	Yes
Nickel-63	2.61	50[a]	Yes

[a]Lookup value corresponding to a dose rate of 4 mrem/yr.

Figures 5 and 6, shallow zone and staging pile area respectively, show the individual organ dose rates for radionuclides predicted over 1,000 years, as shown in the comparison to drinking water standards calculation brief (Appendix C). None of the organ dose rates are predicted to exceed the 4 mrem/yr standard over 1,000 years. Results of the RESRAD calculations are shown in Appendix C.

6.2.2 Nonradionuclides

Nonradionuclide COCs were not identified for the 118-B-10 Burial Ground; therefore, they are not discussed further.

Figure 5. Dose Rates to Organs from Groundwater (Shallow Zone).

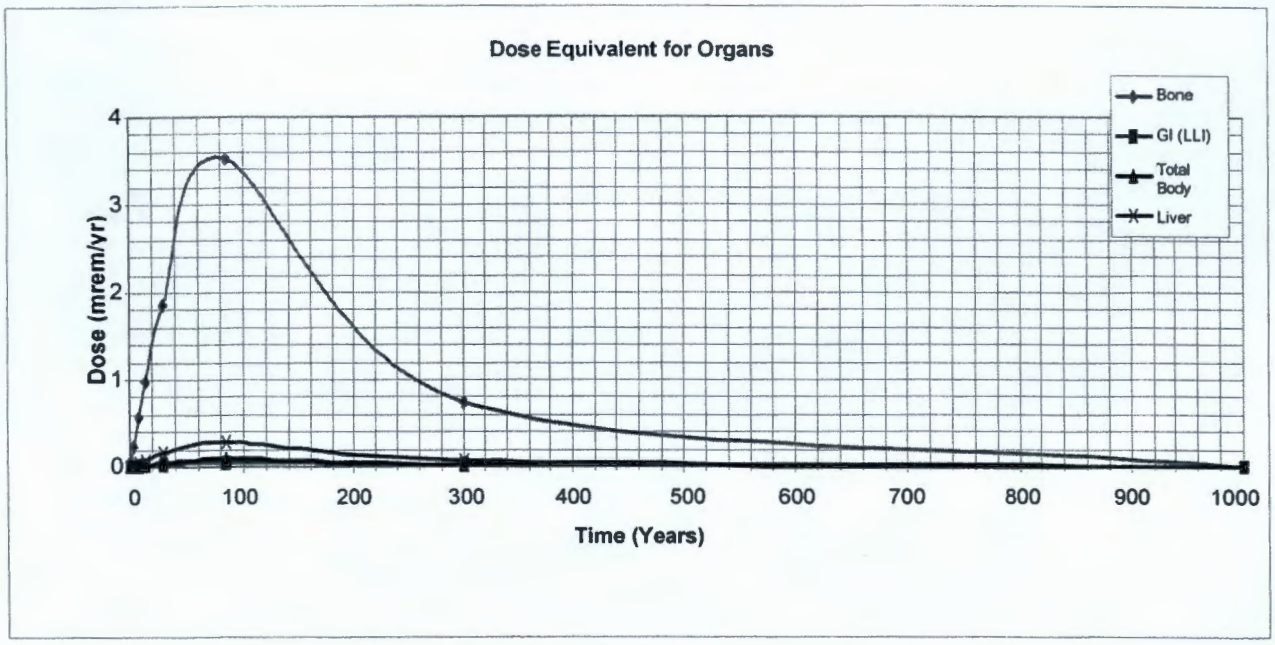
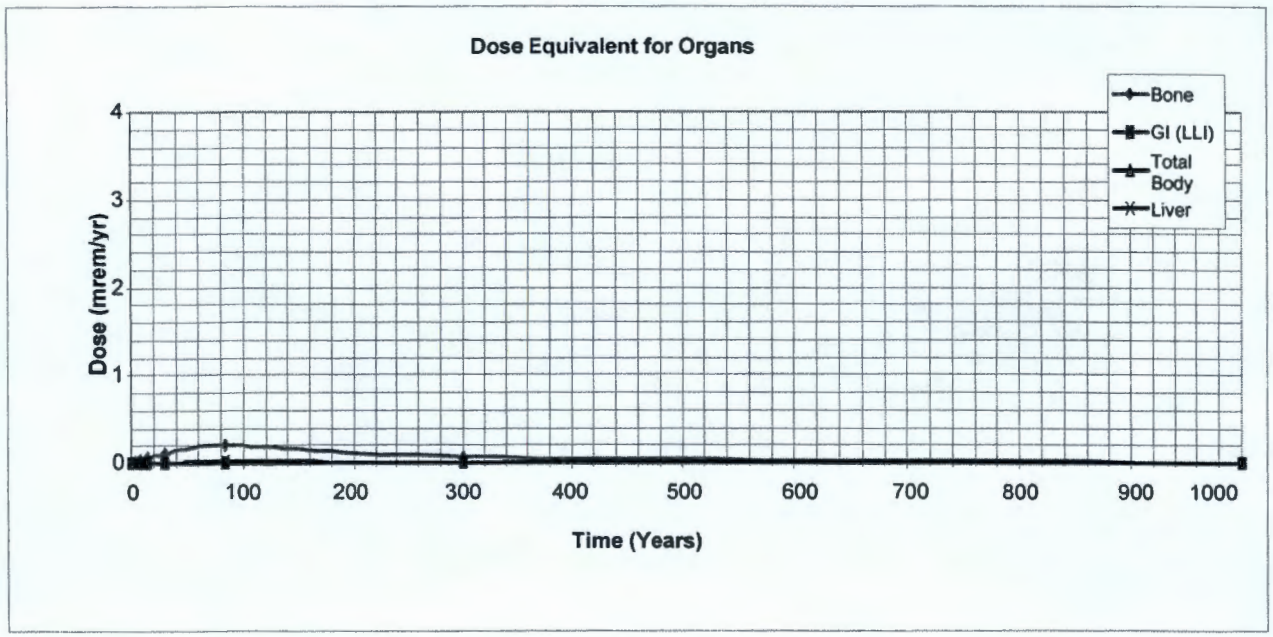


Figure 6. Dose Rates to Organs from Groundwater (Staging Pile Area).



6.3 COLUMBIA RIVER REMEDIAL ACTION GOALS ATTAINED

6.3.1 Radionuclides

The river protection RAGs for radionuclides are identical to the groundwater protection RAGs. The RESRAD modeling results were compared to the groundwater protection RAGs in Table 3. The results indicated that radionuclides are not predicted to reach groundwater (and by extension, not predicted to reach the Columbia River) at levels above 4 mrem/yr; therefore, the Columbia River protection RAGs have been attained.

6.3.2 Nonradionuclides

Nonradionuclide COCs were not identified for the 118-B-10 Burial Ground; therefore, they are not discussed further.

6.4 WAC 173-340 THREE-PART TEST FOR NONRADIONUCLIDES

Nonradionuclide COCs were not identified for the 118-B-10 Burial Ground; therefore, they are not discussed further.

7.0 RADIONUCLIDE RISK INFORMATION

The radionuclide RAG for direct exposure is derived from the 100 Area Burial Grounds ROD (EPA 2000) and is expressed in terms of an allowable radiation dose rate above background (i.e., 15 mrem/yr). The RAG evaluation (Section 5.0) involved using the RESRAD model to estimate total annual radiation dose rates for 1,000 years for comparison to the RAG. Radiation presents a carcinogenic risk, and the RESRAD model also calculates the excess lifetime cancer risk associated with the estimated radiation dose rates using the EPA's Health Effects Assessment Summary Tables (dated April 16, 2001, "Update of Radionuclide Carcinogenicity Slope Factors," available on the Internet at www.epa.gov/radiation/heast). The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300) presents a target range for residual risk of 10^{-4} to 10^{-6}. Figures 7 and 8 illustrate excess lifetime cancer risk (for the site and staging pile area, respectively) as estimated using the RESRAD model. Because of radioactive decay, the risk decreases over time.

As shown in Figure 3, the estimated risk for the site (shallow zone) is largest (1.70×10^{-5}) at present (2004), and decreases to 1.42×10^{-9} in 1,000 years. The estimated risk from the site in 2018 is 3.70×10^{-5}. Figure 4 shows that the estimated cancer risk associated with the staging pile area is largest (3.02×10^{-6}) at present (2004), and decreases to 1.63×10^{-10} in 1,000 years. The estimated risk for the staging pile area in 2018 is 5.96×10^{-7}.

Figure 7. RESRAD Analysis – Radionuclide Risk, All Pathways for the Shallow Zone.

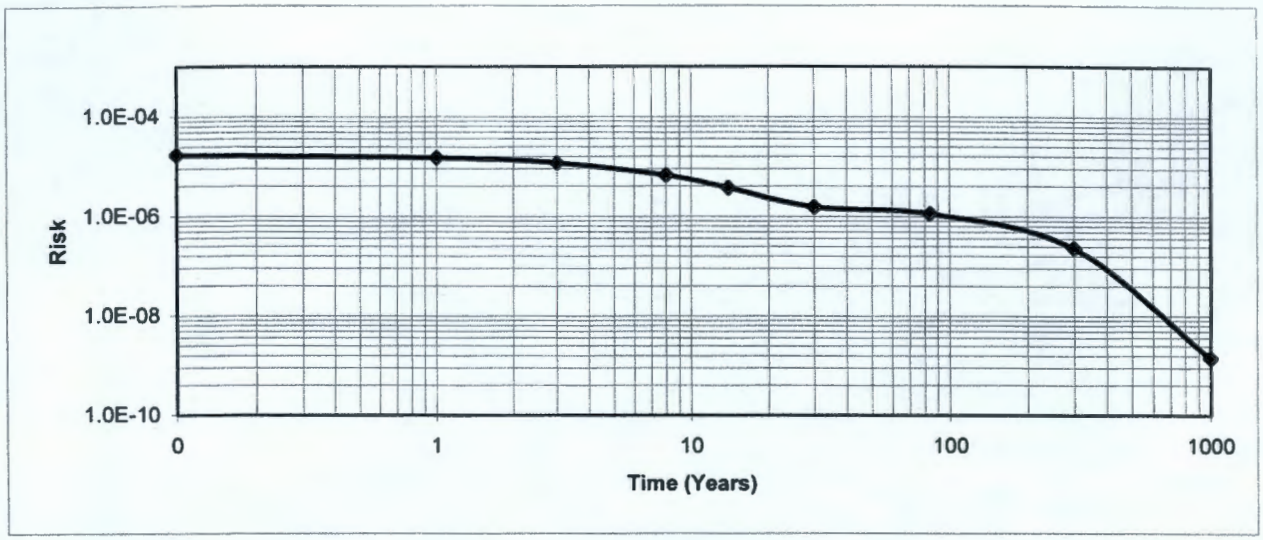
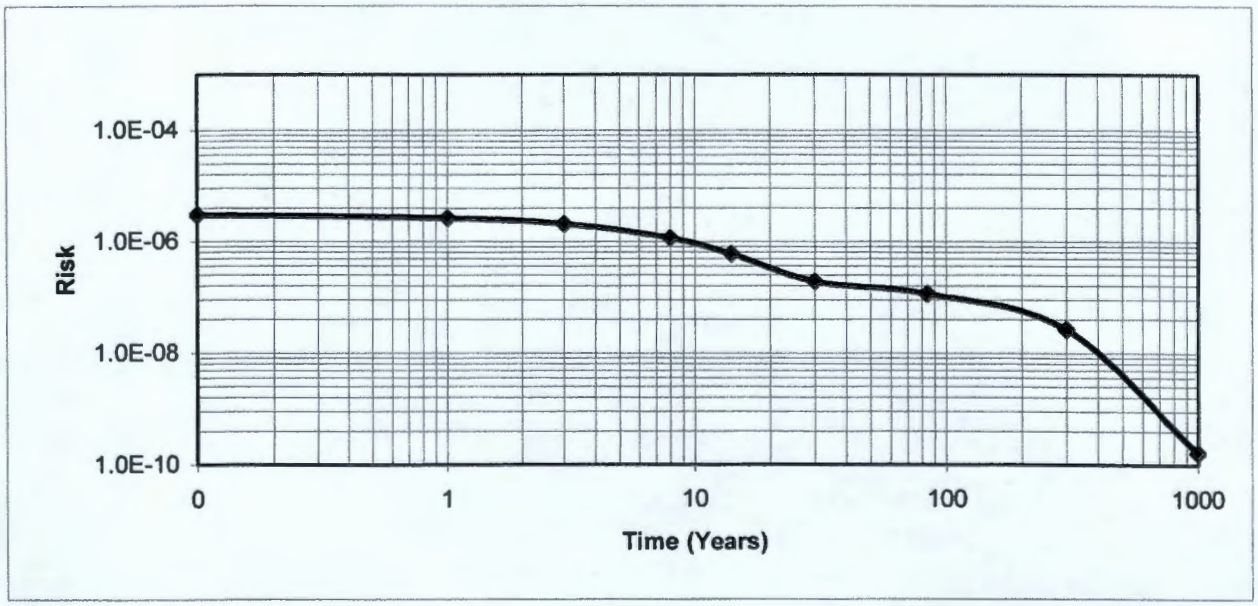


Figure 8. RESRAD Analysis – Radionuclide Risk, All Pathways for the Staging Pile Area.



8.0 STATEMENT OF PROTECTIVENESS

This CVP demonstrates that remedial action at the 118-B-10 Burial Ground has achieved the RAOs and corresponding RAGs established in the approved 100 Area Burial Grounds ROD (EPA 2000) and the RDR/RAWP (DOE-RL 2002). The remaining soils at this site (including the staging pile area) have been sampled, analyzed, and modeled.

The results of this effort indicate that the materials from the 118-B-10 Burial Ground containing COCs at concentrations exceeding the RAGs have been excavated and disposed of at the ERDF. These results also indicate that residual concentrations will support future land uses that can be represented (or bounded) by a rural-residential scenario, and that residual concentrations throughout the site are protective of groundwater and the Columbia River. Shallow zone soil cleanup criteria have been applied to the entire vadose zone underlying the 118-B-10 excavation; therefore, institutional controls against drilling or digging are not required for this site. The 118-B-10 Burial Ground is verified to be remediated in accordance with the 100 Area Burial Grounds ROD (EPA 2000) and may be backfilled.

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APPENDIX A

SUMMARY OF VERIFICATION SOIL SAMPLING AND ANALYTICAL RESULTS

Table A-1. Shallow Zone Cleanup Verification Data.

Sample Area	HEIS Number	Sample Date	Cobalt-60			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J01714	1/14/2004	6.5E-02	U	6.5E-02	4.61E+01		5.60E+00
Duplicate of J01714	J01715	1/14/2004	9.9E-02	U	9.9E-02	1.57E+02		5.80E+00
A1	J01711	1/14/2004	4.3E-02	U	4.3E-02	1.45E+00	U	5.60E+00
A2	J01712	1/14/2004	4.6E-01		8.2E-02	5.45E+01		5.70E+00
A3	J01713	1/14/2004	1.0E-01	U	1.0E-01	2.46E+01		5.70E+00

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analytical result was below laboratory detection limit.

Table A-2. Staging Pile Area Cleanup Verification Data.

Sample Area	HEIS Number	Sample Date	Cobalt-60			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J01708	1/14/2004	5.2E-02	U	5.2E-02	4.2E+00	U	5.4E+00
Duplicate of J01708	J01709	1/14/2004	7.5E-02	U	7.5E-02	1.3E+00	U	5.5E+00
A1	J01705	1/14/2004	6.6E-02	U	6.6E-02	-3.5E-01	U	5.6E+00
A2	J01706	1/14/2004	7.1E-02	U	7.1E-02	1.4E+00	U	5.3E+00
A3	J01707	1/14/2004	1.5E-01	U	1.5E-01	6.2E+00		5.5E+00

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analytical result was below laboratory detection limit.

Table A-3. Split Results.

Sample Area	HEIS Number	Sample Date	Cobalt-60			Nickel-63		
			pCi/g	Q	MDA	pCi/g	Q	MDA
Shallow zone A4 Split of J01714	J01717	1/14/2004	6.3E-02	U	5.5E-02	1.76E+01		5.99E+00
Staging pile area A4 Split of J01708	J01716	1/14/2004	1.7E-02	U	4.0E-02	8.6E+00		6.8E+00

HEIS = Hanford Environmental Information System
MDA = minimum detectable activity
U = Analytical result was below laboratory detection limit.

Table A-4. Focused Sample Data (January 19, 2004).

Sample Area	HEIS Number	Sample Date	Arsenic			Barium			Cadmium			Chromium (Total)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
--	J01750	1/19/2004	2.1E+00		3.5E-01	12.3E+01		2.0E-02	5.0E-02	U	4.0E-02	9.0E+00		5.0E-02
--	J01764	1/19/2004	3.5E+00		3.6E-01	12.7E+01		2.0E-02	4.0E-02	U	4.0E-02	1.14E+01		5.0E-02
--	Background[a]	--	2.0E+01		--	1.32E+02		--	8.1E-01		--	1.85E+01		--

Sample Area	HEIS No.	Sample Date	Lead			Mercury			Selenium			Silver		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
--	J01750	1/19/2004	1.62E+01		2.1E-01	2.3E-01	U	2.0E-02	3.5E-01	U	3.5E-01	6.0E-02	U	6.0E-02
--	J01764	1/19/2004	1.17E+01		2.1E-01	2.0E-02	U	2.0E-02	3.6E-01	U	3.6E-01	6.0E-02	U	6.0E-02
--	Background[a]	--	1.02E+01		--	3.3E-01		--	7.8E-01		--	7.3E-01		--

[a]Represents the 90th percentile of the lognormal distribution (*Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes* [DOE/RL-92-24, Rev. 3] and *Hanford Site Background: Part 2, Soil Background for Radionuclides* [DOE/RL-96-12, Rev. 0], U.S. Department of Energy, Richland Operations Office, Richland, Washington).
HEIS = Hanford Environmental Information System
PQL = practical quantitation limit
U = Analytical result was below laboratory detection limit.

APPENDIX B

DATA QUALITY ASSESSMENT

B1.0 DATA QUALITY ASSESSMENT FOR THE 118-B-10 BURIAL GROUND

B1.1 OVERVIEW

This data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA includes a review of the field logbook information to verify sample location, date, and time. The DQA also involves the scientific and statistical evaluation of the data to determine if they are of the right type, quality, and quantity to support their intended use (i.e., closeout decisions [EPA 2000]). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with BHI-EE-01, *Environmental Investigations Procedures*. Specific data quality objectives for the site are found in the *100 Area Remedial Action Sampling and Analysis Plan* (SAP) (DOE-RL 2001). The DQA is based on the guidelines presented in *Guidance for Data Quality Assessment* (EPA 2000). Statistical tests used in this DQA were performed as specified in the SAP and the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2002).

Prior to performing statistical tests, the field logbook, sample design, and sample analytical data are evaluated. A portion of the cleanup verification sample analytical data are validated for compliance with quality assurance (QA) project plan requirements (DOE-RL 2001). Data evaluation is performed to determine if the laboratory carried out all steps required by the SAP and the laboratory contract governing the conduct of analysis and reporting of the data. This evaluation also examines the available laboratory data to determine if an analyte is present or absent in a sample and the degree of overall uncertainty associated with that determination. Data validation is done in accordance with validation procedures (BHI 2000a, 2000b) as part of data evaluation. After data evaluation and validation, the appropriate statistical test is performed on the adjusted raw analytical data (see calculation briefs in Appendix C) to determine statistical values for each contaminant. The number of samples collected for cleanup verification is then evaluated to confirm assumptions concerning contaminant variability.

The DQA for the 118-B-10 Burial Ground determined that the data are of the right type, quality, and quantity to support site cleanup verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation verified that the sample design was sufficient for the purpose of cleanup verification for the waste site. Additional quality requirements of the QA project plan included data acquisition requirements. The cleanup verification sample analytical data are stored in the Hanford Environmental Information System and are summarized in Appendix A.

The following subsections describe the DQA results for the 118-B-10 Burial Ground, including formal data validation, supplementary data evaluation, and field QA/quality control (QC) program results. The data evaluations are presented in Sections 4.0 through 7.0 and in the calculation briefs included in Appendix C of the cleanup verification package.

B1.2 DATA VALIDATION

B1.2.1 Laboratory QA/QC Analysis

All verification samples are subject to laboratory-specific QA requirements, including instrument procurement, maintenance, calibration, and operation. Additional laboratory requirements for internal QC checks are performed, as appropriate, for the analytical method at a rate of 1 per sample delivery group (SDG), or 1 in 20, whichever is more frequent. Laboratory internal QC checks include the following:

- Laboratory Contamination. Each analytical batch contains a laboratory (method) blank (material of similar composition as the samples with known/minimal contamination of the analytes of interest) carried through the complete analytical process. The method blank is used to evaluate false-positive results in samples due to contamination during handling at the laboratory.

- Analytical Accuracy. For most analyses, a known quantity of representative analytes of interest (matrix spike [MS]) is added to a separate aliquot of a sample from the analytical batch. The recovery percentage of the added MS is used to evaluate analytical accuracy. For analyses not amenable to MS techniques (e.g., gamma energy analysis) or where analytical recovery is corrected via internal standards (e.g., alpha spectral analyses), accuracy is evaluated from recovery of the QC reference sample (e.g., laboratory control spike or blank spike sample).

- Analytical Precision. Separate aliquots removed from the same sample container (replicate samples) are analyzed for each analytical batch. The replicate sample results (evaluated as relative percent differences [RPDs]) are used to assess analytical precision.

- QC Reference Samples. A QC reference sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.

Verification sample laboratories are also subject to periodic and random assessments of the laboratory performance, systems, and overall program. These assessments are performed by the Bechtel Hanford, Inc. QA group to ensure that the laboratories are performing to meet laboratory contract requirements.

B1.2.2 Data Validation Results

After sampling was completed, all of the fixed-base laboratory data from one SDG, H2495, were validated to Level C per BHI-EE-01, Procedure 2.5, "Data Package Validation Process." Level C validation procedures are specified in *Data Validation Procedure for Radiochemical Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b). Validation was performed by Tech Law, Inc. (Tech Law 2004).

Under the Level C validation procedure, the following items were reviewed, as appropriate, for each analytical method:

- Sample holding times
- Method blanks
- MS recovery
- Surrogate recovery
- MS/matrix spike duplicate results
- Sample replicates
- Associated batch laboratory control sample results
- Data package completeness
- Achievement of required (or contractual) detection limits (RDLs).

Data flagged by the validator as estimated (i.e., "J") indicate that the associated concentration is an estimate but that the data may be used for decision-making purposes. Data flagged as below detection limits (i.e., "U") indicate the contaminant was analyzed for but not detected, and the concentration is below the minimum detectable activity (MDA) for radionuclides or the practical quantitation limit (PQL) (i.e., reporting limit) for nonradionuclides. For nonradionuclides, nondetects are reported as the PQL. For radionuclides, nondetects report the actual value obtained from analysis (positive or negative but less than the MDA) except for limited analyses where no value can be calculated. In these cases, the MDA is reported. This situation is applicable for sample results that are below detection limits. All other validated results are considered to be accurate within the standard errors associated with the methods.

The adequacy of laboratory QA/QC was evaluated for precision, accuracy, completeness, and RDLs pursuant to the SAP (DOE-RL 2001). The organization performing the data validation reported that, of the data given formal validation, the laboratory met the standards for performance for precision (±30%), accuracy (±30%), and completeness (>90%). Comparison of the RDL with the respective MDA or PQL is discussed in Section B1.3.

A summary of deficiencies noted during validation of H2293 follows.

Radionuclides. The validation DQA noted no major deficiencies. Reported radionuclide analytical detection levels for undetected analytes are compared against the SAP-specified detection limits to ensure that laboratory detection levels meet the required criteria. Some of the radionuclide MDAs were reported above the specified detection limit; however, none exceeded the specified detection limit by more than a factor of 3. All radionuclide MDAs were less than their associated remedial action goals (RAGs).

Nonradionuclides. The localized lead contamination reported for the focused sample does not apply to the general site. There are no nonradionuclides listed for this site.

All other parameters meet acceptance criteria for SDG H2495.

B1.3 DATA EVALUATION

The following paragraphs include the results of the data evaluation of all SDGs.

To ensure adequate data quality, DQA investigators reviewed the study objectives in the SAP (DOE-RL 2001) to determine the context for assessing the data. The context for assessing the data includes evaluating the sample data using the statistical methodology of the SAP (included in the calculation brief excerpts in Appendix C) and a comparison of analytical results to the precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters as specified in the SAP. This section summarizes the results of the PARCC parameter comparison and presents an evaluation of the affected data.

RDL Comparison: Reported analytical detection levels for nondetected analytes were compared to the RDLs specified in the SAP (DOE-RL 2001). When detected results are obtained, evaluation of detection limits is not performed. The data validation and supplemental data evaluation noted any analyses in which the detection limit (MDA or PQL) was above the SAP RDLs for nondetected analytes.

Radionuclides. Most of the reported MDAs for cobalt-60 exceeded the PQLs; however, because the reported values are sufficiently less than the RAGs, the data are of sufficient quality for decision-making purposes. All values meet RAGs applicable to shallow zone soils as demonstrated in the calculation briefs (Appendix C) and discussed in the cleanup verification package.

Nonradionuclides. The localized lead contamination reported for the focused sample does not apply to the general site. There are no nonradionuclides listed for this site.

Precision and Accuracy Evaluation: Analytical accuracy and precision were evaluated by examination of the percent recovery and RPD of analytical spikes (MS and/or laboratory control sample) between the main and duplicate samples. Only the contaminants of concern (COCs) detected at five times the detection limit (or greater) are used for data analysis with respect to accuracy and precision.

The RPDs for laboratory duplicates were within acceptable limits for all COCs.

B1.4 FIELD QA/QC

Field QA/QC measures were used to assess potential sources of error and cross-contamination of soil samples that could bias results. Field QA/QC samples listed in Field Logbook EFL-1173-1 included the following:

Equipment blanks:

- Shallow zone: J01710
- Staging pile area: J01704.

Duplicates and splits for the shallow zone:

- Duplicate J01715, and split J01717, both associated with sample J01714.

Duplicates and splits for the staging pile area:

- Duplicate J01709, and split J01716, both associated with sample 1708.

All main and QA/QC sample results are presented in Appendix A.

B1.4.1 Equipment Blank Samples

Two equipment blank samples were collected, one each from the shallow zone and the staging pile area, as part of the QA/QC measures. Site COCs were not detected in the equipment blank samples.

B1.4.2 Field Duplicate Samples

Duplicate samples were collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the duplicate samples for each COC. Only analytes with values above five times the detection limits for both the main and duplicate samples are compared. With the exception of a nickel-63 RPD of 109% for the J01714-J01715 main-duplicate sample pair, the main-duplicate sample pairs are within acceptable control limits. Nickel-63 was detected in the main (J01714) at a concentration of 46.1 pCi/g and in the duplicate (J01715) at a concentration of 157 pCi/g. The difference between the results is likely due to sample heterogeneity. Both concentrations are well below cleanup levels. The data is suitable for the intended purpose of cleanup verification. The 95% UCL calculation brief in Appendix C provides details on duplicate pair evaluation and RPD calculation.

B1.4.3 Field Split Samples

Split samples were collected to provide a relative measure of the degree of variability in the sampling, sample handling, and analytical techniques used by commercial laboratories. The field main and split samples are evaluated by computing the RPD of the split samples for each COC to determine the usability of the verification data. The U.S. Environmental Protection Agency Contract Laboratory Program duplicate sample comparison methodology, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (EPA 1994), is used as an initial test of the data from the splits. Only analytes that had values above five times the contractually RDL for both the main and split sample were compared. Based on the comparison criteria, the main-split sample pairs are within acceptable control limits. The 95% UCL calculation brief in Appendix C provides details on split pair evaluation and RPD calculation.

B1.5 SUITABILITY OF DATA

The conclusion of the DQA is that the data are of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and SDG completeness were analyzed to determine if any analytical results should be rejected as a result of QA/QC deficiencies. All COC analytical data were found to be acceptable for decision-making purposes, and the raw data are acceptable for calculating the required statistical values.

B2.0 REFERENCES

BHI, 2000a, *Data Validation Procedure for Radiochemical Analysis*, BHI-01433, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI, 2000b, *Data Validation Procedure for Chemical Analysis*, BHI-01435, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

DOE-RL, 2001, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-35, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2000, *Guidance for Data Quality Assessment*, EPA QA/G-9, QA00 Update, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C.

Tech Law, 2004, *Radiochemistry - Data Package No. H2495-LLI (SDG No. H2495)*, Tech Law, Inc., Richland, Washington.

APPENDIX C

RESRAD INPUT PARAMETERS AND CALCULATION BRIEF EXCERPTS

RESRAD INPUT PARAMETERS FOR THE SHALLOW ZONE – RADIONUCLIDES

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Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Co-60	2.190E-04	2.190E-04	DCF2(1)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(2)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Co-60	2.690E-05	2.690E-05	DCF3(1)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(2)
D-34	Food transfer factors:			
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(1,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(1,3)
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(2,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(2,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(1,2)
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.370E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.870E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.200E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	8.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.400E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	8.400E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	3.100E-01	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ni-63	8.110E+01	0.000E+00	---	S1(2)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(2)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.472E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.778E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.685E-01	FPLANT
R018	Contamination fraction of meat	-1	-1	0.685E-02	FMEAT
R018	Contamination fraction of milk	-1	-1	0.685E-02	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

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Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

```
1RESRAD, Version 6.21     T« Limit = 0.5 year        02/07/2004  13:12  Page   8
 Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
 File    : 118-B-10_Shallow_Zone.RAD

      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:     137.00 square meters                Co-60      3.100E-01
   Thickness:      28.70 meters                       Ni-63      8.110E+01
 Cover Depth:       0.00 meters
0
                                             Total Dose TDOSE(t), mrem/yr
                                       Basic Radiation Dose Limit = 1.500E+01 mrem/yr
                     Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  8.000E+00  1.400E+01  3.000E+01  8.400E+01  3.000E+02  1.000E+03
     TDOSE(t):  2.785E+00  2.444E+00  1.884E+00  9.878E-01  4.624E-01  8.024E-02  3.047E-02  6.328E-03  3.878E-05
         M(t):  1.856E-01  1.630E-01  1.256E-01  6.585E-02  3.083E-02  5.350E-03  2.031E-03  4.219E-04  2.586E-06
0Maximum TDOSE(t):  2.785E+00 mrem/yr   at t = 0.000E+00 years
```

1RESRAD, Version 6.21 T< Limit = 0.5 year 02/07/2004 13:12 Page 9
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.758E+00	0.9906	1.743E-06	0.0000	0.000E+00	0.0000	5.150E-03	0.0018	2.443E-04	0.0001	5.598E-05	0.0000	6.672E-05	0.0000
Ni-63	0.000E+00	0.0000	1.309E-05	0.0000	0.000E+00	0.0000	1.806E-02	0.0065	2.250E-04	0.0001	2.084E-03	0.0007	3.744E-04	0.0001
Total	2.758E+00	0.9906	1.484E-05	0.0000	0.000E+00	0.0000	2.321E-02	0.0083	4.693E-04	0.0002	2.140E-03	0.0008	4.411E-04	0.0002

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.764E+00	0.9925
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.076E-02	0.0075
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.785E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T< Limit = 0.5 year 02/07/2004 13:12 Page 10
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	2.418E+00	0.9894	1.528E-06	0.0000	0.000E+00	0.0000	4.515E-03	0.0018	2.142E-04	0.0001	4.908E-05	0.0000	5.850E-05	0.0000
Ni-63	0.000E+00	0.0000	1.300E-05	0.0000	0.000E+00	0.0000	1.793E-02	0.0073	2.234E-04	0.0001	2.069E-03	0.0008	3.717E-04	0.0002
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Total	2.418E+00	0.9894	1.453E-05	0.0000	0.000E+00	0.0000	2.245E-02	0.0092	4.376E-04	0.0002	2.118E-03	0.0009	4.302E-04	0.0002

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	1.364E-05	0.0000	2.469E-07	0.0000	0.000E+00	0.0000	1.917E-07	0.0000	2.642E-08	0.0000	1.049E-08	0.0000	2.423E+00	0.9914
Ni-63	4.014E-04	0.0002	2.504E-06	0.0000	0.000E+00	0.0000	5.823E-06	0.0000	2.579E-07	0.0000	3.480E-06	0.0000	2.102E-02	0.0086
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Total	4.150E-04	0.0002	2.751E-06	0.0000	0.000E+00	0.0000	6.015E-06	0.0000	2.843E-07	0.0000	3.490E-06	0.0000	2.444E+00	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	1.859E+00	0.9866	1.174E-06	0.0000	0.000E+00	0.0000	3.471E-03	0.0018	1.646E-04	0.0001	3.773E-05	0.0000	4.496E-05	0.0000
Ni-63	0.000E+00	0.0000	1.281E-05	0.0000	0.000E+00	0.0000	1.767E-02	0.0094	2.202E-04	0.0001	2.039E-03	0.0011	3.663E-04	0.0002
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Total	1.859E+00	0.9866	1.398E-05	0.0000	0.000E+00	0.0000	2.114E-02	0.0112	3.848E-04	0.0002	2.076E-03	0.0011	4.113E-04	0.0002

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	3.161E-05	0.0000	5.901E-07	0.0000	0.000E+00	0.0000	4.748E-07	0.0000	9.450E-08	0.0000	2.947E-08	0.0000	1.863E+00	0.9886
Ni-63	1.190E-03	0.0006	7.562E-06	0.0000	0.000E+00	0.0000	1.795E-05	0.0000	9.514E-07	0.0000	1.148E-05	0.0000	2.154E-02	0.0114
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Total	1.222E-03	0.0006	8.152E-06	0.0000	0.000E+00	0.0000	1.843E-05	0.0000	1.046E-06	0.0000	1.151E-05	0.0000	1.884E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T½ Limit = 0.5 year 02/07/2004 13:12 Page 12
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	9.631E-01	0.9750	6.084E-07	0.0000	0.000E+00	0.0000	1.798E-03	0.0018	8.530E-05	0.0001	1.955E-05	0.0000	2.329E-05	0.0000
Ni-63	0.000E+00	0.0000	1.235E-05	0.0000	0.000E+00	0.0000	1.704E-02	0.0173	2.123E-04	0.0002	1.966E-03	0.0020	3.532E-04	0.0004
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Total	9.631E-01	0.9750	1.296E-05	0.0000	0.000E+00	0.0000	1.884E-02	0.0191	2.976E-04	0.0003	1.985E-03	0.0020	3.765E-04	0.0004

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Co-60	4.374E-05	0.0000	8.242E-07	0.0000	0.000E+00	0.0000	6.702E-07	0.0000	1.451E-07	0.0000	4.300E-08	0.0000	9.650E-01	0.9770
Ni-63	3.064E-03	0.0031	1.957E-05	0.0000	0.000E+00	0.0000	4.675E-05	0.0000	2.598E-06	0.0000	3.048E-05	0.0000	2.275E-02	0.0230
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Total	3.108E-03	0.0031	2.040E-05	0.0000	0.000E+00	0.0000	4.742E-05	0.0000	2.744E-06	0.0000	3.052E-05	0.0000	9.878E-01	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T* Limit = 0.5 year 02/07/2004 13:12 Page 13
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	4.374E-01	0.9460	2.763E-07	0.0000	0.000E+00	0.0000	8.167E-04	0.0018	3.874E-05	0.0001	8.877E-06	0.0000	1.058E-05	0.0000
Ni-63	0.000E+00	0.0000	1.182E-05	0.0000	0.000E+00	0.0000	1.631E-02	0.0353	2.032E-04	0.0004	1.882E-03	0.0041	3.381E-04	0.0007
Total	4.374E-01	0.9460	1.210E-05	0.0000	0.000E+00	0.0000	1.713E-02	0.0370	2.420E-04	0.0005	1.891E-03	0.0041	3.487E-04	0.0008

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	3.479E-05	0.0001	6.570E-07	0.0000	0.000E+00	0.0000	5.357E-07	0.0000	1.183E-07	0.0000	3.465E-08	0.0000	4.383E-01	0.9480
Ni-63	5.135E-03	0.0111	3.285E-05	0.0001	0.000E+00	0.0000	7.859E-05	0.0002	4.419E-06	0.0000	5.147E-05	0.0001	2.405E-02	0.0520
Total	5.170E-03	0.0112	3.351E-05	0.0001	0.000E+00	0.0000	7.912E-05	0.0002	4.537E-06	0.0000	5.151E-05	0.0001	4.624E-01	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/07/2004 13:12 Page 14
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	5.332E-02	0.6645	3.368E-08	0.0000	0.000E+00	0.0000	9.955E-05	0.0012	4.722E-06	0.0001	1.082E-06	0.0000	1.290E-06	0.0000
Ni-63	0.000E+00	0.0000	1.052E-05	0.0001	0.000E+00	0.0000	1.452E-02	0.1809	1.809E-04	0.0023	1.675E-03	0.0209	3.010E-04	0.0038
Total	5.332E-02	0.6645	1.056E-05	0.0001	0.000E+00	0.0000	1.462E-02	0.1822	1.856E-04	0.0023	1.676E-03	0.0209	3.022E-04	0.0038

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	9.092E-06	0.0001	1.720E-07	0.0000	0.000E+00	0.0000	1.405E-07	0.0000	3.146E-08	0.0000	9.140E-09	0.0000	5.344E-02	0.6659
Ni-63	9.800E-03	0.1221	6.275E-05	0.0008	0.000E+00	0.0000	1.503E-04	0.0019	8.521E-06	0.0001	9.878E-05	0.0012	2.681E-02	0.3341
Total	9.809E-03	0.1222	6.293E-05	0.0008	0.000E+00	0.0000	1.504E-04	0.0019	8.553E-06	0.0001	9.879E-05	0.0012	8.024E-02	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/07/2004 13:12 Page 15
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	4.386E-05	0.0014	2.771E-11	0.0000	0.000E+00	0.0000	8.190E-08	0.0000	3.885E-09	0.0000	8.902E-10	0.0000	1.061E-09	0.0000
Ni-63	0.000E+00	0.0000	7.105E-06	0.0002	0.000E+00	0.0000	9.801E-03	0.3217	1.221E-04	0.0040	1.131E-03	0.0371	2.032E-04	0.0067
Total	4.386E-05	0.0014	7.105E-06	0.0002	0.000E+00	0.0000	9.801E-03	0.3217	1.221E-04	0.0040	1.131E-03	0.0371	2.032E-04	0.0067

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.097E-08	0.0000	3.971E-10	0.0000	0.000E+00	0.0000	3.247E-10	0.0000	7.326E-11	0.0000	2.119E-11	0.0000	4.397E-05	0.0014
Ni-63	1.855E-02	0.6089	1.189E-04	0.0039	0.000E+00	0.0000	2.849E-04	0.0094	1.623E-05	0.0005	1.876E-04	0.0062	3.043E-02	0.9986
Total	1.855E-02	0.6089	1.189E-04	0.0039	0.000E+00	0.0000	2.849E-04	0.0094	1.623E-05	0.0005	1.876E-04	0.0062	3.047E-02	1.0000

*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T* Limit = 0.5 year 02/07/2004 13:12 Page 16
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.009E-17	0.0000	1.269E-23	0.0000	0.000E+00	0.0000	3.751E-20	0.0000	1.779E-21	0.0000	4.077E-22	0.0000	4.859E-22	0.0000
Ni-63	0.000E+00	0.0000	1.475E-06	0.0002	0.000E+00	0.0000	2.035E-03	0.3216	2.535E-05	0.0040	2.347E-04	0.0371	4.218E-05	0.0067
Total	2.009E-17	0.0000	1.475E-06	0.0002	0.000E+00	0.0000	2.035E-03	0.3216	2.535E-05	0.0040	2.347E-04	0.0371	4.218E-05	0.0067

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.683E-20	0.0000	5.083E-22	0.0000	0.000E+00	0.0000	4.159E-22	0.0000	9.423E-23	0.0000	2.719E-23	0.0000	2.016E-17	0.0000
Ni-63	3.863E-03	0.6104	2.476E-05	0.0039	0.000E+00	0.0000	5.935E-05	0.0094	3.389E-06	0.0005	3.912E-05	0.0062	6.328E-03	1.0000
Total	3.863E-03	0.6104	2.476E-05	0.0039	0.000E+00	0.0000	5.935E-05	0.0094	3.389E-06	0.0005	3.912E-05	0.0062	6.328E-03	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/07/2004 13:12 Page 17
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	9.041E-09	0.0002	0.000E+00	0.0000	1.247E-05	0.3216	1.554E-07	0.0040	1.439E-06	0.0371	2.585E-07	0.0067
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Total	0.000E+00	0.0000	9.041E-09	0.0002	0.000E+00	0.0000	1.247E-05	0.3216	1.554E-07	0.0040	1.439E-06	0.0371	2.585E-07	0.0067

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ		ÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃÃ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃ
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.367E-05	0.6104	1.517E-07	0.0039	0.000E+00	0.0000	3.637E-07	0.0094	2.077E-08	0.0005	2.398E-07	0.0062	3.878E-05	1.0000
ïïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï	ïïïïïïïïï	ïïïïïï
Total	2.367E-05	0.6104	1.517E-07	0.0039	0.000E+00	0.0000	3.637E-07	0.0094	2.077E-08	0.0005	2.398E-07	0.0062	3.878E-05	1.0000

0*Sum of all water independent and dependent pathways.

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 Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
 File    : 118-B-10_Shallow_Zone.RAD
```

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	8.916E+00	7.817E+00	6.009E+00	3.113E+00	1.414E+00	1.724E-01	1.418E-04	6.502E-17	0.000E+00
0Ni-63	Ni-63	1.000E+00	2.560E-04	2.592E-04	2.656E-04	2.805E-04	2.966E-04	3.306E-04	3.752E-04	7.803E-05	4.782E-07

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
Co-60	1.682E+00	1.919E+00	2.496E+00	4.818E+00	1.061E+01	8.702E+01	1.057E+05	*1.131E+15	*1.131E+15
Ni-63	5.860E+04	5.787E+04	5.648E+04	5.348E+04	5.058E+04	4.538E+04	3.998E+04	1.922E+05	3.137E+07

*At specific activity limit
0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Co-60	3.100E-01	0.000E+00	8.916E+00	1.682E+00	8.916E+00	1.682E+00
Ni-63	8.110E+01	84.2 ñ 0.2	3.752E-04	3.998E+04	2.560E-04	5.860E+04

1RESRAD, Version 6.21 T* Limit = 0.5 year 02/07/2004 13:12 Page 19
Summary : 118-B-10 Burial Ground Shallow Zone Radionuclides
File : 118-B-10_Shallow_Zone.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated
DOSE(j,t), mrem/yr

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	2.764E+00	2.423E+00	1.863E+00	9.650E-01	4.383E-01	5.344E-02	4.397E-05	2.016E-17	0.000E+00
0Ni-63	Ni-63	1.000E+00	2.076E-02	2.102E-02	2.154E-02	2.275E-02	2.405E-02	2.681E-02	3.043E-02	6.328E-03	3.878E-05
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated
S(j,t), pCi/g

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄÄ
Co-60	Co-60	1.000E+00	3.100E-01	2.718E-01	2.089E-01	1.082E-01	4.916E-02	5.992E-03	4.930E-06	2.258E-18	0.000E+00
0Ni-63	Ni-63	1.000E+00	8.110E+01	8.051E+01	7.935E+01	7.651E+01	7.324E+01	6.519E+01	4.401E+01	9.136E+00	5.600E-02
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 0.72 seconds

RESRAD INPUT PARAMETERS FOR THE SHALLOW ZONE – NONRADIONUCLIDES

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/15/2004 23:54 Page 1
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

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Time = 1.400E+01 13
Time = 3.000E+01 14
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1RESRAD, Version 6.21 T< Limit = 0.5 year 02/15/2004 23:54 Page 2
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(1)
B-1	Th-229+D	2.160E+00	2.160E+00	DCF2(2)
B-1	U-233	1.350E-01	1.350E-01	DCF2(3)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Np-237+D	4.440E-03	4.440E-03	DCF3(1)
D-1	Th-229+D	4.030E-03	4.030E-03	DCF3(2)
D-1	U-233	2.890E-04	2.890E-04	DCF3(3)
D-34	Food transfer factors:			
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(1,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(1,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(1,3)
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(2,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(3,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(3,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(3,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(1,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(1,2)
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(2,2)
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(3,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(3,2)

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Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.370E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	9.200E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.200E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	8.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.400E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	8.400E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Np-237	1.620E+01	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Np-237	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

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Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.950E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.500E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	1.500E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Np-237				
R016	Contaminated zone (cm**3/g)	3.000E+01	-1.000E+00	2.574E+02	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	3.000E+01	-1.000E+00	2.574E+02	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.108E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.049E-08	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.083E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	not used	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	not used	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI

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Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	not used	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV

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0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	suppressed
2 -- inhalation (w/o radon)	suppressed
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	suppressed
9 -- radon	suppressed
Find peak pathway doses	active

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Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
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Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	137.00 square meters	Np-237	1.620E+01
Thickness:	9.20 meters		
Cover Depth:	0.00 meters		

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 1.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
TDOSE(t):	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
M(t):	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

0Maximum TDOSE(t): 0.000E+00 mrem/yr at t = 0.000E+00 years

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T½ Limit = 0.5 year 02/15/2004 23:54 Page 10
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/15/2004 23:54 Page 11
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/15/2004 23:54 Page 12
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T< Limit = 0.5 year 02/15/2004 23:54 Page 13
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T< Limit = 0.5 year 02/15/2004 23:54 Page 14
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T« Limit = 0.5 year 02/15/2004 23:54 Page 15
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T½ Limit = 0.5 year 02/15/2004 23:54 Page 16
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ		ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
ÄÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ	ÄÄÄÄÄÄÄÄÄ	ÄÄÄÄÄÄ
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
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Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T½ Limit = 0.5 year 02/15/2004 23:54 Page 17
Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

0

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

0

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-														
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Np-237	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

0*Sum of all water independent and dependent pathways.

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1RESRAD, Version 6.21     T< Limit = 0.5 year        02/15/2004  23:54  Page  18
 Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
 File    : 118-B-10_Shallow_Zone_Pb.RAD

                                Dose/Source Ratios Summed Over All Pathways
                          Parent and Progeny Principal Radionuclide Contributions Indicated
0Parent  Product  Branch                                  DSR(j,t)  (mrem/yr)/(pCi/g)
  (i)      (j)   Fraction* t= 0.000E+00 1.000E+00 3.000E+00 8.000E+00 1.400E+01 3.000E+01 8.400E+01 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Np-237  Np-237  1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Np-237  U-233   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Np-237  Th-229  1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 Np-237  ÄDSR(j)             0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
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 *Branch Fraction is the cumulative factor for the j't principal radionuclide daughter:  CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
 The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.
0
                                Single Radionuclide Soil Guidelines G(i,t) in pCi/g
                                   Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide
  (i)     t= 0.000E+00   1.000E+00   3.000E+00   8.000E+00   1.400E+01   3.000E+01   8.400E+01   3.000E+02   1.000E+03
 ÄÄÄÄÄÄÄ    ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ
 Np-237    *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08  *7.045E+08
 ßßßßßßß    ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß
 *At specific activity limit
0
                Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
                and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
            at tmin = time of minimum single radionuclide soil guideline
        and at tmax = time of maximum total dose = 0.000E+00 years
0Nuclide  Initial          tmin        DSR(i,tmin) G(i,tmin) DSR(i,tmax) G(i,tmax)
  (i)     (pCi/g)        (years)                   (pCi/g)               (pCi/g)
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ
 Np-237  1.620E+01     0.000E+00      0.000E+00 *7.045E+08  0.000E+00 *7.045E+08
 ßßßßßßß ßßßßßßßßß  ßßßßßßßßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß  ßßßßßßßßß
 *At specific activity limit
```

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Summary : 118-B-10 Burial Ground Shallow Zone Nonradionuclides
File : 118-B-10_Shallow_Zone_Pb.RAD

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated
DOSE(j,t), mrem/yr

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ
Np-237	Np-237	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0U-233	Np-237	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
0Th-229	Np-237	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated
S(j,t), pCi/g

0Nuclide (j)	Parent (i)	BRF(i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ	ÃÃÃÃÃÃÃÃÃ
Np-237	Np-237	1.000E+00	1.620E+01	1.620E+01	1.620E+01	1.620E+01	1.620E+01	1.619E+01	1.617E+01	1.610E+01	1.[illegible]+01
0U-233	Np-237	1.000E+00	0.000E+00	7.084E-05	2.125E-04	5.665E-04	9.909E-04	2.121E-03	5.918E-03	2.083E-02	6.627E-02
0Th-229	Np-237	1.000E+00	0.000E+00	3.345E-09	3.010E-08	2.140E-07	6.549E-07	3.004E-06	2.345E-05	2.943E-04	3.100E-03
ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ	ÍÍÍÍÍÍÍÍÍ

BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time = 0.70 seconds

RESRAD INPUT PARAMETERS FOR THE STAGING PILE AREA – RADIONUCLIDES

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

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File : 118-B-10_Staging_Area.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Co-60	2.190E-04	2.190E-04	DCF2(1)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(2)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Co-60	2.690E-05	2.690E-05	DCF3(1)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(2)
D-34	Food transfer factors:			
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(1,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(1,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(1,3)
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(2,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(2,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(1,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(1,2)
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(2,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(2,2)

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	3.240E+02	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.870E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.800E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	8.000E+00	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.400E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	8.400E+01	3.000E+02	---	T(7)
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---	T(8)
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	5.300E-02	0.000E+00	---	S1(1)
R012	Initial principal radionuclide (pCi/g): Ni-63	4.800E+00	0.000E+00	---	S1(2)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(1)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(2)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	4.050E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Number of unsaturated zone strata	0	1	---	NS
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.472E-05	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCC(2)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.778E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R017	Inhalation rate (m**3/yr)	7.300E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	8.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	6.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.000E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.100E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	2.700E+00	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	1.000E+02	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	3.600E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	1.970E+01	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	7.300E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.162E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.162E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.162E-01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	1	---	---	LYMAX
TITL	Maximum number of integration points for risk	5	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

```
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 Summary : 118-B-10 Burial Ground Staging Area Radionuclides
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      Contaminated Zone Dimensions             Initial Soil Concentrations, pCi/g
      ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ             ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:    324.00 square meters                Co-60      5.300E-02
   Thickness:     28.70 meters                       Ni-63      4.800E+00
 Cover Depth:      0.00 meters
0
                                            Total Dose TDOSE(t), mrem/yr
                                      Basic Radiation Dose Limit = 1.500E+01 mrem/yr
                     Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)
                     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
    t (years):  0.000E+00  1.000E+00  3.000E+00  8.000E+00  1.400E+01  3.000E+01  8.400E+01  3.000E+02  1.000E+03
     TDOSE(t):  5.042E-01  4.424E-01  3.408E-01  1.780E-01  8.245E-02  1.265E-02  2.762E-03  6.955E-04  4.262E-06
         M(t):  3.361E-02  2.949E-02  2.272E-02  1.186E-02  5.496E-03  8.432E-04  1.841E-04  4.636E-05  2.842E-07
0Maximum TDOSE(t):  5.042E-01 mrem/yr   at t = 0.000E+00 years
```

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	4.990E-01	0.9898	3.267E-07	0.0000	0.000E+00	0.0000	2.082E-03	0.0041	9.878E-05	0.0002	2.264E-05	0.0000	2.698E-05	0.0001
Ni-63	0.000E+00	0.0000	8.498E-07	0.0000	0.000E+00	0.0000	2.528E-03	0.0050	3.150E-05	0.0001	2.917E-04	0.0006	5.241E-05	0.0001
Total	4.990E-01	0.9898	1.177E-06	0.0000	0.000E+00	0.0000	4.611E-03	0.0091	1.303E-04	0.0003	3.143E-04	0.0006	7.938E-05	0.0002

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.013E-01	0.9942
Ni-63	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.905E-03	0.0058
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.042E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	4.375E-01	0.9890	2.864E-07	0.0000	0.000E+00	0.0000	1.826E-03	0.0041	8.661E-05	0.0002	1.985E-05	0.0000	2.365E-05	0.0001
Ni-63	0.000E+00	0.0000	8.437E-07	0.0000	0.000E+00	0.0000	2.510E-03	0.0057	3.127E-05	0.0001	2.895E-04	0.0007	5.203E-05	0.0001
Total	4.375E-01	0.9890	1.130E-06	0.0000	0.000E+00	0.0000	4.336E-03	0.0098	1.179E-04	0.0003	3.094E-04	0.0007	7.568E-05	0.0002

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.332E-06	0.0000	6.656E-08	0.0000	0.000E+00	0.0000	7.750E-08	0.0000	1.068E-08	0.0000	4.240E-09	0.0000	4.395E-01	0.9934
Ni-63	2.376E-05	0.0001	2.337E-07	0.0000	0.000E+00	0.0000	8.151E-07	0.0000	3.610E-08	0.0000	4.871E-07	0.0000	2.909E-03	0.0066
Total	2.609E-05	0.0001	3.003E-07	0.0000	0.000E+00	0.0000	8.926E-07	0.0000	4.678E-08	0.0000	4.913E-07	0.0000	4.424E-01	1.0000

*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	3.363E-01	0.9870	2.202E-07	0.0000	0.000E+00	0.0000	1.403E-03	0.0041	6.657E-05	0.0002	1.525E-05	0.0000	1.818E-05	0.0001
Ni-63	0.000E+00	0.0000	8.315E-07	0.0000	0.000E+00	0.0000	2.474E-03	0.0073	3.082E-05	0.0001	2.854E-04	0.0008	5.127E-05	0.0002
Total	3.363E-01	0.9870	1.052E-06	0.0000	0.000E+00	0.0000	3.877E-03	0.0114	9.739E-05	0.0003	3.006E-04	0.0009	6.945E-05	0.0002

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	5.404E-06	0.0000	1.591E-07	0.0000	0.000E+00	0.0000	1.920E-07	0.0000	3.821E-08	0.0000	1.192E-08	0.0000	3.378E-01	0.9914
Ni-63	7.045E-05	0.0002	7.056E-07	0.0000	0.000E+00	0.0000	2.513E-06	0.0000	1.332E-07	0.0000	1.607E-06	0.0000	2.917E-03	0.0086
Total	7.585E-05	0.0002	8.647E-07	0.0000	0.000E+00	0.0000	2.705E-06	0.0000	1.714E-07	0.0000	1.619E-06	0.0000	3.408E-01	1.0000

*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)

0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	1.742E-01	0.9791	1.141E-07	0.0000	0.000E+00	0.0000	7.270E-04	0.0041	3.449E-05	0.0002	7.903E-06	0.0000	9.418E-06	0.0001
Ni-63	0.000E+00	0.0000	8.018E-07	0.0000	0.000E+00	0.0000	2.385E-03	0.0134	2.972E-05	0.0002	2.752E-04	0.0015	4.944E-05	0.0003
Total	1.742E-01	0.9791	9.158E-07	0.0000	0.000E+00	0.0000	3.112E-03	0.0175	6.421E-05	0.0004	2.831E-04	0.0016	5.886E-05	0.0003

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.000E+00 years
0 Water Dependent Pathways

0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio- Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	7.478E-06	0.0000	2.222E-07	0.0000	0.000E+00	0.0000	2.710E-07	0.0000	5.865E-08	0.0000	1.739E-08	0.0000	1.750E-01	0.9835
Ni-63	1.813E-04	0.0010	1.826E-06	0.0000	0.000E+00	0.0000	6.544E-06	0.0000	3.637E-07	0.0000	4.266E-06	0.0000	2.935E-03	0.0165
Total	1.888E-04	0.0011	2.049E-06	0.0000	0.000E+00	0.0000	6.815E-06	0.0000	4.224E-07	0.0000	4.283E-06	0.0000	1.780E-01	1.0000

0*Sum of all water independent and dependent pathways.

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Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	7.914E-02	0.9599	5.181E-08	0.0000	0.000E+00	0.0000	3.302E-04	0.0040	1.566E-05	0.0002	3.589E-06	0.0000	4.278E-06	0.0001
Ni-63	0.000E+00	0.0000	7.675E-07	0.0000	0.000E+00	0.0000	2.283E-03	0.0277	2.845E-05	0.0003	2.634E-04	0.0032	4.733E-05	0.0006
Total	7.914E-02	0.9599	8.193E-07	0.0000	0.000E+00	0.0000	2.614E-03	0.0317	4.411E-05	0.0005	2.670E-04	0.0032	5.161E-05	0.0006

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	5.947E-06	0.0001	1.771E-07	0.0000	0.000E+00	0.0000	2.166E-07	0.0000	4.782E-08	0.0000	1.401E-08	0.0000	7.950E-02	0.9642
Ni-63	3.039E-04	0.0037	3.065E-06	0.0000	0.000E+00	0.0000	1.100E-05	0.0001	6.186E-07	0.0000	7.205E-06	0.0001	2.949E-03	0.0358
Total	3.099E-04	0.0038	3.242E-06	0.0000	0.000E+00	0.0000	1.122E-05	0.0001	6.664E-07	0.0000	7.219E-06	0.0001	8.245E-02	1.0000

*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	9.647E-03	0.7627	6.315E-09	0.0000	0.000E+00	0.0000	4.025E-05	0.0032	1.909E-06	0.0002	4.375E-07	0.0000	5.215E-07	0.0000
Ni-63	0.000E+00	0.0000	6.831E-07	0.0001	0.000E+00	0.0000	2.032E-03	0.1607	2.532E-05	0.0020	2.344E-04	0.0185	4.213E-05	0.0033
Total	9.647E-03	0.7627	6.894E-07	0.0001	0.000E+00	0.0000	2.073E-03	0.1639	2.723E-05	0.0022	2.349E-04	0.0186	4.265E-05	0.0034

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years
Water Dependent Pathways

0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	1.554E-06	0.0001	4.637E-08	0.0000	0.000E+00	0.0000	5.681E-08	0.0000	1.272E-08	0.0000	3.696E-09	0.0000	9.691E-03	0.7662
Ni-63	5.800E-04	0.0459	5.856E-06	0.0005	0.000E+00	0.0000	2.104E-05	0.0017	1.193E-06	0.0001	1.383E-05	0.0011	2.957E-03	0.2338
Total	5.816E-04	0.0460	5.902E-06	0.0005	0.000E+00	0.0000	2.110E-05	0.0017	1.205E-06	0.0001	1.383E-05	0.0011	1.265E-02	1.0000

0*Sum of all water independent and dependent pathways.

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Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	7.936E-06	0.0029	5.195E-12	0.0000	0.000E+00	0.0000	3.311E-08	0.0000	1.571E-09	0.0000	3.599E-10	0.0000	4.290E-10	0.0000
Ni-63	0.000E+00	0.0000	4.611E-07	0.0002	0.000E+00	0.0000	1.372E-03	0.4968	1.709E-05	0.0062	1.583E-04	0.0573	2.844E-05	0.0103
Total	7.936E-06	0.0029	4.611E-07	0.0002	0.000E+00	0.0000	1.372E-03	0.4968	1.709E-05	0.0062	1.583E-04	0.0573	2.844E-05	0.0103

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 8.400E+01 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	3.585E-09	0.0000	1.070E-10	0.0000	0.000E+00	0.0000	1.313E-10	0.0000	2.962E-11	0.0000	8.568E-12	0.0000	7.975E-06	0.0029
Ni-63	1.098E-03	0.3976	1.109E-05	0.0040	0.000E+00	0.0000	3.988E-05	0.0144	2.271E-06	0.0008	2.626E-05	0.0095	2.754E-03	0.9971
Total	1.098E-03	0.3976	1.109E-05	0.0040	0.000E+00	0.0000	3.988E-05	0.0144	2.271E-06	0.0008	2.626E-05	0.0095	2.762E-03	1.0000

*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T½ Limit = 0.5 year 02/07/2004 13:46 Page 16
Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	3.634E-18	0.0000	2.379E-24	0.0000	0.000E+00	0.0000	1.517E-20	0.0000	7.194E-22	0.0000	1.648E-22	0.0000	1.965E-22	0.0000
Ni-63	0.000E+00	0.0000	9.574E-08	0.0001	0.000E+00	0.0000	2.848E-04	0.4095	3.549E-06	0.0051	3.286E-05	0.0472	5.904E-06	0.0085
Total	3.634E-18	0.0000	9.574E-08	0.0001	0.000E+00	0.0000	2.848E-04	0.4095	3.549E-06	0.0051	3.286E-05	0.0472	5.904E-06	0.0085

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	5.892E-21	0.0000	1.760E-22	0.0000	0.000E+00	0.0000	2.160E-22	0.0000	4.887E-23	0.0000	1.411E-23	0.0000	3.657E-18	0.0000
Ni-63	3.434E-04	0.4937	3.469E-06	0.0050	0.000E+00	0.0000	1.248E-05	0.0179	7.124E-07	0.0010	8.224E-06	0.0118	6.955E-04	1.0000
Total	3.434E-04	0.4937	3.469E-06	0.0050	0.000E+00	0.0000	1.248E-05	0.0179	7.124E-07	0.0010	8.224E-06	0.0118	6.955E-04	1.0000

*Sum of all water independent and dependent pathways.

1RESRAD, Version 6.21 T< Limit = 0.5 year 02/07/2004 13:46 Page 17
Summary : 118-B-10 Burial Ground Staging Area Radionuclides
File : 118-B-10_Staging_Area.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	0.000E+00	0.0000	5.868E-10	0.0001	0.000E+00	0.0000	1.746E-06	0.4096	2.175E-08	0.0051	2.014E-07	0.0472	3.619E-08	0.0085
Total	0.000E+00	0.0000	5.868E-10	0.0001	0.000E+00	0.0000	1.746E-06	0.4096	2.175E-08	0.0051	2.014E-07	0.0472	3.619E-08	0.0085

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Ni-63	2.104E-06	0.4937	2.126E-08	0.0050	0.000E+00	0.0000	7.646E-08	0.0179	4.366E-09	0.0010	5.040E-08	0.0118	4.262E-06	1.0000
Total	2.104E-06	0.4937	2.126E-08	0.0050	0.000E+00	0.0000	7.646E-08	0.0179	4.366E-09	0.0010	5.040E-08	0.0118	4.262E-06	1.0000

*Sum of all water independent and dependent pathways.

```
1RESRAD, Version 6.21      T« Limit = 0.5 year        02/07/2004  13:46  Page  18
 Summary : 118-B-10 Burial Ground Staging Area Radionuclides
 File    : 118-B-10_Staging_Area.RAD
```

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
			DSR(j,t) (mrem/yr)/(pCi/g)								
Co-60	Co-60	1.000E+00	9.458E+00	8.292E+00	6.374E+00	3.302E+00	1.500E+00	1.829E-01	1.505E-04	6.900E-17	0.000E+00
0Ni-63	Ni-63	1.000E+00	6.051E-04	6.060E-04	6.078E-04	6.114E-04	6.144E-04	6.160E-04	5.737E-04	1.449E-04	8.880E-07

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ó 0.5 yr) daughters.
0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 1.500E+01 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	8.000E+00	1.400E+01	3.000E+01	8.400E+01	3.000E+02	1.000E+03
Co-60	1.586E+00	1.809E+00	2.353E+00	4.542E+00	1.000E+01	8.203E+01	9.969E+04	*1.131E+15	*1.131E+15
Ni-63	2.479E+04	2.475E+04	2.468E+04	2.453E+04	2.441E+04	2.435E+04	2.615E+04	1.035E+05	1.689E+07

*At specific activity limit
0

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Co-60	5.300E-02	0.000E+00	9.458E+00	1.586E+00	9.458E+00	1.586E+00
Ni-63	4.800E+00	24.86 ñ 0.05	6.164E-04	2.433E+04	6.051E-04	2.479E+04

```
1RESRAD, Version 6.21     T< Limit = 0.5 year        02/07/2004  13:46  Page  19
 Summary : 118-B-10 Burial Ground Staging Area Radionuclides
 File    : 118-B-10_Staging_Area.RAD
```

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

```
0Nuclide Parent    BRF(i)                                   DOSE(j,t), mrem/yr
   (j)     (i)                t= 0.000E+00 1.000E+00 3.000E+00 8.000E+00 1.400E+01 3.000E+01 8.400E+01 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Co-60   Co-60    1.000E+00    5.013E-01 4.395E-01 3.378E-01 1.750E-01 7.950E-02 9.691E-03 7.975E-06 3.657E-18 0.000E+00
0Ni-63   Ni-63    1.000E+00    2.905E-03 2.909E-03 2.917E-03 2.935E-03 2.949E-03 2.957E-03 2.754E-03 6.955E-04 4.262E-06
 fffffff fffffff fffffffff     fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff
 BRF(i) is the branch fraction of the parent nuclide.
```

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

```
0Nuclide Parent    BRF(i)                                   S(j,t), pCi/g
   (j)     (i)                t= 0.000E+00 1.000E+00 3.000E+00 8.000E+00 1.400E+01 3.000E+01 8.400E+01 3.000E+02 1.000E+03
 ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ   ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Co-60   Co-60    1.000E+00    5.300E-02 4.647E-02 3.572E-02 1.850E-02 8.405E-03 1.024E-03 8.428E-07 3.860E-19 0.000E+00
0Ni-63   Ni-63    1.000E+00    4.800E+00 4.765E+00 4.696E+00 4.529E+00 4.335E+00 3.858E+00 2.605E+00 5.407E-01 3.315E-03
 fffffff fffffff fffffffff     fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff fffffffff
 BRF(i) is the branch fraction of the parent nuclide.
0RESCALC.EXE execution time =     1.24 seconds
```

CALCULATION BRIEF EXCERPTS

CALCULATION BRIEFS

The following calculation briefs have been prepared in accordance with BHI-DE-01, *Design Engineering Procedures Manual*, EDPI-4.37-01, "Project Calculations," Bechtel Hanford, Inc., Richland, Washington.

Verification Sample Design for 118-B-10 Burial Ground, Calculation No. 0100B-CA-V0206, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

118-B-10 Burial Ground 95% UCL Calculation, Calculation No. 0100B-CA-V0228, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

118-B-10 Burial Ground RESRAD Calculation Brief, Calculation No. 0100B-CA-V0229, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL), Calculation No. 0100B-CA-V0230, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

NOTE: The calculation briefs referenced in this appendix are kept in the active Environmental Restoration Contractor project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. Only excerpts of the calculation briefs are included in this appendix.

CALCULATION COVER SHEET

Project Title	100 BC Burial Ground		**Job No.** 22192
Area	100-BC		
Discipline	Environmental		***Calc. No.** 0100B-CA-V0206
Subject	Verification Sample Design for 118-B-10 Burial Ground		
Computer Program	Excel	**Program No.** Excel 97	

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 6 Appendix A - 1 Appendix B - 1 Appendix C - 2 Appendix D - 1 Total - 12	1/12/04 G. Cruz 1-12-04 D.N. Strom	1-12-04 J.D. Ludowise	K.E. Cook 1/13/04 K.E. Cook	1/19/04 M.A. Buckmaster	1/19/04

SUMMARY OF REVISIONS

* Obtain Calc. No. from DIS.

Bechtel Hanford, Inc. **CALCULATION**

Originator D.N. Strom DNS **Date** 1/5/04 **Calc. No.** 0100B-CA-V0206 **Rev. No.** 0
Project 100 Area Remediation **Job No.** 22192 **Checked** J.D. Ludowise JDL **Date** 1-12-04
Subject Verification Sample Design for 118-B-10 Burial Ground
Sheet No. 1 of 6

1. Purpose

Calculate the coordinate locations of the cleanup verification samples for the Shallow Zone and Staging Pile Area associated with 118-B-10 Burial Ground per the requirements of the 100 Area Burial Grounds Remedial Action Sampling and Analysis Plan *DOE/RL-2001-35, Rev. 0.*

2. Results Summary

Based on this Calculation, 4 composite samples from the Shallow Zone and Staging Pile Areas are required. The area associated with the Shallow Zone is 137 m^2 (1,474 ft^2) and 324 m^2 (3,486 ft^2) for the Staging Pile Area.

Contents

Sheet No.	Title	Topic/Contents
	Cover	Cover
1 of 6	Calculation Sheet 1	Purpose, Results Summary, and Contents
2 of 6	Calculation Sheet 2	Requirements, References, Calculations, and Given/Assumed Information
3 of 6	Calculation Sheet 3	Calculations (Continued)
4 of 6	Calculation Sheet 4	Calculations Continued, Figure 1 Shallow Zone.
5 of 6	Calculation Sheet 5	Calculations Continued, Figure 2 Staging Pile Area.
6 of 6	Calculation Sheet 6	Calculations Continued

Attachments

Number of Sheets	Attachments	Topic/Contents
1	Attachment A	Sample Locations (Shallow Zone)
1	Attachment B	Sample Locations (Staging Pile Area)
2	Attachment C	Random Generation of possible Sample Locations
1	Attachment D	Sample Locations in Washington State Plane Coordinates

Bechtel Hanford, Inc. CALCULATION SHEET

Originator D.N. Strom DNS **Date** 1/12/04 **Calc. No.** 0100B-CA-V0206 **Rev. No.** 0

Project 100 Area Remediation **Job No.** 22192 **Checked** J.D. Ludowise JDL **Date** 1-12-04

Subject Verification Sample Design for 118-B-10 Burial Ground

Sheet No. 2 of 6

3. Requirements

Section III of the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan DOE/RL-2001-35, Rev. 0* requires the following number of samples based on exposed surface area:

Table 1. Table III-5 from the Burial Ground SAP

Exposed Surface Area After Excavation	Number of Decision Subunits	Number of Blocks	Number of Discreet Samples	Number of Composite Samples
Small Site: ≤ 30,500 m^2 (≤ 100,000 ft^2)	1	4	16	4
Medium Site: >30,500 m^2 (>100,000 ft^2) but ≤ 122,000 m^2 (≤ 400,000 ft^2)	4	16	64	16
Large Site: >122,000 m^2 (>400,000 ft^2)	8	32	128	32

- The exposed surface area for the Shallow Zone is classified as a Small Site.
- The exposed surface area for the Staging Pile Area is classified as a Small Site.
- 4 composite samples to be collected from each of the Shallow Zone and the Staging Pile Areas
- A simple random sampling method

4. Given/Assumed Information

The coordinates of the corners of a rectangle that encloses the excavation (design rectangle):

Shallow Zone		Staging Pile Area	
Washington State Plane Coordinates (meters)		Washington State Plane Coordinates (meters)	
Easting	Northing	Easting	Northing
565,293.00	144,465.00	565,300.00	144,471.00
565,305.00	144,465.00	565,327.00	144,471.00
565,305.00	144,480.00	565,327.00	144,487.00
565,293.00	144,480.00	565,300.00	144,487.00

- Field measurements will be accurate to within 1 meter.
- All sidewalls/sideslopes for this site are less than 30°, therefore no horizontal slope modifications will be necessary.

5. References

Stewart, J., 1991, *Calculus*, 2 ed., Brooks/Cole Publishing Co., Pacific Grove, California.

DOE-RL, 2001, 100 Area Burial Grounds Remedial Action *Sampling and Analysis Plan DOE/RL-2001-35, Rev. 0,* U.S. Department of Energy, Richland Operations Office, Richland, Washington.

6. Calculations

Coordinates of sampling locations can be calculated by using the procedure outlined in Appendix B of DOE-RL (2001):

1. Generate a set of coordinates (X,Y) using the following equations:

$$X = X_{min} + (X_{max}-X_{min})*RND \quad \text{(Eq. 1)}$$

$$Y = Y_{min} + (Y_{max}-Y_{min})*RND \quad \text{(Eq. 2)}$$

where RND is the next unused random number between 0 and 1 in a sequence of random numbers (Attachment C).

2. If (X,Y) is located outside the sample area, return to step 1 to generate another random coordinate; Otherwise go to step 3.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator D.N. Strom DNS Date 1/12/04 Calc. No. 0100B-CA-V0206 Rev. No. 0

Project 100 Area Remediation Job No. 22192 Checked J.D. Ludowise JL Date 1-12-04

Subject Verification Sample Design for 118-B-10 Burial Ground

Sheet No. 3 of 6

6. Calculations (Continued)

3. Define (X_i, Y_i) using the following steps:
   a. Round X to the nearest unit that can be located easily in the field; set this to X_i.
   b. Round Y to the nearest unit that can be located easily in the field; set this to Y_i.

4. Continue to generate the next random coordinate (X_i, Y_i).

The sampling coordinates are calculated with respect to a site coordinate system described as follows:

- The origin of the site's coordinates is established as the southwest corner of the design rectangle at Washington State Plane Coordinates E565370.0, N144057.0 for the Shallow Zone and E565383.5, N144069.5 for the Staging Pile Area.
- The X-axis parallels the east-west direction
- The Y-axis parallels the north-south direction

The coordinate system is shown on Figure 1 and Figure 2.

The trench space coordinates of the 4 corners of the trench are calculated from the Washington State Plane Coordinates using the Pythagorean Theorem. Results are shown in Tables 2 and 3.

Table 2. Coordinates of design rectangle for the Shallow Zone

Washington State Plane Coordinates (meters)		Trench Space Coordinates (meters)	
Easting	Northing	X	Y
565,293.00	144,465.00	0.00	12.00
565,305.00	144,465.00	0.00	0.00
565,305.00	144,480.00	15.00	0.00
565,293.00	144,480.00	15.00	12.00

Table 3. Coordinates of design rectangle for the Staging Pile Area

Washington State Plane Coordinates (meters)		Trench Space Coordinates (meters)	
Easting	Northing	X	Y
565,300.00	144,471.00	0.00	27.00
565,327.00	144,471.00	0.00	0.00
565,327.00	144,487.00	16.00	0.00
565,300.00	144,487.00	16.00	27.00

The minimum and maximum X values are:

	Shallow Zone	Staging Pile Area
X_{min}	0.00	0.00
X_{max}	15.00	16.00

The minimum and maximum Y values are:

	Shallow Zone	Staging Pile Area
Y_{min}	0.00	0.00
Y_{max}	12.00	27.00

Bechtel Hanford, Inc. **CALCULATION SHEET**

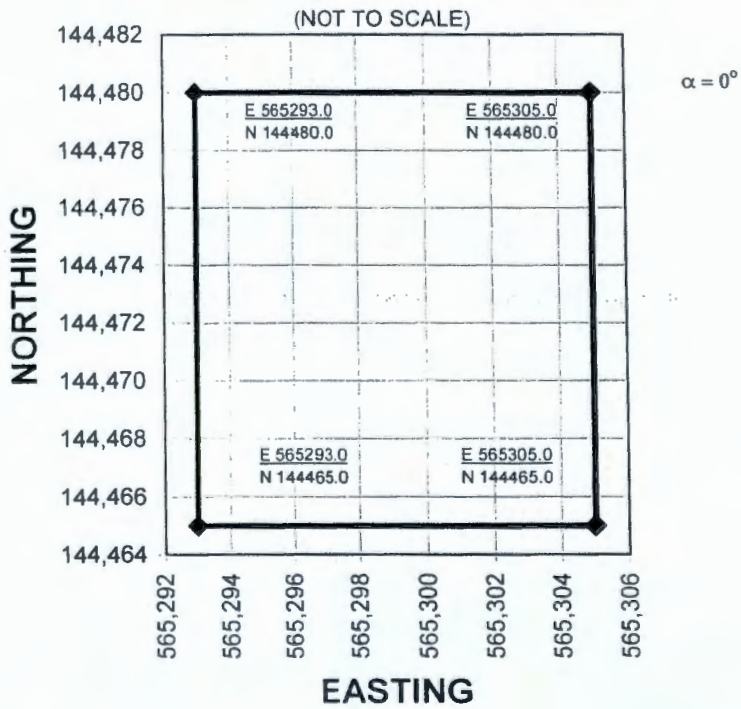
Originator D.N. Strom DNS **Date** 1/05/04 **Calc. No.** 0100B-CA-V0206 **Rev. No.** 0

Project 100 Area Remediation **Job No.** 22192 **Checked** J.D. Ludowise JDL **Date** 1-12-04

Subject Verification Sample Design for 118-B-10 Burial Ground
Sheet No. 4 of 6

5. Calculations (Continued).

FIGURE 1. Shallow Zone



Note: Figure 1. illustrates the coordinate rotation (α) of the design rectangle that is used in Equations 3 and 4.

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator D.N. Strom DNS **Date** 1/05/04 **Calc. No.** 0100B-CA-V0206 **Rev. No.** 0

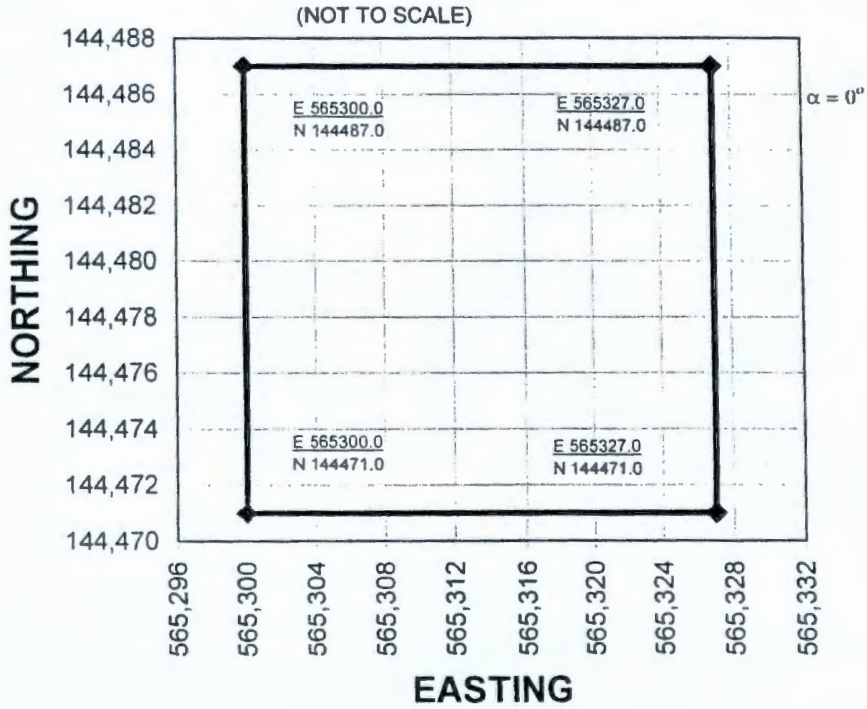
Project 100 Area Remediation **Job No.** 22192 **Checked** J.D. Ludowise JDL **Date** 1-12-04

Subject Verification Sample Design for 118-B-10 Burial Ground
Sheet No. 5 of 6

5. Calculations (Continued).

FIGURE 2. Staging Pile Area

(NOT TO SCALE)



Note: Figure 1. illustrates the coordinate rotation (α) of the design rectangle that is used in Equations 3 and 4.

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator D.N. Strom DNS **Date** 1/05/04 **Calc. No.** 0100B-CA-V0206 **Rev. No.** 0

Project 100 Area Remediation **Job No.** 22192 **Checked** J.D. Ludowise JDL **Date** 1-12-04

Subject Verification Sample Design for 118-B-10 Burial Ground

Sheet No. 6 of 6

6. Calculations (Continued).

The coordinates in Attachment C need to be converted to Washington State Plane Coordinates. This conversion is accomplished by rotating the X-Y axes into the Washington State Plane Coordinates (Attachment D).

If x and y are the Easting and Northing valued, respectively, and X and Y are the trench space coordinates, then the formulas for conversion are provided in Appendix E of Stewart (1991):

$$x = X\cos(\alpha) - Y\sin(\alpha) \qquad \text{(Eq. 3)}$$

$$y = X\sin(\alpha) + Y\cos(\alpha) \qquad \text{(Eq. 4)}$$

where α is the angle of rotation as shown in Figure 1.

α is calculated from the formula:

$$\alpha = \arctan[(y_2-y_1)/(x_2-x_1)]$$

Using the coordinates of the southeast and northeast corners of the trench excavation,

Shallow Zone α = arctan $[(y_2-y_1)/(x_2-x_1)]$
= arctan [(144,480.00 - 144,465.00) / (565,305.00 - 565,305.00)]
= 0.00 radians or 0.00 degrees

Staging Pile Area α = arctan $[(y_2-y_1)/(x_2-x_1)]$
= arctan [(144,487.00 - 144,471.00) / (565,327.00 - 565,327.00)]
= 0.00 radians or 0.00 degrees

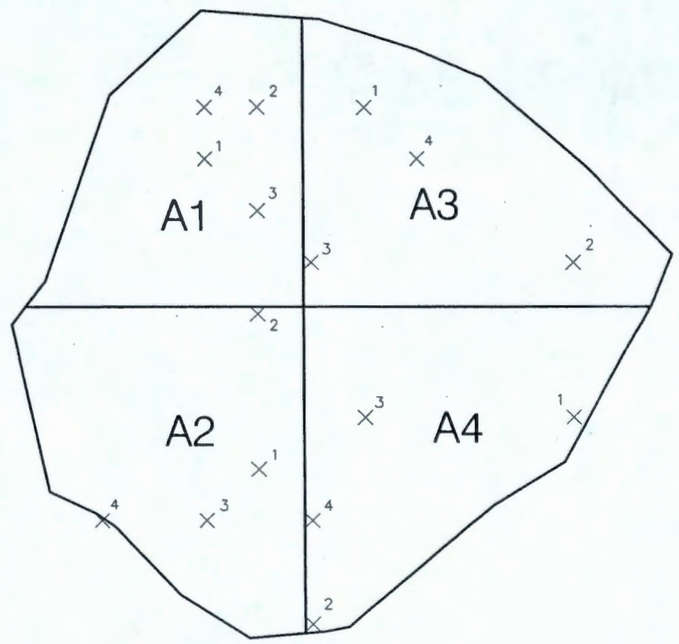
Because the origin of the trench coordinate system and the Washington State Plane Coordinate system are not the same point, equations 3 and 4 need to be adjusted by this difference:

$$x = X_0 + X\cos(\alpha) - Y\sin(\alpha) \qquad \text{(Eq. 5)}$$

$$y = Y_0 + X\sin(\alpha) + Y\cos(\alpha) \qquad \text{(Eq. 6)}$$

where X_0 and Y_0 are the Washington State Plane Coordinates of the origin of the trench space coordinate system, 565,305.00 and 144,465.00 meters, respectively for the Shallow Zone and 565,327.00 and 144,471.00 for the Staging Pile Area. The results, using equations 5 and 6 are shown in Appendix D.

1BC:010204A



SAMPLE LOCATION TABLE

SAMPLE NO.	SAMPLE NO. FROM ATTACHMENT C	WASHINGTON STATE PLANE COORDINATES, ROUNDED TO THE NEAREST METER	
		EASTING	NORTHING
SZ-A1-1	6	565298	144476
SZ-A1-2	11	565299	144477
SZ-A1-3	12	565299	144475
SZ-A1-4	15	565298	144477
SZ-A2-1	9	565299	144470
SZ-A2-2	42	565299	144473
SZ-A2-3	48	565298	144469
SZ-A2-4	49	565296	144469
SZ-A3-1	2	565301	144477
SZ-A3-2	8	565305	144474
SZ-A3-3	14	565300	144474
SZ-A3-4	16	565302	144476
SZ-A4-1	18	565305	144471
SZ-A4-2	19	565300	144467
SZ-A4-3	21	565301	144471
SZ-A4-4	28	565300	144469

Attachment A
Originator G. CRUZ
Ch'k'd By [illegible]
Calc. No. 010B-CA-V0266

Sheet No. 1 of 1
Date 1/07/04
Date 1-12-04
Rev. No. 0

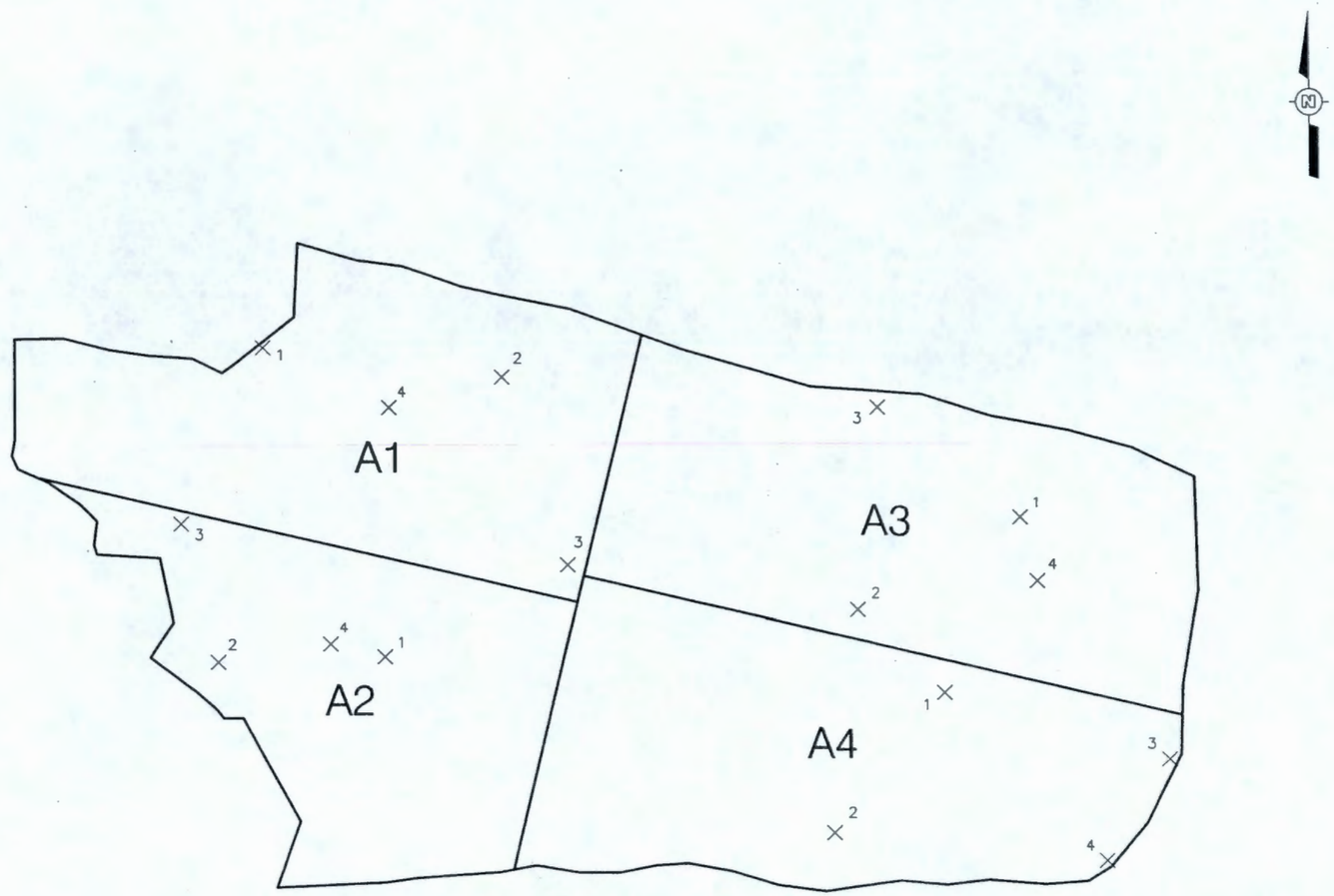
ATTACHMENT A

SCALE 1:100
1 0 1 2 4 meters

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 B/C AREA
118-B-10 BURIAL GROUND
SHALLOW ZONE VERIFICATION SAMPLING PLAN

1BC:010204B



SAMPLE LOCATION TABLE

SAMPLE NO.	SAMPLE NO. FROM ATTACHMENT C	WASHINGTON STATE PLANE COORDINATES, ROUNDED TO THE NEAREST METER	
		EASTING	NORTHING
SPA-A1-1	63	565306	144483
SPA-A1-2	64	565311	144483
SPA-A1-3	72	565312	144479
SPA-A1-4	87	565309	144482
SPA-A2-1	69	565309	144477
SPA-A2-2	74	565306	144477
SPA-A2-3	88	565305	144480
SPA-A2-4	91	565308	144477
SPA-A3-1	62	565321	144480
SPA-A3-2	67	565318	144478
SPA-A3-3	90	565321	144479
SPA-A3-4	96	565318	144482
SPA-A4-1	53	565319	144477
SPA-A4-2	80	565317	144474
SPA-A4-3	84	565324	144475
SPA-A4-4	99	565322	144473

Attachment B
Originator S. CRUZ
Chk'd By
Calc. No. C1001B-CA-V0206
Sheet No. 1 of 1
Date 11/22/04
Date 6-12-04
Rev. No. 0

ATTACHMENT B

SCALE 1:100
1 0 1 2 4 meters

U.S DEPARTMENT OF ENERGY
DOE FIELD OFFICE, RICHLAND
HANFORD ENVIRONMENTAL RESTORATION PROGRAM

100 B/C AREA
118-B-10 BURIAL GROUND STAGING
PILE AREA VERIFICATION SAMPLING PLAN

Sampling Locations in Trench Space Coordinates

Attachment C			
Originator: D.N. Strom	DNS	Date:	01/05/04
Checked: J.D. Ludowise	JDL	Date:	1-12-04
Calc. No.: 0100B-CA-V0206			
Rev.: 0		Sheet No.: 1 of 2	

The values for X_i and Y_i are calculated using Equations 1 and 2. The Microsoft Excel (R) RAND() function was used to calculate values for RND.

Shallow Zone						
	Random Number = RAND()		Trench Space Coordinates, Rounded to the Nearest Meter		Washington State Plane Coordinates, Rounded to the Nearest Meter	
Sample No.	For Calculating X Coordinate	For Calculating Y Coordinate	X	Y	Easting	Northing
1	0.6749	0.1215	8	2	565,301	144,467
2	0.6511	0.7779	8	12	565,301	144,477
3	0.6010	0.9516	7	14	565,300	144,479
4	0.9363	0.2669	11	4	565,304	144,469
5	0.1722	0.9637	2	14	565,295	144,479
6	0.3798	0.7041	5	11	565,298	144,476
7	0.6917	0.9982	8	15	565,301	144,480
8	0.9776	0.6218	12	9	565,305	144,474
9	0.4938	0.3312	6	5	565,299	144,470
10	0.2366	0.1794	3	3	565,296	144,468
11	0.4978	0.8311	6	12	565,299	144,477
12	0.4901	0.6973	6	10	565,299	144,475
13	0.8692	0.2245	10	3	565,303	144,468
14	0.5787	0.5819	7	9	565,300	144,474
15	0.4216	0.7923	5	12	565,298	144,477
16	0.7346	0.7615	9	11	565,302	144,476
17	0.3997	0.7946	5	12	565,298	144,477
18	0.9714	0.3775	12	6	565,305	144,471
19	0.5897	0.1306	7	2	565,300	144,467
20	0.4650	0.0793	6	1	565,299	144,466
21	0.6842	0.4170	8	6	565,301	144,471
22	0.1739	0.8179	2	12	565,295	144,477
23	0.9063	0.0245	11	0	565,304	144,465
24	0.0105	0.3556	0	5	565,293	144,470
25	0.4285	0.7672	5	12	565,298	144,477
26	0.9320	0.1037	11	2	565,304	144,467
27	0.4904	0.5953	6	9	565,299	144,474
28	0.6094	0.2681	7	4	565,300	144,469
29	0.9945	0.8841	12	13	565,305	144,478
30	0.8085	0.4481	10	7	565,303	144,472
31	0.9087	0.7484	11	11	565,304	144,476
32	0.9435	0.9425	11	14	565,304	144,479
33	0.7835	0.0831	9	1	565,302	144,466
34	0.9636	0.8023	12	12	565,305	144,477
35	0.4472	0.9717	5	15	565,298	144,480
36	0.2841	0.1193	3	2	565,296	144,467
37	0.9588	0.0174	12	0	565,305	144,465
38	0.1890	0.2751	2	4	565,295	144,469
39	0.1675	0.9714	2	15	565,295	144,480
40	0.0934	0.1631	1	2	565,294	144,467
41	0.5107	0.0514	6	1	565,299	144,466
42	0.5120	0.5203	6	8	565,299	144,473
43	0.3745	0.8275	4	12	565,297	144,477
44	0.4232	0.9389	5	14	565,298	144,479
45	0.6699	0.4605	8	7	565,301	144,472
46	0.8234	0.2309	10	3	565,303	144,468
47	0.4200	0.8220	5	12	565,298	144,477
48	0.4477	0.2624	5	4	565,298	144,469
49	0.2202	0.2548	3	4	565,296	144,469
50	0.7563	0.7195	9	11	565,302	144,476

Sampling Locations in Trench Space Coordinates

Attachment C			
Originator: D.N. Strom	DNS	Date:	01/05/04
Checked: J.D. Ludowise	JDL	Date:	1-12-04
Calc. No.: 0100B-CA-V0206			
Rev.: 0		Sheet No.:	2 of 2

The values for X_i and Y_i are calculated using Equations 1 and 2. The Microsoft Excel (R) RAND() function was used to calculate values for RND.

Staging Pile Area						
	Random Number = RAND()		Trench Space Coordinates, Rounded to the Nearest Meter		Washington State Plane Coordinates, Rounded to the Nearest Meter	
Sample No.	For Calculating X Coordinate	For Calculating Y Coordinate	X	Y	Easting	Northing
1	0.1353	0.1102	4	2	565,304	144,473
2	0.9205	0.9047	25	14	565,325	144,485
3	0.7191	0.3464	19	6	565,319	144,477
4	0.7234	0.8822	20	14	565,320	144,485
5	0.0353	0.2169	1	3	565,301	144,474
6	0.7261	0.8126	20	13	565,320	144,484
7	0.4015	0.8642	11	14	565,311	144,485
8	0.7393	0.0550	20	1	565,320	144,472
9	0.1996	0.7758	5	12	565,305	144,483
10	0.0041	0.1935	0	3	565,300	144,474
11	0.8372	0.7007	23	11	565,323	144,482
12	0.7733	0.5591	21	9	565,321	144,480
13	0.2397	0.7648	6	12	565,306	144,483
14	0.4082	0.7287	11	12	565,311	144,483
15	0.9886	0.6281	27	10	565,327	144,481
16	0.0984	0.4565	3	7	565,303	144,478
17	0.6579	0.4464	18	7	565,318	144,478
18	0.2103	0.1271	6	2	565,306	144,473
19	0.3248	0.3899	9	6	565,309	144,477
20	0.9671	0.0081	26	0	565,326	144,471
21	0.9528	0.1914	26	3	565,326	144,474
22	0.4538	0.5009	12	8	565,312	144,479
23	0.9417	0.5393	25	9	565,325	144,480
24	0.2072	0.3836	6	6	565,306	144,477
25	0.6797	0.0669	18	1	565,318	144,472
26	0.8692	0.7837	23	13	565,323	144,484
27	0.9370	0.6188	25	10	565,325	144,481
28	0.4467	0.8743	12	14	565,312	144,485
29	0.0194	0.0666	1	1	565,301	144,472
30	0.6406	0.1760	17	3	565,317	144,474
31	0.1224	0.0199	3	0	565,303	144,471
32	0.8359	0.7786	23	12	565,323	144,483
33	0.1092	0.9741	3	16	565,303	144,487
34	0.8771	0.2657	24	4	565,324	144,475
35	0.0984	0.2830	3	5	565,303	144,476
36	0.7865	0.9192	21	15	565,321	144,486
37	0.3280	0.6922	9	11	565,309	144,482
38	0.1816	0.5516	5	9	565,305	144,480
39	0.0199	0.3234	1	5	565,301	144,476
40	0.7851	0.4817	21	8	565,321	144,479
41	0.2861	0.4057	8	6	565,308	144,477
42	0.2056	0.5193	6	8	565,306	144,479
43	0.9888	0.6005	27	10	565,327	144,481
44	0.4549	0.9770	12	16	565,312	144,487
45	0.5560	0.8530	15	14	565,315	144,485
46	0.6726	0.6921	18	11	565,318	144,482
47	0.8452	0.9319	23	15	565,323	144,486
48	0.4047	0.7072	11	11	565,311	144,482
49	0.8326	0.1427	22	2	565,322	144,473
50	0.1648	0.7192	4	12	565,304	144,483

Sample Locations in Washington State Plane Coordinates

Attachment D	
Originator: D.N. Strom	Date: 01/05/04
Checked: J.D. Ludowise	Date: 1-12-04
Calc. No.: 0100B-CA-V0206	
Rev.: 0	Sheet No.: 1 of 1

The following table represents the 16 sample locations for the Shallow Zone Decision Unit that fell within the sample area as shown in Attachment A.

Shallow Zone

Sample No.	Sample No. from Attachment C	Trench Space Coordinates, Rounded to the Nearest Meter		Washington State Plane Coordinates, Rounded to the Nearest Meter	
		X	Y	Easting	Northing
SZ-A1-1	6	5	11	565,298	144,476
SZ-A1-2	11	6	12	565,299	144,477
SZ-A1-3	12	6	10	565,299	144,475
SZ-A1-4	15	5	12	565,298	144,477
SZ-A2-1	9	6	5	565,299	144,470
SZ-A2-2	42	6	8	565,299	144,473
SZ-A2-3	48	5	4	565,298	144,469
SZ-A2-4	49	3	4	565,296	144,469
SZ-A3-1	2	8	12	565,301	144,477
SZ-A3-2	8	12	9	565,305	144,474
SZ-A3-3	14	7	9	565,300	144,474
SZ-A3-4	16	9	11	565,302	144,476
SZ-A4-1	18	12	6	565,305	144,471
SZ-A4-2	19	7	2	565,300	144,467
SZ-A4-3	21	8	6	565,301	144,471
SZ-A4-4	28	7	4	565,300	144,469

The following table represents the 16 sample locations for the Staging Pile Area Decision Unit that fell within the sample area as shown in Attachment B.

Staging Pile Area

Sample No.	Sample No. from Attachment C	Trench Space Coordinates, Rounded to the Nearest Meter		Washington State Plane Coordinates, Rounded to the Nearest Meter	
		X	Y	Easting	Northing
SPA-A1-01	13	6	12	565,306	144,483
SPA-A1-02	14	11	12	565,311	144,483
SPA-A1-03	22	12	8	565,312	144,479
SPA-A1-04	37	9	11	565,309	144,482
SPA-A2-01	19	9	6	565,309	144,477
SPA-A2-02	24	6	6	565,306	144,477
SPA-A2-03	38	5	9	565,305	144,480
SPA-A2-04	41	8	6	565,308	144,477
SPA-A3-01	12	21	9	565,321	144,480
SPA-A3-02	17	18	7	565,318	144,478
SPA-A3-03	40	21	8	565,321	144,479
SPA-A3-04	46	18	11	565,318	144,482
SPA-A4-01	3	19	6	565,319	144,477
SPA-A4-02	30	17	3	565,317	144,474
SPA-A4-03	34	24	4	565,324	144,475
SPA-A4-04	49	22	2	565,322	144,473

CALCULATION COVER SHEET

Project Title:	100-B/C Burial Ground Cleanup Verification	**Job No.**	22192
Area	100-B/C		
Discipline	Environmental	***Calc. No.**	0100B-CA-V0228
Subject	118-B-10 Burial Ground 95% UCL Calculation		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 5 Total = 6	K. A. Anselm 2-23-04 K. A. Anselm	J. E. Thomson 2/23/04 J. E. Thomson TB Miley 2/23/04 T. B. Miley	SW Callison 2-23-04 S. W. Callison	D. N. Strom 2-27-04 D. N. Strom FM Corpuz F. M. Corpuz	3-2-04

SUMMARY OF REVISIONS

* Obtain calc no. from DIS

Dec-02

DE01-437.03

Bechtel Hanford, Inc. CALCULATION SHEET

Originator	K. A. Anselm	Date	02/23/04	Calc. No.	0100B-CA-V0228	Rev. No.	0
Project	100-B/C Burial Ground Cleanup Verification	Job No.	22192	Checked	J. E. Thomson	Date	2/23/04
Subject	118-B-10 Burial Ground 95% UCL Calculation			Checked	T. B. Miley	Date	2/23/04
						Sheet No.	1 of 5

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) to evaluate compliance with cleanup standards for the subject site. Also, calculate the carcinogenic risk for applicable nonradionuclide analytes, if relevant, perform the *Washington Administrative Code* (WAC) 173-340, (Model Toxics Control Act [MTCA]) 3-part test, if required (all nonradionuclide analytes), and calculate the relative percent difference (RPD) for each contaminant of concern (COC).

Table of Contents:
Sheets 1 to 2 - Calculation Sheet Summary
Sheet 3 - Calculation Sheet Sorting (Staging) Area
Sheet 4 - Calculation Sheet Shallow Zone Excavation Area
Sheet 5 - Calculation Sheet Split-Dup Analysis

Given/References:
1) Sample Results
2) Lookup values are taken from the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) (DOE-RL 2002) unless otherwise specified.
3) DOE-RL, 2001, *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-35, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) DOE-RL, 2002, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
5) Ecology, 1993, Statistical Guidance for Ecology Site Managers, Supplement S-6, Analyzing Site or Background Data with Below-Detection Limit or Below-PQL Values (Censored Data Sets).
6) EPA, 1994, *WSEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.
7) Model Toxics Control Act, WAC 173-340, and Statistical Guidance for Ecology Site Managers, Ecology Pub. #92-54, Washington Department of Ecology, Olympia, Washington.

Solution:
Calculation methodology is described in Ecology Pub. #92-54, and below. Use data from attached worksheets to calculate the 95% UCL for each analyte, the carcinogenic risk (if applicable), perform the WAC 173-340 3-part test for nonradionuclides (if applicable), and the RPD calculations for each COC. Note that there are no nonradiounuclide COCs for this site; therefore, some of the following calculations may not be required.

Calculation Description:
The subject calculations were performed on data from soil verification samples from the subject waste site. The data were entered into an EXCEL 97 spreadsheet and calculations performed by using the built-in spreadsheet functions and/or creating formulae within the cells. The statistical evaluation of data for use in accordance with the RDR/RAWP is documented by this calculation. Split and duplicate RPD results are used in evaluation of data quality and are presented in the Cleanup Verification Package (CVP) for this site.

Methodology:
The statistical value calculated to evaluate the effectiveness of cleanup was the 95% UCL. For nonradioactive analytes with > 50% of the data below detection limits, the maximum value for the sample data was used instead of the 95% UCL. All nonradionuclide (e.g., metals) data reported as being below detection limits were set to ½ the detection limit value for calculation of the statistics (Ecology 1993). For radionuclide data, calculation of the statistics was done on the reported value. In cases where the laboratory does not report a value below the minimal detectable activity (MDA), half of the MDA is used in the calculation.

For the statistical evaluation of duplicate sample pairs, the samples are averaged before being included in the data set, after adjustments for censored data as described above.

For nonradionuclides, the WAC 173-340 statistical guidance suggests that a test for distributional form be performed on the data and the 95% UCL calculated on the appropriate distribution using Ecology software. For nonradionuclide small data sets (n < 10) and all radionuclide data sets, the calculations are performed assuming nonparametric distribution, and no test for distribution is performed.

The estimated hazard quotient (for applicable nonradionuclide COCs) is determined by dividing the statistical value (derived in this calculation) by the WAC 173-340 Method B non-carcinogenic cleanup limit. The nonradionuclide carcinogenic risk, above background, is determined by dividing the statistical value by the WAC 173-340 Method B carcinogenic cleanup limit and then multiplying by 10^{-6}. For data sets where all values are below detection, neither of these calculations are required. For nonradionuclide COCs, the estimated fraction of risk computation must be performed.

The WAC 173-340 3-part test is performed for nonradionuclide analytes only and determines if:
1) the statistical value exceeds the most stringent cleanup limit for each non-radionuclide COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each non-radionuclide COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each non-radionuclide COC.

The RPD is performed when both the main value and either the duplicate or split values are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method. These detection limit requirements are located in Table II-2 of the sampling and analysis plan (DOE-RL 2001) where they are referred to as the practical quantitation limit or PQL. The RPD calculations use the following formula: RPD =[|M-S|/((M+S)/2)]*100

where, M = Main Sample Value S = Split (or duplicate) Sample Value

For quality assurance/quality control (QA/QC) split and duplicate RPD calculations, a value less than +/- 30% indicates the data compare favorably. For regulatory splits, a threshold of +/- 35% is used (EPA 1994). If the RPD is greater than +/- 30% (or +/- 35% for regulatory split data), further investigation regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable CVP.

If regulator split comparison is required, an additional parameter is evaluated. A control limit of +/- 2 times the TDL shall be used if either the main or regulator split value is less than 5 times the TDL and above detection. In the case where only one result is greater than five times the TDL and the other is below, the +/- 2 times the TDL criteria applies. Therefore, the following calculation is performed as part of the evaluation for these two cases involving regulator split data: difference = main - regulator split.

If the difference is greater than +/- 2 times the TDL, then further investigation regarding the usability of the data is performed and presented in the applicable CVP data quality assessment.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator	K. A. Anselm	Date	02/23/04	Calc. No.	0100B-CA-V0228	Rev. No.	0
Project	100-B/C Burial Ground Cleanup Verification	Job No.	22192	Checked	J. E. Thomson	Date	2/23/04
Subject	118-B-10 Burial Ground 95% UCL Calculation			Checked	T. B. Miley	Date	2/25/04
						Sheet No.	2 of 5

Summary

Results:
The results presented in the summary tables that follow are for use in RESRAD dose/risk analysis and the CVP for this site.

Result Summary - Sorting (Staging) Area			
Co-60	5.3E-02	U	pCi/g
Ni-63	4.8E+00		pCi/g

Result Summary - Shallow Zone Excavation Area		
Co-60	3.1E-01	pCi/g
Ni-63	8.11E+01	pCi/g

RPD Results - QA/QC Analysis*		
Analyte	Duplicate Analysis	Split Analysis
Co-60		
Ni-63		

*A blank cell indicates that RPD evaluation was not required

RPD Results - QA/QC Analysis *		
Analyte	Duplicate Analysis	Split Analysis
Co-60		
Ni-63		

*A blank cell indicates that RPD evaluation was not required

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	K. A. Anselm KAA	**Date**	02/23/04	**Calc. No.**	0100B-CA-V0228	**Rev. No.**	0
Project	100-B/C Burial Ground Cleanup Verification	**Job No.**	22192	**Checked**	J. E. Thomson	**Date**	2/23/04
Subject	118-B-10 Burial Ground 95% UCL Calculation			**Checked**	T. B. Miley TBM	**Date**	2/23/04
						Sheet No.	3 of 5

Sorting (Staging) Area Sample Data

Sampling Area	HEIS Number	Sample Date	Co-60 pCi/g	Co-60 Q	Co-60 MDA	Ni-63 pCi/g	Ni-63 Q	Ni-63 MDA
A4	J01708	1/14/2004	5.2E-02	U	5.2E-02	4.2E+00	U	5.4E+00
Duplicate of J01708	J01709	1/14/2004	7.5E-02	U	7.5E-02	1.3E+00	U	5.5E+00
A1	J01705	1/14/2004	6.6E-02	U	6.6E-02	-3.5E-01	U	5.6E+00
A2	J01706	1/14/2004	7.1E-02	U	7.1E-02	1.4E+00	U	5.3E+00
A3	J01707	1/14/2004	1.5E-01	U	1.5E-01	6.2E+00		5.5E+00

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Co-60 pCi/g			Ni-63 pCi/g		
A4	J01708/ J01709	1/14/2004	3.2E-02			2.7E+00		
A1	J01705	1/14/2004	3.3E-02			-3.5E-01		
A2	J01706	1/14/2004	3.6E-02			1.4E+00		
A3	J01707	1/14/2004	7.5E-02			6.2E+00		

Statistical Computations

	Co-60			Ni-63		
Statistical value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4		
% < Detection limit	100%			75%		
mean	4.4E-02			2.5E+00		
st. dev.	2.1E-02			2.8E+00		
Z-statistic	1.645			1.645		
95% UCL on mean	6.1E-02			4.8E+00		
max value	1.5E-01			6.2E+00		
Statistical value	6.1E-02			4.8E+00		
Background	0.008			NA		
Statistical value above background	5.3E-02			4.8E+00		
Lookup Value - 15 mrem/yr for radionuclide	1.4			4026		

Bechtel Hanford, Inc.

CALCULATION SHEET

Originator	K. A. Anselm KAA	**Date**	02/23/04	**Calc. No.**	0100B-CA-V0228	**Rev. No.**	0
Project	100-B/C Burial Ground Cleanup Verification	**Job No.**	22192	**Checked**	J. E. Thomson	**Date**	2/23/04
Subject	118-B-10 Burial Ground 95% UCL Calculation			**Checked**	T. B. Miley TBM	**Date**	2/23/04
						Sheet No.	4 of 5

Shallow Zone Excavation Area Sample Data

Sampling Area	HEIS Number	Sample Date	Co-60 pCi/g	Co-60 Q	Co-60 MDA	Ni-63 pCi/g	Ni-63 Q	Ni-63 MDA
A4	J01714	1/14/2004	6.5E-02	U	6.5E-02	4.61E+01		5.60E+00
Duplicate of J01714	J01715	1/14/2004	9.9E-02	U	9.9E-02	1.57E+02		5.80E+00
A1	J01711	1/14/2004	4.3E-02	U	4.3E-02	1.45E+00	U	5.60E+00
A2	J01712	1/14/2004	4.6E-01		8.2E-02	5.45E+01		5.70E+00
A3	J01713	1/14/2004	1.0E-01	U	1.0E-01	2.46E+01		5.70E+00

Statistical Computation Input Data

Sampling Area	HEIS Number	Sample Date	Co-60 pCi/g			Ni-63 pCi/g		
A4	J01714/ J01715	1/14/2004	4.1E-02			1.02E+02		
A1	J01711	1/14/2004	2.2E-02			1.45E+00		
A2	J01712	1/14/2004	4.6E-01			5.45E+01		
A3	J01713	1/14/2004	5.0E-02			2.46E+01		

Statistical Computations

	Co-60			Ni-63		
Statistical value based on	Radionuclide data set. Use nonparametric z-stat.			Radionuclide data set. Use nonparametric z-stat.		
N	4			4		
% < Detection limit	75%			25%		
mean	1.4E-01			4.55E+01		
st. dev.	2.1E-01			4.32E+01		
Z-statistic	1.645			1.645		
95% UCL on mean	3.1E-01			8.11E+01		
max value	4.6E-01			1.57E+02		
Statistical value	3.1E-01			8.11E+01		
Background	NA			NA		
Statistical value above background	3.1E-01			8.11E+01		
Lookup Value - 15 mrem/yr for radionuclide	1.4			4026		

CALCULATION SHEET

Bechtel Hanford, Inc.

Originator	K. A. Anselm KAA	**Date**	02/23/04	**Calc. No.**	0100B-CA-V0228	**Rev. No.**	0
Project	100-B/C Burial Ground Cleanup Verification	**Job No.**	22192	**Checked**	J. E. Thomson JEO	**Date**	2/23/04
Subject	118-B-10 Burial Ground 95% UCL Calculation				T. B. Miley TBM	**Date**	2/23/04
						Sheet	5 of 5

Split-Dup Analysis

Sorting (Staging) Area Results:

Composite Area	HEIS Number	Co-60			Ni-63		
		pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J01708	5.2E-02	U	5.2E-02	4.2E+00	U	5.4E+00
Duplicate of J01708	J01709	7.5E-02	U	7.5E-02	1.3E+00	U	5.5E+00
Split of J01708	J01716	1.7E-02	U	4.0E-02	8.6E+00		6.8E+00

Sorting (Staging) Area Analysis:

(TDL)		0.05	30
Duplicate Analysis	Both> MDA?	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?		
	RPD		
Split Analysis	Both> MDA?	No-Stop (acceptable)	No-Stop (acceptable)
	Both >5xTDL?		
	RPD		

Shallow Zone Excavation Area Results:

Composite Area	HEIS Number	Co-60			Ni-63		
		pCi/g	Q	MDA	pCi/g	Q	MDA
A4	J01714	6.5E-02	U	6.5E-02	4.61E+01		5.60E+00
Duplicate of J01714	J01715	9.9E-02	U	9.9E-02	1.57E+02		5.80E+00
Split of J01714	J01717	6.3E-02	U	5.5E-02	1.76E+01		5.99E+00

Shallow Zone Excavation Area Analysis:

(TDL)		0.05	30
Duplicate Analysis	Both> MDA?	No-Stop (acceptable)	**Yes (continue)**
	Both >5xTDL?		No-Stop (acceptable)
	RPD		
Split Analysis	Both> MDA?	No-Stop (acceptable)	**Yes (continue)**
	Both >5xTDL?		No-Stop (acceptable)
	RPD		

CALCULATION COVER SHEET

Project Title 118-B-10 Burial Ground Cleanup Verification **Job No.** 22192
Area 100 B/C Area
Discipline Environmental ***Calc. No.** 0100B-CA-V0229
Subject 118-B-10 Burial Ground RESRAD Calculation Brief
Computer Program RESRAD **Program No.** Version 6.21

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation ☒ **Preliminary** ☐ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 6 pg Attm. 1 - 1 pg Attm. 2 - 19 pg Attm. 3 - 20 pg Attm. 4 - 10 pg Attm. 5 - 19 pg Attm. 6 - 20 pg Attm. 7 - 10 pg Attm. 8 - 19 pg Attm. 9 - 10 pg Total – 135 pages	S. W. Clark S.W. Clark 2/15/04	J. E. Thomson J.E. Thomson 2/15/04	S. W. Callison SW Callison 2-23-04	D. N. Strom D.N. Strom 2-27-04 F. M. Corpuz FM Corpuz 3-2-04	3-2-04

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

December 2002

DE01-437.03

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22192	Checked:	J. E. Thomson	Date:	2/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No. 1 of 6	

PURPOSE:

Calculate the soil and groundwater concentrations, dose, and risk contributions from remaining radionuclide contaminants in the vadose zone and staging areas at the 118-B-10 Burial Ground over a period of 1,000 years.

GIVEN/REFERENCES:

1) Cleanup verification data from *118-B-10 Burial Ground 95% UCL Calculation*, Calculation No. 0100B-CA-V0228, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.
2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) Radioactive and nonradioactive contaminants of concern from the *100 Area Burial Grounds Remedial Action Sampling and Analysis Plan*, DOE/RL-2001-35, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. For the purpose of these RESRAD calculations, the radioactive contaminants of concern (COCs) are cobalt-60 and nickel-63.
4) RESidual RADioactivity (RESRAD) computer code, version 6.21, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
5) Sample design data from the *118-B-10 Burial Ground Sampling Plan*, Calculation No. 0100B-CA-V0206.

SOLUTION:

1) Separate RESRAD runs were performed to model the radionuclides for the shallow vadose zone soil horizon and for the burial ground excavation staging area. Table 1 shows the waste site parameters used for the RESRAD modeling. For the RESRAD runs, the model uses the conservative assumption that the residual radionuclide contamination levels from the data set extend uniformly from the ground surface to groundwater. Input factors for each RESRAD run are shown in the "Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printouts in Attachments to this Calculation Summary.

2) The year where the peak dose (or concentration) occurs from each individual radionuclide COC is determined by a preliminary run. This year is then added for all final RESRAD runs. For the direct exposure pathway (i.e. soil ingestion and inhalation and external radiation), the peak year occurred at year zero (year 2004) for all COCs. For the water pathways (i.e. drinking water and food ingestion) the peak years were 8 for cobalt-60 and 84 for nickel-63. The 8- and 84-year time periods were added to the RESRAD runs.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22192	Checked:	J. E. Thomson	Date:	2/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No. 2 of 6	

Table 1. Waste Site Dimensions for RESRAD Modeling of Radionuclides

Parameter	Units	Value	Comments
Cover Depth	m	0	
Area of Shallow Zone	m^2	137	Based on Sample Design [a]
Area of Staging Area	m^2	324	Based on Sample Design [a]
Elevation: Surface	m	144.5	NAVD88
Excavation Depth	m	3.21	Shallow Zone
Elevation: Groundwater	m	115.8	NAVD88
Thickness: Contaminated Zone	m	28.7	Conservative assumption for modeling
Length Parallel to Aquifer Flow	m	12	Shallow Zone
Length Parallel to Aquifer Flow	m	18	Staging Area

[a] Sample design data from the *100-B-10 Burial Ground Sampling Plan*, Calculation No. 0100B-CA-V0206

3) A single RESRAD run was performed to model protection of groundwater and the Columbia River from nonradionuclides in the vadose zone at the 118-B-10 Burial Ground. Based on the conservative assumption (outlined in the RDR/RAWP) that contaminant concentrations extend uniformly throughout the vadose zone to groundwater, the maximum concentration of lead detected during focused sampling (16.2 mg/kg) will result in groundwater concentrations that exceed the drinking water standard. Because this approach is too conservative in the case of lead, test pit data from an excavation at the bottom of the 116-C-1 site was used to more accurately describe the site for modeling using RESRAD. The *Cleanup Verification Package for the 116-C-1 Process Effluent Trench* (CVP-98-0006) provides a complete summary of the 116-C-1 test pit characterization results. The lead concentration profile and depth distributions from the test pit were applied to the 118-B-10 residual lead concentration to establish a lower vadose zone contaminant concentration of less than Hanford site background for use in RESRAD modeling. Table 2 shows the waste site parameters used for RESRAD modeling of nonradionuclides.

Table 2. Waste Site Dimensions for RESRAD Modeling of Nonradionuclides

Parameter	Units	Value	Comments
Cover Depth	m	0	
Area of Shallow Zone	m^2	137	Based on Sample Design [a]
Elevation: Surface	m	144.5	NAVD88
Elevation: Groundwater	m	115.8	NAVD88
Thickness: Contaminated Zone	m	9.2	Upper vadose zone thickness, based on test pit concentration vs. depth profile
Thickness: Uncontaminated Zone	m	19.5	Lower vadose zone thickness
Length Parallel to Aquifer Flow	m	12	Shallow Zone

[a] Sample design data from the *100-B-10 Burial Ground Sampling Plan*, Calculation No. 0100B-CA-V0206

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	3/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22192	Checked:	J. E. Thomson	Date:	3/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No. 3 of 6	

METHODOLOGY:

1) Runs of RESRAD version 6.21 were completed for shallow zone and staging area soils using the radionuclide concentrations shown in Table 3. RESRAD numerical output reports for dose, risk, and concentration for the shallow zone and staging area are presented in the Attachments to this calculation summary.

Table 3. Soil Radionuclide Activity [a]

COCs	Shallow Zone (pCi/g)	Staging Area (pCi/g)
Co-60	0.31	0.053 U
Ni-63	81.1	4.8

[a] Soil concentrations are from *118-B-10 Burial Ground 95% UCL Calculation*, Calculation No. 0100B-CA-V0228, Rev. 0. Bechtel Hanford, Inc., Richland, Washington.

2) A single run of RESRAD version 6.21 was completed for the upper vadose zone soil using a radionuclide surrogate to model the lead concentration shown in Table 4. RESRAD numerical output reports showing input soil concentration and predicted groundwater concentrations are presented in the Attachments to this calculation summary.

Table 4. Soil Nonradionuclide Concentration

Contaminant	Upper Vadose Zone (mg/kg)	Lower Vadose Zone (mg/kg)
Lead	16.2 [a]	<10.2 [b,c]

[a] Nonradionuclide value input into RESRAD to assess residual soil contaminant concentrations to groundwater.
[b] Value was not input into RESRAD because the concentration is below Hanford Site background.
[c] The lower vadose zone lead concentration is based on the lead contaminant depth distribution from the 116-C-1 test pit.

3) Modeling Nonradionuclides with RESRAD: RESRAD is used to model the impact of nonradionuclide contaminants on groundwater quality as discussed in Section C3.1 of the 100 Area RDR/RAWP. Long half-life surrogate radionuclides are selected for nonradionuclide contaminants (Table 3). The surrogates are assigned distribution coefficients (Kds) of the compounds being simulated, and are entered into the RESRAD program.

Table 4. Radionuclide Surrogates for Nonradionuclides.

Nonradionuclide	Kd for Nonradionuclide	Radionuclide Surrogate	Half – Life of Surrogate
Lead	30	Np-237	2.14×10^6

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22192	Checked:	J. E. Thomson	Date:	2/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No.	4 of 6

RESULTS:

1) Radionuclide "All Pathways" Dose Rate: The "all pathways" (maximum) dose rates are shown in Table 3. The maximum all-pathways dose rate for the shallow zone, 2.79 mrem/yr, occurs at year zero (2004). The maximum all-pathways dose rate for the staging area, 0.504 mrem/yr, also occurs at year zero (2004).

Table 6. All Pathways Dose Rate (mrem/yr)

Soil Horizon	"All Pathways" Dose Contributions in mrem/yr at each time slice (yr).								
	0	1	3	8	14	30	84	300	1000
Shallow Zone	2.79E+00	2.44E+00	1.88E+00	9.88E-01	4.62E-01	8.02E-02	3.05E-02	6.33E-03	3.88E-05
Staging Area	5.04E-01	4.42E-01	3.41E-01	1.78E-01	8.25E-02	1.27E-02	2.76E-03	6.96E-04	4.26E-06

2) Radionuclide Excess Cancer Risk: The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum shallow zone excess lifetime cancer risk (1.70×10^{-5}) occurs at year zero (2004). The maximum staging area excess lifetime cancer risk (3.02×10^{-6}) also occurs at year zero (2004).

Table 7. Radionuclide Excess Lifetime Cancer Risk

Soil Horizon	Excess Cancer Risk at Each Time Slice (yr)								
	0	1	3	8	14	30	84	300	1000
Shallow Zone	1.70E-05	1.50E-05	1.18E-05	6.70E-06	3.70E-06	1.54E-06	1.12E-06	2.32E-07	1.42E-09
Staging Area	3.02E-06	2.66E-06	2.08E-06	1.15E-06	5.96E-07	1.91E-07	1.16E-07	2.66E-08	1.63E-10

3) Radionuclide Groundwater Protection: The radionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 5. The organ specific dose via the groundwater (and river) pathway is presented in a separate calculation brief. Only concentrations are presented here.

Table 8. RESRAD Predicted Groundwater (Well Water) Concentrations

Soil Horizon	COCs	Predicted Groundwater Concentrations in pCi/L at Each Time Slice (yr)									RAGs[a] (pCi/L)
		0	1	3	8	14	30	84	300	1000	
Shallow Zone	Co-60	0	7.00E-04	1.61E-03	2.23E-03	1.77E-03	4.63E-04	1.07E-06	1.37E-18	0	100
	Ni-63	0	9.57E-01	2.83E+00	7.28E+00	1.22E+01	2.33E+01	4.41E+01	9.17E+00	5.62E-02	50
Staging Area	Co-60	0	1.20E-04	2.76E-04	3.81E-04	3.03E-04	7.92E-05	1.83E-07	3.00E-19	0	100
	Ni-63	0	5.67E-02	1.68E-01	4.31E-01	7.22E-01	1.38E+00	2.61E+00	8.15E-01	5.00E-03	50

[a] Value is the remedial action goal (RAG) from the RDR/RAWP based upon applicable groundwater cleanup levels.

Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22492	Checked:	J. E. Thomson	Date:	2/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No. 5 of 6	

4) Nonradionuclide Groundwater Protection: The nonradionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 5.

Table 9. RESRAD Predicted Groundwater (Well Water) Concentrations

COC	Predicted Groundwater Concentrations in pCi/L at Each Time Slice (yr)									RAG[a] (ug/L)
	0	1	3	8	14	30	84	300	1000	
Lead	0	0	0	0	0	0	0	0	0	15

[a] Value is the remedial action goal (RAG) from the RDR/RAWP based upon applicable groundwater cleanup levels.

CONCLUSIONS:

- The "all pathways" (maximum) dose rates are shown in Table 3. The maximum all-pathways dose rate for the shallow zone is 2.79 mrem/yr and occurs at year zero (2004). The maximum all-pathways dose rate for the staging area soil is 0.504 mrem/yr at year zero (2004).

- The dominant pathway for the dose rate is direct external exposure.

- The primary radionuclide contributing to the direct exposure pathway is cobalt-60

- None of the site COCs are projected to exceed remedial action goals (RAGs).

- The radionuclide excess lifetime cancer risk results are shown in Table 4. The maximum shallow zone excess lifetime cancer risk (1.70×10^{-5}) occurs at year zero (2004). The maximum staging area excess lifetime cancer risk (3.02×10^{-6}) also occurs at year zero (2004).

- The radionuclide contaminants of concern, cobalt-60 and nickel-63, are calculated to reach groundwater in the 1,000 years of the RESRAD model run. These radionuclides are predicted to reach groundwater at concentrations below the RAGs.

- Modeling of the residual concentrations of the nonradionuclide lead indicates that lead will not impact groundwater within 1,000 years.

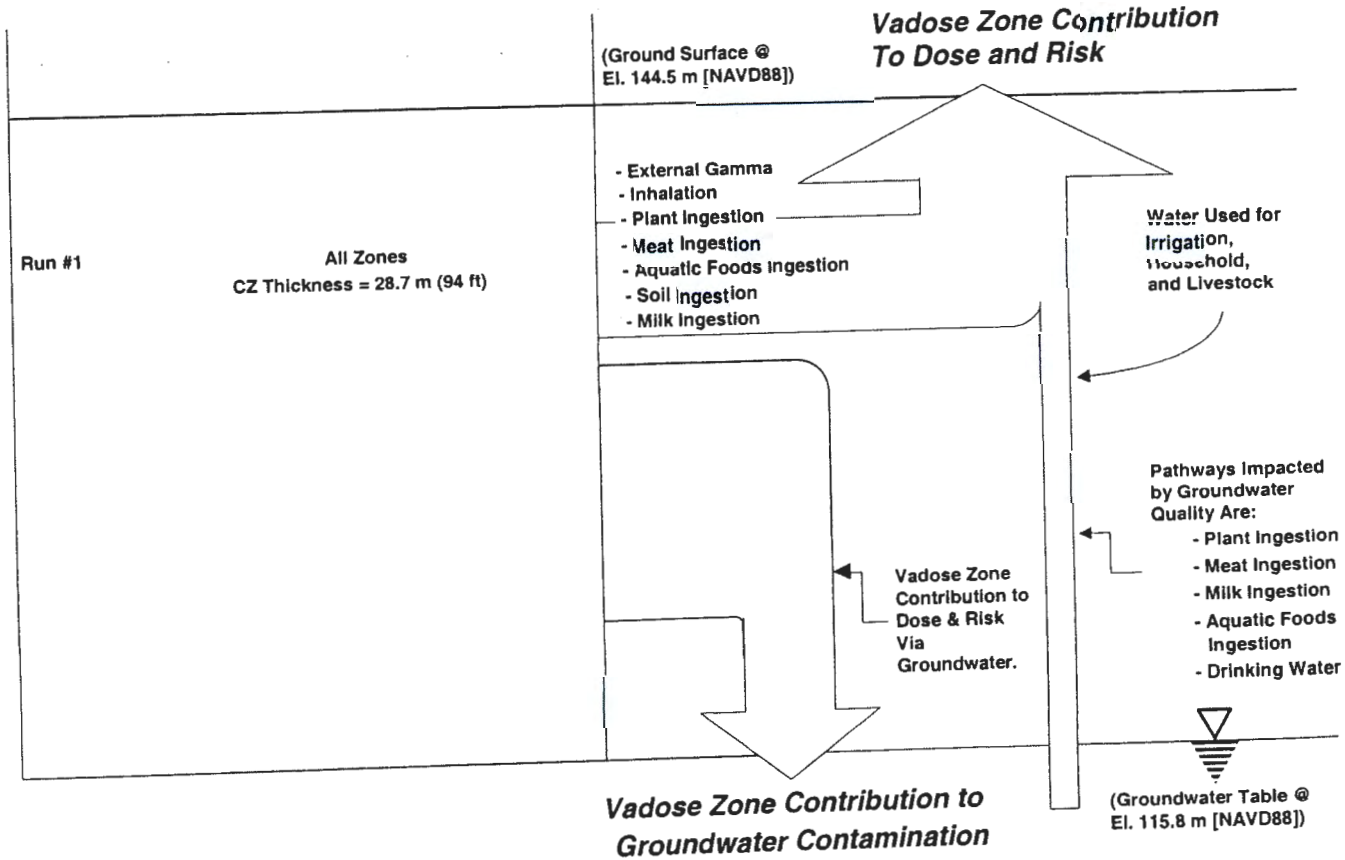
Bechtel Hanford, Inc. CALCULATION SHEET

Originator:	S. W. Clark	Date:	2/15/04	Calc. No.:	0100B-CA-V0229	Rev.:	0
Project:	118-B-10 Cleanup Verification	Job No:	22492	Checked:	J. E. Thomson	Date:	2/15/04
Subject:	118-B-10 Burial Ground RESRAD Calculation Brief					Sheet No. 6 of 6	

ATTACHMENTS:

1. Graphic showing 118-B-10 Burial Ground Cleanup Verification Model (1 page)
2. RESRAD Output: 118-B-10 Burial Ground Shallow Zone Radionuclides - Mixture Sums and Single Radionuclide Guidelines (19 pages)
3. RESRAD Output: 118-B-10 Burial Ground Shallow Zone Radionuclides - Intake Quantities and Health Risk Factors (20 pages)
4. RESRAD Output: 118-B-10 Burial Ground Shallow Zone Radionuclides - Concentration of Radionuclides (10 pages)
5. RESRAD Output: 118-B-10 Burial Ground Staging Area Radionuclides - Mixture Sums and Single Radionuclide Guidelines (19 pages)
6. RESRAD Output: 118-B-10 Burial Ground Staging Area Radionuclides - Intake Quantities and Health Risk Factors (20 pages)
7. RESRAD Output: 118-B-10 Burial Ground Staging Area Radionuclides - Concentration of Radionuclides (10 pages)
8. RESRAD Output: 118-B-10 Burial Ground Shallow Zone Nonradionuclides - Mixture Sums and Single Radionuclide Guidelines (19 pages)
9. RESRAD Output: 118-B-10 Burial Ground Shallow Zone Nonradionuclides - Concentration of Radionuclides (10 pages)

118-B-10 Cleanup Verification RESRAD Model.



Attachment 1 Sheet No. 1 of 1
Originator S. W. Clark Date 2/15/04
Chk'd By J. E. Thomson Date 2/15/04
Calc. No. 0100B-CA-V0229 Rev. No. 0

ATTACHMENT 1

CALCULATION COVER SHEET

Project Title:	118-B-10 Burial Ground Cleanup Verification	**Job No.**	22192
Area	100-BC Area		
Discipline	Environmental	***Calc. No.**	0100B-CA-V0230
Subject	118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)		
Computer Program	Excel	**Program No.**	Excel 97

Use of this calculation by persons who do not have access to all of the pertinent facts could lead to incorrect conclusions or assumptions. Before applying this calculation in your work, this calculation must be thoroughly reviewed with appropriate and authorized Hanford site ERC personnel. Without this review, the ERC cannot assume any responsibility for the use of these calculations.

Committed Calculation X **Preliminary** **Superseded**

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover - 1 Calculations - 4 Total - 5	S. W. Clark SW Clark 2/15/04	J. E. Thomson JE Thomson 2/18/04	S.W. Callison SW Callison 2-23-04	D. N. Strom DN Strom 2-27-04 F. M. Corpuz FM Corpuz	3-2-04

SUMMARY OF REVISIONS

*Obtain Calc. No. from DIS

January 2003

DE01-437.03

Bechtel Hanford, Inc. CALCULATION SHEET

Originator	S. W. Clark	**Date**	2/15/04	**Calc. No.**	0100B-CA-V0230	**Rev. No.**	0
Project	118-B-10 Cleanup Verification	**Job No.**	22192	**Checked**	J. E. Thomson	**Date**	3/18/04
Subject	118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)					**Sheet No.**	1 of 4

Purpose:
Compare RESRAD derived groundwater radionuclide concentrations to remedial action goals and maximum contaminant levels (MCLs) for groundwater.
Compare beta/gamma emitter dose contributions to the maximum allowable dose of 4 mrem/yr.

Table of Contents:
1. Calculation Summary
2. Comparison to MCLs
3. Cumulative Dose Comparison - Shallow Zone
4. Cumulative Dose Comparison - Staging Area

Given/References:
1) RESRAD derived groundwater radionuclide concentrations from Calculation 0100B-CA-V0229, *118-B-10 Burial Ground RESRAD Calculation*.

2) Remedial action goals for groundwater and MCLs summarized in Table 2-3 of the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 4, U.S. Department of Energy, Richland Operations office, Richland, WA.

3) Maximum allowable dose of 4 mrem/yr for beta/gamma emitters from: 40 CFR 141, "National Primary Drinking Water Regulation," *Code of Federal Regulations*, as amended (40 CFR Part 141, Subpart B, 141.51).

4) Individual organ-dose caclulation methodology for beta/gamma emitter dose contribution to the maximum allowable dose of 4 mrem/yr from: *Maximum Permissible Body Burdens and Maximum Permissible Concetrations of Radionuclides in Air or Water for Occupational Exposure*, National Bureau of Standards (NBS) Handbook 69, as amended, U.S. Department of Commerce, Washington D.C., and National Primary Drinking Water Regulations, EPA-570/9-76-003, U.S. Environmental Protection Agency, Office of Water Supply, Washington D.C.

Solution:
1. The site data for the calculation are the groundwater concentrations for the contaminants of concern (COCs) (daughter products are not considered) over time from the RESRAD groundwater concentration file.

2. If the site conceptual model breaks the contamination into multiple layers with differing concentrations, then the groundwater concentrations from the various model runs are added (for each time interval) to provide the concentration data for comparison to the individual remedial action goals and MCLs and the dose calculation for the beta and gamma emitters.

3. Compare the summed concentrations for each radionuclide to the groundwater remedial action goal and MCL given in the RDR/RAWP, Table 2-3.

4. The cumulative dose for each organ for all beta and gamma emitting COCs (Co-60, and Ni-63) at time t is calculated separately using the corresponding to 4 mrem/year dose (C4) and the sum of fractions equation shown below (from EPA-570/9-76-003). The organs for which doses need to be computed are total body, bone, liver and gastrointestinal tract [lower large intestine] (GI(LLI)). The individual organ doses are compared to 4 mrem/yr.

Doseorgan x (t) = [ConcA(t)/C4A(x) + ConcB(t)/C4B(x) + ...] x (4 mrem/yr)

where:
Doseorgan x (t) is the total dose to organ x in mrem/yr
ConcA(t) is the concentration of isotope A at time t in pCi/L
C4A(x) is the 4 mrem/yr dose equivalent concentration for organ x of isotope A at time t in pCi/L
If the dose for organ x < 4 mrem/yr, then the standard is met.

Conclusions:
1. The summed concentrations for each radionuclide COC are less than the groundwater remedial action goal and MCL given in the RDR/RAWP, Table 2-3.

2. The cumulative dose for each total body, bone, liver and gastrointestinal tract for all beta and gamma emitting COCs is less than 4 mrem/yr

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CALCULATION SHEET

Originator	S. W. Clark	**Date** 2/15/04	**Calc. No.** 0100B-CA-V0230	**Rev. No.**	0
Project	118-B-10 Burial Ground Cleanup Verification	**Job** 22192	**Checked** J. E. Thomson	**Date**	2/18/04
Subject	118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)			**Sheet No.**	2 of 4

Shallow Zone - Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modeling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	8	14	30	84	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
Co-60	0	7.00E-04	1.61E-03	2.23E-03	1.77E-03	4.63E-04	1.07E-06	1.37E-18	0	100	No	2.23E-03	8
Ni-63	0	9.57E-01	2.83E+00	7.28E+00	1.22E+01	2.33E+01	4.41E+01	9.17E+00	5.62E-02	50	No	44.1	84

Staging Area - Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modeling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	8	14	30	84	300	1000	MCL	Exceeds MCL?	Peak Conc.	Year of Peak
Co-60	0	1.20E-04	2.76E-04	3.81E-04	3.03E-04	7.92E-05	1.83E-07	3.00E-19	0	100	No	3.81E-04	8
Ni-63	0	5.67E-02	1.68E-01	4.31E-01	7.22E-01	1.38E+00	2.61E+00	8.15E-01	5.00E-03	50	No	2.61	84

Bechtel Hanford, Inc.

CALCULATION SHEET

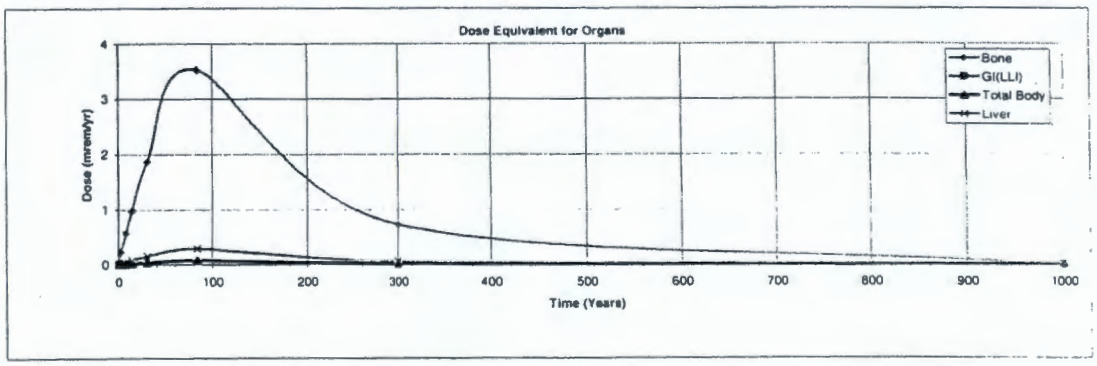
Originator	S. W. Clark	Date 2/15/04	Calc. No. 0100B-CA-V0230		Rev. No. 0
Project	118-B-10 Burial Ground Cleanup Verification	Job 22192	Checked J. E. Thomson		Date 2/18/04
Subject	118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)				Sheet No. 3 of 4

Shallow Zone - Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modeling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	8	14	30	84	300	1000	Organ	C_s	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Co-60	0	7.00E-04	1.61E-03	2.23E-03	1.77E-03	4.63E-04	1.07E-06	1.37E-18	0	GI(LLI)	100	No	2.23E-03	8
										Total Body	900	No		
										Liver	3,000	No		
Ni-63	0	9.57E-01	2.83E+00	7.28E+00	1.22E+01	2.33E+01	4.41E+01	9.17E+00	5.62E-02	Bone	50	No	44.1	84
										GI(LLI)	3,000	No		
										Total Body	2,000	No		
										Liver	600	No		

Shallow Zone - Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	3	8	14	30	84	300	1000	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak
Bone	0.00E+00	7.66E-02	2.26E-01	5.82E-01	9.76E-01	1.86E+00	3.53E+00	7.34E-01	4.50E-03	No	3.53E+00	84
GI(LLI)	0.00E+00	1.30E-03	3.84E-03	9.80E-03	1.63E-02	3.11E-02	5.88E-02	1.22E-02	7.49E-05	No	5.88E-02	84
Total Body	0.00E+00	1.92E-03	5.67E-03	1.46E-02	2.44E-02	4.66E-02	8.82E-02	1.83E-02	1.12E-04	No	8.82E-02	84
Liver	0.00E+00	6.38E-03	1.89E-02	4.85E-02	8.13E-02	1.55E-01	2.94E-01	6.11E-02	3.75E-04	No	2.94E-01	84



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CALCULATION SHEET

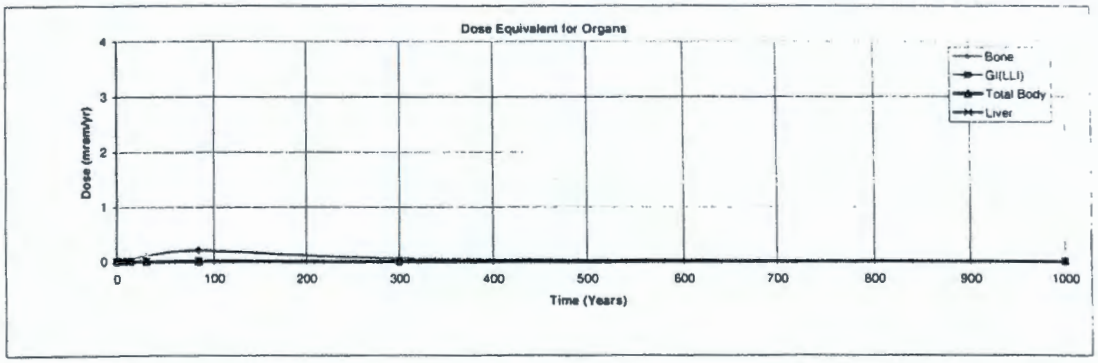
Originator	S. W. Clark	Date 2/13/04	Calc. No. 0100B-CA-V0230		Rev. No. 0
Project	118-B-10 Burial Ground Cleanup Verification	Job 22192	Checked J. E. Thomson		Date 2/18/04
Subject	118-B-10 Burial Ground Comparison to Drinking Water Standards (MCL)				Sheet No. 4 of 4

Staging Area - Comparison of the summed concentrations for each radionuclide to the GW MCL
Data derived from RESRAD modeling, units are pCi/L.

Radionuclide	Time (years) 0	1	3	8	14	30	84	300	1000	Organ	C_4	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak Conc.
Co-60	0	1.20E-04	2.76E-04	3.81E-04	3.03E-04	7.92E-05	1.83E-07	3.00E-19	0	GI(LLI)	100	No	3.81E-04	8
										Total Body	900	No		
										Liver	3,000	No		
Ni-63	0	5.67E-02	1.68E-01	4.31E-01	7.22E-01	1.38E+00	2.61E+00	8.15E-01	5.00E-03	Bone	50	No	2.61	84
										GI(LLI)	3,000	No		
										Total Body	2,000	No		
										Liver	600	No		

Staging Area - Cumulative dose for each organ (with time)

Organ	Time (years) 0	1	3	8	14	30	84	300	1000	Exceeds 4 mrem/yr?	Peak Conc.	Year of Peak
Bone	0.00E+00	4.54E-03	1.34E-02	3.45E-02	5.78E-02	1.10E-01	2.09E-01	6.52E-02	4.00E-04	No	2.09E-01	84
GI(LLI)	0.00E+00	8.04E-05	2.35E-04	5.90E-04	9.75E-04	1.84E-03	3.48E-03	1.09E-03	6.67E-06	No	3.48E-03	84
Total Body	0.00E+00	1.14E-04	3.37E-04	8.64E-04	1.45E-03	2.76E-03	5.22E-03	1.63E-03	1.00E-05	No	5.22E-03	84
Liver	0.00E+00	3.78E-04	1.12E-03	2.87E-03	4.81E-03	9.20E-03	1.74E-02	5.43E-03	3.33E-05	No	1.74E-02	84



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