1221569

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-076

Waste Site Code(s)/Subsite Code(s):

118-N-1, 1303-N Spacer Silos

Reclassification Category: Interim ☒ Final ☐

Reclassification Status: Closed Out ☒ No Action ☐ Rejected ☐
RCRA Postclosure ☐ Consolidated ☐ None ☐

Approvals Needed: DOE ☒ Ecology ☒ EPA ☐

Description of current waste site condition:

The 118-N-1, 1303-N Spacer Silos waste site is located in the 100-NR-1 Operable Unit, approximately 30 m (98 ft) northwest of the 105-N Reactor. The site is identified in the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington*, U.S. Environmental Protection Agency, Region 10, Seattle, Washington (100-N Area ROD) (EPA 1999) with removal and disposal as the selected remedy. The 118-N-1 waste site consisted of three buried silos used for temporary storage of irradiated metallic fuel rod spacers removed from the 105-N Reactor. Silo 1 began operation in 1963 and was a 30.5-cm (12-in.)-thick reinforced concrete culvert 4 m (13 ft) in diameter and 7.6 m (25 ft) long, buried upright, and extending about 7.1 m (20 ft) below grade. Approximately 3 ft of packed aluminum turnings were placed at the base of the silo 1. Silos 2 and 3 were added in 1967 and were corrugated, galvanized-steel culverts 5.2 m (17 ft) in diameter and 10.7 m (35 ft) long that extended 9.1 m (30 ft) below grade. All three silos were standing vertically on end with the top 1.5 m (5 ft) above grade. Each silo had a concrete cover. The silos were numbered 1, 2, and 3 from south to north. The silos were covered and surrounded with an earth berm with a 30.5-m (100-ft) reinforced concrete retaining wall along the west side. The bottom of each silo was open to the soil below. All spacers were removed from the silos in 1995.

Demolition and removal of the silos were completed by the Deactivation, Decontamination, Decommissioning, and Demolition (D4) project on June 27, 2012, as documented in the "Post-Demolition Summary Report for the 1303-N Spacer Silos," CCN 169427, Interoffice Memorandum to M. E. Allen from W. H. Rodgers, Washington Closure Hanford, Richland, Washington (WCH 2013c) and disposed at the Environmental Restoration Disposal Facility (ERDF). After removal of the silos, additional contaminated soil at the waste site was removed by the Field Remediation Project from January 4, 2013, through March 22, 2013. Global positioning environmental radiological surveyor (GPERS) surveys were performed to support excavation and removal of contaminated soil. It is estimated that approximately 8,680 bank cubic meters of soil was removed as part of the soil remediation.

Verification soil samples were collected on April 23 and 25, 2013, and May 2, 2013. A comparison of residual contaminant concentrations against cleanup levels has been performed in accordance with the remedial action objectives (RAOs) and remedial action goals (RAGs) established by DOE/RL-2005-93, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP), Rev. 0, U.S. Department of Energy, Richland, Washington (DOE-RL 2006) and the 100-N Area ROD (EPA 1999). The selected remedy involved (1) excavating the site, (2) disposing of excavation materials at ERDF at the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification as Interim Closed Out.

Basis for reclassification:

The verification sampling and modeling results for the 118-N-1 waste site demonstrates that this site meets the RAOs and corresponding RAGs established in the 100-N Area RDR/RAWP (DOE-RL 2006) and the 100-N Area ROD (EPA 1999). These sampling and modeling results demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. The entire 118-N-1 excavation is located within the deep vadose soil (i.e., greater than 4.6 m [15 ft] depth). Therefore, no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation. However, because contamination above shallow zone direct exposure soil cleanup levels was observed in deep zone soils, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required. The basis for reclassification is described in detail in the *Remaining Sites Verification Package for the 118-N-1, 1303-N Spacer Silos Waste Site* (attached).

Attached to: 1221568

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A-6006-136 (REV 0)

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-NR-1 **Control No.:** 2013-076

Waste Site Code(s)/Subsite Code(s):

118-N-1, 1303-N Spacer Silos

Regulator comments:

Waste Site Controls:

Engineered Controls: ☐ Yes ☒ No

Institutional Controls: ☒ Yes ☐ No

O&M Requirements: ☐ Yes ☒ No

If any of the Waste Site Controls are checked Yes, specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents:

Institutional controls to prevent uncontrolled drilling or excavation into the deep zone of the site are required because contamination above shallow zone direct exposure soil cleanup levels was observed in deep zone soils. This requirement is per the remedial alternatives cited on page 37 to meet the RAOs of the 100-N Area ROD (EPA 1999).

J. P. Neath	J P Neath	8/14/13
DOE Federal Project Director (printed)	Signature	Date
N. Menard	Nina M. Menard	8/16/13
Ecology Project Manager (printed)	Signature	Date
N/A		
EPA Project Manager (printed)	Signature	Date

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REMAINING SITES VERIFICATION PACKAGE FOR THE 118-N-1, 1303-N SPACER SILOS WASTE SITE

Attachment to Waste Site Reclassification Form 2013-076

August 2013

REMAINING SITES VERIFICATION PACKAGE FOR THE 118-N-1, 1303-N SPACER SILOS WASTE SITE

EXECUTIVE SUMMARY

The 118-N-1, 1303 Spacer Silos waste site is located in the 100-NR-1 Operable Unit of the Hanford Site and consisted of three buried silos used for temporary storage of irradiated metallic fuel rod spacers removed from the 105-N Reactor. Silo 1 began operation in 1963 and was a 30.5-cm (12-in.)-thick reinforced concrete culvert 4 m (13 ft) in diameter and 7.6 m (25 ft) long, buried upright, and extending about 7.1 m (20 ft) below grade. Approximately 0.9 m (3 ft) of packed aluminum turnings were placed at the base of silo 1 (GE 1963b). Silos 2 and 3 were added in 1967 and were corrugated, galvanized-steel culverts 5.2 m (17 ft) in diameter and 10.7 m (35 ft) long that extended 9.1 m (30 ft) below grade (GE 1966). All three silos were standing vertically on end with the top 1.5 m (5 ft) above grade. Each silo had a concrete cover. The silos were covered and surrounded with an earth berm, with a 30.5-m (100-ft) reinforced concrete retaining wall along the west side. The bottom of each silo was open to the soil below.

The fuel rod spacers were transferred from the 105-N Reactor fuel storage basin to the silos by placing a spacer in a 7.6-cm (3-in.) spacer transfer line and then pushing it forward with the next spacer. Water from the 105-N fuel storage basin was used to dislodge spacers that became stuck in the transfer line. When a silo was completely full, the spacers were removed and shipped to the 200 Area burial grounds for disposal. The amount of spacers removed and shipped at any one time varied, depending upon reactor operations. All remaining spacers were removed from the silos in 1995 and the silos were inspected with video cameras to confirm that they were empty.

Demolition and removal of the 1303-N Spacer Silos was completed by the Deactivation, Decontamination, Decommissioning, and Demolition (D4) project on June 27, 2012 (WCH 2013b, WCH 2013c, DOE-RL 2013). The Field Remediation (FR) project then removed approximately 8,680 bank cubic meters of contaminated soil from January 4, 2013, through March 22, 2013, after D4 completed the silo removal. No anomalies were encountered during remedial activities.

Following remediation, verification soil samples were collected on April 23 and 25, 2013, and May 2, 2013. A summary of the cleanup evaluation for the soil results compared to the applicable cleanup criteria is presented in Table ES-1. The current site conditions achieve the Remedial Action Goals (RAGs) established by the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2006b) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999). The results of the verification sampling were used to make a reclassification decision for the 118-N-1 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

Table ES-1. Summary of Remedial Action Goals for the 118-N-1 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain dose rate of <15-mrem/yr above background over 1,000 years.	There is no direct exposure pathway for this site because it is located below 4.6 m (15 ft) depth.	NA
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	There is no direct exposure pathway for this site because it is located below 4.6 m (15 ft) depth.	NA
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	There is no direct exposure pathway for this site because it is located below 4.6 m (15 ft) depth.	NA
	Attain a cumulative hazard quotient of <1 for noncarcinogens.		
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.		
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.		
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	Residual concentrations of radionuclides, consisting of cesium-137 and strontium-90, at the 118-N-1waste site exceed soil lookup values for groundwater and river protection. However, based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), it is predicted that residual radionuclide contamination at the 118-N-1 waste site will not reach groundwater and thus the Columbia River within 1,000 years [d].	Yes
	Attain national primary drinking water standards [a]. 4 mrem/yr (beta/gamma) dose rate to target receptor/organs.		
	Meet drinking water standards for alpha emitters: the most stringent of 15 pCi/L MCL or 1/25th of the derived concentration guides from DOE Order 5400.5 [b].		
	Meet total uranium standard of 30 µg/L (21.2 pCi/L) [c].	Uranium was not quantified above background levels for this site.	

Table ES-1. Summary of Remedial Action Goals for the 118-N-1 Waste Site. (2 Pages)

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Selenium was detected in one focused sample at 1.1 mg/kg, exceeding the soil RAG of 1 mg/kg for protection of the Columbia River. Mercury was detected in one sample at a concentration exceeding criteria for protection of groundwater and the river. However, based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b), it is predicted that residual concentrations of selenium and mercury are protective of groundwater and thus the Columbia River [e, f].	Yes

[a] "National Primary Drinking Water Regulations" (40 *Code of Federal Regulations* 141).

[b] *Radiation Protection of the Public and Environment* (DOE Order 5400.5).

[c] Based on the isotopic distribution of uranium in the 100 Areas, the 30 µg/L 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* (BHI 2001).

[d] A site-specific RESRAD model evaluation (0100N-CA-V0226) provided in Appendix A predicts that the residual activities of radionuclides at the 118-N-1 waste site are protective of groundwater and the Columbia River.

[e] A site-specific RESRAD evaluation (0100N-CA-V0225) provided in Appendix A determined that the concentration of residual selenium contamination was insufficient to exceed river protection criteria within 1,000 years.

[f] Based on RESRAD modeling discussed in Appendix C of the 100-N RDR/RAWP (DOE-RL 2006b), the residual concentration of mercury is not predicted to migrate more than 2.0 m (6.6 ft) vertically within 1,000 years based on the K_d value for mercury of 30 mL/g. The distance to groundwater from the bottom of the excavation area is 9.5 m (31.2 ft). Therefore, residual concentrations of mercury are predicted to be protective of groundwater and the Columbia River.

COPC = contaminant of potential concern
DOE = U.S. Department of Energy
MCL = maximum contaminant level
NA = not applicable
RAG = remedial action goal
RESRAD = RESidual RADioactivity (dose model)
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan for the 100 Area

In accordance with this evaluation, the verification sampling results support a reclassification of the 118-N-1 waste site to Interim Closed Out. The current site conditions achieve the remedial action objectives and the corresponding RAGs established in the 100-N Area ROD (EPA 1999) and 100-N Area RDR/RAWP (DOE-RL 2006b). The verification sample results and modeling show that residual contaminant concentrations are protective of groundwater and the Columbia River. The entire 118-N-1 excavation is located within the deep vadose zone (i.e., greater than 4.6 m [15 ft] depth). Therefore, no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation and evaluation of attainment of RAGs for the site is limited to demonstrating that residual contamination is protective of groundwater and the Columbia River. However, because contamination above shallow zone

direct exposure soil cleanup levels was observed in deep zone soils, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the 100-N Area ROD (EPA 1999), a comparison against ecological risk screening levels is made for sites with contamination located above 4.6 m (15 ft). However, because the 118-N-1 excavation is located below a depth of 4.6 m (15 ft), there is no risk to ecological receptors and no evaluation of ecological risk is required.

REMAINING SITES VERIFICATION PACKAGE FOR THE 118-N-1, 1303-N SPACER SILOS WASTE SITE

STATEMENT OF PROTECTIVENESS

This report demonstrates that the 118-N-1, 1303-N waste site meets the objectives to support a reclassification of this site to Interim Closed Out as established in the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (100-N Area RDR/RAWP) (DOE-RL 2006b) and the *Interim Action Record of Decision for the 100-NR-1 and 100-NR-2 Operable Units, Hanford Site, Benton County, Washington* (100-N Area ROD) (EPA 1999). The entire 118-N-1 waste site excavation is located within the deep vadose zone (i.e., greater than 4.6 m [15 ft] depth). Therefore, no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation and evaluation of attainment of remedial action goals (RAGs) for the site is limited to demonstrating that residual contamination is protective of groundwater and the Columbia River. The results of the verification sampling and modeling show that residual contaminant concentrations are protective of groundwater and the Columbia River. However, because contamination above shallow zone direct exposure soil cleanup levels was observed in deep zone soils, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

Soil cleanup levels were established in the 100-N Area ROD (EPA 1999) based on a limited ecological risk assessment. Although not required by the 100-N Area ROD (EPA 1999), a comparison against ecological risk screening levels is made for sites with contamination located above 4.6 m (15 ft). Because the 118-N-1 excavation is located below a depth of 4.6 m (15 ft), there is no risk to ecological receptors and no evaluation of ecological risk is required.

GENERAL SITE INFORMATION AND BACKGROUND

The 118-N-1, 1303-N Spacer Silos waste site is located in the 100-NR-1 Operable Unit of the Hanford Site, approximately 30 m (98 ft) northwest of the 105-N Reactor (Figure 1). The 1303-N Spacer Silos consisted of three buried silos used for temporary storage of irradiated metallic fuel rod spacers removed from the 105-N Reactor. Silo 1 began operation in 1963 and was a 30.5-cm (12-in.)-thick reinforced concrete culvert 4 m (13 ft) in diameter and 7.6 m (25 ft) long, buried upright and extending about 7.1 m (20 ft) below grade. Approximately 0.9 m (3 ft) of packed aluminum turnings were placed at the base of silo 1 (GE 1963b). Silos 2 and 3 were added in 1967 and were corrugated, galvanized-steel culverts 5.2 m (17 ft) in diameter and 10.7 m (35 ft) long that extended 9.1 m (30 ft) below grade (GE 1966). All three silos were standing vertically on end with the top 1.5 m (5 ft) above grade and had concrete covers. The silos were numbered 1, 2, and 3 from south to north. Figure 2 is an aerial photograph taken in 1983 and shows the top of silo 3 exposed at the surface. The silos were covered and surrounded with an earth berm and had a 30.5 m (100 ft) reinforced concrete retaining wall along the west side (Figure 3). The bottom of each silo was open to the soil below.

Figure 1. The 118-N-1 Waste Site Location Map.

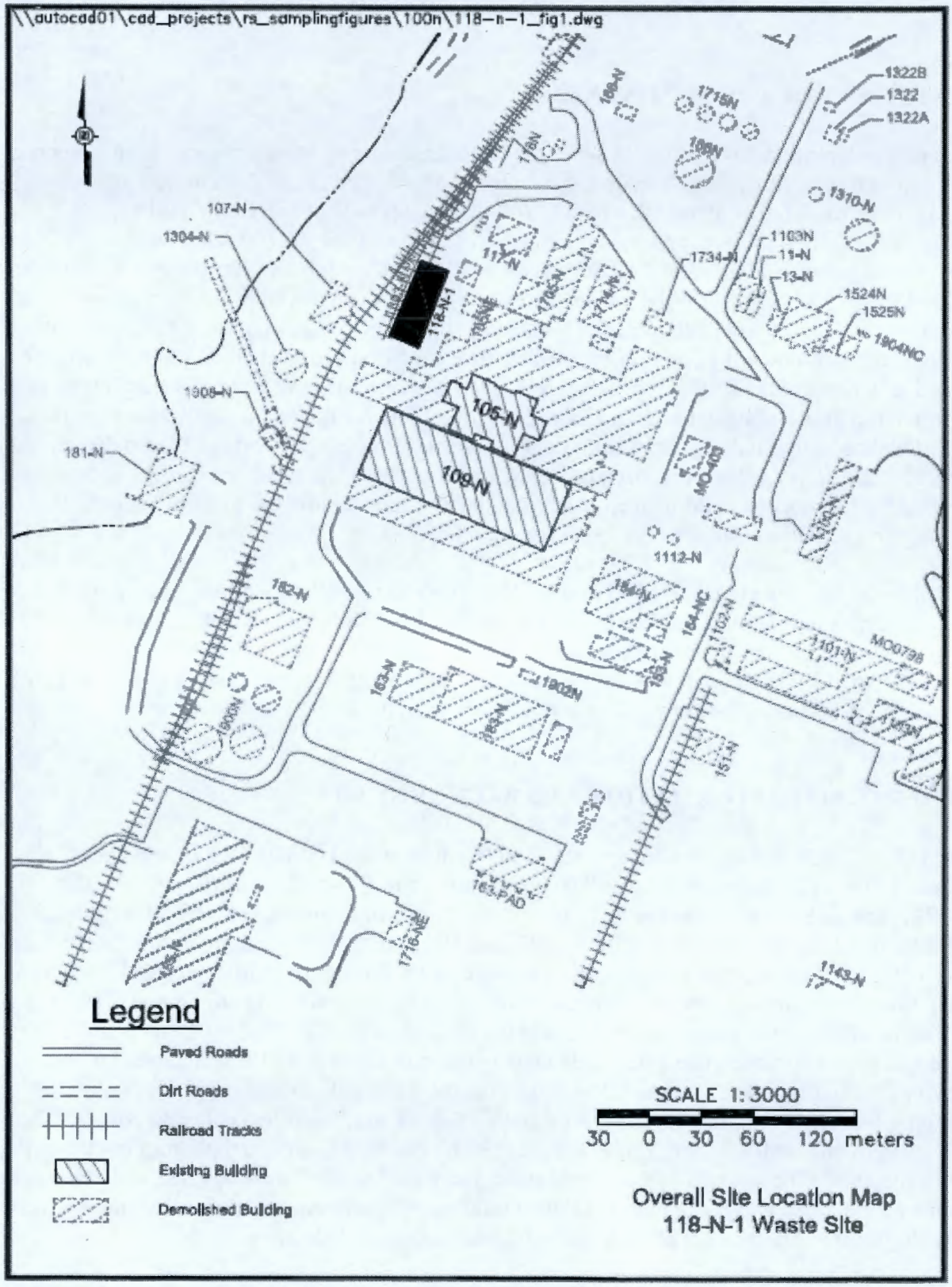


Figure 2. 118-N-1, 1303-N Fuel Rod Spacer Silos (1983).

Figure 3. 118-N-1, 1303-N Fuel Rod Spacer Silos – Pre-Demolition.

The fuel rod spacers (also known as fuel element dummies) were used to optimize the position of fuel in the pressure tubes of N-Reactor. The spacers consisted of 5.1-cm (2-in.) internal diameter carbon steel pipe with 0.3-cm (1/8-in.) wall thickness. They were in basic lengths of 43 cm (17 in.), 57 cm (22.5 in.), and 70 cm (27.5 in.), but the predominant size used in reactor reloads was 57 cm (22.5 in.). Interspersed about their walls were 1.3-cm (0.5-in.) diameter holes numbering 72, 92, and 120 respectively. Radioactive contamination associated with the spacers consisted of mixed fission products associated with reactor process water (as surface contamination) and Co-60 as an activation product in the carbon steel spacers.

The fuel rod spacers were transferred from the 105-N Reactor fuel storage basin to the silos by placing a spacer in a 7.6-cm (3-in.) spacer transfer line and then pushing it forward with the next spacer using a winch and cable carrier system. Openings in the carrier end plates prevented excess amounts of water from reaching the silos (burial pits) (GE 1963a). Water from the 105-N fuel storage basin was used to dislodge spacers that became stuck in the transfer line. This spacer transfer line is known as the "dummy disposal line" and is identified in the Hanford Waste Information Data System (WIDS) as part of the 100-N-84:6, 100-N Area Chemical and Process Sewer Pipelines waste site. However, this transfer line is a unique pipeline and is not interconnected with any of the other 100-N-84:6 pipelines. When a silo was completely full, the spacers were removed and shipped to the 200 Area burial grounds for disposal (Figure 4). The amount of spacers removed and shipped at any one time varied, depending upon reactor operations.

Figure 4. Removal of Spacers from Silos (April 1983).

Noncontaminated water was sprayed into the silos in 1984 to prevent airborne contamination during removal of the spacers. However, it was decided to discontinue spraying water because it could potentially wash contamination into the soil. Therefore, paint was used to fix the contamination instead of using water spray to control airborne contamination levels.

Beyond the intended use of the open-bottomed silos, two documented releases to the ground have been associated with the spacer storage silos and associated piping:

- March 8, 1978 (UN-100-N-3): A leak was detected in the spacer transfer line. The first indication of the leak was the appearance of a 1.2-m (4-ft) diameter by 76 cm (30-in.) deep sinkhole between the 105-N Lift Station and the spacer storage silos. Excavation of the sinkhole area revealed a crack in the 7.6-cm (3-in.) reinforced plastic pipe approximately 3.4 m (11 ft) below grade. It was estimated that approximately 1,400,000 L (360,000 gal) of irradiated N Reactor fuel storage basin water entered the ground (UNI 1978). An unknown amount of soil was removed and disposed at the 200 Area burial ground. This release is administratively designated as the UPR-100-N-3 waste site.

- February 27, 1979 (UN-100-N-12): A leak similar to the March 8, 1978, release occurred. A 0.6 m by 0.9 m by 46 cm (2 ft by 3 ft by 18 in.) sinkhole was discovered at the backfilled location of the previous leak. The pressure necessary to transport the spacers within the transfer line apparently caused the line to rupture. An estimated 950,000 L (250,000 gal) of irradiated 105-N Reactor fuel storage basin water was released to the ground (UNI 1979). The plastic pipe was replaced with a stainless steel pipe. It is unknown if the contaminated soil was removed or covered. This release is administratively designated as the UPR-100-N-12 waste site.

All remaining spacers were removed from the silos in 1995 and the silos were inspected with video cameras to confirm they were empty. The videos showed an accumulation of several inches of paint in the bottom of silos 2 and 3 from the use of paint for airborne contamination control. In 1996, contamination was found outside the chain link fence surrounding the site. To provide interim stabilization to prevent the spread of contamination, a bulldozer was used to push the contaminated material into the area surrounding the silos and cover the entire contaminated area with 15 cm (6 in.) of crushed rock. The site was then posted as an underground radioactive material area (URMA) (WCH 2005). Demolition and removal of the 1303-N Spacer Silos (Figure 5) was completed by the Deactivation, Decontamination, Decommissioning, and Demolition (D4) project on June 27, 2012 (WCH 2013b, WCH 2013c, DOE-RL 2013). All waste was managed within the area of contamination (AOC) prior to shipment to the ERDF. No waste staging piles were used.

Figure 5. Spacer Silo Decommissioning (May 2012).

A general Global Positioning Environmental Radiological Surveyor (GPERS) survey of the 1303-N/117-N/105-NE/107-N Fuel Storage Basin Transfer Bay area was conducted on December 14, 2012, at the completion of D4 activities in the general area. Beta and gamma contamination was detected in these surveys, including contamination within the spacer silo excavation.

The Field Remediation (FR) project subsequently removed contaminated soil from the area northwest of the 105-N Reactor, including removing additional soil from the 118-N-1 excavation. New beta (Figure 6) and gamma (Figure 7) GPERS surveys were performed March 8, 2013, after this additional soil removal. These surveys show residual radiological beta and gamma contamination remains in the excavation below the former locations of silos 2 and 3. Up to 70,316 counts per minute gamma activity was detected below the former location of silo 2; gamma contamination was also detected below the former location of silo 3 at lower activities. Beta activity was detected above background in the excavation below the former locations of both silo 2 and silo 3. Focused verification samples were collected below the former locations of each of these silos to support evaluation of this residual radiological contamination (WCH 2013d).

Figure 6. 118-N-1 GPERS Radiological Survey Beta Track Map.

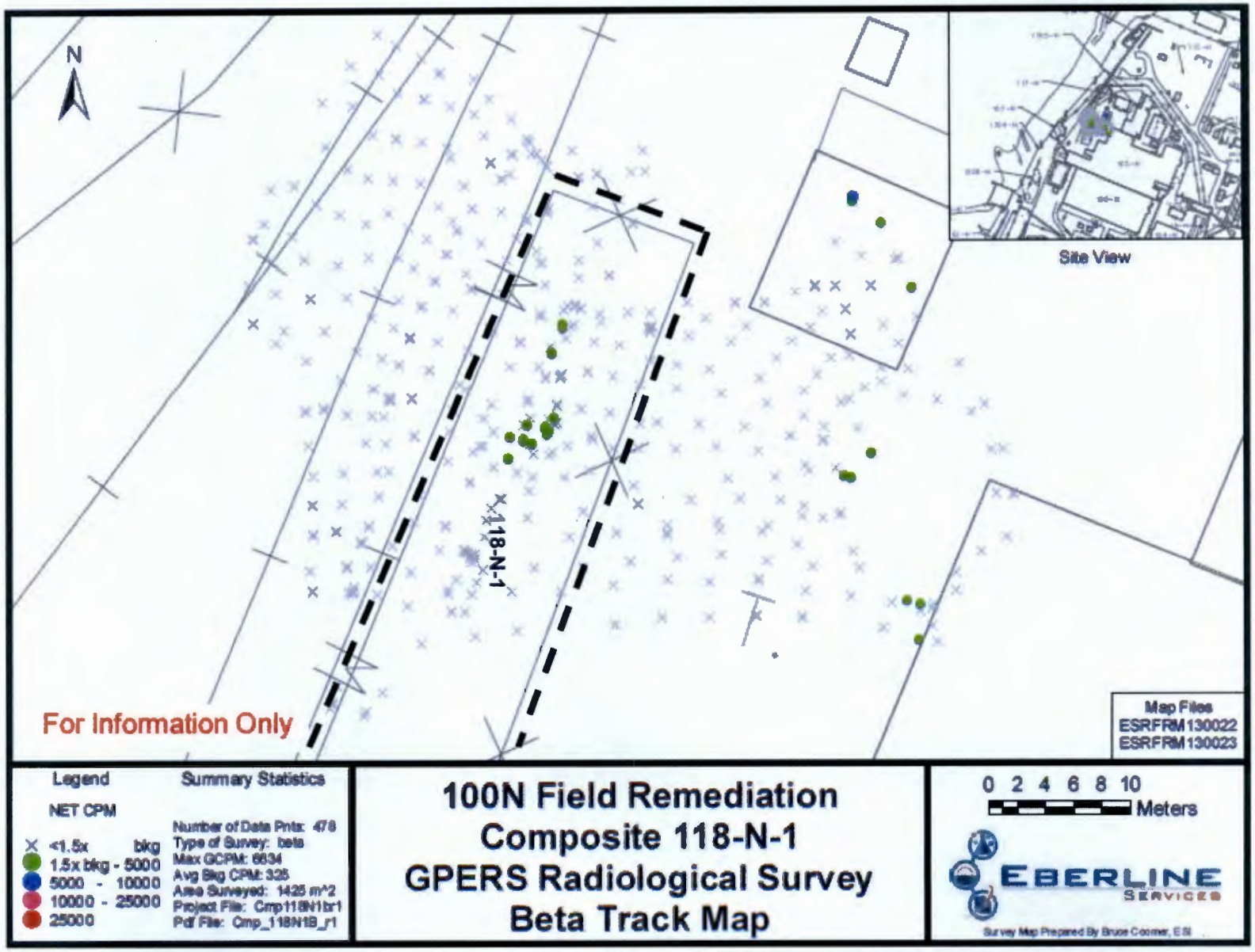
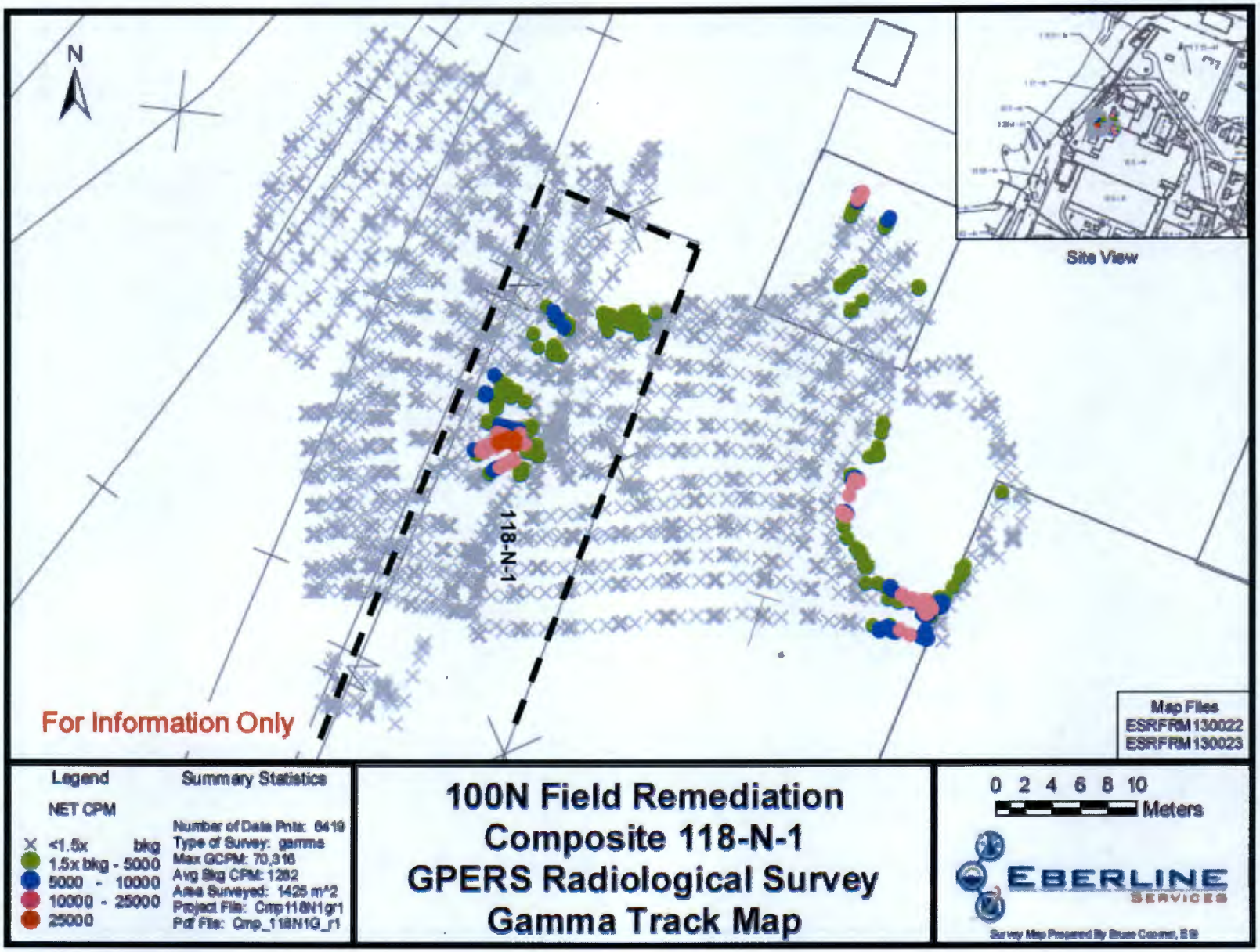


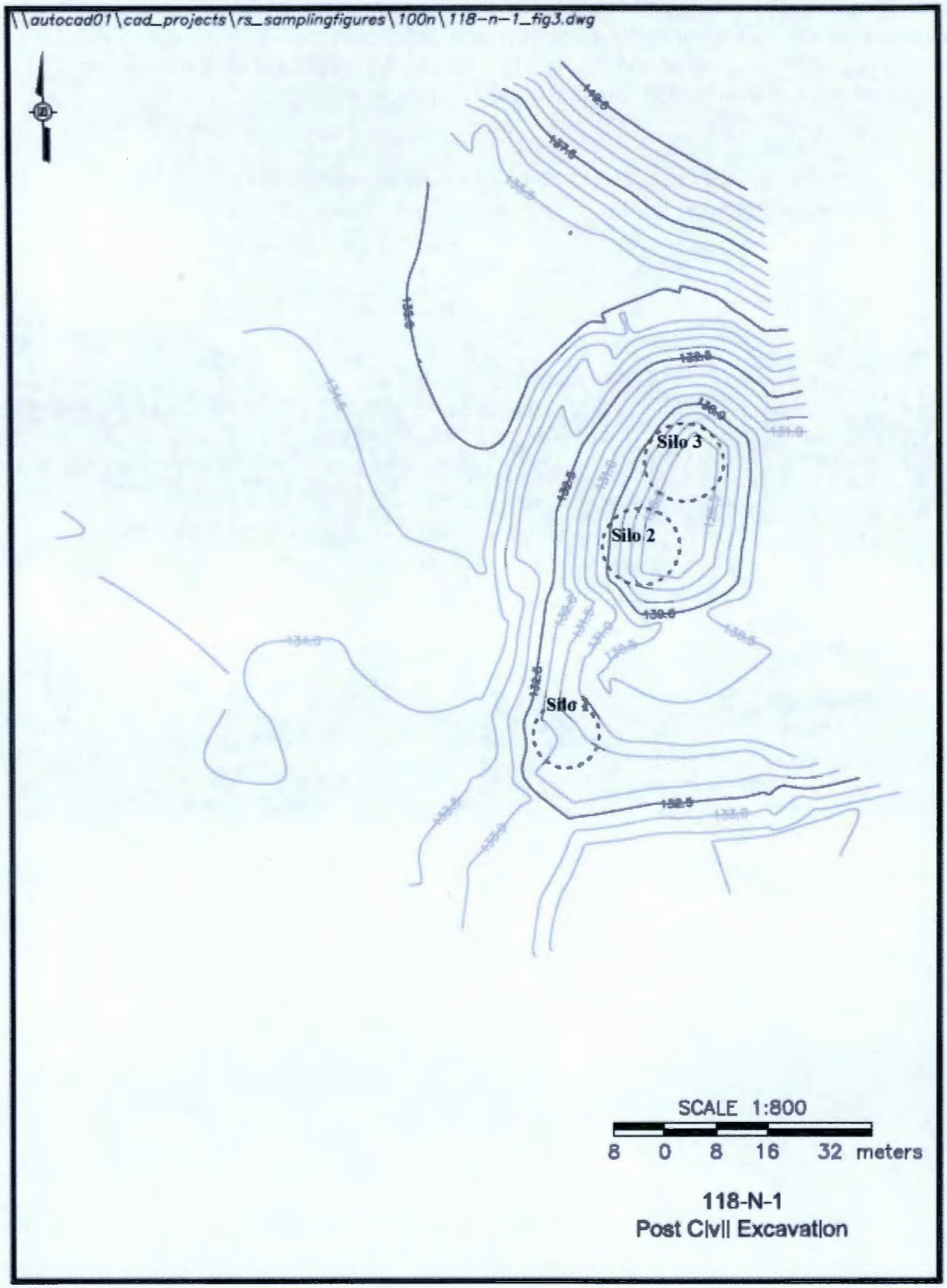
Figure 7. 118-N-1 GPERS Radiological Survey Gamma Track Map.



It is estimated that approximately 8,680 bank cubic meters of soil was removed by the FR project from January 4, 2013, through March 22, 2013, as part of the additional soil remediation. All waste was direct loaded during the excavation and disposed at the ERDF. Figure 8 is a photograph of the excavation and Figure 9 provides a post-excavation civil survey. No anomalies were encountered during the remedial action activities.

Figure 8. 118-N-1 Soil Excavation (July 2012).

Figure 9. 118-N-1 Post-Excavation Civil Survey.



VERIFICATION SAMPLING ACTIVITIES

Significant demolition and remediation has been performed over much of the area on the western side of the 105/109-N Reactor complex (Figure 8), affecting the overall topography of the area. Verification sampling for the 118-N-1 waste site was focused to the excavation footprint area of the former silos and on the immediately surrounding remediation footprint. This verification sampling was also used to support the future reclassification basis for the portion of the 100-N-84:6 transfer pipeline that was within the same footprint without further verification sampling. The UPR-100-N-3, UPR-100-N-10, and UPR-100-N-12 sites were addressed by a separate verification sampling instruction (WCH 2013e) and included the remaining portion of the 100-N-84:6 transfer pipeline.

Verification sampling of the 118-N-1 waste site was performed on April 23 and 25, 2013, and May 13, 2013 (WCH 2013a), to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100-N Area RDR/RAWP (DOE-RL 2006b) and the 100-N Area ROD (EPA 1999). The verification sample results are provided in Appendix A and indicate that the waste removal action achieved compliance with the remedial action objectives (RAOs) and RAGs for the 118-N-1 waste site. The following subsections provide additional discussion of the verification sampling design. The results of verification sampling are also summarized to support interim closure of the site. A more detailed discussion of the verification sample design can be found in the *Work Instruction for Verification Sampling of the 118-N-1 Waste Site* (WCH 2013d).

Contaminants of Potential Concern

The contaminants of potential concern (COPCs) for the 118-N-1, 1303-N Spacer Silos waste site were identified based on known and suspected sources of contaminants associated with discharges to the silos and historical sample results collected for the 105-N Fuel Storage Basin. The COPCs included americium-241, carbon-14, cesium-137, cobalt-60, europium-152, europium-154, europium-155, nickel-63, plutonium-238, plutonium-239, strontium-90, tritium, uranium-234, uranium-235, uranium-238, polychlorinated biphenyls (PCBs), chromium (total), hexavalent chromium, lead, and mercury. In addition, the expanded list of inductively coupled plasma (ICP) metals analysis included antimony, arsenic, barium, beryllium, boron, cadmium, cobalt, copper, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

A summary of the contaminants analyzed and their analytical methods is provided in Table 1. Verification samples were analyzed using EPA-approved analytical methods (DOE-RL 2006b).

Table 1. 118-N-1 Laboratory Analytical Methods and Contaminants of Potential Concern. (2 Pages)

Analytical Method	Contaminant of Potential Concern
GEA – Gamma spectroscopy	Americium-241, cesium-137, cobalt-60, europium-152, europium-154, europium-155
Sr-90 – Liquid scintillation counting	Strontium-90
Ni-63 – Liquid scintillation counting	Nickel-63

Table 1. 118-N-1 Laboratory Analytical Methods and Contaminants of Potential Concern. (2 Pages)

Analytical Method	Contaminant of Potential Concern
C-14 – Liquid scintillation counting	Carbon-14
Isotopic uranium	Uranium-233/234, uranium-235, uranium-238
Isotopic plutonium	Plutonium-238, plutonium-239/240
Tritium – Liquid scintillation counting	Tritium
ICP metals [a] – EPA Method 6010	Chromium, lead
Mercury – EPA Method 7471	Mercury
Hexavalent chromium – EPA Method 7196	Hexavalent chromium
PCB – EPA Method 8082	Polychlorinated biphenyls

[a] Analysis for the expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.

EPA = U.S. Environmental Protection Agency
GEA = gamma energy analysis
ICP = inductively coupled plasma
PCB = polychlorinated biphenyl

Verification Sample Design

This section describes the basis for selection of the sample design and determination of the number of verification samples. A statistical sampling design was used to collect verification samples from within the footprint of the 118-N-1 waste site excavation. Additionally, one focused soil sample was collected from directly below each of the three silos (WCH 2013d).

A test pit was also excavated at the location of the highest radiological contamination identified in the GPERS survey, in the excavation beneath the former location of silo 2 (Figure 7). Soil samples were collected at 1 m (3.3 ft) depth intervals within the test pit to provide vertical distribution profile data for evaluation of residual radiological contamination and support evaluation of protection of groundwater and the river.

All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (DOE-RL 2006a). The samples were submitted for full protocol laboratory analyses. Additional information concerning sample collection can be found in the field sampling logbook (WCH 2013a).

Table 2 provides a summary of the verification samples and Figure 10 shows the sample locations.

Table 2. 118-N-1 Verification Sample Summary [a].

Sample Location	HEIS Sample Number	Washington State Plane		Sample Analysis
		Easting (m)	Northing (m)	
Statistical Sample Locations				
EXC-1	J1RLK3	571139.6	149553.3	GEA, strontium-90, nickel-63, carbon-14, isotopic uranium, isotopic plutonium, tritium [b], PCBs, ICP metals [c], mercury, hexavalent chromium
EXC-2	J1RLK1	571148.9	149548.3	
EXC-3	J1RLK2	571148.6	149558.9	
EXC-4	J1RLR9	571157.9	149553.9	
EXC-5	J1RKW7	571148.2	149569.4	GEA, strontium-90, nickel-63, carbon-14, isotopic uranium, isotopic plutonium, tritium [b], PCBs, ICP metals [c], mercury, hexavalent chromium
EXC-6	J1RKW8	571157.6	149564.5	
EXC-7	J1RKW9	571157.2	149575.0	
EXC-8	J1RKX0	571166.6	149570.1	
EXC-9	J1RKX1	571156.9	149585.6	
EXC-10	J1RKX2	571166.2	149580.6	
EXC-11	J1RKX3	571156.5	149596.2	
EXC-12	J1RKX4	571165.9	149591.2	
Duplicate of J1RKW9	J1RKX5	571157.2	149575.0	
Split of J1RKW9	J1RKX6	571157.2	149575.0	
Focus Sample Locations				
FS-1 (Silo #1)	J1RKX7	571151.7	149565.3	GEA, strontium-90, nickel-63, carbon-14, isotopic uranium, isotopic plutonium, tritium [b], PCBs, ICP metals [c], mercury, hexavalent chromium
FS-2 (Silo #2)	J1RKX8	571157.7	149580.2	
FS-3 (Silo #3)	J1RKX9	571160.9	149586.7	
Test Pit Samples				
Excavation floor	J1RLR5	571157.4	149579.0	GEA, strontium-90, nickel-63, carbon-14, isotopic uranium, isotopic plutonium, tritium, PCBs, ICP metals [c], mercury, hexavalent chromium
1 m (3.3 ft) depth	J1RLR6			
2 m (6.6 ft) depth	J1RLR7			
3 m (9.8 ft) depth	J1RLR8			
Equipment blank	J1RLT0	NA	NA	ICP metals [c], mercury

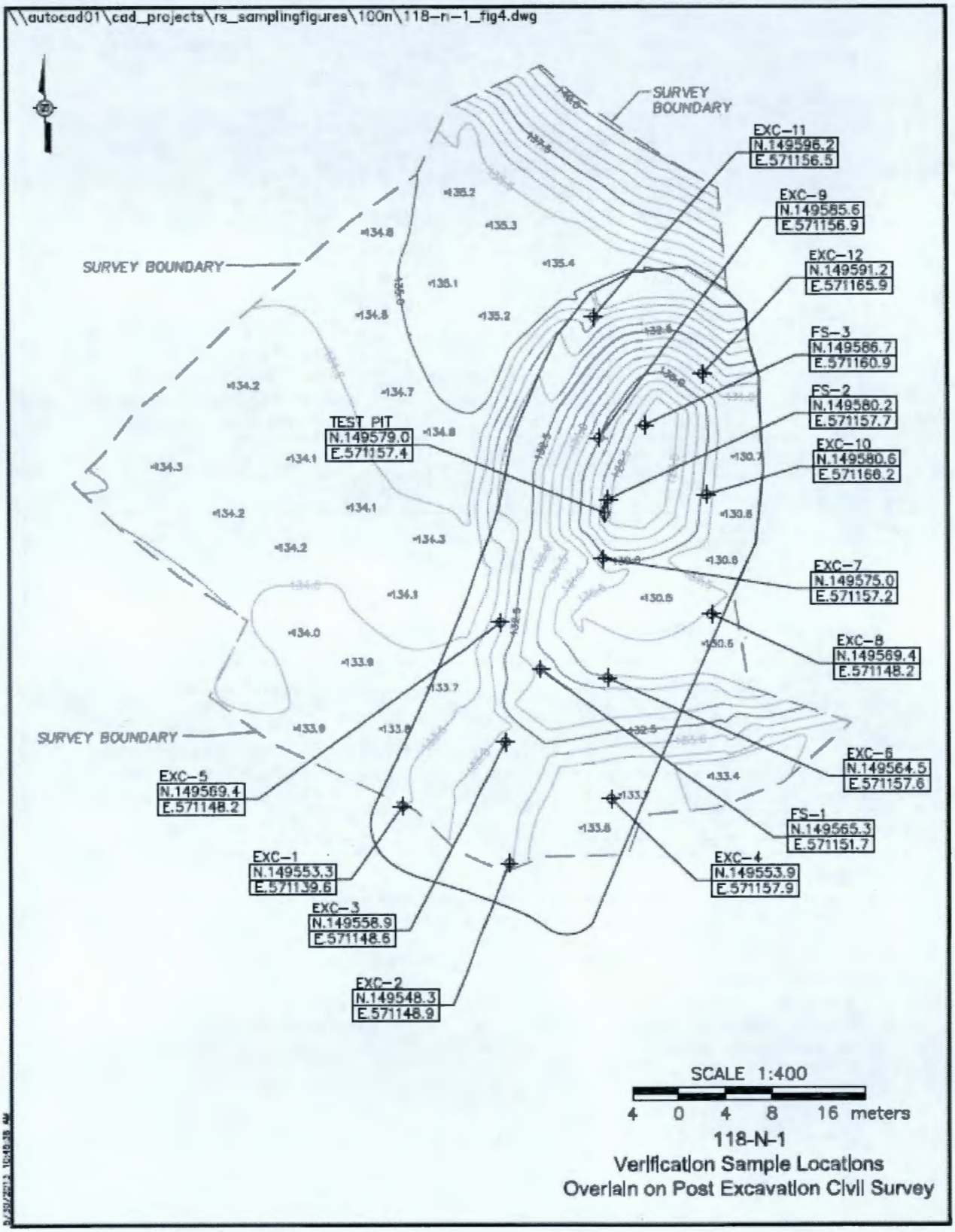
[a] Full protocol laboratory analysis was performed as defined in Table 1. Discrete, grab samples were collected from each sampling location.

[b] The portion of the sample for tritium analyses was collected at a depth of 0.15 m (6 in.) below the excavation surface per Tri-Party Agreement Change Notice TPA-CN-177 (dated August 21, 2007).

[c] The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium(total), cobalt, copper, lead, manganese, magnesium, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.

GEA = gamma energy analysis
HEIS = Hanford Environmental Information System
ICP = inductively coupled plasma
NA = not applicable
PCB = polychlorinated biphenyl

Figure 10. Verification Sample Locations for the 118-N-1 Waste Site.



Verification Sampling Results

Evaluation of the verification data from the excavation was performed by direct comparison of the statistical or maximum sample results for each COPC against cleanup criteria. The primary statistical calculation to evaluate compliance with cleanup standards is the 95% upper confidence limit (UCL) on the arithmetic mean of the data. The 95% UCL values for each detected COPC are computed for the 118-N-1 waste site as specified by the 100-N Area RDR/RAWP (DOE-RL 2006b). The calculations are provided in Appendix A. When a nonradionuclide COPC was detected in fewer than 50% of the verification samples collected for a decision unit, the maximum detected value was used for comparison to the RAGs. If no detections for a given COPC were reported in the data set, then no statistical calculation or evaluation was performed for that COPC. The sample results for the focused samples and the test pit samples were evaluated using the maximum detected concentration for each COPC and comparing the value directly against the RAG.

Comparisons of the sample results against the RAGs for each COPC from statistical verification samples and the focused samples for the 118-N-1 waste site are summarized in Tables 3 and 4, respectively. Comparison of the sample results for the test pit against the RAGs is provided in Table 5. Since the entire 118-N-1 excavation is located within the deep vadose zone (i.e., greater than 4.6 m [15 ft] depth), no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation. Therefore, evaluation of attainment of RAGs for the site as shown in Tables 3, 4, and 5 is limited to demonstrating that residual contamination is protective of groundwater and the Columbia River. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2012) under WAC 173-340-740(3), "Model Toxics Control Act – Cleanup," for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COPCs and are not included in the table. The complete laboratory results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archival in the HEIS, and are presented in Attachment 1 of the 95% UCL calculation (Appendix A).

Table 3. Comparison of Statistical Values to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Statistical or Maximum Result [b] (pCi/g)	Soil Lookup Values (pCi/g) [a]		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Americium-241	0.0587	-- [c]	-- [c]	No	--
Cesium-137 [d]	0.748 (<BG)	1,465	2,930	No	--
Cobalt-60 [d]	0.0429	13,900	27,800	No	--
Europium-155	0.0378 (<BG)	-- [c]	-- [c]	No	--
Nickel-63 [d]	60.2	83	166	No	--
Plutonium-239/240	0.235	-- [c]	-- [c]	No	--

Table 3. Comparison of Statistical Values to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Statistical or Maximum Result [b] (pCi/g)	Soil Lookup Values (pCi/g) [a]		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Strontium-90 [d]	1.70	27.6	55.2	No	--
Tritium [d]	0.0307	12.6	25.2	No	--
Uranium-234	0.190 (<BG)	1.1 [e]	1.1 [e]	No	--
Uranium-238	0.221 (<BG)	1.1 [e]	1.1 [e]	No	--
COPC	**Statistical or Maximum Result [b] (mg/kg)**	**Remedial Action Goals (mg/kg) [a]**		**Does the Result Exceed RAGs?**	**Do the Results Pass RESRAD Modeling?**
		Soil Cleanup Level for Groundwater Protection	**Soil Cleanup Level for River Protection**		
Antimony [f]	1.1 (<BG)	5 [e]	5 [e]	No	--
Arsenic	1.3 (<BG)	20 [e]	20 [e]	No	--
Barium	53.1 (<BG)	200	400	No	--
Beryllium	0.21 (<BG)	1.51 [e]	1.51 [e]	No	--
Cadmium [f]	0.12 (<BG)	0.81 [e]	0.81 [e]	No	--
Chromium	4.6 (<BG)	18.5 [e]	18.5 [e]	No	--
Cobalt	9.6 (<BG)	32	-- [g]	No	--
Copper	13.1 (<BG)	59.2	22.0 [e]	No	--
Hexavalent chromium [h]	0.314	4.8	2	No	--
Lead	2.5 (<BG)	10.2 [e]	10.2 [e]	No	--
Manganese	289 (<BG)	512 [e]	-- [g]	No	--
Molybdenum [h]	0.28	8	-- [g]	No	--
Nickel	8.7 (<BG)	19.1 [e]	27.4	No	--
Selenium [f]	0.84	5	1	No	--
Silver	0.17 (<BG)	8	0.73 [e]	No	--
Vanadium	59.9 (<BG)	85.1 [e]	-- [g]	No	--
Zinc	41.5 (<BG)	480	67.8 [e]	No	--

[a] Lookup values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless otherwise noted.
[b] Maximum or 95% UCL, depending on data censorship, as described in the *118-N-1 Waste Site Cleanup Verification 95% UCL Calculation* (Appendix A).
[c] No value because the distribution coefficient (K_d) value for this contaminant is greater than 80 mL/g, RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009) predicts that the contaminant will show no migration within the 100 Area vadose zone and no impact on groundwater or the Columbia River.
[d] Lookup values and RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009).
[e] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).
[f] Hanford site-specific background not available. Value is from Ecology (1994).
[g] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).
[h] No Hanford Site-specific or Washington State background value available.

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
UCL = upper confidence limit
WAC = *Washington Administrative Code*

Table 4. Comparison of Focused Sample Results to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Maximum Result [b] (pCi/g)	Soil Lookup Values (pCi/g) [a]		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Americium-241	0.119	-- [c]	-- [c]	No	--
Carbon-14	1.53	-- [c]	-- [c]	No	--
Cesium-137 [d]	2.86	1,465	2,930	No	--
Cobalt-60 [d]	2.78	13,900	27,800	No	--
Nickel-63 [d]	18.0	83	166	No	--
Plutonium-239/240	0.383	-- [c]	-- [c]	No	--
Strontium-90 [d]	5.84	27.6	55.2	No	--
Tritium [d]	0.223	12.6	25.2	No	--
Uranium-234	0.163 (<BG)	1.1 [e]	1.1 [e]	No	--
Uranium-238	0.169 (<BG)	1.1 [e]	1.1 [e]	No	--
COPC	**Maximum Result [b] (mg/kg)**	**Remedial Action Goals (mg/kg) [a]**		**Does the Result Exceed RAGs?**	**Do the Results Pass RESRAD Modeling?**
		Soil Cleanup Level for Groundwater Protection	**Soil Cleanup Level for River Protection**		
Arsenic	1.2 (<BG)	20 [e]	20 [e]	No	--
Barium	62.9 (<BG)	200	400	No	--
Beryllium	0.24 (<BG)	1.51 [e]	1.51 [e]	No	--
Cadmium [f]	0.12 (<BG)	0.81 [e]	0.81 [e]	No	--
Chromium	4.7 (<BG)	18.5 [e]	18.5 [e]	No	--
Cobalt	9.6 (<BG)	32	-- [g]	No	--
Copper	11.2 (<BG)	59.2	22.0 [e]	No	--
Lead	2.5 (<BG)	10.2 [e]	10.2 [e]	No	--
Manganese	299 (<BG)	512 [e]	-- [g]	No	--
Mercury	0.21 (<BG)	0.33 [e]	0.33 [e]	No	--
Molybdenum [h]	0.25	8	-- [g]	No	--
Nickel	8.7 (<BG)	19.1 [e]	27.4	No	--
Selenium [f]	1.1	5	1	Yes	Yes [i]
Vanadium	59.0 (<BG)	85.1 [e]	-- [g]	No	--
Zinc	43.0 (<BG)	480	67.8 [e]	No	--

Table 4. Comparison of Focused Sample Results to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]		Does the Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Aroclor-1254	0.003	0.017 [j]	0.017 [j]	No	--

[a] Lookup values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless otherwise noted.
[b] Focused sample results are provided in Appendix A.
[c] No value; because the distribution coefficient (K_d) value for this contaminant is greater than 80 mL/g, RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009) predicts that the contaminant will show no migration within the 100 Area vadose zone and no impact on groundwater or the Columbia River.
[d] Lookup values and RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009).
[e] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).
[f] Hanford site-specific background not available. Value is from Ecology (1994).
[g] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).
[h] No Hanford Site-specific or Washington State background value available.
[i] A site-specific RESRAD evaluation (0100N-CA-V0225) determined that the concentration of residual selenium contamination was insufficient to exceed river protection criteria within 1,000 years. Calculation is provided in Appendix A.
[j] Where cleanup levels are less than RDLs, cleanup levels default to RDLs per WAC 173-340-707(2) (Ecology 1996).

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDL = required detection limit
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

Table 5. Comparison of Test Pit Sample Results to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Maximum Result [b] (pCi/g)	Soil Lookup Values (pCi/g) [a]		Does the Result Exceed Lookup Values?	Does the Result Pass RESRAD Modeling?
		Soil Lookup Value for Groundwater Protection	Soil Lookup Value for River Protection		
Americium-241	448	-- [c]	-- [c]	No	--
Carbon-14	0.363	-- [c]	-- [c]	No	--
Cesium-137 [d]	2250	1,465	2,930	Yes	Yes [e]
Cobalt-60 [d]	81.6	13,900	27,800	No	--
Europium-154	28.8	-- [c]	-- [c]	No	--
Europium-155	2.92	-- [c]	-- [c]	No	--
Nickel-63 [d]	58.7	83	166	No	--
Plutonium-238	2.50	-- [c]	-- [c]	No	--
Plutonium-239/240	28.8	-- [c]	-- [c]	No	--
Strontium-90 [d]	970	27.6	55.2	Yes	Yes [e]
Uranium-234	0.307 (<BG)	1.1 [f]	1.1 [f]	No	--
Uranium-238	0.279 (<BG)	1.1 [f]	1.1 [f]	No	--

Table 5. Comparison of Test Pit Sample Results to Action Levels for the 118-N-1 Waste Site Excavation. (2 Pages)

COPC	Maximum Result [b] (mg/kg)	Remedial Action Goals (mg/kg) [a]		Does the Result Exceed RAGs?	Do the Results Pass RESRAD Modeling?
		Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection		
Antimony [g]	0.96 (<BG)	5 [f]	5 [f]	No	–
Arsenic	1.1 (<BG)	20 [f]	20 [f]	No	–
Barium	49.7 (<BG)	200	400	No	--
Beryllium	0.079 (<BG)	1.51 [f]	1.51 [f]	No	--
Cadmium [g]	0.15 (<BG)	0.81 [f]	0.81 [f]	No	--
Chromium	3.7 (<BG)	18.5 [f]	18.5 [f]	No	--
Cobalt	9.4 (<BG)	32	-- [h]	No	--
Copper	14.2 (<BG)	59.2	22.0 [f]	No	--
Hexavalent chromium [i]	0.194	4.8	2	No	--
Lead	2.3 (<BG)	10.2 [f]	10.2 [f]	No	--
Manganese	282 (<BG)	512 [f]	-- [h]	No	--
Mercury	0.46	0.33 [f]	0.33 [f]	No	Yes [j]
Nickel	6.7 (<BG)	19.1 [f]	27.4	No	--
Vanadium	57.7 (<BG)	85.1 [f]	-- [h]	No	--
Zinc	58.3 (<BG)	480	67.8 [f]	No	--

[a] Lookup values and RAGs obtained from the 100-N Area RDR/RAWP (DOE-RL 2006b), unless otherwise noted.

[b] Test pit sample results are provided in Appendix A.

[c] No value; because the distribution coefficient (K_d) value for this contaminant is greater than 80 mL/g, RESRAD modeling discussed in Appendix C of the 100 Area RDR/RAWP (DOE-RL 2009) predicts that the contaminant will show no migration within the 100 Area vadose zone and no impact on groundwater or the Columbia River.

[d] Lookup values and RAGs obtained from the 100 Area RDR/RAWP (DOE-RL 2009).

[e] A site-specific RESRAD evaluation (0100N-CA-V0226) based on modeling discussed in Appendix C of the 100-N RDR/RAWP (DOE/RL 2006b) determined that residual radiological contamination will not exceed groundwater and/or Columbia River protection criteria within 1,000 years. Calculation is provided in Appendix A.

[f] Where cleanup levels are less than background, cleanup levels default to background per WAC 173-340-700(4)(d) (Ecology 1996). The arsenic cleanup level of 20 mg/kg has been agreed to by the Tri-Party Agreement project managers as discussed in Section 2.1.2.1 of the 100-N Area RDR/RAWP (DOE-RL 2006b).

[g] Hanford Site-specific background not available. Value is from Ecology (1994).

[h] No parameters (bioconcentration factors or ambient water quality criteria values) are available from the Washington State Department of Ecology Cleanup Levels and Risk Calculations database or other databases to calculate cleanup levels (WAC 173-340-730[3][a][iii], 1996 [Method B for surface waters]).

[i] No Hanford Site-specific or Washington State background value available.

[j] Based on RESRAD modeling discussed in Appendix C of the 100-N RDR/RAWP (DOE-RL 2006b), the residual concentration of mercury is not predicted to migrate more than 2.0 m (6.6 ft) vertically within 1,000 years based on the K_d value for mercury of 30 mL/g. The distance to groundwater from the bottom of the excavation area is 9.5 m (31.2 ft). Therefore, residual concentrations of mercury are predicted to be protective of groundwater and the Columbia River.

-- = not applicable
BG = background
COPC = contaminant of potential concern
RAG = remedial action goal
RDR/RAWP = Remedial Design Report/Remedial Action Work Plan
RESRAD = RESidual RADioactivity (dose model)
WAC = *Washington Administrative Code*

DATA EVALUATION

This section demonstrates that residual contaminant concentrations at the 118-N-1 waste site achieve the applicable RAGs developed to support unrestricted land use at the 100-N Area as established in the 100-N Area ROD (EPA 1999) and the 100-N Area RDR/RAWP (DOE-RL 2006b).

Attainment of Nonradionuclide RAGs

Tables 3 and 4 compare the statistical and focused verification sampling results, respectively, to the applicable soil RAGs for protection of groundwater and the Columbia River. Table 5 compares the maximum test pit verification sampling results to the RAGs for protection of groundwater and the Columbia River.

The entire 118-N-1 excavation is located within the deep vadose zone (i.e., greater than 4.6 m [15 ft] depth). Therefore, no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation and evaluation of attainment of RAGs for the site is limited to demonstrating that residual contamination is protective of groundwater and the Columbia River.

All COPCs were quantified below groundwater and/or river protection soil RAGs with the exception of mercury and selenium. For mercury, given the soil-partitioning coefficient of 30 mL/g, this contaminant is not expected to migrate more than 2 m (6.6 ft) vertically in 1,000 years based on Residual Radioactivity (RESRAD) modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b). The vadose zone beneath the 118-N-1 waste site is approximately 9.5 m (31.2 ft) thick; therefore, the residual concentration of mercury is predicted to be protective of groundwater and the Columbia River.

Selenium concentrations exceeded the soil RAGs for protection of the Columbia River. There is insufficient vadose zone to show groundwater/river protection for selenium with a soil-partitioning coefficient of 5 mL/g using the generic RESRAD model. Therefore, a site-specific RESRAD evaluation (0100N-CA-V0225) (Appendix A) was used to determine that the concentration of residual selenium contamination was insufficient to exceed river protection criteria within 1,000 years.

Three-Part Test for Nonradionuclides

A RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test, which consists of the following criteria: (1) the cleanup verification 95% UCL value must be less than the cleanup level, (2) no single detection shall exceed two times the cleanup criteria, and (3) the percentage of samples exceeding the cleanup criteria must be less than 10% of the data set.

The application of the three-part test for the 118-N-1 waste site is included in the 95% UCL calculations, where half or more of the data set was detected (Appendix A). The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs.

An additional application of the three-part test is included for the statistical data sets that default to the maximum because less than half of the data set was detected. The results of this evaluation indicate that residual COPC concentrations pass the three-part test in comparison against applicable RAGs.

Nonradionuclide Direct Contact Hazard Quotient and Carcinogenic Risk RAGs Attained

Nonradionuclide risk requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative carcinogenic risk of less than 1×10^{-5}. For the 118-N-1 waste site, these risk values were not calculated since the site consists entirely of soil located below a depth of 4.6 m (15 ft) and there is no direct exposure pathway.

Nonradionuclide Groundwater Hazard Quotient and Carcinogenic Risk RAGs Attained

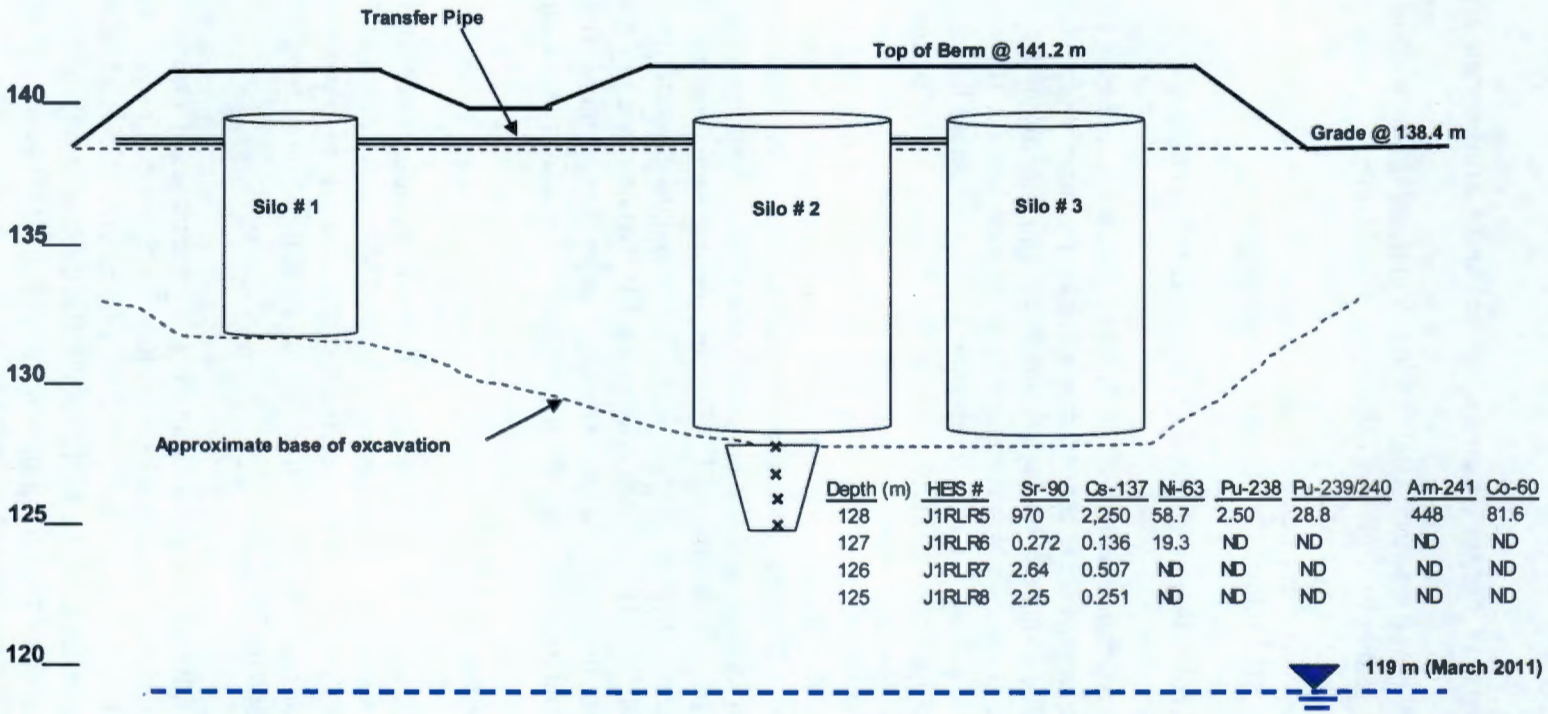
Assessment of the risk requirements for the 118-N-1 waste site included calculation of the hazard quotient and carcinogenic (excess cancer) risk values for groundwater protection for nonradionuclides. The requirements include an individual and cumulative hazard quotient of less than 1.0, an individual excess carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. Risk values were calculated for constituents that were detected at concentrations above Hanford Site or Washington State background values or for which there is no background value. In addition, the distribution coefficients for these contaminants must be less than that necessary to show no migration to groundwater in 1,000 years based on RESRAD modeling discussed in Appendix C of the 100-N Area RDR/RAWP (DOE-RL 2006b). Based on this model and a vadose zone of approximately 9.5 m (31.2 ft) in thickness, a distribution coefficient (K_d) of 7.5 or greater is required to show no predicted migration to groundwater in 1,000 years. All individual hazard quotients for noncarcinogenic constituents are less than 1.0. The cumulative hazard quotient for the 118-N-1 waste site is 2.0×10^{-1}, which is less than 1.0. No carcinogenic constituents met the criteria for evaluation; therefore, no calculations of excess carcinogenic risks were performed. Therefore, nonradionuclide risk requirements related to groundwater are met.

Attainment of Radionuclide RAGs

Evaluation of direct exposure RAG attainment for radionuclides is not required for the 118-N-1 waste site, since the site consists of soil located below a depth of 4.6 m (15 ft) and there is no direct exposure pathway. However, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required due to residual radiological activity in the deep zone exceeding direct exposure RAGs.

Radiological contamination was detected in the test pit samples. Cesium-137 and strontium-90 were detected at activities exceeding lookup values for protection of groundwater and the Columbia River (Table 5, Figure 11). However, site-specific RESRAD modeling performed in accordance with Appendix C of the RDR/RAWP (DOE/RL-2006b) indicates that tritium is the only radionuclide predicted to reach groundwater within 1,000 years, but at concentrations protective of groundwater and the Columbia River.

Figure 11. Cross-section for the Remediated 118-N-1 Waste Site.



Depth (m)	HEIS #	Sr-90	Cs-137	Ni-63	Pu-238	Pu-239/240	Am-241	Co-60
128	J1RLR5	970	2,250	58.7	2.50	28.8	448	81.6
127	J1RLR6	0.272	0.136	19.3	ND	ND	ND	ND
126	J1RLR7	2.64	0.507	ND	ND	ND	ND	ND
125	J1RLR8	2.25	0.251	ND	ND	ND	ND	ND

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the verification sampling approach (WCH 2013d), the field logbook (WCH 2013a), and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications. The DQA for the 118-N-1 waste site established that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. The evaluation verified that the sample design was sufficient for the purpose of clean site verification.
The cleanup verification sample analytical data are stored in the ENRE project-specific database for data evaluation prior to its archival in the HEIS and are summarized in Appendix A. The detailed DQA is presented in Appendix B.

SUMMARY FOR INTERIM CLOSURE

The 118-N-1 waste site has been evaluated in accordance with the 100-N Area ROD (EPA 1999) and the 100-N Area RDR/RAWP (DOE-RL 2006b). The entire 118-N-1 excavation is located within the deep vadose zone. Therefore, no direct exposure pathway to humans or ecological receptors will exist after backfill of the excavation and evaluation of attainment of remedial action goals for the site is limited to demonstrating that residual contamination is protective of groundwater and the Columbia River. The results of verification sampling and modeling show that residual contaminant concentrations are protective of groundwater and the Columbia River.

In accordance with this evaluation, the verification sampling results support a reclassification of the 118-N-1 waste site to Interim Closed Out. Site contamination is present in the deep zone soils; therefore, institutional controls to prevent uncontrolled drilling or excavation into the deep zone are required.

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APPENDIX A

CALCULATIONS

APPENDIX A

CALCULATIONS

The calculations in this appendix are kept in the active Washington Closure Hanford 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. The calculations have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculation," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix:

118-N-1 Waste Site Cleanup Verification 95% UCL Calculation, 0100N-CA-V0222, Rev. 0, Washington Closure Hanford, Richland, Washington.

118-N-1 Hazard Quotient and Carcinogenic Risk Calculations for Protection of Groundwater, 0100N-CA-V0224, Rev. 0, Washington Closure Hanford, Richland, Washington.

118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection, 0100N-CA-V0225, Rev. 0, Washington Closure Hanford, Richland, Washington.

118-N-1 RESRAD Calc Brief for Radionuclide Contamination, 0100N-CA-V0226, Rev. 0, Washington Closure Hanford, Richland, Washington.

DISCLAIMER FOR CALCULATIONS

The calculations provided in this appendix have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents.

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0222

Subject: 118-N-1 Waste Site Cleanup Verification 95% UCL Calculation

Computer Program: Excel Program No: Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 13 Attm. 1 = 6 Total = 20	N. K. Schiffern N.K. Schiffern	C. H. Dobie C H Dobie	I. B. Berezovskiy I B Berezovskiy	D. F. Obenauer D. F. Obenauer	8/20/13

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford **CALCULATION SHEET**

Originator N. K. Schiffern NS	**Date** 06/03/13	**Calc. No.** 0100N-CA-V0222	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** C. H. Dobie CD	**Date** 06/03/13
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations			**Sheet No.** 1 of 13

Summary

Purpose:
Calculate the 95% upper confidence limit (UCL) values to evaluate compliance with cleanup standards for the subject site. Also, perform the *Washington Administrative Code* (WAC) 173-340-740(7)(e) Model Toxics Control Act (MTCA) 3-part test for nonradionuclide analytes and calculate the relative percent difference (RPD) for primary-duplicate sample pairs for each contaminant of concern (COC) and contaminant of potential concern (COPC), as necessary.

Table of Contents:
Sheets 1 to 5 - Calculation Sheet Summary
Sheet 6 to 10 - Calculation Sheet Verification Data - Excavation
Sheet 11 to 12 - Ecology Software (MTCAStat) Results
Sheet 13 - Calculation Sheet Duplicate/Split Analysis
Attachment 1 - 118-N-1, Verification Sampling Results (6 sheets)

Given/References:
1) Sample Results (Attachment 1).
2) DOE-RL, 2006a, 100-N Area Sampling and Analysis Plan for CERCLA Waste Sites, DOE/RL-2005-92, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
3) DOE-RL, 2006b, Remedial Design Report/Remedial Action Work Plan for the 100-N Area, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
4) Ecology, 1992, Statistical Guidance for Ecology Site Managers, Publication #92-54, Washington Department of Ecology, Olympia, 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), Publication #92-54, Washington Department of Ecology, Olympia, Washington.
6) Ecology, 2012, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.
7) EPA, 1989, Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual, Part A; Interim Final, EPA/540/1-89/002, U.S. Environmental Protection Agency, Washington, D. C.
8) WAC 173-340, 1996, "Model Toxic Control Act - Cleanup," Washington Administrative Code.

Solution:
Calculation methodology is described in Ecology Pub. #92-54 (Ecology 1992, 1993), below, and in the RDR/RAWP (DOE-RL 2006b). Use data from attached worksheets to perform the 95% UCL calculation for each analyte, the WAC 173-340-740(7)(e) 3-part test for nonradionuclides, and the RPD calculations for each COC/COPC. The hazard quotient and carcinogenic risk calculations are located in a separate calculation brief as an appendix to the Remaining Sites Verification Package (RSVP).

Calculation Description:
The subject calculations were performed on statistical data from soil verification samples (Attachment 1) from the 118-N-1 waste site. The data were entered into an EXCEL 2003 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 (DOE-RL 2006b) is documented by this calculation. Duplicate RPD results are used in evaluation of data quality within the RSVP for this site.

Methodology:
The 118-N-1 waste site underwent verification sampling at one decision unit: excavation area. Twelve statistical samples (EXC-1 to EXC-12) were collected from the floor of the excavation. In addition, one focused soil sample was collected from below each of the three silos (FS-1 to FS-3) and four focused samples were collected from a test pit located below Silo #2 (FS-2). Sample results from the test pit location are provided in the attachment 1 only and will be used for evaluation in the RSVP.

Analytical results for all sampling locations are summarized in the tables provided on sheets 4 and 5. Further information of the sample data quality is presented in the data quality assessment section of the associated RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator N. K. Schiffern NS	**Date** 06/03/13	**Calc. No.** 0100N-CA-V0222	**Rev. No.** 0
Project 100-N Field Remediation	**Job No.** 14655	**Checked** C. H. Dobie CD	**Date** 06/03/13
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations			**Sheet No.** 2 of 13

Summary (continued)

Methodology, continued:

For nonradioactive analytes with ≤ 50% of the data below detection limits, the statistical value calculated to evaluate the effectiveness of cleanup is the 95% UCL. For nonradioactive analytes with >50% of the data below detection limits, as determined by direct inspection of the sample results (Attachment 1), the maximum detected value for the data set (which includes primary and duplicate samples) is used instead of the 95% UCL, and no further calculations are performed for those data sets. For convenience, these maximum detected values are included in the summary tables that follow. The 95% UCL was not calculated for data sets with no reported detections. Calculated cleanup levels are not available in (Ecology 2012) under WAC 173-340-740(3) for calcium, magnesium, potassium, silicon, and sodium. The EPA's *Risk Assessment Guidance for Superfund* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COCs/COPCs and are also not included in these calculations. The 95% UCL values were not calculated for potassium-40, radium-226, radium-228, thorium-228, and thorium-232 based on natural occurence at the Hanford Site.

All nonradionuclide data reported as being undetected are set to ½ the detection limit value for calculation of the statistics (Ecology 1993). 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 radionuclide data, calculation of the statistics is done using the reported value. In cases where the laboratory does not report a value below the minimum 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 ($n < 10$), the calculations are performed assuming nonparametric distribution, so no tests for distribution are performed. For nonradionuclide data sets of ten or greater, as for the subject site, distributional testing is done using Ecology's MTCAStat software (Ecology 1993). Due to differences in addressing censored data between the RDR/RAWP (DOE-RL 2006b) and MTCAStat coding and due to a limitation in the MTCAStat coding (no direct capability to address variable quantitation limits within a data set), substitutions for censored data are performed before software input and the resulting data set treated as uncensored.

The WAC 173-340-740(7)(e) 3-part test is performed for nonradionuclide analytes only and determines if:
1) the 95% UCL exceeds the most stringent cleanup limit for each COPC/COC,
2) greater than 10% of the raw data exceed the most stringent cleanup limit for each COPC/COC,
3) the maximum value of the raw data set exceeds two times the most stringent cleanup limit for each COPC/COC.

The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDLs are pre-determined values for analytical methods and constituents with cleanup levels as listed in Table 2-1 of the SAP (DOE-RL 2006a). Table 2-1 includes nominal TDLs for identified methods based organic analyses. The nominal TDLs are also used in support of the RPD calculation for the methods based analytes. TDLs not included in Table 2-1 are based on the laboratory and/or methods used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. 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) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. If the RPD is greater than 30%, further investigation regarding the usability of the data is performed. To assist in the identification of anomalous sample pairs, when an analyte is detected in the primary or duplicate/split sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate/split result exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. Additional discussion as necessary is provided in the data quality assessment section of the applicable RSVP.

Washington Closure Hanford **CALCULATION SHEET**

Originator	N. K. Schiffern NS	**Date**	06/03/13	**Calc. No.**	0100N-CA-V0222	**Rev. No.**	0
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD	**Date**	06/03/13
Subject	118-N-1 Waste Site Cleanup Verification 95% UCL Calculations					**Sheet No.**	3 of 13

Summary (continued)

QUALIFIER LIST

B = estimate
J = estimate
N = recovery is outside control limits
U = undetected
X = serial dilution indicates that physical and chemical interferences are present.

ACRONYM LIST

-- = not applicable
DE = direct exposure
EXC = excavation
GW = groundwater
MDA = minimum detected activity
MTCA = *Model Toxics Control Act*
NA = not applicable
PQL = practical quantitation limit
Q = qualifier
QA/QC = quality assurance/quality control
RAG = remedial action goal
RDR/RAWP = remedial design report/remedial action work plan
RESRAD = RESidual RADioactivity (dose model)
RPD = relative percent difference
RSVP = remaining sites verification package
SAP = sampling and analysis plan
TDL = target detection limit
UCL = upper confidence limit
WAC = Washington Administrative Code

Washington Closure Hanford **CALCULATION SHEET**

Originator N. K. Schiffern NS **Date** 06/03/13 **Calc. No.** 0100N-CA-V0222 **Rev. No.** 0
Project 100-N Field Remediation **Job No.** 14655 **Checked** C. H. Dobie CD **Date** 06/03/13
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations **Sheet No.** 4 of 13

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the excavation, the WAC 173-340-740(7)(e) 3-part test evaluation, and the RPD calculations, and are for use in risk analysis and the RSVP for this site.

Results Summary - Excavation Samples [a]

Analyte	EXC			Units
	95% UCL Result	Maximum Result	Focused Sample	
Americium-241	0.0587	--	0.119	pCi/g
Carbon-14	--	--	1.53	pCi/g
Cesium-137	0.748	--	2.86	pCi/g
Cobalt-60	0.0429	--	2.78	pCi/g
Europium-155	0.0378	--	--	pCi/g
Nickel-63	60.2	--	18.0	pCi/g
Plutonium-239/240	0.235	--	0.383	pCi/g
Total beta radiostrontium	1.70	--	5.84	pCi/g
Tritium	0.0307	--	0.223	pCi/g
Uranium-234	0.190	--	0.163	pCi/g
Uranium-238	0.221	--	0.169	pCi/g
Antimony	--	1.1	--	mg/kg
Arsenic	1.3	--	1.2	mg/kg
Barium	53.1	--	62.9	mg/kg
Beryllium	0.21	--	0.24	mg/kg
Cadmium	0.12	--	0.12	mg/kg
Chromium	4.6	--	4.7	mg/kg
Cobalt	9.6	--	9.6	mg/kg
Copper	13.1	--	11.2	mg/kg
Hexavalent Chromium	--	0.314	--	mg/kg
Lead	2.5	--	2.5	mg/kg
Manganese	289	--	299	mg/kg
Mercury	--	--	0.21	mg/kg
Molybdenum	--	0.28	0.25	mg/kg
Nickel	8.7	--	8.7	mg/kg
Selenium	--	0.84	1.1	mg/kg
Silver	--	0.17	--	mg/kg
Vanadium	59.9	--	59.0	mg/kg
Zinc	41.5	--	43.0	mg/kg
Aroclor-1254	--	--	0.0030	mg/kg

3-Part Test Evaluation:	EXC	
95% UCL or maximum > Cleanup Limit?	NA	NO
> 10% above Cleanup Limit?	NA	NO
Any sample > 2x Cleanup Limit?	NA	NO

[a] The 95% UCL result or maximum value, depending on data censorship, as described in the methodology section.

Washington Closure Hanford **CALCULATION SHEET**

Originator	N. K. Schiffern	**Date**	06/03/13	**Calc. No.**	0100N-CA-V0222	**Rev. No.**	0
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD	**Date**	06/03/13
Subject	118-N-1 Waste Site Cleanup Verification 95% UCL Calculations					**Sheet No.**	5 of 13

Summary (continued)

Results:
The results presented in the tables that follow include the summary of the results of the 95% UCL calculations for the excavation, the WAC 173-340-740(7)(e) 3-part test evaluation, and the RPD calculations, and are for use in risk analysis and the RSVP for this site.

Relative Percent Difference Results and QA/QC Analysis[a]

Analyte	Duplicate Analysis	Split Analysis
Potassium-40	1.3%	--
Aluminum	***45.8%***	27.8%
Barium	22.2%	24.4%
Calcium	22.1%	2.8%
Copper	5.3%	12.4%
Iron	***31.3%***	9.1%
Magnesium	***42.3%***	13.2%
Manganese	***56.8%***	26.3%
Silicon	***44.6%***	15.9%
Vanadium	***41.2%***	13.2%
Zinc	***30.1%***	21.5%

[a]RPD listed where result produced, based on criteria. If RPD not required, no value is listed. The significance of the reported RPD values, including values greater than 30% for duplicate analysis and 35% for split analysis, is addressed in the data quality assessment section of the RSVP.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/03/13
Job No. 14655

Calc. No. 0100N-CA-V0222
Checked C. H. Dobie CD

Rev. No. 0
Date 06/03/13
Sheet No. 6 of 13

1 **118-N-1 Statistical Calculations**
2 **Verification Data - Excavation Area (EXC)**

3	Sample	Sample	Sample	Americium-241			Cesium-137			Cobalt-60			Europium-155			Nickel-63			Plutonium-239/240			Total beta radiostrontium			Tritium		
4	Area	Number	Date	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
5	EXC-7	J1RKW9	4/23/2013	-0.0107	U	0.0327	-0.00623	U	0.0229	0.00434	U	0.0254	0.0389	U	0.0563	36.5		12.8	-0.0269	U	0.258	0.0121	U	0.119	0.000838	UJ	0.0174
6	Duplicate of JIRKW9	J1RKX5	4/23/2013	0.00985	U	0.0260	-0.00253	U	0.0191	0.00696	U	0.0217	0.00677	U	0.0385	11.1	U	11.4	-0.00240	U	0.121	0.0234	U	0.114	0.00667	UJ	0.0199
7	EXC-1	J1RLK3	4/25/2013	-0.00104	U	0.0353	-0.00353	U	0.0223	-0.00150	U	0.0225	0.0484	U	0.0558	9.42	U	13.9	0.00328	U	0.0930	0.0129	U	0.0839	0.0365		0.0201
8	EXC-2	J1RLK1	4/25/2013	0.00509	U	0.0378	0.0285	U	0.0308	0.00731	U	0.0270	0.0108	U	0.0557	35.0		23.6	-0.00255	U	0.0728	0.0446	U	0.0843	0.0299		0.0217
9	EXC-3	J1RLK2	4/25/2013	0.0148	U	0.0272	0.0309		0.0220	0.0124	U	0.0279	0.0285	U	0.0404	13.6	U	18.6	-0.00220	U	0.0790	0.0563	U	0.0792	0.0201	U	0.0213
10	EXC-4	J1RLR9	5/2/2013	0.144	U	0.317	1.35		0.0700	0.118	U	0.106	-0.0204	U	0.138	26.2		11.3	0.101		0.0526	0.965		0.250	0.0199	U	0.0384
11	EXC-5	J1RKW7	4/23/2013	0.00838	U	0.0246	0.0649		0.0198	0.00270	U	0.0226	0.0361	U	0.0392	11.4		10.8	-0.00330	U	0.0940	0.0835	U	0.123	0.0193	UJ	0.0203
12	EXC-6	J1RKW8	4/23/2013	0.00835	U	0.0359	-0.00526	U	0.0235	-0.0126	U	0.0236	0.0182	U	0.0563	184		11.4	-0.00485	U	0.174	0.0554	U	0.113	0.00579	UJ	0.0211
13	EXC-8	J1RKX0	4/23/2013	-0.00686	U	0.0241	-0.00449	U	0.0181	0.000613	U	0.0190	0.0547		0.0367	54.1		12.2	-0.00483	U	0.174	0.0206	U	0.139	-0.00621	UJ	0.0201
14	EXC-9	J1RKX1	4/23/2013	0.0201	U	0.0269	0.667		0.0234	0.0267	U	0.0330	0.0183	U	0.0387	27.9		9.79	0.214		0.158	0.938		0.123	0.0500	J	0.0196
15	EXC-10	J1RKX2	4/23/2013	0.0191	U	0.0236	0.424		0.0213	0.0356	U	0.0309	0.0165	U	0.0379	24.7		12.7	0.172	U	0.191	0.977		0.117	0.0111	UJ	0.0175
16	EXC-11	J1RKX3	4/23/2013	0.00272	U	0.158	0.172		0.0247	-0.0122	U	0.0216	-0.00691	U	0.0669	13.4		10.6	0.0493	U	0.0793	0.582		0.122	0.0207	J	0.0184
17	EXC-12	J1RKX4	4/23/2013	0.0765		0.0266	2.23		0.0241	0.133		0.0196	0.0265	U	0.0423	34.3		12.1	0.767		0.117	6.40		0.117	0.0565	J	0.0202

18
19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Americium-241	Cesium-137	Cobalt-60	Europium-155	Nickel-63	Plutonium-239/240	Total beta radiostrontium	Tritium
21	Area	Number	Date	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
22	EXC-7	J1RKW9/J1RKX5	4/23/2013	0.0147	0.0105	0.0118	0.0237	21.1	0.0948	0.0583	0.00933
23	EXC-1	J1RLK3	4/25/2013	0.0177	0.0112	0.0113	0.0279	6.95	0.0465	0.0420	0.0365
24	EXC-2	J1RLK1	4/25/2013	0.0189	0.0154	0.0135	0.0279	35.0	0.0364	0.0422	0.0299
25	EXC-3	J1RLK2	4/25/2013	0.0136	0.0309	0.0140	0.0202	9.30	0.0395	0.0396	0.0107
26	EXC-4	J1RLR9	5/2/2013	0.159	1.35	0.0530	0.0690	26.2	0.101	0.965	0.0192
27	EXC-5	J1RKW7	4/23/2013	0.0123	0.0649	0.0113	0.0196	11.4	0.0470	0.0615	0.0102
28	EXC-6	J1RKW8	4/23/2013	0.0180	0.0118	0.0118	0.0282	184	0.0870	0.0565	0.0106
29	EXC-8	J1RKX0	4/23/2013	0.0121	0.00905	0.00950	0.0547	54.1	0.0870	0.0695	0.0101
30	EXC-9	J1RKX1	4/23/2013	0.0135	0.667	0.0165	0.0194	27.9	0.214	0.938	0.0500
31	EXC-10	J1RKX2	4/23/2013	0.0118	0.424	0.0155	0.0190	24.7	0.0955	0.977	0.00875
32	EXC-11	J1RKX3	4/23/2013	0.0790	0.172	0.0108	0.0335	13.4	0.0397	0.582	0.0207
33	EXC-12	J1RKX4	4/23/2013	0.0765	2.23	0.133	0.0212	34.3	0.767	6.40	0.0565

34 **Statistical Computations**

35		Americium-241	Cesium-137	Cobalt-60	Europium-155	Nickel-63	Plutonium-239/240	Total beta radiostrontium	Tritium
36	95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.	Radionuclide data set. Use nonparametric z-statistic.
37	N	12	12	12	12	12	12	12	12
38	% < Detection limit	92%	42%	92%	92%	17%	75%	58%	58%
39	Mean	0.0372	0.416	0.0260	0.0303	37.4	0.138	0.853	0.0227
40	Standard deviation	0.0453	0.699	0.0357	0.0157	48.1	0.204	1.79	0.0169
41	Z-statistic	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
42	95% UCL on mean	0.0587	0.748	0.0429	0.0378	60.2	0.235	1.70	0.0307
43	Maximum value	0.0765	2.23	0.133	0.0547	184	0.767	6.40	0.0565

44 Qualifiers are defined on page 3.
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CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NO
Project 100-N Field Remediation
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/03/13
Job No. 14655
Calc. No. 0100N-CA-V0222
Checked C. H. Dobie CD
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1 **118-N-1 Statistical Calculations**
2 **Verification Data - Excavation Area (EXC)**

3	Sample	Sample	Sample	Uranium-234			Uranium-238		
4	Area	Number	Date	pCi/g	Q	MDA	pCi/g	Q	MDA
5	EXC-7	J1RKW9	4/23/2013	0.150		0.0752	0.0996		0.0693
6	Duplicate of JIRKW9	J1RKX5	4/23/2013	0.106		0.0618	0.120		0.0618
7	EXC-1	J1RLK3	4/25/2013	0.150		0.0622	0.151		0.0569
8	EXC-2	J1RLK1	4/25/2013	0.110		0.0539	0.120		0.0619
9	EXC-3	J1RLK2	4/25/2013	0.163		0.0868	0.220		0.0769
10	EXC-4	J1RLR9	5/2/2013	0.0812		0.0552	0.149		0.0627
11	EXC-5	J1RKW7	4/23/2013	0.308		0.0749	0.338		0.0622
12	EXC-6	J1RKW8	4/23/2013	0.0700	U	0.0989	0.170		0.0903
13	EXC-8	J1RKX0	4/23/2013	0.168		0.0524	0.168		0.0554
14	EXC-9	J1RKX1	4/23/2013	0.0859		0.0500	0.171		0.0594
15	EXC-10	J1RKX2	4/23/2013	0.226		0.0548	0.180		0.0437
16	EXC-11	J1RKX3	4/23/2013	0.252		0.0642	0.293		0.0613
17	EXC-12	J1RKX4	4/23/2013	0.130		0.0570	0.197		0.0531

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Uranium-234			Uranium-238		
21	Area	Number	Date	pCi/g			pCi/g		
22	EXC-7	J1RKW9/J1RKX5	4/23/2013	0.128			0.110		
23	EXC-1	J1RLK3	4/25/2013	0.150			0.151		
24	EXC-2	J1RLK1	4/25/2013	0.110			0.120		
25	EXC-3	J1RLK2	4/25/2013	0.163			0.220		
26	EXC-4	J1RLR9	5/2/2013	0.0812			0.149		
27	EXC-5	J1RKW7	4/23/2013	0.308			0.338		
28	EXC-6	J1RKW8	4/23/2013	0.0495			0.170		
29	EXC-8	J1RKX0	4/23/2013	0.168			0.168		
30	EXC-9	J1RKX1	4/23/2013	0.0859			0.171		
31	EXC-10	J1RKX2	4/23/2013	0.226			0.180		
32	EXC-11	J1RKX3	4/23/2013	0.252			0.293		
33	EXC-12	J1RKX4	4/23/2013	0.130			0.197		

34 **Statistical Computations**

35		Uranium-234			Uranium-238		
36	95% UCL based on	Radionuclide data set. Use nonparametric z-statistic.			Radionuclide data set. Use nonparametric z-statistic.		
37	N	12			12		
38	% < Detection limit	8%			0%		
39	Mean	0.154			0.189		
40	Standard deviation	0.0756			0.0670		
41	Z-statistic	1.64			1.64		
42	95% UCL on mean	0.190			0.221		
43	Maximum value	0.308			0.338		

44 Qualifiers are defined on page 3.
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CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/03/13
Job No. 14655

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1 **118-N-1 Statistical Calculations**

2 **Verification Data -Excavation (EXC)**

3	Sample	Sample	Sample	Arsenic			Barium			Beryllium			Cadmium			Chromium			Cobalt			Copper			Lead		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-7	J1RKW9	4/23/2013	0.88	B	0.60	46.0	X	0.069	0.23		0.030	0.089	B	0.037	3.8	X	0.052	8.9	X	0.090	9.1	X	0.20	2.0		0.24
6	Duplicate of JIRKW9	J1RKX5	4/23/2013	0.67	U	0.67	36.8	X	0.078	0.15	B	0.034	0.076	B	0.042	1.5	X	0.059	5.9	X	0.10	9.6	X	0.22	1.4		0.28
7	EXC-1	J1RLK3	4/25/2013	1.1		0.59	60.2	X	0.068	0.038	B	0.030	0.12	B	0.037	3.8	X	0.052	9.4	X	0.090	15.7	X	0.20	2.0		0.24
8	EXC-2	J1RLK1	4/25/2013	1.6		0.60	47.2	X	0.069	0.060	B	0.030	0.12	B	0.037	4.8	X	0.052	10.1	X	0.090	15.2	X	0.20	2.3		0.24
9	EXC-3	J1RLK2	4/25/2013	1.6		0.65	43.7	X	0.075	0.033	U	0.033	0.13	B	0.041	4.7	X	0.058	10.6	X	0.099	14.8	X	0.22	2.5		0.27
10	EXC-4	J1RLR9	5/2/2013	0.73	B	0.59	40.8	X	0.068	0.030	B	0.030	0.13	B	0.037	2.9	X	0.052	9.2	X	0.089	13.8	X	0.19	1.8		0.24
11	EXC-5	J1RKW7	4/23/2013	0.91		0.60	67.1	X	0.069	0.27		0.030	0.12	B	0.037	3.5	X	0.053	10.0	X	0.091	11.3	X	0.20	2.7		0.25
12	EXC-6	J1RKW8	4/23/2013	0.93	B	0.64	48.1	X	0.074	0.20		0.032	0.11	B	0.040	3.6	X	0.056	9.0	X	0.097	9.2	X	0.21	2.0		0.26
13	EXC-8	J1RKX0	4/23/2013	0.98		0.61	40.8	X	0.070	0.23		0.030	0.10	B	0.038	3.5	X	0.053	9.3	X	0.092	9.5	X	0.20	2.2		0.25
14	EXC-9	J1RKX1	4/23/2013	0.98	B	0.67	48.6	X	0.077	0.22		0.033	0.08	B	0.042	2.4	X	0.059	8.2	X	0.10	10.6	X	0.22	2.0		0.27
15	EXC-10	J1RKX2	4/23/2013	1.1		0.64	39.4	X	0.074	0.26		0.032	0.12	B	0.040	4.7	X	0.057	8.9	X	0.097	9.0	X	0.21	2.4		0.26
16	EXC-11	J1RKX3	4/23/2013	1.3		0.64	50.2	X	0.073	0.26		0.032	0.10	B	0.040	6.4	X	0.056	8.9	X	0.096	10.6	X	0.21	3.1		0.26
17	EXC-12	J1RKX4	4/23/2013	0.96	B	0.64	53.9	X	0.073	0.20		0.032	0.082	B	0.040	3.7	X	0.056	8.5	X	0.097	11.0	X	0.21	2.4		0.26

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
22	EXC-7	J1RKW9/J1RKX5	4/23/2013	0.61	41.4	0.19	0.083	2.7	7.4	9.4	1.7
23	EXC-1	J1RLK3	4/25/2013	1.1	60.2	0.038	0.12	3.8	9.4	15.7	2.0
24	EXC-2	J1RLK1	4/25/2013	1.6	47.2	0.060	0.12	4.8	10.1	15.2	2.3
25	EXC-3	J1RLK2	4/25/2013	1.6	43.7	0.017	0.13	4.7	10.6	14.8	2.5
26	EXC-4	J1RLR9	5/2/2013	0.73	40.8	0.030	0.13	2.9	9.2	13.8	1.8
27	EXC-5	J1RKW7	4/23/2013	0.91	67.1	0.27	0.12	3.5	10.0	11.3	2.7
28	EXC-6	J1RKW8	4/23/2013	0.93	48.1	0.20	0.11	3.6	9.0	9.2	2.0
29	EXC-8	J1RKX0	4/23/2013	0.98	40.8	0.23	0.10	3.5	9.3	9.5	2.2
30	EXC-9	J1RKX1	4/23/2013	0.98	48.6	0.22	0.081	2.4	8.2	10.6	2.0
31	EXC-10	J1RKX2	4/23/2013	1.1	39.4	0.26	0.12	4.7	8.9	9.0	2.4
32	EXC-11	J1RKX3	4/23/2013	1.3	50.2	0.26	0.10	6.4	8.9	10.6	3.1
33	EXC-12	J1RKX4	4/23/2013	0.96	53.9	0.20	0.082	3.7	8.5	11.0	2.4

34 **Statistical Computations**

35		Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead
36	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), lognormal and normal distribution rejected, use z-statistic.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
37	N	12	12	12	12	12	12	12	12
38	% < Detection limit	0%	0%	8%	0%	0%	0%	0%	0%
39	Mean	1.1	48.5	0.16	0.11	3.9	9.1	11.7	2.3
40	Standard deviation	0.30	8.5	0.099	0.019	1.1	0.87	2.5	0.40
41	95% UCL on mean	1.3	53.1	0.21	0.12	4.6	9.6	13.1	2.5
42	Maximum value	1.6	67.1	0.27	0.13	6.4	10.6	15.7	3.1
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	20 DE, GW & River Protection	200 GW Protection	1.51 GW & River Protection	0.81 GW & River Protection	18.5 GW & River Protection	32 GW Protection	22.0 River Protection	10.2 GW & River Protection
44	**WAC 173-340 3-PART TEST**								
45	95% UCL > Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
46	> 10% above Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
47	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA	NA	NA	NA	NA
48	**WAC 173-340 Compliance?**	Because all values are below background (6.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (132 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (1.51 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (0.81 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (18.5 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (15.7 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (22.0 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (10.2 mg/kg) the WAC 173-340 3-part test is not required.

49 Qualifiers are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/03/13
Job No. 14655

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1 **118-N-1 Statistical Calculations**
2 **Verification Data -Excavation (EXC)**

3	Sample	Sample	Sample	Manganese			Nickel			Vanadium			Zinc		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-7	J1RKW9	4/23/2013	305	X	0.090	7.4	X	0.11	55.0	X	0.085	37.1	X	0.36
6	Duplicate of JIRKW9	J1RKX5	4/23/2013	170	X	0.10	3.6	BX	0.13	36.2	X	0.096	27.4	X	0.41
7	EXC-1	J1RLK3	4/25/2013	266	X	0.090	7.9	X	0.11	52.7	X	0.085	38.7	X	0.36
8	EXC-2	J1RLK1	4/25/2013	293	X	0.090	8.6	X	0.11	57.8	X	0.085	41.0	X	0.36
9	EXC-3	J1RLK2	4/25/2013	316	X	0.099	8.7	X	0.12	60.8	X	0.093	45.2	X	0.39
10	EXC-4	J1RLR9	5/2/2013	251	X	0.089	6.5	X	0.11	57.2	X	0.084	39.9	X	0.36
11	EXC-5	J1RKW7	4/23/2013	306	X	0.091	7.6	X	0.11	67.0	X	0.086	43.3	X	0.36
12	EXC-6	J1RKW8	4/23/2013	283	X	0.097	9.0	X	0.12	58.0	X	0.091	39.7	X	0.39
13	EXC-8	J1RKX0	4/23/2013	287	X	0.092	8.3	X	0.11	60.6	X	0.086	39.8	X	0.37
14	EXC-9	J1RKX1	4/23/2013	233	X	0.10	6.0	X	0.12	52.2	X	0.095	36.4	X	0.40
15	EXC-10	J1RKX2	4/23/2013	268	X	0.097	8.1	X	0.12	60.5	X	0.092	40.8	X	0.39
16	EXC-11	J1RKX3	4/23/2013	288	X	0.096	10.9	X	0.12	57.7	X	0.091	41.2	X	0.38
17	EXC-12	J1RKX4	4/23/2013	268	X	0.097	6.8	X	0.12	48.8	X	0.091	36.7	X	0.38

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19 **Statistical Computation Input Data**

20	Sample	Sample	Sample	Manganese	Nickel	Vanadium	Zinc
21	Area	Number	Date	mg/kg	mg/kg	mg/kg	mg/kg
22	EXC-7	J1RKW9/J1RKX5	4/23/2013	238	5.5	45.6	32.3
23	EXC-1	J1RLK3	4/25/2013	266	7.9	52.7	38.7
24	EXC-2	J1RLK1	4/25/2013	293	8.6	57.8	41.0
25	EXC-3	J1RLK2	4/25/2013	316	8.7	60.8	45.2
26	EXC-4	J1RLR9	5/2/2013	251	6.5	57.2	39.9
27	EXC-5	J1RKW7	4/23/2013	306	7.6	67.0	43.3
28	EXC-6	J1RKW8	4/23/2013	283	9.0	58.0	39.7
29	EXC-8	J1RKX0	4/23/2013	287	8.3	60.6	39.8
30	EXC-9	J1RKX1	4/23/2013	233	6.0	52.2	36.4
31	EXC-10	J1RKX2	4/23/2013	268	8.1	60.5	40.8
32	EXC-11	J1RKX3	4/23/2013	288	10.9	57.7	41.2
33	EXC-12	J1RKX4	4/23/2013	268	6.8	48.8	36.7

34 **Statistical Computations**

35		Manganese	Nickel	Vanadium	Zinc
36	95% UCL based on	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.	Large data set (n ≥ 10), use MTCAStat lognormal distribution.
37	N	12	12	12	12
38	% < Detection limit	0%	0%	0%	0%
39	Mean	275	7.8	56.6	39.6
40	Standard deviation	25.7	1.5	5.9	3.4
41	95% UCL on mean	289	8.7	59.9	41.5
42	Maximum value	316	10.9	67.0	45.2
43	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	512 GW Protection	19.1 GW Protection	85.1 GW Protection	67.8 River Protection
44	**WAC 173-340 3-PART TEST**				
45	95% UCL > Cleanup Limit?	NA	NA	NA	NA
46	> 10% above Cleanup Limit?	NA	NA	NA	NA
47	Any sample > 2X Cleanup Limit?	NA	NA	NA	NA
48	**WAC 173-340 Compliance?**	Because all values are below background (512 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (19.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (85.1 mg/kg) the WAC 173-340 3-part test is not required.	Because all values are below background (67.8 mg/kg) the WAC 173-340 3-part test is not required.

49 Qualifiers are defined on page 3.

MAXIMUM VALUE 3-PART TEST CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
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1 **118-N-1 Maximum Calculations**
2 **Verification Data -Excavation (EXC)**

3	Sample	Sample	Sample	Antimony			Hexavalent Chromium			Molybdenum			Selenium			Silver		
4	Area	Number	Date	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
5	EXC-7	J1RKW9	4/23/2013	0.34	UJ	0.34	0.155	U	0.155	0.23	U	0.23	0.78	U	0.78	0.14	U	0.14
6	Duplicate of JIRKW9	J1RKX5	4/23/2013	0.39	UJ	0.39	0.155	U	0.155	0.27	U	0.27	0.88	U	0.88	0.16	U	0.16
7	EXC-1	J1RLK3	4/25/2013	1.1	J	0.34	0.155	U	0.155	0.23	U	0.23	0.77	U	0.77	0.15	B	0.14
8	EXC-2	J1RLK1	4/25/2013	1.0		0.34	0.155	U	0.155	0.28	B	0.23	0.78	U	0.78	0.14	B	0.14
9	EXC-3	J1RLK2	4/25/2013	1.1		0.38	0.155	U	0.155	0.26	U	0.26	0.85	U	0.85	0.17	B	0.16
10	EXC-4	J1RLR9	5/2/2013	0.77		0.34	0.314		0.155	0.23	U	0.23	0.77	U	0.77	0.14	U	0.14
11	EXC-5	J1RKW7	4/23/2013	0.35	UJ	0.35	0.155	U	0.155	0.28	B	0.24	0.78	U	0.78	0.15	U	0.15
12	EXC-6	J1RKW8	4/23/2013	0.37	UJ	0.37	0.155	U	0.155	0.25	B	0.25	0.84	B	0.84	0.16	U	0.16
13	EXC-8	J1RKX0	4/23/2013	0.35	UJ	0.35	0.155	U	0.155	0.24	U	0.24	0.79	U	0.79	0.15	U	0.15
14	EXC-9	J1RKX1	4/23/2013	0.39	UJ	0.39	0.155	U	0.155	0.26	U	0.26	0.87	U	0.87	0.16	U	0.16
15	EXC-10	J1RKX2	4/23/2013	0.37	UJ	0.37	0.155	U	0.155	0.25	U	0.25	0.84	U	0.84	0.16	U	0.16
16	EXC-11	J1RKX3	4/23/2013	0.37	UJ	0.37	0.203		0.155	0.25	U	0.25	0.83	U	0.83	0.15	U	0.15
17	EXC-12	J1RKX4	4/23/2013	0.37	UJ	0.37	0.169		0.155	0.25	U	0.25	0.83	U	0.83	0.15	U	0.15

18 **Statistical Computations**

19		Antimony	Hexavalent Chromium	Molybdenum	Selenium	Silver
20	% < Detection limit	67%	75%	75%	92%	75%
21	Maximum value	1.1	0.314	0.28	0.84	0.17
22	**Most Stringent Cleanup Limit for nonradionuclide and RAG type (mg/kg)**	5 GW & River Protection	2 River Protection	8 GW Protection	1 River Protection	0.73 River Protection
23	**3-PART TEST**					
24	Maximum > Cleanup Limit?	NA	NO	NO	NO	NA
25	> 10% above Cleanup Limit?	NA	NO	NO	NO	NA
26	Any sample > 2X Cleanup Limit?	NA	NO	NO	NO	NA
27	**3-Part Test Compliance?**	Because all values are below background (5 mg/kg) the WAC 173-340 3-part test is not required.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	The data set meets the 3-part test criteria when compared to the most stringent RAG.	Because all values are below background (0.73 mg/kg) the WAC 173-340 3-part test is not required.

28 Qualifiers are defined on page 3.
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CALCULATION SHEET

Washington Closure Hanford

Originator	N. K. Schiffern NO	**Date**	06/03/13	**Calc. No.**	0100N-CA-V0222
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD
Subject	118-N-1 Waste Site Cleanup Verification 95% UCL Calculations				

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Date 06/03/13
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Ecology Software (MTCAStat) Results, 118-N-1 Excavation (EXC)

Arsenic 95% UCL Calculation

DATA	ID
0.61	J1RKW9/J1RKX5
1.1	J1RLK3
1.6	J1RLK1
1.6	J1RLK2
0.73	J1RLR9
0.91	J1RKW7
0.93	J1RKW8
0.98	J1RKX0
0.98	J1RKX1
1.1	J1RKX2
1.3	J1RKX3
0.96	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	1.1
Censored		Lognormal mean	1.1
Detection limit or PQL		Std. devn.	0.30
Method detection limit		Median	0.98
TOTAL	12	Min.	0.61
		Max.	1.6

Lognormal distribution? r-squared is: 0.946
Normal distribution? r-squared is: 0.916
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 1.3

Barium 95% UCL Calculation

DATA	ID
41.4	J1RKW9/J1RKX5
60.2	J1RLK3
47.2	J1RLK1
43.7	J1RLK2
40.8	J1RLR9
67.1	J1RKW7
48.1	J1RKW8
40.8	J1RKX0
48.6	J1RKX1
39.4	J1RKX2
50.2	J1RKX3
53.9	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	48.5
Censored		Lognormal mean	48.5
Detection limit or PQL		Std. devn.	8.5
Method detection limit		Median	47.7
TOTAL	12	Min.	39.4
		Max.	67.1

Lognormal distribution? r-squared is: 0.928
Normal distribution? r-squared is: 0.895
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 53.1

Beryllium 95% UCL Calculation

DATA	ID
0.19	J1RKW9/J1RKX5
0.038	J1RLK3
0.060	J1RLK1
0.017	J1RLK2
0.030	J1RLR9
0.27	J1RKW7
0.20	J1RKW8
0.23	J1RKX0
0.22	J1RKX1
0.26	J1RKX2
0.26	J1RKX3
0.20	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	0.16
Censored		Lognormal mean	0.20
Detection limit or PQL		Std. devn.	0.099
Method detection limit		Median	0.20
TOTAL	12	Min.	0.017
		Max.	0.27

Lognormal distribution? r-squared is: 0.788
Normal distribution? r-squared is: 0.850
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.21

Cadmium 95% UCL Calculation

DATA	ID
0.083	J1RKW9/J1RKX5
0.12	J1RLK3
0.12	J1RLK1
0.13	J1RLK2
0.13	J1RLR9
0.12	J1RKW7
0.11	J1RKW8
0.096	J1RKX0
0.081	J1RKX1
0.12	J1RKX2
0.10	J1RKX3
0.082	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	0.11
Censored		Lognormal mean	0.11
Detection limit or PQL		Std. devn.	0.019
Method detection limit		Median	0.12
TOTAL	12	Min.	0.081
		Max.	0.13

Lognormal distribution? r-squared is: 0.879
Normal distribution? r-squared is: 0.894
Recommendations:
Reject BOTH lognormal and normal distributions.

UCL (based on Z-statistic) is 0.12

Chromium 95% UCL Calculation

DATA	ID
2.7	J1RKW9/J1RKX5
3.8	J1RLK3
4.8	J1RLK1
4.7	J1RLK2
2.9	J1RLR9
3.5	J1RKW7
3.6	J1RKW8
3.5	J1RKX0
2.4	J1RKX1
4.7	J1RKX2
6.4	J1RKX3
3.7	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	3.9
Censored		Lognormal mean	3.9
Detection limit or PQL		Std. devn.	1.1
Method detection limit		Median	3.7
TOTAL	12	Min.	2.4
		Max.	6.4

Lognormal distribution? r-squared is: 0.962
Normal distribution? r-squared is: 0.918
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 4.6

Cobalt 95% UCL Calculation

DATA	ID
7.4	J1RKW9/J1RKX5
9.4	J1RLK3
10.1	J1RLK1
10.6	J1RLK2
9.2	J1RLR9
10.0	J1RKW7
9.0	J1RKW8
9.3	J1RKX0
8.2	J1RKX1
8.9	J1RKX2
8.9	J1RKX3
8.5	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	9.1
Censored		Lognormal mean	9.1
Detection limit or PQL		Std. devn.	0.87
Method detection limit		Median	9.1
TOTAL	12	Min.	7.4
		Max.	10.6

Lognormal distribution? r-squared is: 0.961
Normal distribution? r-squared is: 0.972
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 9.6

Copper 95% UCL Calculation

DATA	ID
9.4	J1RKW9/J1RKX5
15.7	J1RLK3
15.2	J1RLK1
14.8	J1RLK2
13.8	J1RLR9
11.3	J1RKW7
9.2	J1RKW8
9.5	J1RKX0
10.6	J1RKX1
9.0	J1RKX2
10.6	J1RKX3
11.0	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	11.7
Censored		Lognormal mean	11.7
Detection limit or PQL		Std. devn.	2.5
Method detection limit		Median	10.8
TOTAL	12	Min.	9.0
		Max.	15.7

Lognormal distribution? r-squared is: 0.900
Normal distribution? r-squared is: 0.879
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 13.1

Lead 95% UCL Calculation

DATA	ID
1.7	J1RKW9/J1RKX5
2.0	J1RLK3
2.3	J1RLK1
2.5	J1RLK2
1.8	J1RLR9
2.7	J1RKW7
2.0	J1RKW8
2.2	J1RKX0
2.0	J1RKX1
2.4	J1RKX2
3.1	J1RKX3
2.4	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	2.3
Censored		Lognormal mean	2.3
Detection limit or PQL		Std. devn.	0.40
Method detection limit		Median	2.3
TOTAL	12	Min.	1.7
		Max.	3.1

Lognormal distribution? r-squared is: 0.976
Normal distribution? r-squared is: 0.955
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 2.5

Manganese 95% UCL Calculation

DATA	ID
238	J1RKW9/J1RKX5
266	J1RLK3
293	J1RLK1
316	J1RLK2
251	J1RLR9
306	J1RKW7
283	J1RKW8
287	J1RKX0
233	J1RKX1
268	J1RKX2
288	J1RKX3
268	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	275
Censored		Lognormal mean	275
Detection limit or PQL		Std. devn.	25.7
Method detection limit		Median	276
TOTAL	12	Min.	233
		Max.	316

Lognormal distribution? r-squared is: 0.968
Normal distribution? r-squared is: 0.975
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 289

Qualifiers are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator	N. K. Schiffern NS	**Date**	06/03/13	**Calc. No.**	0100N-CA-V0222
Project	100-N Field Remediation	**Job No.**	14655	**Checked**	C. H. Dobie CD
Subject	118-N-1 Waste Site Cleanup Verification 95% UCL Calculations				

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Ecology Software (MTCAStat) Results, 118-N-1 Excavation (EXC)

Nickel 95% UCL Calculation

DATA	ID
5.5	J1RKW9/J1RKX5
7.9	J1RLK3
8.6	J1RLK1
8.7	J1RLK2
6.5	J1RLR9
7.6	J1RKW7
9.0	J1RKW8
8.3	J1RKX0
6.0	J1RKX1
8.1	J1RKX2
10.9	J1RKX3
6.8	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	7.8
Censored		Lognormal mean	7.8
Detection limit or PQL		Std. devn.	1.5
Method detection limit		Median	8.0
TOTAL	12	Min.	5.5
		Max.	10.9

Lognormal distribution? r-squared is: 0.968
Normal distribution? r-squared is: 0.960
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 8.7

Vanadium 95% UCL Calculation

DATA	ID
45.6	J1RKW9/J1RKX5
52.7	J1RLK3
57.8	J1RLK1
60.8	J1RLK2
57.2	J1RLR9
67.0	J1RKW7
58.0	J1RKW8
60.6	J1RKX0
52.2	J1RKX1
60.5	J1RKX2
57.7	J1RKX3
48.8	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	56.6
Censored		Lognormal mean	56.6
Detection limit or PQL		Std. devn.	5.9
Method detection limit		Median	57.8
TOTAL	12	Min.	45.6
		Max.	67.0

Lognormal distribution? r-squared is: 0.935
Normal distribution? r-squared is: 0.946
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 59.9

Zinc 95% UCL Calculation

DATA	ID
32.3	J1RKW9/J1RKX5
38.7	J1RLK3
41.0	J1RLK1
45.2	J1RLK2
39.9	J1RLR9
43.3	J1RKW7
39.7	J1RKW8
39.8	J1RKX0
36.4	J1RKX1
40.8	J1RKX2
41.2	J1RKX3
36.7	J1RKX4

Number of samples		Uncensored values	
Uncensored	12	Mean	39.6
Censored		Lognormal mean	39.6
Detection limit or PQL		Std. devn.	3.4
Method detection limit		Median	39.9
TOTAL	12	Min.	32.3
		Max.	45.2

Lognormal distribution? r-squared is: 0.920
Normal distribution? r-squared is: 0.940
Recommendations:
Use lognormal distribution.

UCL (Land's method) is 41.5

Qualifiers are defined on page 3.

CALCULATION SHEET

Washington Closure Hanford

Originator N. K. Schiffern NS
Project 100-N Field Remediation
Subject 118-N-1 Waste Site Cleanup Verification 95% UCL Calculations

Date 06/05/13
Job No. 14655

Calc. No. 0100N-CA-V0222
Checked C. H. Doble CD

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Date 06/05/13
Sheet No. 13 of 13

Duplicate/Split Analysis - 118-N-1 Excavation (EXC)

Sampling Area	Sample Number	Sample Date	Potassium-40			Radium-226			Uranium-234			Uranium-238			Aluminum			Arsenic			Barium			Beryllium			Cadmium		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013	9.31		0.210	0.339		0.0424	0.150		0.0752	0.0996		0.0693	3810	X	1.4	0.88	B	0.60	46.0	X	0.069	0.23		0.030	0.089	B	0.037
Duplicate of JIRKW9	J1RKX5	4/23/2013	9.43		0.165	0.330		0.0353	0.106		0.0618	0.120		0.0618	2390	X	1.6	0.67	U	0.67	36.8	X	0.078	0.15	B	0.034	0.076	B	0.042
Split of J1RKW9	J1RKX6	4/23/2013				0	U	1.51	0.254		0.0560	0.241		0.0602	2880	N	27.3	1.4	BN	0.62	36.0		0.49	0.33	U	0.33	0.20	U	0.20

Analysis:

TDL		0.5	0.1	1	1	5	10	2	0.2	0.2
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	No-Stop (acceptable)	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**		**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	1.3%				*45.8%*		22.2%		
	Difference > 2 TDL?	Not applicable	No - acceptable	No - acceptable	No - acceptable	Not applicable	No - acceptable	Not applicable	No - acceptable	No - acceptable
Split Analysis	Both > PQL?			**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**		
	Both >5xTDL?			No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**		
	RPD					27.8%		24.4%		
	Difference > 2 TDL?			No - acceptable	No - acceptable	Not applicable	No - acceptable	Not applicable		

Duplicate/Split Analysis - 118-N-1 Excavation (EXC)

Sampling Area	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper			Iron			Lead			Magnesium			Manganese			Nickel		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013	5030	X	12.7	3.8	X	0.052	8.9	X	0.090	9.1	X	0.20	20700	X	3.4	2.0		0.24	3640	X	3.3	305	X	0.090	7.4	X	0.11
Duplicate of JIRKW9	J1RKX5	4/23/2013	4030	X	14.4	1.5	X	0.059	5.9	X	0.10	9.6	X	0.22	15100	X	3.9	1.4		0.28	2370	X	3.8	170	X	0.10	3.6	BX	0.13
Split of J1RKW9	J1RKX6	4/23/2013	4890	N	25.9	0.60	U	0.60	7.2	B	1.8	10.3		1.4	18900		5.8	2.2		0.34	3190	N	16.2	234	N	0.30	3.5	B	0.44

Analysis:

TDL		100	1	2	1	5	5	75	5	4
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**	No-Stop (acceptable)	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)
	RPD	22.1%			5.3%	*31.3%*		*42.3%*	*56.8%*	
	Difference > 2 TDL?	Not applicable	Yes - assess further	No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable
Split Analysis	Both > PQL?	**Yes (continue)**		**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	**Yes (calc RPD)**		No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**	No-Stop (acceptable)
	RPD	2.8%			12.4%	9.1%		13.2%	26.3%	
	Difference > 2 TDL?	Not applicable		No - acceptable	Not applicable	Not applicable	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate/Split Analysis - 118-N-1 Excavation (EXC)

Sampling Area	HEIS Number	Sample Date	Potassium			Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013	514		37.0	116	J	5.1	249		53.2	55.0	X	0.085	37.1	X	0.36
Duplicate of JIRKW9	J1RKX5	4/23/2013	335		41.8	73.7	J	5.8	212		60.2	36.2	X	0.096	27.4	X	0.41
Split of J1RKW9	J1RKX6	4/23/2013	657	U	657	136	N	3.1	179	B	91.9	48.2	N	2.5	29.9	N	3.9

Analysis:

TDL		400	2	50	2.5	1
Duplicate Analysis	Both > PQL?	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?	No-Stop (acceptable)	**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD		*44.6%*		*41.2%*	*30.1%*
	Difference > 2 TDL?	No - acceptable	Not applicable	No - acceptable	Not applicable	Not applicable
Split Analysis	Both > PQL?		**Yes (continue)**	**Yes (continue)**	**Yes (continue)**	**Yes (continue)**
	Both >5xTDL?		**Yes (calc RPD)**	No-Stop (acceptable)	**Yes (calc RPD)**	**Yes (calc RPD)**
	RPD		15.9%		13.2%	21.5%
	Difference > 2 TDL?		Not applicable	No - acceptable	Not applicable	Not applicable

Qualifiers are defined on page 3.

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Radionuclides).

Sample Area	HEIS Number	Sample Date	Americium-241			Carbon-14			Cesium-137			Cobalt-60			Europium-152			Europium-154		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-7	J1RKW9	4/23/2013	-0.0107	U	0.0327	0.0252	UJ	0.904	-0.00623	U	0.0229	0.00434	U	0.0254	0.0130	U	0.0622	0.00305	U	0.0771
Duplicate of JIRKW9	J1RKX5	4/23/2013	0.00985	U	0.0260	0.668	UJ	0.914	-0.00253	U	0.0191	0.00696	U	0.0217	-0.00579	U	0.0426	0.0129	U	0.0718
EXC-1	J1RLK3	4/25/2013	-0.00104	U	0.0353	-0.437	U	0.807	-0.00353	U	0.0223	-0.00150	U	0.0225	-0.0185	U	0.0564	-0.0464	U	0.0719
EXC-2	J1RLK1	4/25/2013	0.00509	U	0.0378	0.196	U	0.815	0.0285	U	0.0308	0.00731	U	0.0270	0.0250	U	0.0613	-0.0233	U	0.0759
EXC-3	J1RLK2	4/25/2013	0.0148	U	0.0272	0.0851	U	0.814	0.0309		0.0220	0.0124	U	0.0279	0.0116	U	0.0455	0.0470	U	0.0878
EXC-4	J1RLR9	5/2/2013	0.144	U	0.317	-0.0927	U	0.257	1.35		0.0700	0.118	U	0.106	0.0106	U	0.152	-0.0386	U	0.211
EXC-5	J1RKW7	4/23/2013	0.00838	U	0.0246	0.207	UJ	0.904	0.0649		0.0198	0.00270	U	0.0226	0.0165	U	0.0459	0.0331	U	0.0803
EXC-6	J1RKW8	4/23/2013	0.00835	U	0.0359	-0.478	UJ	0.888	-0.00526	U	0.0235	-0.0126	U	0.0236	0.0140	U	0.0591	0.0240	U	0.0864
EXC-8	J1RKX0	4/23/2013	-0.00686	U	0.0241	0.337	UJ	0.911	-0.00449	U	0.0181	0.000613	U	0.0190	-0.0277	U	0.0397	-0.00136	U	0.0701
EXC-9	J1RKX1	4/23/2013	0.0201	U	0.0269	0.340	UJ	0.891	0.667		0.0234	0.0267	U	0.0330	0.0105	U	0.0480	0.0381	U	0.0858
EXC-10	J1RKX2	4/23/2013	0.0191	U	0.0236	0.512	UJ	0.900	0.424		0.0213	0.0356	U	0.0309	0.00863	U	0.0438	-0.0130	U	0.0663
EXC-11	J1RKX3	4/23/2013	0.00272	U	0.158	0.532	UJ	0.901	0.172		0.0247	-0.0122	U	0.0216	0.0358	U	0.0625	0.0294	U	0.0812
EXC-12	J1RKX4	4/23/2013	0.0765		0.0266	0.653	UJ	0.889	2.23		0.0241	0.133		0.0196	0.0111	U	0.0565	-0.00457	U	0.0729
Split of J1RKW9	J1RKX6	4/23/2013	-0.039	U	0.193	-0.230	U	0.929	-0.061	U	0.0946	-0.10	U	0.116	-0.0037	U	0.158	0.00483	U	0.515
FS-1 (Silo #1)	J1RKX7	4/23/2013	0.119		0.0289	0.0504	U	0.910	2.86		0.0227	0.268		0.0194	-0.00622	U	0.0591	0.000207	U	0.0728
FS-2 (Silo #2)	J1RKX8	4/23/2013	0.0173	U	0.0317	1.08		0.666	1.29		0.0251	0.174		0.0211	0.00455	U	0.0545	0.0263	U	0.0768
FS-3 (Silo #3)	J1RKX9	4/23/2013	0.117	U	0.119	1.53		0.696	1.38		0.0510	2.78		0.0402	-0.0268	U	0.118	-0.0183	U	0.123
TP- Excavation floor	J1RLR5	5/2/2013	448		0.869	0.363		0.255	2250		0.476	81.6		0.201	0.796	U	1.80	28.8		0.617
TP -1 m	J1RLR6	5/2/2013	0.000196	U	0.0426	0.0897	U	0.257	0.156		0.0425	0.0206	U	0.0695	-0.00652	U	0.119	0.0384	U	0.203
TP -2 m	J1RLR7	5/2/2013	-0.00838	U	0.0348	0.0367	U	0.304	0.507		0.0403	0.0487	U	0.0704	0.0237	U	0.0917	-0.00159	U	0.150
TP -3 m	J1RLR8	5/2/2013	0.00392	U	0.0428	0.0288	U	0.260	0.251		0.0500	0.0363	U	0.0722	0.0237	U	0.112	-0.000143	U	0.180

Grey cells indicate not applicable or data will not be used.

Acronyms and notes apply to all of the tables in this attachment.

Note: Data qualified with B, J, M, N, P and/or X are considered acceptable values.

B = Estimated result. Result is less than the RL, but greater than the MDL.

HEIS = Hanford Environmental Information System

EXC = excavation

J = estimate

M = sample dupliacte precision not met.

MDA = minimum detected activity

N= recovery exceeds upper or lower control limits

P = aroclor flag, greater than 25% difference for detected concentrations between the two GC columns.

PCB = polychlorinated biphenyls

PQL = practical quantitation limit

Q = qualifier

RAG = remedial action goal

RSVP = remaining site verification package

U = undetected

X = serial dilution indicates that physical and chemical interferences are present.

Attachment	1	Sheet No.	1 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Radionuclides).

Sample Area	HEIS Number	Sample Date	Europium-155			Nickel-63			Plutonium-238			Plutonium-239/240			Potassium-40			Radium-226		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-7	J1RKW9	4/23/2013	0.0389	U	0.0563	36.5		12.8	-0.0111	UJ	0.204	-0.0269	U	0.258	9.31		0.210	0.339		0.0424
Duplicate of J1RKW9	J1RKX5	4/23/2013	0.00677	U	0.0385	11.1	U	11.4	0.0276	UJ	0.121	-0.00240	U	0.121	9.43		0.165	0.330		0.0353
EXC-1	J1RLK3	4/25/2013	0.0484	U	0.0558	9.42	U	13.9	-0.00551	U	0.0777	0.00328	U	0.0930	8.94		0.189	0.315		0.0430
EXC-2	J1RLK1	4/25/2013	0.0108	U	0.0557	35.0		23.6	0.0147	U	0.0641	-0.00255	U	0.0728	10.3		0.153	0.385		0.0416
EXC-3	J1RLK2	4/25/2013	0.0285	U	0.0404	13.6	U	18.6	-0.00220	U	0.0790	-0.00220	U	0.0790	10.1		0.258	0.369		0.0343
EXC-4	J1RLR9	5/2/2013	-0.0204	U	0.138	26.2		11.3	0.0266	U	0.0661	0.101		0.0526	10.2		0.701	0.481		0.116
EXC-5	J1RKW7	4/23/2013	0.0361	U	0.0392	11.4		10.8	0.0181	UJ	0.0889	-0.00330	U	0.0940	9.57		0.216	0.401	U	0.0873
EXC-6	J1RKW8	4/23/2013	0.0182	U	0.0563	184		11.4	-0.00486	UJ	0.174	-0.00485	U	0.174	9.49		0.219	0.350		0.0449
EXC-8	J1RKX0	4/23/2013	0.0547		0.0367	54.1		12.2	-0.00483	UJ	0.174	-0.00483	U	0.174	9.52		0.138	0.291		0.0336
EXC-9	J1RKX1	4/23/2013	0.0183	U	0.0387	27.9		9.79	-0.00127	UJ	0.116	0.214		0.158	9.77		0.219	0.341		0.0380
EXC-10	J1RKX2	4/23/2013	0.0165	U	0.0379	24.7		12.7	0.0868	UJ	0.161	0.172	U	0.191	10.4		0.157	0.347		0.0342
EXC-11	J1RKX3	4/23/2013	-0.00691	U	0.0669	13.4		10.6	0.0153	UJ	0.0750	0.0493	U	0.0793	10.1		0.194	0.278		0.0430
EXC-12	J1RKX4	4/23/2013	0.0265	U	0.0423	34.3		12.1	0.101	UJ	0.103	0.767		0.117	9.62		0.233	0.355		0.0414
Split of J1RKW9	J1RKX6	4/23/2013	-0.011	U	0.192	0.617	U	0.897	0.0241	U	0.0864	0.00355	U	0.0837				0	U	1.51
FS-1 (Silo #1)	J1RKX7	4/23/2013	0.0161	U	0.0477	18.0		11.0	0.0532	U	0.112	0.383		0.127	9.72		0.186	0.288		0.0437
FS-2 (Silo #2)	J1RKX8	4/23/2013	0.0119	U	0.0470	4.01	U	9.41	0.0210	U	0.138	0.207		0.168	9.40		0.193	0.356		0.0441
FS-3 (Silo #3)	J1RKX9	4/23/2013	0.0479	U	0.100	6.64	U	11.0	0.0185	U	0.111	0.320		0.106	8.72		0.300	0.296	U	0.136
TP- Excavation floor	J1RLR5	5/2/2013	2.92		1.21	58.7		10.4	2.50		0.0594	28.8		0.0755	10.5		1.61	0.418	U	0.917
TP -1 m	J1RLR6	5/2/2013	-0.00393	U	0.0779	19.3		10.9	0.0144	U	0.0544	0.0425	U	0.0683	8.77		0.585	0.267		0.0798
TP -2 m	J1RLR7	5/2/2013	0.0817	U	0.0710	8.89	U	10.9	-0.000580	U	0.0527	0.0290	U	0.0527	8.07		0.481	0.268		0.0858
TP -3 m	J1RLR8	5/2/2013	0.0377	U	0.0821	-1.65	U	10.3	-0.00180	U	0.0648	0.0294	U	0.0546	7.37		0.618	0.188	U	0.158

Sample Area	HEIS Number	Sample Date	Total beta radiostrontium			Tritium			Uranium-234			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
EXC-7	J1RKW9	4/23/2013	0.0121	U	0.119	0.000838	UJ	0.0174	0.150		0.0752	-0.00104	UJ	0.0522	0.0996		0.0693
Duplicate of J1RKW9	J1RKX5	4/23/2013	0.0234	U	0.114	0.00667	UJ	0.0199	0.106		0.0618	0.0135	UJ	0.0492	0.120		0.0618
EXC-1	J1RLK3	4/25/2013	0.0129	U	0.0839	0.0365		0.0201	0.150		0.0622	0.00968	U	0.0476	0.151		0.0569
EXC-2	J1RLK1	4/25/2013	0.0446	U	0.0843	0.0299		0.0217	0.110		0.0539	0	U	0.0409	0.120		0.0619
EXC-3	J1RLK2	4/25/2013	0.0563	U	0.0792	0.0201	U	0.0213	0.163		0.0868	0.0117	U	0.0573	0.220		0.0769
EXC-4	J1RLR9	5/2/2013	0.965		0.250	0.0199	U	0.0384	0.0812		0.0552	0	U	0.0499	0.149		0.0627
EXC-5	J1RKW7	4/23/2013	0.0835	U	0.123	0.0193	UJ	0.0203	0.308		0.0749	-0.000545	UJ	0.0496	0.338		0.0622
EXC-6	J1RKW8	4/23/2013	0.0554	U	0.113	0.00579	UJ	0.0211	0.0700	U	0.0989	0.0243	UJ	0.0688	0.170		0.0903
EXC-8	J1RKX0	4/23/2013	0.0206	U	0.139	-0.00621	UJ	0.0201	0.168		0.0524	-0.000971	UJ	0.0488	0.168		0.0554
EXC-9	J1RKX1	4/23/2013	0.938		0.123	0.0500	J	0.0196	0.0859		0.0500	-0.00149	UJ	0.0536	0.171		0.0594
EXC-10	J1RKX2	4/23/2013	0.977		0.117	0.0111	UJ	0.0175	0.226		0.0548	-0.000480	UJ	0.0437	0.180		0.0437
EXC-11	J1RKX3	4/23/2013	0.582		0.122	0.0207	J	0.0184	0.252		0.0642	-0.00215	UJ	0.0613	0.293		0.0613
EXC-12	J1RKX4	4/23/2013	6.40		0.117	0.0565	J	0.0202	0.130		0.0570	0	UJ	0.0480	0.197		0.0531
Split of J1RKW9	J1RKX6	4/23/2013	-0.092	U	0.262	-0.065	U	0.410	0.254		0.0560	0.0105	U	0.0550	0.241		0.0602
FS-1 (Silo #1)	J1RKX7	4/23/2013	5.84		0.115	0.0337		0.0180	0.140		0.0724	-0.000527	U	0.0479	0.169		0.0602
FS-2 (Silo #2)	J1RKX8	4/23/2013	3.64		0.123	0.00812	U	0.0183	0.163		0.0966	0.0237	U	0.0672	0.0684	U	0.0966
FS-3 (Silo #3)	J1RKX9	4/23/2013	0.725		0.119	0.223		0.0213	0.147		0.0793	0.0507	U	0.0466	0.123		0.0724
TP- Excavation floor	J1RLR5	5/2/2013	970		0.711	0.224	U	3.24	0.307		0.0665	0	U	0.0453	0.232		0.0685
TP -1 m	J1RLR6	5/2/2013	0.272		0.232	0.0814	U	0.0846	0.298		0.0840	0.0223	U	0.0513	0.279		0.0720
TP -2 m	J1RLR7	5/2/2013	2.64		0.244	0.0270	U	0.0519	0.200		0.0734	0.0349	U	0.0523	0.190		0.0647
TP -3 m	J1RLR8	5/2/2013	2.25		0.261	0.0166	U	0.0483	0.212		0.0486	0.0216	U	0.0452	0.156		0.0514

Attachment	1	Sheet No.	2 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Metals).

Sample Area	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium			Boron			Cadmium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013	3810	X	1.4	0.34	UJ	0.34	0.88	B	0.60	46.0	X	0.069	0.23		0.030	0.88	U	0.88	0.089	B	0.037
Duplicate of JIRKW9	J1RKX5	4/23/2013	2390	X	1.6	0.39	UJ	0.39	0.67	U	0.67	36.8	X	0.078	0.15	B	0.034	1.0	U	1.0	0.076	B	0.042
EXC-1	J1RLK3	4/25/2013	4810	X	1.4	1.1	J	0.34	1.1		0.59	60.2	X	0.068	0.038	B	0.030	0.88	U	0.88	0.12	B	0.037
EXC-2	J1RLK1	4/25/2013	5110	X	1.4	1.0		0.34	1.6		0.60	47.2	X	0.069	0.060	B	0.030	0.88	U	0.88	0.12	B	0.037
EXC-3	J1RLK2	4/25/2013	4920	X	1.5	1.1		0.38	1.6		0.65	43.7	X	0.075	0.033	U	0.033	0.97	U	0.97	0.13	B	0.041
EXC-4	J1RLR9	5/2/2013	3270	X	1.4	0.77		0.34	0.73	B	0.59	40.8	X	0.068	0.030	B	0.030	0.88	U	0.88	0.13	B	0.037
EXC-5	J1RKW7	4/23/2013	4660	X	1.4	0.35	UJ	0.35	0.91		0.60	67.1	X	0.069	0.27		0.030	0.89	U	0.89	0.12	B	0.037
EXC-6	J1RKW8	4/23/2013	3540	X	1.5	0.37	UJ	0.37	0.93	B	0.64	48.1	X	0.074	0.20		0.032	0.95	U	0.95	0.11	B	0.040
EXC-8	J1RKX0	4/23/2013	3710	X	1.4	0.35	UJ	0.35	0.98		0.61	40.8	X	0.07	0.23		0.030	0.90	U	0.90	0.096	B	0.038
EXC-9	J1RKX1	4/23/2013	3710	X	1.6	0.39	UJ	0.39	0.98	B	0.67	48.6	X	0.077	0.22		0.033	0.99	U	0.99	0.081	B	0.042
EXC-10	J1RKX2	4/23/2013	4980	X	1.5	0.37	UJ	0.37	1.1		0.64	39.4	X	0.074	0.26		0.032	0.96	U	0.96	0.12	B	0.040
EXC-11	J1RKX3	4/23/2013	5120	X	1.5	0.37	UJ	0.37	1.3		0.64	50.2	X	0.073	0.26		0.032	0.94	U	0.94	0.10	B	0.040
EXC-12	J1RKX4	4/23/2013	4000	X	1.5	0.37	UJ	0.37	0.96	B	0.64	53.9	X	0.073	0.20		0.032	0.95	U	0.95	0.082	B	0.040
Split of J1RKW9	J1RKX6	4/23/2013	2880	N	27.3	1.3	UN	1.3	1.4	BN	0.62	36.0		0.49	0.33	U	0.33	2.9	U	2.9	0.20	U	0.20
FS-1 (Silo #1)	J1RKX7	4/23/2013	4120	X	1.4	0.34	U	0.34	1.2		0.59	48.5	X	0.068	0.24		0.029	0.87	UN	0.87	0.12	B	0.037
FS-2 (Silo #2)	J1RKX8	4/23/2013	4500	X	1.5	0.37	U	0.37	0.93	B	0.64	57.1	X	0.074	0.21		0.032	0.95	U	0.95	0.11	B	0.040
FS-3 (Silo #3)	J1RKX9	4/23/2013	3710	X	1.5	0.37	U	0.37	0.64	U	0.64	62.9	X	0.073	0.23		0.032	0.95	U	0.95	0.11	B	0.040
TP- Excavation floor	J1RLR5	5/2/2013	3670	X	1.5	0.94		0.36	1.1		0.62	47.2	X	0.071	0.031	U	0.031	0.92	U	0.92	0.15	B	0.038
TP -1 m	J1RLR6	5/2/2013	3350	X	1.4	0.80		0.33	0.85	B	0.58	48.2	X	0.066	0.044	BM	0.029	0.85	U	0.85	0.11	B	0.036
TP -2 m	J1RLR7	5/2/2013	3970	X	1.5	0.96		0.37	0.67	B	0.65	45.7	X	0.074	0.079	B	0.032	0.96	U	0.96	0.12	B	0.040
TP -3 m	J1RLR8	5/2/2013	3620	X	1.5	0.92		0.37	0.64	U	0.64	49.7	X	0.074	0.048	B	0.032	0.95	U	0.95	0.12	B	0.040
Equipment blank	J1RLT0	5/2/2013	163	X	1.4	0.36	U	0.36	0.62	U	0.62	1.8	X	0.071	0.038	B	0.031	0.92	U	0.92	0.038	U	0.038

Sample Area	HEIS Number	Sample Date	Calcium			Chromium			Cobalt			Copper			Hexavalent Chromium			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013	5030	X	12.7	3.8	X	0.052	8.9	X	0.090	9.1	X	0.20	0.155	U	0.155	20700	X	3.4	2.0		0.24
Duplicate of JIRKW9	J1RKX5	4/23/2013	4030	X	14.4	1.5	X	0.059	5.9	X	0.10	9.6	X	0.22	0.155	U	0.155	15100	X	3.9	1.4		0.28
EXC-1	J1RLK3	4/25/2013	5350	X	12.7	3.8	X	0.052	9.4	X	0.090	15.7	X	0.20	0.155	U	0.155	23300	X	3.4	2.0		0.24
EXC-2	J1RLK1	4/25/2013	5580	XM	12.7	4.8	X	0.052	10.1	X	0.090	15.2	X	0.20	0.155	U	0.155	24000	X	3.4	2.3		0.24
EXC-3	J1RLK2	4/25/2013	5390	X	14.0	4.7	X	0.058	10.6	X	0.099	14.8	X	0.22	0.155	U	0.155	26500	X	3.8	2.5		0.27
EXC-4	J1RLR9	5/2/2013	5760	X	12.6	2.9	X	0.052	9.2	X	0.089	13.8	X	0.19	0.314		0.155	21700	X	3.4	1.8		0.24
EXC-5	J1RKW7	4/23/2013	5760	X	12.9	3.5	X	0.053	10.0	X	0.091	11.3	X	0.20	0.155	U	0.155	25600	X	3.5	2.7		0.25
EXC-6	J1RKW8	4/23/2013	4720	X	13.7	3.6	X	0.056	9.0	X	0.097	9.2	X	0.21	0.155	U	0.155	23100	X	3.7	2.0		0.26
EXC-8	J1RKX0	4/23/2013	5010	X	13.0	3.5	X	0.053	9.3	X	0.092	9.5	X	0.20	0.155	U	0.155	22900	X	3.5	2.2		0.25
EXC-9	J1RKX1	4/23/2013	5010	X	14.3	2.4	X	0.059	8.2	X	0.10	10.6	X	0.22	0.155	U	0.155	21100	X	3.9	2.0		0.27
EXC-10	J1RKX2	4/23/2013	6020	X	13.7	4.7	X	0.057	8.9	X	0.097	9.0	X	0.21	0.155	U	0.155	23000	X	3.7	2.4		0.26
EXC-11	J1RKX3	4/23/2013	5340	X	13.6	6.4	X	0.056	8.9	X	0.096	10.6	X	0.21	0.203		0.155	22300	X	3.7	3.1		0.26
EXC-12	J1RKX4	4/23/2013	5080	X	13.6	3.7	X	0.056	8.5	X	0.097	11.0	X	0.21	0.169		0.155	21400	X	3.7	2.4		0.26
Split of J1RKW9	J1RKX6	4/23/2013	4890	N	25.9	0.60	U	0.60	7.2	B	1.8	10.3		1.4	0.11	B	0.10	18900		5.8	2.2		0.34
FS-1 (Silo #1)	J1RKX7	4/23/2013	5410	X	12.6	4.1	X	0.052	9.6	X	0.089	11.2	X	0.19	0.155	U	0.155	24500	X	3.4	2.5		0.24
FS-2 (Silo #2)	J1RKX8	4/23/2013	5410	X	13.7	4.7	X	0.056	9.0	X	0.097	10.3	X	0.21	0.155	U	0.155	24100	X	3.7	2.3		0.26
FS-3 (Silo #3)	J1RKX9	4/23/2013	5330	X	13.6	2.8	X	0.056	9.3	X	0.097	10.3	X	0.21	0.155	U	0.155	24700	X	3.7	2.2		0.26
TP- Excavation floor	J1RLR5	5/2/2013	5200	X	13.2	3.7	X	0.054	9.1	X	0.094	11.5	X	0.20	0.194		0.155	21700	X	3.6	2.3		0.25
TP -1 m	J1RLR6	5/2/2013	4960	X	12.3	2.6	X	0.051	9.4	X	0.087	13.8	X	0.19	0.155	U	0.155	23100	X	3.3	1.7		0.24
TP -2 m	J1RLR7	5/2/2013	5650	X	13.8	1.9	X	0.057	9.2	X	0.098	14.0	X	0.21	0.155	U	0.155	21800	X	3.7	1.9		0.26
TP -3 m	J1RLR8	5/2/2013	4840	X	13.7	3.0	X	0.056	9.4	X	0.097	14.2	X	0.21	0.155	U	0.155	23900	X	3.7	1.7		0.26
Equipment blank	J1RLT0	5/2/2013	32.1	BX	13.2	0.18	BX	0.054	0.14	BX	0.094	0.46	BX	0.20				635	X	3.6	0.30	B	0.25

Attachment	1	Sheet No.	3 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Metals).

Sample Area	HEIS Number	Sample Date	Lithium			Magnesium			Manganese			Mercury			Molybdenum			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
EXC-7	J1RKW9	4/23/2013				3640	X	3.3	305	X	0.090	0.0054	U	0.0054	0.23	U	0.23	7.4	X	0.11	514		37.0
Duplicate of J1RKW9	J1RKX5	4/23/2013				2370	X	3.8	170	X	0.10	0.0060	U	0.0060	0.27	U	0.27	3.6	BX	0.13	335		41.8
EXC-1	J1RLK3	4/25/2013				4040	X	3.3	266	X	0.090	0.0047	U	0.0047	0.23	U	0.23	7.9	X	0.11	643		36.9
EXC-2	J1RLK1	4/25/2013				4280	X	3.3	293	X	0.090	0.0051	U	0.0051	0.28	B	0.23	8.6	X	0.11	638		37.0
EXC-3	J1RLK2	4/25/2013				4800	X	3.7	316	X	0.099	0.0062	U	0.0062	0.26	U	0.26	8.7	X	0.12	737		40.7
EXC-4	J1RLR9	5/2/2013				3460	X	3.3	251	X	0.089	0.0058	U	0.0058	0.23	U	0.23	6.5	X	0.11	461		36.7
EXC-5	J1RKW7	4/23/2013				4110	X	3.4	306	X	0.091	0.0055	U	0.0055	0.28	B	0.24	7.6	X	0.11	690		37.4
EXC-6	J1RKW8	4/23/2013				4090	X	3.6	283	X	0.097	0.0056	U	0.0056	0.25	B	0.25	9.0	X	0.12	543		39.8
EXC-8	J1RKX0	4/23/2013				4120	X	3.4	287	X	0.092	0.0052	U	0.0052	0.24	U	0.24	8.3	X	0.11	531		37.7
EXC-9	J1RKX1	4/23/2013				3440	X	3.8	233	X	0.10	0.0050	U	0.0050	0.26	U	0.26	6.0	X	0.12	515		41.6
EXC-10	J1RKX2	4/23/2013				3990	X	3.6	268	X	0.097	0.0048	U	0.0048	0.25	U	0.25	8.1	X	0.12	631		40.0
EXC-11	J1RKX3	4/23/2013				4330	X	3.6	288	X	0.096	0.0056	U	0.0056	0.25	U	0.25	10.9	X	0.12	817		39.5
EXC-12	J1RKX4	4/23/2013				3600	X	3.6	268	X	0.097	0.0053	U	0.0053	0.25	U	0.25	6.8	X	0.12	617		39.6
Split of J1RKW9	J1RKX6	4/23/2013	2.9	B	1.3	3190	N	16.2	234	N	0.30	0.011	U	0.011	0.61	U	0.61	3.5	B	0.44	657	U	657
FS-1 (Silo #1)	J1RKX7	4/23/2013				4300	X	3.3	299	X	0.089	0.011	BM	0.0048	0.23	U	0.23	8.7	X	0.11	556		36.5
FS-2 (Silo #2)	J1RKX8	4/23/2013				4120	X	3.6	298	X	0.097	0.0048	U	0.0048	0.25	B	0.25	7.4	X	0.12	711		39.8
FS-3 (Silo #3)	J1RKX9	4/23/2013				3980	X	3.6	286	X	0.097	0.21		0.0065	0.25	U	0.25	6.7	X	0.12	515		39.6
TP- Excavation floor	J1RLR5	5/2/2013				4010	X	3.5	282	X	0.094	0.46	MN	0.0061	0.24	U	0.24	6.7	X	0.12	568		38.4
TP -1 m	J1RLR6	5/2/2013				3420	X	3.2	244	X	0.087	0.0054	U	0.0054	0.23	U	0.23	6.2	X	0.11	430		35.7
TP -2 m	J1RLR7	5/2/2013				3520	X	3.6	241	X	0.098	0.0057	U	0.0057	0.25	U	0.25	5.8	X	0.12	501		40.2
TP -3 m	J1RLR8	5/2/2013				3730	X	3.6	257	X	0.097	0.0051	U	0.0051	0.25	U	0.25	5.8	X	0.12	427		39.8
Equipment blank	J1RLT0	5/2/2013				25.6	X	3.5	5.1	X	0.094	0.0055	U	0.0055	0.24	U	0.24	0.33	BX	0.12	47.9	B	38.3

Sample Area	HEIS Number	Sample Date	Selenium			Silicon			Silver			Sodium			Vanadium			Zinc			Percent moisture		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
EXC-7	J1RKW9	4/23/2013	0.78	U	0.78	116	J	5.1	0.14	U	0.14	249		53.2	55.0	X	0.085	37.1	X	0.36	1.9		0.10
Duplicate of J1RKW9	J1RKX5	4/23/2013	0.88	U	0.88	73.7	J	5.8	0.16	U	0.16	212		60.2	36.2	X	0.096	27.4	X	0.41	2.0		0.10
EXC-1	J1RLK3	4/25/2013	0.77	U	0.77	228		5.1	0.15	B	0.14	352		53.2	52.7	X	0.085	38.7	X	0.36	1.8		0.10
EXC-2	J1RLK1	4/25/2013	0.78	U	0.78	135		5.1	0.14	B	0.14	283		53.3	57.8	X	0.085	41.0	X	0.36	3.7		0.10
EXC-3	J1RLK2	4/25/2013	0.85	U	0.85	221		5.6	0.17	B	0.16	253		58.5	60.8	X	0.093	45.2	X	0.39	2.2		0.10
EXC-4	J1RLR9	5/2/2013	0.77	U	0.77	85.9	N	5.1	0.14	U	0.14	287		52.7	57.2	X	0.084	39.9	X	0.36	2.7		0.10
EXC-5	J1RKW7	4/23/2013	0.78	U	0.78	188	J	5.2	0.15	U	0.15	364		53.8	67.0	X	0.086	43.3	X	0.36	2.9		0.10
EXC-6	J1RKW8	4/23/2013	0.84	B	0.84	96.3	J	5.5	0.16	U	0.16	252		57.3	58.0	X	0.091	39.7	X	0.39	2.9		0.10
EXC-8	J1RKX0	4/23/2013	0.79	U	0.79	116	J	5.2	0.15	U	0.15	253		54.2	60.6	X	0.086	39.8	X	0.37	1.9		0.10
EXC-9	J1RKX1	4/23/2013	0.87	U	0.87	169	J	5.7	0.16	U	0.16	372		59.8	52.2	X	0.095	36.4	X	0.40	2.3		0.10
EXC-10	J1RKX2	4/23/2013	0.84	U	0.84	140	J	5.5	0.16	U	0.16	329		57.5	60.5	X	0.092	40.8	X	0.39	2.3		0.10
EXC-11	J1RKX3	4/23/2013	0.83	U	0.83	235	J	5.5	0.15	U	0.15	283		56.9	57.7	X	0.091	41.2	X	0.38	2.1		0.10
EXC-12	J1RKX4	4/23/2013	0.83	U	0.83	162	J	5.5	0.15	U	0.15	283		57.0	48.8	X	0.091	36.7	X	0.38	3.3		0.10
Split of J1RKW9	J1RKX6	4/23/2013	0.56	UN	0.56	136	N	3.1	0.46	UN	0.46	179	B	91.9	48.2	N	2.5	29.9	N	3.9			
FS-1 (Silo #1)	J1RKX7	4/23/2013	0.77	U	0.77	164		5.0	0.14	U	0.14	296		52.5	59.0	X	0.084	43.0	X	0.35	2.3		0.10
FS-2 (Silo #2)	J1RKX8	4/23/2013	1.1		0.83	189		5.5	0.16	U	0.16	330		57.2	57.7	X	0.091	40.0	X	0.39	1.8		0.10
FS-3 (Silo #3)	J1RKX9	4/23/2013	0.83	U	0.83	132		5.5	0.15	U	0.15	294		57.0	58.0	X	0.091	41.2	X	0.38	2.3		0.10
TP- Excavation floor	J1RLR5	5/2/2013	0.80	U	0.80	99.3	N	5.3	0.15	U	0.15	247		55.2	52.6	X	0.088	58.3	X	0.37	2.9		0.10
TP -1 m	J1RLR6	5/2/2013	0.75	U	0.75	69.8	N	4.9	0.14	U	0.14	293		51.4	52.4	X	0.082	37.8	X	0.35	4.4		0.10
TP -2 m	J1RLR7	5/2/2013	0.84	U	0.84	76.3	N	5.5	0.16	U	0.16	361		57.8	52.4	X	0.092	37.8	X	0.39	3.7		0.10
TP -3 m	J1RLR8	5/2/2013	0.83	U	0.83	78.4	N	5.5	0.16	U	0.16	273		57.2	57.7	X	0.091	42.0	X	0.39	4.5		0.10
Equipment blank	J1RLT0	5/2/2013	0.80	U	0.80	65.8	N	5.3	0.15	U	0.15	55.2	U	55.2	0.71	BX	0.088	1.7	X	0.37	0.10	U	0.10

Attachment	1	Sheet No.	4 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1RKW9, EXC-7			J1RKX5, Duplicate of J1RKW9			J1RLK3, EXC-1			J1RLK1, EXC-2		
		4/23/2013			4/23/2013			4/25/2013			4/25/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.6	U	2.6	2.8	U	2.8	2.8	U	2.8
Aroclor-1221	PCB	8.2	U	8.2	7.6	U	7.6	8.0	U	8.0	8.1	U	8.1
Aroclor-1232	PCB	2.0	U	2.0	1.9	U	1.9	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.7	U	4.7	4.4	U	4.4	4.7	U	4.7	4.7	U	4.7
Aroclor-1248	PCB	4.7	U	4.7	4.4	U	4.4	4.7	U	4.7	4.7	U	4.7
Aroclor-1254	PCB	2.6	U	2.6	2.5	U	2.5	2.6	U	2.6	2.6	U	2.6
Aroclor-1260	PCB	2.6	U	2.6	2.5	U	2.5	2.6	U	2.6	2.6	U	2.6

CONSTITUENT	CLASS	J1RLK2, EXC-3			J1RLR9, EXC-4			J1RKW7, EXC-5			J1RKW8, EXC-6		
		4/25/2013			5/2/2013			4/23/2013			4/23/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.7	U	2.7	2.8	U	2.8	2.8	U	2.8
Aroclor-1221	PCB	8.0	U	8.0	7.9	U	7.9	8.1	U	8.1	8.1	U	8.1
Aroclor-1232	PCB	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.6	U	4.6	4.6	U	4.6	4.7	U	4.7	4.7	U	4.7
Aroclor-1248	PCB	4.6	U	4.6	4.6	U	4.6	4.7	U	4.7	4.7	U	4.7
Aroclor-1254	PCB	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6
Aroclor-1260	PCB	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6	2.6	U	2.6

CONSTITUENT	CLASS	J1RKX0, EXC-8			J1RKX1, EXC-9			J1RKX2, EXC-10			J1RKX3, EXC-11		
		4/23/2013			4/23/2013			4/23/2013			4/23/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.8	U	2.8	2.8	U	2.8	2.7	U	2.7
Aroclor-1221	PCB	8.2	U	8.2	8.1	U	8.1	8.2	U	8.2	8.0	U	8.0
Aroclor-1232	PCB	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.8	U	4.8	4.7	U	4.7	4.8	U	4.8	4.6	U	4.6
Aroclor-1248	PCB	4.8	U	4.8	4.7	U	4.7	4.8	U	4.8	4.6	U	4.6
Aroclor-1254	PCB	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7	2.6	U	2.6
Aroclor-1260	PCB	2.7	U	2.7	2.6	U	2.6	2.7	U	2.7	2.6	U	2.6

CONSTITUENT	CLASS	J1RKX4, EXC-12			J1RKX6, Split of J1RKW9			J1RKX7, FS-1 (Sile #1)			J1RKX8, FS-2 (Sile #2)		
		4/23/2013			4/23/2013			4/23/2013			4/23/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	8.8	U	8.8	2.7	U	2.7	2.8	U	2.8
Aroclor-1221	PCB	8.1	U	8.1	8.8	U	8.8	7.9	U	7.9	8.0	U	8.0
Aroclor-1232	PCB	2.0	U	2.0	8.8	U	8.8	2.0	U	2.0	2.0	U	2.0
Aroclor-1242	PCB	4.7	U	4.7	8.8	U	8.8	4.6	U	4.6	4.7	U	4.7
Aroclor-1248	PCB	4.7	U	4.7	8.8	U	8.8	4.6	U	4.6	4.7	U	4.7
Aroclor-1254	PCB	2.6	U	2.6	5.6	U	5.6	3.0	JP	2.6	2.6	U	2.6
Aroclor-1260	PCB	2.6	U	2.6	5.6	U	5.6	2.6	U	2.6	2.6	U	2.6

Attachment	1	Sheet No.	5 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Attachment 1. 118-N-1 Waste Site Verification Sample Results (Organics).

CONSTITUENT	CLASS	J1RKX9, FS-3 (Sile #3)			J1RLR5, TP -Excavation Floor			J1RLR6, TP -1 m			J1RLR7, TP -2 m		
		4/23/2013			5/2/2013			5/2/2013			5/2/2013		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8	2.9	U	2.9	2.9	U	2.9	2.8	U	2.8
Aroclor-1221	PCB	8.1	U	8.1	8.3	U	8.3	8.4	U	8.4	8.2	U	8.2
Aroclor-1232	PCB	2.0	U	2.0	2.1	U	2.1	2.1	U	2.1	2.0	U	2.0
Aroclor-1242	PCB	4.7	U	4.7	4.8	U	4.8	4.9	U	4.9	4.8	U	4.8
Aroclor-1248	PCB	4.7	U	4.7	4.8	U	4.8	4.9	U	4.9	4.8	U	4.8
Aroclor-1254	PCB	2.6	U	2.6	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7
Aroclor-1260	PCB	2.6	U	2.6	2.7	U	2.7	2.7	U	2.7	2.7	U	2.7

CONSTITUENT	CLASS	J1RLR8, TP -3 m		
		5/2/2013		
		ug/kg	Q	PQL
Aroclor-1016	PCB	2.8	U	2.8
Aroclor-1221	PCB	8.1	U	8.1
Aroclor-1232	PCB	2.0	U	2.0
Aroclor-1242	PCB	4.7	U	4.7
Aroclor-1248	PCB	4.7	U	4.7
Aroclor-1254	PCB	2.6	U	2.6
Aroclor-1260	PCB	2.6	U	2.6

Attachment	1	Sheet No.	6 of 6
Originator	N. K. Schiffern	Date	06/03/13
Checked	C. H. Dobie	Date	06/03/13
Calc. No.	0100N-CA-V0222	Rev. No.	0

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 100-N Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0224

Subject: 118-N-1 Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater

Computer Program: Excel Program No: Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Sheets = 3 Total = 4	N. K. Schiffern N.K. Schiffern	C. H. Dobie CH Dobie	I. B. Berezovskiy I.B. Berezovskiy	O. F. Obenauer O. F. Obenauer	8/20/13

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	06/03/13	Calc. No.:	0100N-CA-V0224	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	06/03/13
Subject:	118-N-1 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and excess carcinogenic risk associated with soil contaminant levels compared to soil cleanup levels for protection of groundwater for the 118-N-1 waste site. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) for the 100-N Area (DOE-RL 2006), the following criteria must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

GIVEN/REFERENCES:

1) DOE-RL, 2006, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.

3) WAC 173-340-740 (3)(a)(ii)(A), "Groundwater Protection".

4) WCH, 2013, *118-N-1 Waste Site Cleanup Verification 95% UCL Calculation*, 0100N-CA-V0222, Rev. 0, Washington Closure Hanford, Inc., Richland, Washington

SOLUTION:

1) Generate a HQ for each noncarcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (DOE-RL 2006).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background in soil and with a K_d less than that required to show no migration to groundwater in 1,000 years using the RESRAD generic site model (DOE-RL 2006).

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern	Date:	06/03/13	Calc. No.:	0100N-CA-V0224	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	C. H. Dobie	Date:	06/03/13
Subject:	118-N-1 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No. 2 of 3	

METHODOLOGY:

The 118-N-1 waste site is comprised of one decision unit for verification sampling, consisting of an excavation area. The protection of groundwater hazard quotient and carcinogenic risk calculations for the 118-N-1 waste site was conservatively calculated for the entire waste site using the statistical or maximum value for each analyte (WCH 2013). Based on the generic site RESRAD model (DOE-RL 2006) and a vadose zone of approximately 9.5 m (31 ft) thickness, a K_d of 7.9 or greater is required to show no predicted migration to groundwater in 1,000 years. Selenium requires HQ and risk calculations because this analyte was detected above a Washington State or Hanford Site background value, and has a K_d of less than 7.9. Hexavalent chromium requires HQ and risk calculations because this analyte has a K_d of less than 7.9, and no Hanford background value has been established. All other site nonradionuclide COPCs were undetected, quantified below background levels, or have a K_d greater than or equal to 7.9. An example of the HQ and risk calculations for soil constituents with a potential impact to groundwater is presented below:

1) The hazard quotient is defined as the ratio of the dose of a substance obtained over a specified time (mg/kg/day) to a reference dose for the same substance derived over the same specified time (mg/kg/day). The hazard quotient can also be calculated as the ratio of the concentration in soil (maximum or statistical value) (mg/kg) to the soil RAG (mg/kg) for protection of groundwater, where the RAG is the groundwater cleanup level (µg/L) (calculated with, and related to the hazard quotient through, WAC 173-340-720 (3)(a)(ii)(A), (1996) x 100 x 1 mg/1000 µg (conversion factor). This is based on the "100 times rule" of WAC 173-340-740(3)(a)(ii) (A) (1996). For example, the maximum value for hexavalent chromium of 0.314 mg/kg, divided by the noncarcinogenic RAG value of 4.8 mg/kg is 6.5×10^{-2}. Comparing this value to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate analytes, the cumulative HQ can be obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation.) The cumulative HQ for the 118-N-1 waste site is 2.0×10^{-1}. Comparing this value to the requirement of <1.0, this criterion is met.

3) To calculate the excess cancer risk, the maximum or statistical value is divided by the carcinogenic RAG value, and then multiplied by 1×10^{-6}. There were not any detected constituents with a carcinogenic RAG associated with the 118-N-1 waste site. Therefore, the requirement of $<1 \times 10^{-6}$ is met. The criterion for cumulative excess cancer risk for carcinogens is also met.

4) The soil cleanup RAGs for protection of groundwater are based on the "100 times" provision in WAC 173-340-740(3)(a)(ii)(A). WAC 173-340-740(3)(a)(ii)(A) (1996) provides the "100 times rule" but also states "unless it can be demonstrated that a higher soil concentration is protective of ground water at the site." When the "100 times rule" values are exceeded, RESRAD was used to demonstrate that higher soil concentrations may be protective of groundwater.

Washington Closure Hanford, Inc. CALCULATION SHEET

Originator:	N. K. Schiffern NS	Date:	06/03/13	Calc. No.:	0100N-CA-V0224	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	C. H. Dobie CD	Date:	06/03/13
Subject:	118-N-1 Waste Site Hazard Quotient and Carcinogenic Risk Calculation for Protection of Groundwater					Sheet No.	3 of 3

RESULTS:

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk >1 x 10^{-6}: None
4) List the cumulative excess cancer risk for carcinogens >1 x 10^{-5}: None.

Table 1 shows the results of the calculations.

Table 1. Hazard Quotient and Excess Cancer Risk Results for the Protection of Groundwater for the 118-N-1 Waste Site.

Contaminants of Potential Concern	Maximum or Statistical Value[a] (mg/kg)	Noncarcinogen RAG[b] (mg/kg)	Hazard Quotient	Carcinogen RAG[b] (mg/kg)	Carcinogen Risk
Metals					
Chromium, hexavalent	0.314	4.8	6.5E-02	--	--
Selenium	1.1	8	1.4E-01	--	--
Totals					
Cumulative Hazard Quotient:			**2.0E-01**		
Cumulative Excess Cancer Risk:					**0.0E+00**

Notes:
[a] = From WCH (2013).
[b] = Value obtained from the Cleanup Levels and Risk Calculations (CLARC) database using Groundwater, Method B, results and the "100 times" model.
-- = not applicable
RAG = remedial action goal

CONCLUSION:

This calculation demonstrates that the 118-N-1 waste site meets the requirements for the hazard quotients and excess carcinogenic risk for protection of groundwater as identified in the RDR/RAWP (DOE-RL 2006).

CALCULATION COVER SHEET

Project Title: 100-N Area Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0225

Subject: 118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection

Computer Program: RESRAD Program No: Version 6.5

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 5 pg Attm. 1 – 19 pg Attm. 2 – 10 pg Total – 35 pages	S. W. Clark	M. W. Perrott	H. M. Sulloway	T. Q. Howell	6/10/13

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark SWC	Date:	6/10/13	Calc. No.:	0100N-CA-V0225	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott MWP	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection					Sheet No. 1 of 5	

PURPOSE:

Predict the selenium concentrations in groundwater and the Columbia River over a period of 1,000 years based on selenium analytical results from cleanup verification soil samples collected within the excavation of the 118-N-1 waste site.

GIVEN/REFERENCES:

1) Cleanup verification samples were collected from the excavation at the 118-N-1 waste site. The maximum selenium concentration of 1.1 mg/kg in these samples exceeds the selenium soil cleanup level for protection of the Columbia River of 1 mg/kg. A site-specific RESidual RADioactivity (RESRAD) (ANL 2009) modeling evaluation for nonradionuclides was performed as described in Appendix C of the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (RDR/RAWP) (DOE-RL 2006) to predict the selenium concentration in groundwater based on selenium in the soil. Dilution and attenuation of selenium concentrations in groundwater as it flows from the area of the 118-N-1 waste site to the Columbia River were calculated using the formulas from the U.S. Environmental Protection Agency (EPA) *Soil Screening Guidance: User's Guide*, (EPA 1996).
2) The selenium data was obtained from the "118-N-1 Waste Site Cleanup Verification 95% UCL Calculations" (WCH 2013).

SOLUTION:

1) As discussed in Section 3.6.9 of the RDR/RAWP (DOE-RL 2006), the residual concentrations of nonradionuclides in the soil are compared to the soil remedial action goals (RAGs) for Columbia River protection developed in Table B-3 of Appendix B of the RDR/RAWP. The river protection RAG is attained if the residual concentrations in soil are less than the Table B-2 RAGs and each sample data set meets the requirements of the WAC 173-340-740(7)(e) (1996) three-part test. If this is not the case, a more detailed assessment using RESRAD modeling or other appropriate methods (e.g., dilution-attenuation evaluations) are used to assess the potential of residual soil contaminants to impact groundwater and the river. If this assessment indicates that the residual contamination in the site soils will not impact groundwater or the river at concentrations above groundwater or surface water cleanup levels, then the RAGs and corresponding remedial action objectives for groundwater and river protection will have been attained.
2) A site-specific RESRAD evaluation was performed because the river protection RAG (1 mg/kg) was exceeded at the selenium soil concentration of 1.1 mg/kg. The area of the 118-N-1 waste site is 1,165.6 m^2. The area is included in Table 1, which also includes other parameters used in the RESRAD and dilution-attenuation calculations. Input parameters for the RESRAD evaluation are also shown in the "Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printout in Attachment 1 to this Calculation Summary.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0225	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection					Sheet No.	2 of 5

Table 1. 118-N-1 Site-Specific Parameters for RESRAD and Dilution-Attenuation Modeling

Parameter	Units	118-N-1 Waste Site
Contaminant-Specific Input Parameters		
Radionuclide Surrogate for Selenium		Cl-36
Selenium Concentration	mg/kg	1.1
Selenium Kd Value	mL/g	5
Contaminated Zone Dimensions		
Cover Depth	m	9.5
Area of Contaminated Zone (CZ)	m^2	1,165.6
Length Parallel to Aquifer Flow	m	18
Thickness of Vadose Zone Horizon		
Thickness: Contaminated Zone	m	1
Thickness: Uncontaminated Unsaturated Zone	m	9
Saturated Zone Parameters		
Aquifer Thickness	m	12
Distance to the Columbia River	m	76

3) The year when the peak selenium concentration is predicted to occur in groundwater from the 118-N-1 waste site was determined by a preliminary RESRAD run. This year was included for the final RESRAD run. The peak year for selenium in groundwater is predicted to occur at year 591 for the 118-N-1 waste site.

METHODOLOGY:

1) Using the methodology described in Appendix C of the RDR/RAWP (DOE-RL 2006), RESRAD modeling was used to determine if the residual soil concentration of selenium is protective of groundwater. A run of RESRAD version 6.5 (ANL 2009) was completed using the long half-life radionuclide chlorine-36 (Cl-36) as a surrogate for evaluation of selenium (Table 1). RESRAD numerical output reports of predicted selenium concentrations in soil and groundwater are presented in Attachment 2 to this calculation.
2) Methodology for modeling to predict if soil concentrations are protective of the Columbia River is similar to that for modeling the protection of groundwater, with the groundwater concentration reduced by dividing by a dilution and attenuation factor to account for changes as the contaminant migrates through the groundwater to the river. Calculation of an appropriate dilution and attenuation factor is accomplished using the formulas in the EPA *Soil Screening Guidance: User's Guide* (EPA 1996). The following Excel spreadsheet incorporates the formulas for calculation of the dilution factor to account for dilution and attenuation as contaminants migrate through the groundwater to the river:

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0225	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection					Sheet No. 3 of 5	

Table 2. Excel Calculation of Dilution Factor for Protection of the Columbia River

	A	B	C	D	E	F	G	H
1	Apparent Mixing Zone Depth (d) calculated from EPA *Soil Screening Guidance: User's Guide*, Equation 12:							
2	Apparent Mixing Zone Depth (d) = $(0.0112*L^2)^{0.5} + d_a(1 - \exp((-L*I)/(K*i*d_a)))$							
3	Variable	Value	Description					
4	L1	76	m, Distance to the Columbia River					
5	d_a	12	m, Aquifer Thickness					
6	I	0.07992	m/yr, Infiltration Rate, from I = (1-Ce((1-Cr)Pr + Irr					
7	Ce	0.91	Evapotranspiration Coefficient					
8	Cr	0.2	Runoff Coefficient					
9	Pr	0.16	m/yr, Precipitation					
10	Irr	0.76	m/yr, Irrigation					
11	K	5530	m/yr, Aquifer Hydraulic Conductivity					
12	i	0.00125	m/m, Hydraulic Gradient					
13	d	8.89	m, Apparent Mixing Zone Depth					
14	Apparent Mixing Zone Depth (d) = B13 = ((0.0112*B4*B4)^0.5)+(B5*(1-EXP(((-B4)*(B6))/(B11*B12*B5))))							
15	If d = B13 is greater than d_a = B5 default to B22 = B5 in Equation 11, below. Otherwise, use B22 = B13.							
16								
17	Calculation of Dilution Factor per the EPA *Soil Screening Guidance: User's Guide*, Equation 11.							
18	Dilution Factor, D = 1 + (K*i*d/I*L)							
19	Variable	Value	Description					
20	K	5530	m/yr, Aquifer Hydraulic Conductivity					
21	i	0.00125	m/m, Hydraulic Gradient					
22	d	2.11	m, Apparent Mixing Zone Depth					
23	I	0.07992	m/yr, Infiltration Rate, from I = (1-Ce((1-Cr)Pr + Irr					
24	L1	18	m, Source Length Parallel to GW Flow					
25	Dilution Factor (D) = C26 = 1+((B20*B21*B22)/(B23*B24))							
26	Dilution Factor (D) =		43.7					

RESULTS:

1) Groundwater Protection

Selenium is predicted to reach groundwater within the 1,000 years of the RESRAD model evaluation and is predicted to peak at year 591 for the 118-N-1 waste site. The maximum selenium concentration in groundwater due to the 118-N-1 waste site is predicted to be 9.03 ug/L (see Table 3). The predicted groundwater concentration is less than the selenium groundwater remedial action goal (RAG) of 50 ug/L given in Table B-1 of the RDR/RAWP (DOE-RL 2006).

Table 3. Predicted Groundwater (Well Water/Drinking Water) Concentrations from the 118-N-1 Waste Site

Contaminant	Groundwater Concentrations in ug/L at Each Time Interval (yr)								RAG, ug/L
	0	1	10	30	100	300	591	1000	
Selenium	0	0	0	0	0	0	9.03	0.17	50[a]

[a] Based on the maximum contaminant level (MCL) for selenium from 40 CFR 141, as discussed in Appendix B, Table B-2, of the 100 Area RDR/RAWP (DOE-RL 2009).

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0225	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection					Sheet No. 4 of 5	

2) Columbia River Protection

Predicted near-river selenium concentrations in groundwater at the Columbia River summarized in Table 4 were calculated by dividing the predicted groundwater concentrations at the 118-N-1 waste site in Table 3 by the dilution factor of 43.7 determined in Table 2. Due to dilution and attenuation, selenium is predicted to reach the river at a maximum groundwater concentration of 0.21 ug/L, which is less than the RAG of 5.0 ug/L, from Table B-2 of the RDR/RAWP (DOE-RL 2006).

Table 4. Predicted Near-River Groundwater Concentrations Based on Dilution and Attenuation of Groundwater from the 118-N-1 Waste Site

Contaminant	Near-River Groundwater Concentrations in ug/L at Each Time Interval (yr)								RAG, ug/L
	0	1	10	30	100	300	591	1000	
Selenium	0	0	0	0	0	0	0.21	0.0039	5.0[a]

[a] Based on the surface water ambient water quality criteria (AWQC) for selenium from 40 CFR 131.36, as discussed in Appendix B, Table B-2, of the 100-N Area RDR/RAWP (DOE-RL 2006).

CONCLUSIONS:

- Maximum selenium concentrations in the soil at the 118-N-1 waste site are predicted to be protective of groundwater and the Columbia River for 1,000 years.
- Selenium concentrations in groundwater are predicted to peak at year 591 at a maximum concentration of 9.03 ug/L. The predicted maximum groundwater concentration is less than the groundwater cleanup RAG of 50 ug/L for selenium from Table B-1 of Appendix B of the RDR/RAWP (DOE-RL 2006).
- Selenium from the 118-N-1 waste site is predicted to reach the river at a maximum groundwater concentration of 0.21 ug/L, which is less than the surface water cleanup RAG of 5 ug/L from Table B-2 of Appendix B of the RDR/RAWP (DOE-RL 2006).

REFERENCES:

40 CFR 141, "Federal Safe Drinking Water Act," *Code of Federal Regulations,* as amended.

ANL, 2009, *RESRAD for Windows*, Version 6.5, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois, < http://www.ead.anl.gov/resrad >.

DOE-RL, 2006, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL 2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0225	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Selenium Groundwater and River Protection					Sheet No. 5 of 5	

EPA, 1996, *Soil Screening Guidance: User's Guide* OSWER 9355.4-23, July 1996, U.S. Environmental Protection Agency, Washington, D.C.

WAC 173-340, "Model Toxics Control Act -- Cleanup," *Washington Administrative Code*, January 1996.

WCH 2013, "118-N-1 Waste Sites Cleanup Verification 95% UCL Calculations," Calc. No. 0100N-CA-V0222, Washington Closure Hanford, Richland, Washington.

ATTACHMENTS:

1. RESRAD Output: 118-N-1 Selenium Groundwater and River Protection Evaluation – Mixture Sums and Single Radionuclide Guidelines (19 pages).
2. RESRAD Output: 118-N-1 Selenium Groundwater and River Protection Evaluation – Concentration of Radionuclides, (10 pages).

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:14  Page   1
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
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Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
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Contaminated Zone and Total Dose Summary 8
Total Dose Components
Time = 0.000E+00 9
Time = 1.000E+00 10
Time = 3.000E+00 11
Time = 1.000E+01 12
Time = 3.000E+01 13
Time = 1.000E+02 14
Time = 3.000E+02 15
Time = 5.910E+02 16
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Attachment 1 Sheet No. 1 of 19
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0225 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days      06/10/2013  07:14  Page   2
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

                        Dose Conversion Factor (and Related) Parameter Summary
                                   Dose Library: FGR 12 & FGR 11
0      ³                                                           ³  Current  ³   Base    ³  Parameter
Menu   ³                        Parameter                          ³  Value#   ³   Case*   ³    Name
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
A-1  ³ DCF's for external ground radiation, (mrem/yr)/(pCi/g)     ³           ³           ³
A-1  ³ Cl-36     (Source: FGR 12)                                  ³ 2.391E-03 ³ 2.391E-03 ³ DCF1( 1)
     ³                                                             ³           ³           ³
B-1  ³ Dose conversion factors for inhalation, mrem/pCi:           ³           ³           ³
B-1  ³ Cl-36                                                       ³ 2.190E-05 ³ 2.190E-05 ³ DCF2( 1)
     ³                                                             ³           ³           ³
D-1  ³ Dose conversion factors for ingestion, mrem/pCi:            ³           ³           ³
D-1  ³ Cl-36                                                       ³ 3.030E-06 ³ 3.030E-06 ³ DCF3( 1)
     ³                                                             ³           ³           ³
D-34 ³ Food transfer factors:                                      ³           ³           ³
D-34 ³ Cl-36     , plant/soil concentration ratio, dimensionless   ³ 2.000E+01 ³ 2.000E+01 ³ RTF(  1,1)
D-34 ³ Cl-36     , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)   ³ 6.000E-02 ³ 6.000E-02 ³ RTF(  1,2)
D-34 ³ Cl-36     , milk/livestock-intake ratio, (pCi/L)/(pCi/d)    ³ 2.000E-02 ³ 2.000E-02 ³ RTF(  1,3)
     ³                                                             ³           ³           ³
D-5  ³ Bioaccumulation factors, fresh water, L/kg:                 ³           ³           ³
D-5  ³ Cl-36     , fish                                            ³ 1.000E+03 ³ 1.000E+03 ³ BIOFAC(  1,1)
D-5  ³ Cl-36     , crustacea and mollusks                          ³ 1.900E+02 ³ 1.900E+02 ³ BIOFAC(  1,2)
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
#For DCF1(xxx) only, factors are for infinite depth & area.  See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.
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Attachment 1	Sheet No. 2 of 19
Originator: S. W. Clark	Date 6/10/2013
Chk'd By M. W. Perrott	Date 6/10/2013
Calc. No. 0100N-CA-V0225	Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:14  Page   3
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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)	1.166E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.000E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	1.800E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+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)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	5.910E+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): Cl-36	1.100E+00	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Cl-36	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	9.500E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.600E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	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)	0.000E+00	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	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	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

Attachment 1 Sheet No. 3 of 19
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	9.000E+00	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 Cl-36				
R016	Contaminated zone (cm**3/g)	5.000E+00	1.000E-01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+00	1.000E-01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	5.000E+00	1.000E-01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.754E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
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)

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Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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1RESRAD, Version 6.5       T« Limit = 180 days        06/10/2013  07:14  Page   5
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.583E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.583E-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)

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Originator: S. W. Clark	Date 6/10/2013
Chk'd By M. W. Perrott	Date 6/10/2013
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1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:14 Page 6
Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
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
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

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Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   7
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	suppressed

Attachment	1	Sheet No.	7 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   8
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

      Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
      ____________________________            __________________________________
        Area:    1165.60 square meters              Cl-36       1.100E+00
   Thickness:       1.00 meters
 Cover Depth:       9.50 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  1.000E+01  3.000E+01  1.000E+02  3.000E+02  5.910E+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  4.778E-02  8.837E-04
        M(t):  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  3.185E-03  5.891E-05
0Maximum TDOSE(t):  4.789E-02 mrem/yr   at t =     590 ñ 1 years
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 = 5.903E+02 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.
 Nuclide
 _______ _________ ______  _________ ______  _________ ______  _________ ______  _________ ______  _________ ______  _________ ______
 Cl-36   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 = 5.903E+02 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.
 Nuclide
 _______ _________ ______  _________ ______  _________ ______  _________ ______  _________ ______  _________ ______  _________ ______
 Cl-36   2.006E-02 0.4190  7.028E-03 0.1468  0.000E+00 0.0000  1.566E-02 0.3269  2.716E-03 0.0567  2.424E-03 0.0506  4.789E-02 1.0000
 ///////// ////////// ////// ////////// ////// ////////// ////// ////////// ////// ////////// ////// ////////// ////// ////////// //////
 Total   2.006E-02 0.4190  7.028E-03 0.1468  0.000E+00 0.0000  1.566E-02 0.3269  2.716E-03 0.0567  2.424E-03 0.0506  4.789E-02 1.0000
0*Sum of all water independent and dependent pathways.
```

Attachment	1	Sheet No.	8 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   9
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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)

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Cl-36	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 = 0.000E+00 years
Water Dependent Pathways

Radio- Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Cl-36	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.

Attachment	1	Sheet No.	9 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page  10
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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.
Cl-36	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 = 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.
Cl-36	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.

Attachment	1	Sheet No.	10 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:14  Page  11
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
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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 = 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.
Cl-36	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.
Cl-36	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.

Attachment	1	Sheet No.	11 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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+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.
Cl-36	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 = 1.000E+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.
Cl-36	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.

Attachment	1	Sheet No.	12 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:14  Page  13
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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)

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.
Cl-36	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+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.
Cl-36	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.

Attachment	1	Sheet No.	13 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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1RESRAD, Version 6.5      T= Limit = 180 days        06/10/2013  07:14  Page  14
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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+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.
Cl-36	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 = 1.000E+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.
Cl-36	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.

Attachment	1	Sheet No.	14 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

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1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:14  Page  15
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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.
Cl-36	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+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.
Cl-36	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.

Attachment	1	Sheet No.	15 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:14  Page  16
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.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 = 5.910E+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.
Cl-36	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 = 5.910E+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.
Cl-36	1.997E-02	0.4180	7.005E-03	0.1466	0.000E+00	0.0000	1.563E-02	0.3271	2.740E-03	0.0573	2.432E-03	0.0509	4.778E-02	1.0000
Total	1.997E-02	0.4180	7.005E-03	0.1466	0.000E+00	0.0000	1.563E-02	0.3271	2.740E-03	0.0573	2.432E-03	0.0509	4.778E-02	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	16 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page  17
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
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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 = 1.000E+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.
Cl-36	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 = 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.
Cl-36	3.694E-04	0.4180	1.296E-04	0.1466	0.000E+00	0.0000	2.891E-04	0.3271	5.068E-05	0.0573	4.499E-05	0.0509	8.837E-04	1.0000
Total	3.694E-04	0.4180	1.296E-04	0.1466	0.000E+00	0.0000	2.891E-04	0.3271	5.068E-05	0.0573	4.499E-05	0.0509	8.837E-04	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	17 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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1RESRAD, Version 6.5       T½ Limit = 180 days        06/10/2013  07:14  Page  18
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

                                   Dose/Source Ratios Summed Over All Pathways
                             Parent and Progeny Principal Radionuclide Contributions Indicated
0  Parent     Product     Thread                        DSR(j,t) At Time in Years   (mrem/yr)/(pCi/g)
    (i)         (j)      Fraction   0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 5.910E+02 1.000E+03
 ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Cl-36      Cl-36       1.000E+00  0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.344E-02 8.034E-04
 ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß  ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß
 The DSR includes contributions from associated (half-life ó 180 days) 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   1.000E+01   3.000E+01   1.000E+02   3.000E+02   5.910E+02   1.000E+03
 ÄÄÄÄÄÄÄ     ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ
 Cl-36      *3.302E+10  *3.302E+10  *3.302E+10  *3.302E+10  *3.302E+10  *3.302E+10  *3.302E+10  3.453E+02  1.867E+04
 ßßßßßßß     ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß
 *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 =     590 ñ 1 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 ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Cl-36   1.100E+00      590 ñ 1      4.353E-02 3.446E+02 4.353E-02 3.446E+02
 ßßßßßßß ßßßßßßßßßß ßßßßßßßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß ßßßßßßßßßß
```

Attachment	1	Sheet No.	18 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 1

```
1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:14  Page  19
 Summary : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

                                   Individual Nuclide Dose Summed Over All Pathways
                                     Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   THF(i)                                          DOSE(j,t), mrem/yr
   (j)     (i)              t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 5.910E+02 1.000E+03
 AAAAAAA AAAAAAA AAAAAAAAA    AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA
 Cl-36   Cl-36   1.000E+00    0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.778E-02 8.837E-04
 ??????? ??????? ?????????    ????????? ????????? ????????? ????????? ????????? ????????? ????????? ????????? ?????????
 THF(i) is the thread fraction of the parent nuclide.


                                     Individual Nuclide Soil Concentration
                                     Parent Nuclide and Branch Fraction Indicated
0Nuclide Parent   THF(i)                                          S(j,t), pCi/g
   (j)     (i)              t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 3.000E+01 1.000E+02 3.000E+02 5.910E+02 1.000E+03
 AAAAAAA AAAAAAA AAAAAAAAA    AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA
 Cl-36   Cl-36   1.000E+00    1.100E+00 1.089E+00 1.068E+00 9.978E-01 8.209E-01 4.147E-01 5.892E-02 3.446E-03 6.373E-05
 ??????? ??????? ?????????    ????????? ????????? ????????? ????????? ????????? ????????? ????????? ????????? ?????????
 THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time =    1.39 seconds
```

Attachment	1	Sheet No.	19 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:14  Page   1
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

                    Table of Contents
                    ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
              Part IV: Concentration of Radionuclides
              ƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒƒ
```

Concentration of radionuclides in different media

Time= 0.000E+00 2
Time= 1.000E+00 3
Time= 3.000E+00 4
Time= 1.000E+01 5
Time= 3.000E+01 6
Time= 1.000E+02 7
Time= 3.000E+02 8
Time= 5.910E+02 9
Time= 1.000E+03 10

Attachment 2 Sheet No. 1 of 10
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0225 Rev. No. 0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:14  Page  2
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Concentration of radionuclides in environmental media
at t = 0.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Cl-36	1.100E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 0.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Cl-36	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	2 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:14  Page   3
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Cl-36	1.089E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Cl-36	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	3 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   4
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

      Concentration of radionuclides in environmental media
                  at t = 3.000E+00 years

          Contaminat-  Surface   Air Par-     Well      Surface
           ted Zone     Soil*    ticulate     Water      Water
 Radio-   ########### ########### ########### ########### ###########
 Nuclide     pCi/g      pCi/g    pCi/m**3     pCi/L      pCi/L
 ########  ########### ########### ########### ########### ###########
 Cl-36     1.068E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 ########  ########### ########### ########### ########### ###########
 *The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.


                          Concentration of radionuclides in foodstuff media
                                      at t = 3.000E+00 years*

           Drinking   Nonleafy     Leafy     Fodder     Fodder      Meat       Milk       Fish    Crustacea
             Water    Vegetable  Vegetable    Meat       Milk
 Radio-   ########### ########### ########### ########### ########### ########### ########### ########### ###########
 Nuclide     pCi/L      pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/L      pCi/kg     pCi/kg
 ########  ########### ########### ########### ########### ########### ########### ########### ########### ###########
 Cl-36      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
 ########  ########### ########### ########### ########### ########### ########### ########### ########### ###########
 *Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
  For livestock fodder, consumption time is t minus meat or milk storage time.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.
```

Attachment	2	Sheet No.	4 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   5
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Cl-36	9.978E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Cl-36	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	5 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:14  Page   6
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

      Concentration of radionuclides in environmental media
                    at t = 3.000E+01 years

          Contaminat-  Surface   Air Par-     Well      Surface
           ted Zone     Soil*    ticulate     Water      Water
 Radio-   ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Nuclide    pCi/g      pCi/g   pCi/m**3     pCi/L      pCi/L
 ÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Cl-36     8.209E-01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 ïïïïïïï  ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï
 *The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.


                    Concentration of radionuclides in foodstuff media
                                at t = 3.000E+01 years*

           Drinking   Nonleafy    Leafy     Fodder     Fodder      Meat       Milk       Fish    Crustacea
             Water   Vegetable  Vegetable    Meat       Milk
 Radio-   ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Nuclide    pCi/L     pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/L .    pCi/kg     pCi/kg
 ÄÄÄÄÄÄÄ  ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ ÄÄÄÄÄÄÄÄÄÄ
 Cl-36     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
 ïïïïïïï  ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï ïïïïïïïïïï
 *Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
  For livestock fodder, consumption time is t minus meat or milk storage time.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.
```

Attachment	2	Sheet No.	6 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   7
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

     Concentration of radionuclides in environmental media
                    at t = 1.000E+02 years

          Contaminat-  Surface   Air Par-     Well      Surface
           ted Zone     Soil*    ticulate     Water      Water
 Radio-   ########## ########## ########## ########## ##########
 Nuclide     pCi/g      pCi/g    pCi/m**3     pCi/L      pCi/L
 ####### ########## ########## ########## ########## ##########
 Cl-36     4.147E-01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 ####### ########## ########## ########## ########## ##########
 *The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.


                          Concentration of radionuclides in foodstuff media
                                        at t = 1.000E+02 years*

           Drinking   Nonleafy     Leafy     Fodder     Fodder      Meat       Milk       Fish    Crustacea
            Water    Vegetable  Vegetable    Meat       Milk
 Radio-   ########## ########## ########## ########## ########## ########## ########## ########## ##########
 Nuclide     pCi/L      pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/L      pCi/kg     pCi/kg
 ####### ########## ########## ########## ########## ########## ########## ########## ########## ##########
 Cl-36     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
 ####### ########## ########## ########## ########## ########## ########## ########## ########## ##########
 *Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
  For livestock fodder, consumption time is t minus meat or milk storage time.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.
```

Attachment	2	Sheet No.	7 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:14  Page   8
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD

      Concentration of radionuclides in environmental media
                    at t = 3.000E+02 years

          Contaminat-  Surface   Air Par-     Well      Surface
           ted Zone     Soil*    ticulate     Water      Water
 Radio-   ########### ########### ########### ########### ###########
 Nuclide     pCi/g       pCi/g     pCi/m**3     pCi/L      pCi/L
 ########  ########### ########### ########### ########### ###########
 Cl-36      5.892E-02  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 #######   ########### ########### ########### ########### ###########
 *The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.


                         Concentration of radionuclides in foodstuff media
                                   at t = 3.000E+02 years*

           Drinking   Nonleafy    Leafy     Fodder     Fodder      Meat       Milk       Fish    Crustacea
            Water    Vegetable  Vegetable    Meat       Milk
 Radio-   ########### ########### ########### ########### ########### ########### ########### ########### ###########
 Nuclide     pCi/L      pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/kg     pCi/L      pCi/kg     pCi/kg
 ########  ########### ########### ########### ########### ########### ########### ########### ########### ###########
 Cl-36      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
 #######   ########### ########### ########### ########### ########### ########### ########### ########### ###########
 *Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
  For livestock fodder, consumption time is t minus meat or milk storage time.

  Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters,
  i.e. using parameters appearing in the input screen when the pathways are active.
```

Attachment	2	Sheet No.	8 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:14  Page   9
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Concentration of radionuclides in environmental media
at t = 5.910E+02 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Cl-36	3.446E-03	0.000E+00	0.000E+00	9.030E+00	2.326E-01

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 5.910E+02 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Cl-36	9.030E+00	8.959E+01	1.710E+02	9.900E+01	9.895E+01	4.310E+02	1.377E+02	2.327E+02	4.421E+01

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	9 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:14  Page  10
 Concent : 118-N-1 Selenium Groundwater and River Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SELENIUM.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+03 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Cl-36	6.373E-05	0.000E+00	0.000E+00	1.670E-01	4.303E-03

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of radionuclides in foodstuff media
at t = 1.000E+03 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Cl-36	1.670E-01	1.657E+00	3.164E+00	1.831E+00	1.830E+00	7.972E+00	2.547E+00	4.303E+00	8.177E-01

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	10 of 10
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0225	Rev. No.	0

CALCULATION COVER SHEET

Project Title: 100-N Area Field Remediation **Job No. 14655**

Area: 100-N

Discipline: Environmental *Calculation No: 0100N-CA-V0226

Subject: 118-N-1 RESRAD Calc Brief for Radionuclide Contamination

Computer Program: RESRAD Program No: Version 6.5

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover – 1 pg Summary – 4 pg Attm. 1 – 30 pg Attm. 2 – 19 pg Total – 54 pages	S. W. Clark	M. W. Perrott	H. M. Sulloway	T. Q. Howell	6/10/13

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0226	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Radionuclide Contamination					Sheet No. 1 of 4	

PURPOSE:

Predict the groundwater concentrations of radionuclides over a period of 1,000 years based on the maximum activities of radionuclides from the test pit within the excavation of the 118-N-1 waste site.

GIVEN/REFERENCES:

1) Soil samples were collected from a test pit at the bottom of the excavation in the 118-N-1 waste site. Soil analyses of several radionuclides exceeded remedial action goals (RAGs) for protection of groundwater and were subsequently evaluated by site-specific RESidual RADioactivity (RESRAD) modeling as described in Appendix C of the *Remedial Design Report/Remedial Action Work Plan for the 100-N Area* (RDR/RAWP) (DOE-RL 2006). Site-specific RESRAD evaluations were performed to predict the radionuclide concentrations in groundwater due to the activities of radionuclides in the soil as reported in Table 1.
2) The radionuclide activity data was obtained from the "118-N-1 Waste Site Cleanup Verification 95% UCL Calculations" (WCH 2013).

SOLUTION:

1) As discussed in Sections 3.6.8 and 3.6.9 of the RDR/RAWP (DOE-RL 2006), the residual concentrations of radionuclides in the soil are compared to the soil remedial action goals (RAGs) for protection of groundwater as summarized in Table 2-1 of the RDR/RAWP. The groundwater protection RAGs are attained if the residual concentrations of radionuclides in soil are less than the RAGs in Table 2-1. If this is not the case, a more detailed assessment using RESRAD or other appropriate methods is used to assess the potential of residual site soil contaminants to impact groundwater. If this more detailed assessment indicates that the residual contamination in the site soils will not impact groundwater at concentrations above groundwater cleanup levels, then the groundwater protection RAGs have been attained.
2) A RESRAD run was performed for the 118-N-1 maximum radionuclide analyses of soil from the excavation floor (WCH 2013). Table 1 summarizes the analytical data used for the RESRAD runs. Table 2 shows the thickness of the soil horizons and other parameters used in the RESRAD calculations. The area of the 118-N-1 waste site is 1,165.6 m^2. Input parameters for the RESRAD evaluation are also shown in the "Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printout in Attachment 1 to this Calculation Summary.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0226	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Radionuclide Contamination					Sheet No. 2 of 4	

Table 1. Comparison of Test Pit Sample Results to Action Levels for the 118-N-1 Waste Site Excavation.

Radionuclides	Test Pit Sample Result, (pCi/g)	Soil RAGs Protective of Groundwater, (pCi/g)	Radionuclide Kd Value, (mL/g)
Americium-241	448	NA	200
Carbon-14	0.363	NA	200
Cesium-137	2,250	1,465	50
Cobalt-60	81.6	13,900	50
Europium-154	28.8	NA	200
Europium-155	2.92	NA	200
Nickel-63	58.7	NA	30
Plutonium-238	2.50	NA	200
Plutonium-239/240	28.8	27.6	200
Strontium-90	970	27.6	15
Tritium	0.223	12.6	0
Uranium-233/234	0.307 (<BG)	1.1	2
Uranium-238	0.279 (<BG)	1.1	2

BG = Hanford Site Background
Kd = Distribution Coefficient from Table 2-1 of the RDR/RAWP (DOE-RL 2006)
NA = Not Available
RAGs = Remedial Action Goals from Table 2-1 of the RDR/RAWP (DOE-RL 2006)

Table 2. 118-N-1 Site-Specific Parameters for RESRAD Modeling

Parameter	Units	118-N-1 Waste Site
Contaminated Zone Dimensions		
Cover Depth	m	9.5
Area of Contaminated Zone (CZ)	m^2	1,165.6
Length Parallel to Aquifer Flow	m	18
Thickness of Vadose Zone Horizons		
Thickness: Contaminated Zone	m	1
Thickness: Uncontaminated Unsaturated Zone	m	9

3) The year where the peak dose (or concentration) occurs from each individual radionuclide COPC and layer is determined by a preliminary run. This year is then added for all horizons for the final RESRAD runs. Tritium is the only radionuclide predicted to reach groundwater within 1,000 years. The peak tritium groundwater concentration is predicted to occur at year 14.92 for the 118-N-1 waste site. This year was included for the final RESRAD run.

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0226	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Radionuclide Contamination					Sheet No. 3 of 4	

METHODOLOGY:

1) Using the methodology described in Appendix C of the RDR/RAWP (DOE-RL 2006), RESRAD modeling was used to determine if the residual soil concentration of tritium is protective of groundwater. A run of RESRAD version 6.5 (ANL 2009) was completed using the test pit tritium soil concentration (Table 1). RESRAD numerical output reports of predicted tritium concentrations in soil and groundwater are presented in Attachment 2 to this calculation.

RESULTS:

1) Groundwater Protection for Tritium

The tritium concentrations in groundwater at different time intervals for up to 1,000 years were calculated by the RESRAD model. RESRAD output is presented in Attachment 2 and summarized in Table 3. Tritium is predicted to reach groundwater within the 1,000 years of the RESRAD model evaluation and is predicted to peak at year 14.92 at the maximum groundwater concentration shown in Table 3 (32.7 pCi/L for tritium), which is less than the groundwater RAG of 20,000 pCi/L for tritium from Table B-6 of Appendix B of the RDR/RAWP (DOE-RL 2006).

Table 3. Predicted Groundwater (Well Water/Drinking Water) Concentrations from the 118-N-1 Waste Site

Contaminant	Groundwater Concentrations in pCi/L at Each Time Interval (yr)								RAG, pCi/L
	0	1	10	14.92	30	100	300	1000	
Tritium	0	0	0	32.7	0.021	0	0	0	20,000 [a]

[a] Based on the maximum contaminant level (MCL) for tritium from 40 CFR 141, as discussed in Appendix B, Table B-6, of the 100-N Area RDR/RAWP (DOE-RL 2006).

2) Columbia River Protection

Radionuclide RAGs for protection of groundwater reported in Table B-6 of the RDR/RAWP (DOE-RL 2006) are also protective of the Columbia River. Therefore, all radionuclides meeting groundwater protection RAGs will also be protective of the river.

CONCLUSIONS:

- Tritium is the only radionuclide predicted to contribute a direct exposure dose or to reach groundwater within 1,000 years.
- Maximum tritium concentrations in the soil at the 118-N-1 waste site are predicted to be protective of groundwater and the Columbia River for 1,000 years.
- Tritium concentrations in groundwater are predicted to peak at year 14.92 at a maximum concentration of 32.7 pCi/L. The predicted maximum groundwater concentration is less than

Washington Closure Hanford CALCULATION SHEET

Originator:	S. W. Clark	Date:	6/10/13	Calc. No.:	0100N-CA-V0226	Rev.:	0
Project:	100-N Area Field Remediation	Job No:	14655	Checked:	M. W. Perrott	Date:	6/10/13
Subject:	118-N-1 RESRAD Calc Brief for Radionuclide Contamination					Sheet No.	4 of 4

the groundwater cleanup RAG of 20,000 pCi/L for tritium from Table B-6 of Appendix B of the RDR/RAWP (DOE-RL 2006).

REFERENCES:

40 CFR 141, "Federal Safe Drinking Water Act," *Code of Federal Regulations,* as amended.

ANL, 2009, *RESRAD for Windows*, Version 6.5, Argonne National Laboratory, Environmental Assessment Division, Argonne, Illinois, < http://www.ead.anl.gov/resrad >.

DOE-RL, 2006, *Remedial Design Report/Remedial Action Work Plan for the 100-N Area*, DOE/RL-2005-93, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1996, *Soil Screening Guidance: User's Guide* OSWER 9355.4-23, July 1996, U.S. Environmental Protection Agency, Washington, D.C.

WAC 173-340, "Model Toxics Control Act -- Cleanup," *Washington Administrative Code*, January 1996.

WCH 2013, "118-N-1 Waste Sites Cleanup Verification 95% UCL Calculations," Calc. No. 0100N-CA-V0222, Washington Closure Hanford, Richland, Washington.

ATTACHMENTS:

1. RESRAD Output: 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation – Mixture Sums and Single Radionuclide Guidelines (30 pages).
2. RESRAD Output: 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation – Concentration of Radionuclides, (19 pages).

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page   1
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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ATTACHMENT 1

1RESRAD, Version 6.5 T« Limit = 180 days 06/10/2013 07:23 Page 2
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-225 (Source: FGR 12)	6.371E-02	6.371E-02	DCF1(1)
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1(2)
A-1	Am-241 (Source: FGR 12)	4.372E-02	4.372E-02	DCF1(3)
A-1	At-217 (Source: FGR 12)	1.773E-03	1.773E-03	DCF1(4)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(5)
A-1	Ba-137m (Source: FGR 12)	3.606E+00	3.606E+00	DCF1(6)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(7)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1(8)
A-1	Bi-213 (Source: FGR 12)	7.660E-01	7.660E-01	DCF1(9)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(10)
A-1	C-14 (Source: FGR 12)	1.345E-05	1.345E-05	DCF1(11)
A-1	Co-60 (Source: FGR 12)	1.622E+01	1.622E+01	DCF1(12)
A-1	Cs-137 (Source: FGR 12)	7.510E-04	7.510E-04	DCF1(13)
A-1	Eu-154 (Source: FGR 12)	7.678E+00	7.678E+00	DCF1(14)
A-1	Eu-155 (Source: FGR 12)	1.822E-01	1.822E-01	DCF1(15)
A-1	Fr-221 (Source: FGR 12)	1.536E-01	1.536E-01	DCF1(16)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1(17)
A-1	H-3 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(18)
A-1	Ni-63 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(19)
A-1	Np-237 (Source: FGR 12)	7.790E-02	7.790E-02	DCF1(20)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1(21)
A-1	Pa-233 (Source: FGR 12)	1.020E+00	1.020E+00	DCF1(22)
A-1	Pb-209 (Source: FGR 12)	7.734E-04	7.734E-04	DCF1(23)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(24)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1(25)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(26)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(27)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1(28)
A-1	Po-213 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(29)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(30)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1(31)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(32)
A-1	Pu-238 (Source: FGR 12)	1.513E-04	1.513E-04	DCF1(33)
A-1	Pu-239 (Source: FGR 12)	2.952E-04	2.952E-04	DCF1(34)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1(35)
A-1	Ra-225 (Source: FGR 12)	1.102E-02	1.102E-02	DCF1(36)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(37)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1(38)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(39)
A-1	Sr-90 (Source: FGR 12)	7.043E-04	7.043E-04	DCF1(40)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1(41)
A-1	Th-229 (Source: FGR 12)	3.213E-01	3.213E-01	DCF1(42)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(43)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1(44)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1(45)
A-1	Tl-209 (Source: FGR 12)	1.293E+01	1.293E+01	DCF1(46)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(47)
A-1	U-233 (Source: FGR 12)	1.397E-03	1.397E-03	DCF1(48)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(49)

Attachment 1 Sheet No. 2 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page   3
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1(50)
A-1	Y-90 (Source: FGR 12)	2.391E-02	2.391E-02	DCF1(51)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2(1)
B-1	Am-241	4.440E-01	4.440E-01	DCF2(2)
B-1	C-14(p) (Class: ORGANIC)	2.090E-06	2.090E-06	DCF2(3)
B-1	C-14(g) (Class: CO2)	2.350E-08	2.350E-08	C14GInhDCF
B-1	Co-60	2.190E-04	2.190E-04	DCF2(4)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(5)
B-1	Eu-154	2.860E-04	2.860E-04	DCF2(6)
B-1	Eu-155	4.140E-05	4.140E-05	DCF2(7)
B-1	H-3	6.400E-08	6.400E-08	DCF2(8)
B-1	Ni-63	6.290E-06	6.290E-06	DCF2(9)
B-1	Np-237+D	5.400E-01	5.400E-01	DCF2(10)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(11)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(12)
B-1	Pu-238	3.920E-01	3.920E-01	DCF2(13)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(15)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(16)
B-1	Sr-90+D	1.308E-03	1.300E-03	DCF2(17)
B-1	Th-229+D	2.169E+00	2.150E+00	DCF2(18)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(19)
B-1	U-233	1.350E-01	1.350E-01	DCF2(20)
B-1	U-234	1.320E-01	1.320E-01	DCF2(21)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(22)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.410E-02	DCF3(1)
D-1	Am-241	3.640E-03	3.640E-03	DCF3(2)
D-1	C-14	2.090E-06	2.090E-06	DCF3(3)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(4)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(5)
D-1	Eu-154	9.550E-06	9.550E-06	DCF3(6)
D-1	Eu-155	1.530E-06	1.530E-06	DCF3(7)
D-1	H-3	6.400E-08	6.400E-08	DCF3(8)
D-1	Ni-63	5.770E-07	5.770E-07	DCF3(9)
D-1	Np-237+D	4.444E-03	4.440E-03	DCF3(10)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(11)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(12)
D-1	Pu-238	3.200E-03	3.200E-03	DCF3(13)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(15)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(16)
D-1	Sr-90+D	1.528E-04	1.420E-04	DCF3(17)
D-1	Th-229+D	4.027E-03	3.530E-03	DCF3(18)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(19)
D-1	U-233	2.890E-04	2.890E-04	DCF3(20)
D-1	U-234	2.830E-04	2.830E-04	DCF3(21)
D-1	U-235+D	2.673E-04	2.660E-04	DCF3(22)

Attachment 1 Sheet No. 3 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page   4
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Am-241 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(2,1)
D-34	Am-241 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-05	5.000E-05	RTF(2,2)
D-34	Am-241 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-06	2.000E-06	RTF(2,3)
D-34				
D-34	C-14 , plant/soil concentration ratio, dimensionless	5.500E+00	5.500E+00	RTF(3,1)
D-34	C-14 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.100E-02	3.100E-02	RTF(3,2)
D-34	C-14 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.200E-02	1.200E-02	RTF(3,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(4,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(4,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(4,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(5,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(5,3)
D-34				
D-34	Eu-154 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	Eu-154 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(6,2)
D-34	Eu-154 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(6,3)
D-34				
D-34	Eu-155 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	Eu-155 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-03	2.000E-03	RTF(7,2)
D-34	Eu-155 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-05	5.000E-05	RTF(7,3)
D-34				
D-34	H-3 , plant/soil concentration ratio, dimensionless	4.800E+00	4.800E+00	RTF(8,1)
D-34	H-3 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.200E-02	1.200E-02	RTF(8,2)
D-34	H-3 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-02	1.000E-02	RTF(8,3)
D-34				
D-34	Ni-63 , plant/soil concentration ratio, dimensionless	5.000E-02	5.000E-02	RTF(9,1)
D-34	Ni-63 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(9,2)
D-34	Ni-63 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-02	2.000E-02	RTF(9,3)
D-34				
D-34	Np-237+D , plant/soil concentration ratio, dimensionless	2.000E-02	2.000E-02	RTF(10,1)
D-34	Np-237+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(10,2)
D-34	Np-237+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(11,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(11,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(11,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(12,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(12,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(12,3)
D-34				

Attachment	1	Sheet No.	4 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page   5
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Pu-238 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(13,1)
D-34	Pu-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(13,2)
D-34	Pu-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(13,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(15,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(15,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(15,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(16,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(16,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(16,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(17,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(17,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(17,3)
D-34				
D-34	Th-229+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(18,1)
D-34	Th-229+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(18,2)
D-34	Th-229+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(18,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(19,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(19,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(19,3)
D-34				
D-34	U-233 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(20,1)
D-34	U-233 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(20,2)
D-34	U-233 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(20,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(21,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(21,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(21,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(22,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(22,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(22,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Am-241 , fish	3.000E+01	3.000E+01	BIOFAC(2,1)
D-5	Am-241 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(2,2)
D-5				
D-5	C-14 , fish	5.000E+04	5.000E+04	BIOFAC(3,1)
D-5	C-14 , crustacea and mollusks	9.100E+03	9.100E+03	BIOFAC(3,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(4,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(4,2)
D-5				

Attachment 1 Sheet No. 5 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:23  Page   6
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

0 Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(5,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5	Eu-154 , fish	5.000E+01	5.000E+01	BIOFAC(6,1)
D-5	Eu-154 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(6,2)
D-5	Eu-155 , fish	5.000E+01	5.000E+01	BIOFAC(7,1)
D-5	Eu-155 , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(7,2)
D-5	H-3 , fish	1.000E+00	1.000E+00	BIOFAC(8,1)
D-5	H-3 , crustacea and mollusks	1.000E+00	1.000E+00	BIOFAC(8,2)
D-5	Ni-63 , fish	1.000E+02	1.000E+02	BIOFAC(9,1)
D-5	Ni-63 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(9,2)
D-5	Np-237+D , fish	3.000E+01	3.000E+01	BIOFAC(10,1)
D-5	Np-237+D , crustacea and mollusks	4.000E+02	4.000E+02	BIOFAC(10,2)
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(11,2)
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(12,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(12,2)
D-5	Pu-238 , fish	3.000E+01	3.000E+01	BIOFAC(13,1)
D-5	Pu-238 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(13,2)
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(15,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(15,2)
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(16,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(16,2)
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(17,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(17,2)
D-5	Th-229+D , fish	1.000E+02	1.000E+02	BIOFAC(18,1)
D-5	Th-229+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(18,2)
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(19,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(19,2)
D-5	U-233 , fish	1.000E+01	1.000E+01	BIOFAC(20,1)
D-5	U-233 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(20,2)
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(21,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(21,2)

Attachment	1	Sheet No.	6 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:23  Page   7
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

                   Dose Conversion Factor (and Related) Parameter Summary (continued)
                                  Dose Library: FGR 12 & FGR 11
0      ³                                                       ³  Current  ³   Base    ³  Parameter
 Menu  ³                     Parameter                         ³   Value#  ³   Case*   ³    Name
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
 D-5   ³ U-235+D    , fish                                     ³ 1.000E+01 ³ 1.000E+01 ³ BIOFAC( 22,1)
 D-5   ³ U-235+D    , crustacea and mollusks                   ³ 6.000E+01 ³ 6.000E+01 ³ BIOFAC( 22,2)
ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ
 #For DCF1(xxx) only, factors are for infinite depth & area.  See ETFG table in Ground Pathway of Detailed Report.
 *Base Case means Default.Lib w/o Associate Nuclide contributions.
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Attachment 1	Sheet No. 7 of 30
Originator: S. W. Clark	Date 6/10/2013
Chk'd By M. W. Perrott	Date 6/10/2013
Calc. No. 0100N-CA-V0226	Rev. No. 0

ATTACHMENT 1

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 8
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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)	1.166E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.000E+00	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	1.800E+01	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+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)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.429E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	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): Am-241	4.480E+02	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): C-14	3.630E-01	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Co-60	8.160E+01	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Cs-137	2.250E+03	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Eu-154	2.880E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Eu-155	2.920E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): H-3	2.230E-01	0.000E+00	---	S1(8)
R012	Initial principal radionuclide (pCi/g): Ni-63	5.870E+01	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): Pu-238	2.500E+00	0.000E+00	---	S1(13)
R012	Initial principal radionuclide (pCi/g): Pu-239	2.880E+01	0.000E+00	---	S1(15)
R012	Initial principal radionuclide (pCi/g): Sr-90	9.600E+02	0.000E+00	---	S1(17)
R012	Concentration in groundwater (pCi/L): Am-241	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): C-14	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Eu-154	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Eu-155	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): H-3	not used	0.000E+00	---	W1(8)
R012	Concentration in groundwater (pCi/L): Ni-63	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): Pu-238	not used	0.000E+00	---	W1(13)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(15)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(17)
R013	Cover depth (m)	1.320E+01	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.600E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	0.000E+00	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)	0.000E+00	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)	8.000E+00	8.000E+00	---	HUMID

Attachment 1 Sheet No. 8 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

1RESRAD, Version 6.5 T= Limit = 180 days 06/10/2013 07:23 Page 9
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	0.000E+00	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
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	9.000E+00	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 Am-241				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for C-14				
R016	Contaminated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	2.000E+02	0.000E+00	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	5.000E+01	1.000E+03	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)

Attachment 1 Sheet No. 9 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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ATTACHMENT 1

```
1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:23  Page  10
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Eu-154				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Eu-155				
R016	Contaminated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	2.000E+02	-1.000E+00	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for H-3				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.126E-01	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R016	Distribution coefficients for Ni-63				
R016	Contaminated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	3.000E+01	1.000E+03	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.658E-03	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for Pu-238				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(13)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCU(13,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(13)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(13)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(13)
R016	Distribution coefficients for Pu-239				
R016	Contaminated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCC(15)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCU(15,1)
R016	Saturated zone (cm**3/g)	2.000E+02	2.000E+03	---	DCNUCS(15)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.496E-04	ALEACH(15)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(15)

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Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  11
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	1.500E+01	3.000E+01	---	DCNUCC(17)
R016	Unsaturated zone 1 (cm**3/g)	1.500E+01	3.000E+01	---	DCNUCU(17,1)
R016	Saturated zone (cm**3/g)	1.500E+01	3.000E+01	---	DCNUCS(17)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.303E-03	ALEACH(17)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(17)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.482E-03	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Np-237				
R016	Contaminated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	-1.000E+00	-1.000E+00	2.574E+02	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.939E-04	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	4.989E-04	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(16)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(16,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(16)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.123E-04	ALEACH(16)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(16)
R016	Distribution coefficients for daughter Th-229				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(18)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(18,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(18)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.325E-07	ALEACH(18)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(18)

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Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  12
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(19)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(19,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(19)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.325E-07	ALEACH(19)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(19)
R016	Distribution coefficients for daughter U-233				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(20)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(20,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(20)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(20)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(20)
R016	Distribution coefficients for daughter U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(21)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(21,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(21)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(21)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(21)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(22)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(22,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(22)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	9.966E-04	ALEACH(22)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(22)
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)

Attachment	1	Sheet No.	12 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 13
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	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	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.583E-01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.583E-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)

Attachment 1 Sheet No. 13 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
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1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:23  Page  14
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	2.000E-05	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	3.000E-02	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	2.000E-02	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	9.800E-01	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	3.000E-01	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	7.000E-07	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	1.000E-10	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	8.000E-01	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	2.000E-01	2.000E-01	---	AVFG5
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

Attachment 1 Sheet No. 14 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

```
1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:23  Page  15
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	suppressed

Attachment 1 Sheet No. 15 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:23  Page  16
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

     Contaminated Zone Dimensions            Initial Soil Concentrations, pCi/g
     ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ            ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ
        Area:    1165.60 square meters                Am-241      4.480E+02
   Thickness:       1.00 meters                       C-14        3.630E-01
 Cover Depth:      13.20 meters                       Co-60       8.160E+01
                                                      Cs-137      2.250E+03
                                                      Eu-154      2.880E+01
                                                      Eu-155      2.920E+00
                                                      H-3         2.230E-01
                                                      Ni-63       5.870E+01
                                                      Pu-238      2.500E+00
                                                      Pu-239      2.880E+01
                                                      Sr-90       9.600E+02
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  1.000E+01  1.429E+01  3.000E+01  1.000E+02  3.000E+02  1.000E+03
     TDOSE(t):  0.000E+00  0.000E+00  0.000E+00  0.000E+00  1.955E-03  1.264E-06  7.134E-21  0.000E+00  0.000E+00
         M(t):  0.000E+00  0.000E+00  0.000E+00  0.000E+00  1.304E-04  8.425E-08  4.756E-22  0.000E+00  0.000E+00
0Maximum TDOSE(t):   1.955E-03 mrem/yr    at t =    14.29 ñ 0.03 years
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 = 1.429E+01 years
0                                 Water Independent Pathways (Inhalation excludes radon)
0
```

Radio- Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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

Attachment 1 Sheet No. 16 of 30
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 1

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 17
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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 = 1.429E+01 years

0 Water Dependent Pathways

0 Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	1.523E-03	0.7790	5.429E-07	0.0003	0.000E+00	0.0000	4.156E-04	0.2126	3.451E-06	0.0018	1.258E-05	0.0064	1.955E-03	1.0000
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	0.000E+00	0.0000
Pu-238	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
Pu-239	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
Sr-90	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	1.523E-03	0.7790	5.429E-07	0.0003	0.000E+00	0.0000	4.156E-04	0.2126	3.451E-06	0.0018	1.258E-05	0.0064	1.955E-03	1.0000

0*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	17 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page  18
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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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)

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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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 = 0.000E+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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	18 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

1RESRAD, Version 6.5 T= Limit = 180 days 06/10/2013 07:23 Page 19
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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
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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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
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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	19 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  20
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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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 = 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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	20 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  21
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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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 = 1.000E+01 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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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+01 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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	21 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  22
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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 = 1.429E+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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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 = 1.429E+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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	1.523E-03	0.7790	5.429E-07	0.0003	0.000E+00	0.0000	4.156E-04	0.2126	3.451E-06	0.0018	1.258E-05	0.0064	1.955E-03	1.0000
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	0.000E+00	0.0000
Pu-238	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
Pu-239	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
Sr-90	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	1.523E-03	0.7790	5.429E-07	0.0003	0.000E+00	0.0000	4.156E-04	0.2126	3.451E-06	0.0018	1.258E-05	0.0064	1.955E-03	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	22 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  23
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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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 = 3.000E+01 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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+01 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	9.703E-07	0.7678	3.551E-10	0.0003	0.000E+00	0.0000	2.814E-07	0.2227	2.876E-09	0.0023	8.747E-09	0.0069	1.264E-06	1.0000
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	0.000E+00	0.0000
Pu-238	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
Pu-239	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
Sr-90	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	9.703E-07	0.7678	3.551E-10	0.0003	0.000E+00	0.0000	2.814E-07	0.2227	2.876E-09	0.0023	8.747E-09	0.0069	1.264E-06	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	23 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page  24
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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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 = 1.000E+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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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 = 1.000E+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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	5.478E-21	0.7678	2.005E-24	0.0003	0.000E+00	0.0000	1.589E-21	0.2227	1.624E-23	0.0023	4.938E-23	0.0069	7.134E-21	1.0000
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	0.000E+00	0.0000
Pu-238	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
Pu-239	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
Sr-90	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	5.478E-21	0.7678	2.005E-24	0.0003	0.000E+00	0.0000	1.589E-21	0.2227	1.624E-23	0.0023	4.938E-23	0.0069	7.134E-21	1.0000

*Sum of all water independent and dependent pathways.

Attachment	1	Sheet No.	24 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  25
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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+02 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	25 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  26
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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 = 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.
Am-241	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
C-14	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
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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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	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
Pu-238	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
Pu-239	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
Sr-90	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.

Attachment	1	Sheet No.	26 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

1RESRAD, Version 6.5 T« Limit = 180 days 06/10/2013 07:23 Page 27
Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

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

0 Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.429E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	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
Am-241	Np-237+D	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
Am-241	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
Am-241	Th-229+D	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
Am-241	ΣDSR(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
0C-14	C-14	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
0Co-60	Co-60	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
0Cs-137+D	Cs-137+D	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
0Eu-154	Eu-154	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
0Eu-155	Eu-155	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
0H-3	H-3	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.768E-03	5.667E-06	3.199E-20	0.000E+00	0.000E+00
0Ni-63	Ni-63	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
0Pu-238	Pu-238	1.840E-09	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
0Pu-238	Pu-238	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
Pu-238	U-234	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
Pu-238	Th-230	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
Pu-238	Ra-226+D	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
Pu-238	Pb-210+D	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
Pu-238	ΣDSR(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
0Pu-239	Pu-239	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
Pu-239	U-235+D	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
Pu-239	Pa-231	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
Pu-239	Ac-227+D	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
Pu-239	ΣDSR(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
0Sr-90+D	Sr-90+D	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

The DSR includes contributions from associated (half-life ó 180 days) daughters.

Attachment	1	Sheet No.	27 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page  28
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

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	1.000E+01	1.429E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12	*3.431E+12
C-14	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12	*4.455E+12
Co-60	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15	*1.132E+15
Cs-137	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13	*8.704E+13
Eu-154	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14	*2.639E+14
Eu-155	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14	*4.652E+14
H-3	*9.597E+15	*9.597E+15	*9.597E+15	*9.597E+15	1.711E+03	2.647E+06	*9.597E+15	*9.597E+15	*9.597E+15
Ni-63	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13	*5.917E+13
Pu-238	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13	*1.712E+13
Pu-239	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10	*6.214E+10
Sr-90	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14	*1.365E+14

*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 = 14.29 ñ 0.03 years

0Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Am-241	4.480E+02	0.000E+00	0.000E+00	*3.431E+12	0.000E+00	*3.431E+12
C-14	3.630E-01	0.000E+00	0.000E+00	*4.455E+12	0.000E+00	*4.455E+12
Co-60	8.160E+01	0.000E+00	0.000E+00	*1.132E+15	0.000E+00	*1.132E+15
Cs-137	2.250E+03	0.000E+00	0.000E+00	*8.704E+13	0.000E+00	*8.704E+13
Eu-154	2.880E+01	0.000E+00	0.000E+00	*2.639E+14	0.000E+00	*2.639E+14
Eu-155	2.920E+00	0.000E+00	0.000E+00	*4.652E+14	0.000E+00	*4.652E+14
H-3	2.230E-01	14.29 ñ 0.03	8.768E-03	1.711E+03	8.768E-03	1.711E+03
Ni-63	5.870E+01	0.000E+00	0.000E+00	*5.917E+13	0.000E+00	*5.917E+13
Pu-238	2.500E+00	0.000E+00	0.000E+00	*1.712E+13	0.000E+00	*1.712E+13
Pu-239	2.880E+01	0.000E+00	0.000E+00	*6.214E+10	0.000E+00	*6.214E+10
Sr-90	9.600E+02	0.000E+00	0.000E+00	*1.365E+14	0.000E+00	*1.365E+14

*At specific activity limit

Attachment	1	Sheet No.	28 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  29
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

0Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.429E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
AAAAAAA	AAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA	AAAAAAAAA
Am-241	Am-241	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
0Np-237	Am-241	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	Am-241	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	Am-241	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
0C-14	C-14	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
0Co-60	Co-60	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
0Cs-137	Cs-137	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
0Eu-154	Eu-154	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
0Eu-155	Eu-155	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
0H-3	H-3	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.955E-03	1.264E-06	7.134E-21	0.000E+00	0.000E+00
0Ni-63	Ni-63	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
0Pu-238	Pu-238	1.840E-09	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
Pu-238	Pu-238	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
Pu-238	ΣDOSE(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
0U-234	Pu-238	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-230	Pu-238	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
0Ra-226	Pu-238	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
0Pb-210	Pu-238	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
0Pu-239	Pu-239	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-235	Pu-239	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
0Pa-231	Pu-239	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
0Ac-227	Pu-239	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
0Sr-90	Sr-90	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

THF(i) is the thread fraction of the parent nuclide.

Attachment	1	Sheet No.	29 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 1

```
1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page  30
 Summary : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.429E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Am-241	Am-241	1.000E+00	4.480E+02	4.472E+02	4.455E+02	4.398E+02	4.363E+02	4.238E+02	3.722E+02	2.569E+02	7.021E+01
0Np-237	Am-241	1.000E+00	0.000E+00	1.450E-04	4.340E-04	1.436E-03	2.044E-03	4.222E-03	1.311E-02	3.235E-02	5.831E-02
0U-233	Am-241	1.000E+00	0.000E+00	3.170E-10	2.847E-09	3.141E-08	6.386E-08	2.770E-07	2.868E-06	2.116E-05	1.216E-04
0Th-229	Am-241	1.000E+00	0.000E+00	9.980E-15	2.690E-13	9.910E-12	2.882E-11	2.634E-10	9.237E-09	2.140E-07	4.776E-06
0C-14	C-14	1.000E+00	3.630E-01	3.629E-01	3.626E-01	3.617E-01	3.611E-01	3.590E-01	3.498E-01	3.248E-01	2.506E-01
0Co-60	Co-60	1.000E+00	8.160E+01	7.147E+01	5.484E+01	2.169E+01	1.229E+01	1.532E+00	1.437E-04	4.453E-16	0.000E+00
0Cs-137	Cs-137	1.000E+00	2.250E+03	2.196E+03	2.093E+03	1.768E+03	1.594E+03	1.092E+03	2.021E+02	1.629E+00	7.674E-08
0Eu-154	Eu-154	1.000E+00	2.880E+01	2.661E+01	2.272E+01	1.307E+01	9.311E+00	2.691E+00	1.066E-02	1.460E-09	1.390E-33
0Eu-155	Eu-155	1.000E+00	2.920E+00	2.939E+00	1.919E+00	7.201E-01	3.950E-01	4.379E-02	2.429E-06	1.680E-18	0.000E+00
0H-3	H-3	1.000E+00	2.230E-01	1.396E-01	5.466E-02	2.055E-03	2.752E-04	1.745E-07	9.854E-22	0.000E+00	0.000E+00
0Ni-63	Ni-63	1.000E+00	5.870E+01	5.818E+01	5.716E+01	5.371E+01	5.171E+01	4.497E+01	2.416E+01	4.091E+00	8.179E-03
0Pu-238	Pu-238	1.840E-09	4.600E-09	4.563E-09	4.489E-09	4.240E-09	4.094E-09	3.602E-09	2.036E-09	3.990E-10	1.329E-12
Pu-238	Pu-238	1.000E+00	2.500E+00	2.480E+00	2.440E+00	2.304E+00	2.225E+00	1.958E+00	1.107E+00	2.168E-01	7.221E-04
Pu-238	ΣS(j):		2.500E+00	2.480E+00	2.440E+00	2.304E+00	2.225E+00	1.958E+00	1.107E+00	2.168E-01	7.221E-04
0U-234	Pu-238	1.000E+00	0.000E+00	7.055E-06	2.097E-05	6.772E-05	9.491E-05	1.857E-04	4.582E-04	6.485E-04	3.646E-04
0Th-230	Pu-238	1.000E+00	0.000E+00	3.180E-11	2.845E-10	3.095E-09	6.238E-09	2.624E-08	2.388E-07	1.311E-06	4.524E-06
0Ra-226	Pu-238	1.000E+00	0.000E+00	4.595E-15	1.234E-13	4.490E-12	1.296E-11	1.152E-10	3.597E-09	6.246E-08	7.146E-07
0Pb-210	Pu-238	1.000E+00	0.000E+00	3.550E-17	2.828E-15	3.296E-13	1.327E-12	2.278E-11	1.717E-09	4.798E-08	6.679E-07
0Pu-239	Pu-239	1.000E+00	2.880E+01	2.879E+01	2.878E+01	2.872E+01	2.869E+01	2.856E+01	2.801E+01	2.649E+01	2.180E+01
0U-235	Pu-239	1.000E+00	0.000E+00	2.835E-08	8.493E-08	2.818E-07	4.016E-07	8.348E-07	2.662E-06	7.042E-06	1.532E-05
0Pa-231	Pu-239	1.000E+00	0.000E+00	2.998E-13	2.694E-12	2.978E-11	6.061E-11	2.639E-10	2.780E-09	2.150E-08	1.419E-07
0Ac-227	Pu-239	1.000E+00	0.000E+00	3.155E-15	8.366E-14	2.912E-12	8.187E-12	6.652E-11	1.518E-09	1.675E-08	1.267E-07
0Sr-90	Sr-90	1.000E+00	9.600E+02	9.343E+02	8.850E+02	7.321E+02	6.517E+02	4.257E+02	6.383E+01	2.822E-01	1.622E-09

THF(i) is the thread fraction of the parent nuclide.
0RESCALC.EXE execution time = 1.21 seconds

Attachment	1	Sheet No.	30 of 30
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

```
1RESRAD, Version 6.5      T« Limit = 180 days       06/10/2013  07:23  Page   1
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Table of Contents

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Part IV: Concentration of Radionuclides

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Concentration of radionuclides in different media .

Time= 0.000E+00 2
Time= 1.000E+00 4
Time= 3.000E+00 6
Time= 1.000E+01 8
Time= 1.429E+01 10
Time= 3.000E+01 12
Time= 1.000E+02 14
Time= 3.000E+02 16
Time= 1.000E+03 18

Attachment 2	Sheet No. 1 of 19
Originator: S. W. Clark	Date 6/10/2013
Chk'd By M. W. Perrott	Date 6/10/2013
Calc. No. 0100N-CA-V0226	Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page   2
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in environmental media
at t = 0.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.480E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.630E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	8.160E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	2.250E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	2.880E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	2.920E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	2.230E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	5.870E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.500E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.880E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	9.600E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	2 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 3
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 0.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	3 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page   4
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	3.155E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.472E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.629E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	7.147E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	2.196E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	2.661E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	2.539E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	1.396E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	5.818E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	1.450E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.998E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	3.550E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.480E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.879E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	4.595E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	9.343E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	9.980E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	3.180E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	3.170E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	7.055E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	2.835E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	4 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 5
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	5 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page   6
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in environmental media
at t = 3.000E+00 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	8.366E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.455E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.626E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	5.484E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	2.093E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	2.272E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	1.919E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	5.466E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	5.716E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	4.340E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.694E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	2.828E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.440E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.878E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	1.234E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	8.850E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	2.690E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	2.845E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	2.847E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	2.097E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	8.493E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment 2 Sheet No. 6 of 19
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 7
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+00 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	7 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T½ Limit = 180 days        06/10/2013  07:23  Page   8
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in environmental media
at t = 1.000E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	2.912E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.398E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.617E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	2.169E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	1.768E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	1.307E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	7.201E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	2.055E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	5.371E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	1.436E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.978E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	3.296E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.304E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.872E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	4.490E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	7.321E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	9.910E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	3.095E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	3.141E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	6.772E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	2.818E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	8 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page   9
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in foodstuff media
at t = 1.000E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	9 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T< Limit = 180 days       06/10/2013  07:23  Page  10
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
```

Concentration of radionuclides in environmental media
at t = 1.429E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	8.187E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.363E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.611E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	1.229E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	1.594E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	9.311E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	3.950E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	2.752E-04	0.000E+00	0.000E+00	3.271E+01	8.427E-01
Ni-63	5.171E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	2.044E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	6.061E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	1.327E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.225E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.869E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	1.296E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	6.517E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	2.882E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	6.238E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	6.386E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	9.491E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	4.016E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	10 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 11
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 1.429E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	3.260E+01	1.138E+02	1.721E+02	4.357E+01	4.770E+01	2.570E+01	3.373E+01	8.236E-01	8.236E-01
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	11 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page  12
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Concentration of radionuclides in environmental media
at t = 3.000E+01 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	6.652E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	4.238E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.590E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	1.532E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	1.092E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	2.691E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	4.379E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	1.745E-07	0.000E+00	0.000E+00	2.075E-02	5.345E-04
Ni-63	4.497E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	4.222E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.639E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	2.278E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	1.958E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.856E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	1.152E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	4.257E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	2.634E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	2.624E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	2.770E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	1.857E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	8.348E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	12 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 13
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+01 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	2.077E-02	7.724E-02	1.101E-01	3.934E-02	3.839E-02	2.142E-02	2.345E-02	5.387E-04	5.387E-04
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment 2 Sheet No. 13 of 19
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 2

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1RESRAD, Version 6.5      T< Limit = 180 days        06/10/2013  07:23  Page  14
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Concentration of radionuclides in environmental media
at t = 1.000E+02 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	1.518E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	3.722E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.498E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	1.437E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	2.021E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	1.066E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	2.429E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	9.854E-22	0.000E+00	0.000E+00	1.171E-16	3.017E-18
Ni-63	2.416E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	1.311E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.780E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	1.717E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	1.107E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.801E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	3.597E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	6.383E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	9.237E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	2.388E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	2.868E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	4.582E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	2.662E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	14 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 15
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+02 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	1.173E-16	4.361E-16	6.217E-16	2.221E-16	2.167E-16	1.209E-16	1.324E-16	3.042E-18	3.042E-18
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	15 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
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ATTACHMENT 2

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1RESRAD, Version 6.5      T½ Limit = 180 days       06/10/2013  07:23  Page  16
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Concentration of radionuclides in environmental media
at t = 3.000E+02 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	1.675E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	2.569E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	3.248E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	4.453E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	1.629E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	1.460E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	1.680E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	4.091E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	3.235E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	2.150E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	4.798E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.168E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.649E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	6.246E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	2.822E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	2.140E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	1.311E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	2.116E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	6.485E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	7.042E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment	2	Sheet No.	16 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

1RESRAD, Version 6.5 T½ Limit = 180 days 06/10/2013 07:23 Page 17
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 3.000E+02 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	17 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

ATTACHMENT 2

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1RESRAD, Version 6.5      T« Limit = 180 days        06/10/2013  07:23  Page  18
 Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
 File    : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD
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Concentration of radionuclides in environmental media
at t = 1.000E+03 years

Radio-Nuclide	Contaminated Zone pCi/g	Surface Soil* pCi/g	Air Particulate pCi/m**3	Well Water pCi/L	Surface Water pCi/L
Ac-227	1.267E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	7.021E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C-14	2.506E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Co-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	7.674E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-154	1.390E-33	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Eu-155	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H-3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-63	8.179E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Np-237	5.831E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	1.419E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	6.679E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	7.221E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-239	2.180E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-226	7.146E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	1.622E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-229	4.776E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	4.524E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-233	1.216E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	3.646E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	1.532E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*The Surface Soil is the top layer of soil within the user specified mixing zone/depth.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Concentration of H-3 in soil moisture = 0.000E+00 pCi/ml
Concentration of gaseous H-3 in air = 0.000E+00 pCi/m**3
Concentration of gaseous C-14 in air = 0.000E+00 pCi/m**3

Attachment 2 Sheet No. 18 of 19
Originator: S. W. Clark Date 6/10/2013
Chk'd By M. W. Perrott Date 6/10/2013
Calc. No. 0100N-CA-V0226 Rev. No. 0

ATTACHMENT 2

1RESRAD, Version 6.5 T< Limit = 180 days 06/10/2013 07:23 Page 19
Concent : 118-N-1 Radionuclide Dose and Groundwater Protection Evaluation
File : C:\RESRAD_FAMILY\RESRAD\6.5\USERFILES\118-N-1_SR-90.RAD

Concentration of radionuclides in foodstuff media
at t = 1.000E+03 years*

Radio-Nuclide	Drinking Water pCi/L	Nonleafy Vegetable pCi/kg	Leafy Vegetable pCi/kg	Fodder Meat pCi/kg	Fodder Milk pCi/kg	Meat pCi/kg	Milk pCi/L	Fish pCi/kg	Crustacea pCi/kg
Ac-227	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
Am-241	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
C-14	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
Co-60	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
Cs-137	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
Eu-154	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
Eu-155	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
H-3	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
Ni-63	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	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
Pa-231	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
Pb-210	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
Pu-238	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
Pu-239	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
Ra-226	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
Sr-90	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
Th-229	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
Th-230	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
U-233	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
U-234	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
U-235	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

*Concentrations are at consumption time and include radioactive decay and ingrowth during storage time.
For livestock fodder, consumption time is t minus meat or milk storage time.

Concentrations in the media occurring in pathways that are suppressed are calculated using the current input parameters, i.e. using parameters appearing in the input screen when the pathways are active.

Attachment	2	Sheet No.	19 of 19
Originator:	S. W. Clark	Date	6/10/2013
Chk'd By	M. W. Perrott	Date	6/10/2013
Calc. No.	0100N-CA-V0226	Rev. No.	0

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2013b). This DQA was performed in accordance with site-specific data quality objectives found in the *100-N Area Sampling and Analysis Plan for CERCLA Waste Sites* (100-N Area SAP) (DOE-RL 2006).

A review of the sample design (WCH 2013b), field logbook (WCH 2013a), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design. To ensure quality data, the SAP data assurance requirements and the data validation procedures for chemical analysis and radiochemical analysis (BHI 2000a, 2000b) are used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

Verification sample data collected at the 118-N-1 waste site were provided by the laboratories in sample delivery groups (SDGs) JP0522, JP0523, JP0525, JP0535, and ZP0006. SDG JP0522 was submitted for third-party validation. No major deficiencies were identified. Minor deficiencies identified in the analytical data sets are discussed as follows. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MAJOR DEFICIENCIES

None.

MINOR DEFICIENCIES

SDG JP0522

This SDG is comprised of nine statistical verification soil samples (J1RKW7 through J1RKW9 and J1RKX0 through J1RKX5) from the 118-N-1 excavation collected on April 23, 2013. Samples J1RKW9 and J1RKX5 comprise a field duplicate pair. All samples were analyzed for gamma energy analysis (GEA), isotopic plutonium, isotopic uranium, carbon-14, nickel-63, strontium-90, tritium, inductively coupled plasma (ICP) metals, mercury, hexavalent chromium, and polychlorinated biphenyls (PCB). SDG JP0526 was submitted for third-party validation. Minor deficiencies are as follows:

In the carbon-14 and tritium analyses, no matrix spike (MS) was performed. In the isotopic plutonium and isotopic uranium analyses, no laboratory control sample (LCS) analysis was performed for plutonium-238 and uranium-235. All carbon-14, tritium, plutonium-238, and uranium-235 results were qualified as estimated and flagged "J" by third party validation due to the lack of quality control (QC) analyses. Estimated data are usable for decision-making purposes.

In the nickel-63 analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits at 91.9%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all nickel-63 results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries were outside of QC limits for aluminum (697%), antimony (51%), iron (2,197%), manganese (169%), and silicon (47%). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample and these data may be considered estimated. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. All antimony and silicon results were qualified as estimated and flagged "J" by third-party validation due to the MS recoveries outside the QC limits. Although not qualified for MS recovery outside of QC limits, all aluminum, iron, and manganese results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, all silicon results were considered qualified as estimated and flagged "J" by third-party validation due to an LCS recovery below QC limits at 20%. Estimated data are usable for decision-making purposes.

SDG JP0523

This SDG is comprised of three focused verification soil samples (J1RKX7 through J1RKX9) from the 118-N-1 excavation collected on April 23, 2013. All samples were analyzed for GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, strontium-90, tritium, ICP metals, mercury, hexavalent chromium, and PCB. Minor deficiencies are as follows:

In the carbon-14 and tritium analyses, no MS was performed. In the isotopic plutonium and isotopic uranium analyses, no LCS analysis was performed for plutonium-238 and uranium-235. Although not qualified for a lack of MS or LCS, all carbon-14, tritium, plutonium-238, and uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the nickel-63 analysis, contamination was detected in the method blank (MB) at less than twice the method detection limit (MDL). Method blank contamination of this magnitude has no significant impact on the field sample results and will have no impact on the evaluation of the 118-N-1 waste site. The data are usable for decision-making purposes.

In the tritium analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits at 57.8%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all tritium results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the PCB analysis, the laboratory noted that sample J1RKX7 appeared to contain PCBs; however, due to weathering or other environmental processes, the PCBs in the sample did not closely match any of the aroclor standards used for instrument calibration. The samples were quantified and reported as aroclor-1254; however, due to the poor match with the aroclor standard(s), there was increased uncertainty associated with these results. The data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (12%). Although not qualified for the LCS recovery outside of QC limits, the silicon data may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries for aluminum (744%), antimony (49%), iron (1,872%), manganese (172%), and silicon (34%) were outside of QC limits. For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample and these data may be considered estimated. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, antimony, iron, manganese, and silicon results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the mercury analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits at 54%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all mercury results may be considered estimated. Estimated data are acceptable for decision-making purposes.

SDG JP0525

This SDG is comprised of three statistical verification soil samples (J1RLK1 through J1RLK3) from the 118-N-1 excavation collected on April 25, 2013. All samples were analyzed for GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, strontium-90, tritium, ICP metals, mercury, hexavalent chromium, and PCB. Minor deficiencies are as follows:

In the carbon-14 and tritium analyses, no MS was performed. In the isotopic plutonium and isotopic uranium analyses, no LCS analysis was performed for plutonium-238 and uranium-235. Although not qualified for a lack of MS or LCS, all carbon-14, tritium, plutonium-238, and uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (11%). Although not qualified for the LCS recovery outside of QC limits, the silicon data may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries for aluminum (583%), antimony (55%), iron (-345%), manganese (64%), and silicon (31%) were outside of QC limits. For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. These data may be considered estimated. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, antimony, iron, manganese, and silicon results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits for calcium (53%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all calcium results may be considered estimated. Estimated data are acceptable for decision-making purposes.

SDG JP0535

This SDG is comprised of four focused verification soil samples (J1RLR5 through J1RLR8) from the 118-N-1 excavation test pit and one statistical verification soil sample (J1RLR9) collected on May 2, 2013. All samples were analyzed for GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, strontium-90, tritium, ICP metals, mercury, hexavalent chromium, and PCB. In addition, one equipment blank (J1RLT0) was analyzed for ICP metals and mercury. Minor deficiencies are as follows:

In the carbon-14 and tritium analyses, no MS was performed. In the isotopic plutonium and isotopic uranium analyses, no LCS analysis was performed for plutonium-238 and uranium-235. Although not qualified for a lack of MS or LCS, all carbon-14, tritium, plutonium-238, and uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the GEA analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits for cesium-137 (75%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all cesium-137 results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, barium was detected in the MB at less than twice the MDL. Method blank contamination of this magnitude has no significant impact on the field sample results. The data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for silicon (8%). Although not qualified for the LCS recovery outside of QC limits, the silicon data may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS recoveries for aluminum (784%), antimony (61%), iron (5,375%), manganese (220%), and silicon (26%) were outside of QC limits. For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. These data may be considered estimated. Antimony and silicon did not have mismatched spike and native concentrations in the original MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, antimony, iron, manganese, and silicon results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the RPDs calculated from the laboratory duplicate analysis were above QC limits for beryllium (87%) and lead (31%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all beryllium and lead results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the mercury analysis, the MS recovery was outside of QC limits at 69%. Although not qualified for the MS recovery outside of QC limits, all mercury results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the mercury analysis, the RPD calculated from the laboratory duplicate analysis was above QC limits at 42%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all mercury results may be considered estimated. Estimated data are acceptable for decision-making purposes.

SDG ZP0006

This SDG is comprised of one soil sample (J1RKX6) from the 118-N-1 excavation collected on April 23, 2013. Sample J1RKX6 is a split of sample J1RKW9. The sample was analyzed for GEA, isotopic plutonium, isotopic uranium, carbon-14, nickel-63, strontium-90, tritium, ICP metals, mercury, hexavalent chromium, and PCB. Minor deficiencies are as follows:

In the isotopic plutonium and isotopic uranium analyses, no LCS analysis was performed for plutonium-238 and uranium-235. Although not qualified for a lack of an LCS, all plutonium-238 and uranium-235 results may be considered estimated. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the LCS recovery was outside of QC limits for aluminum (55%), antimony (55%), and potassium (65%). Although not qualified for the LCS recovery outside of QC limits, the aluminum, antimony, and potassium data may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the MS/matrix spike duplicate (MSD) recoveries for aluminum (138% and 147%), antimony (68% and 66%), calcium (53% and 446%), iron (-243% and 60%), magnesium (48% and 63%), manganese (16% and 46%), silicon (60% [MSD only]), and vanadium (62% [MS only]) were outside of QC limits. For aluminum, calcium, iron, magnesium, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the analytical variability of the native concentration rather than a measure of the recovery from the sample. These data may be considered estimated. Antimony, silicon, and vanadium did not have mismatched spike and native concentrations in the original MS. Although not qualified for MS recoveries outside of QC limits, all aluminum, antimony, calcium, iron, magnesium, manganese, silicon, and vanadium results may be considered estimated. Estimated data are acceptable for decision-making purposes.

In the ICP metals analysis, the RPD calculated from the MS/MSD analyses was above QC limits for calcium (53%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. Although not qualified for the RPD outside of QC limits, all calcium results may be considered estimated. Estimated data are acceptable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference (RPD) evaluations of main sample(s) versus the laboratory duplicate(s) are routinely performed and reported by the laboratory. Any deficiencies in those calculations are reported by SDG in the previous sections.

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples, listed in the field logbook (WCH 2013a) are shown in Table B-1. The main and QA/QC sample results are presented in Appendix A.

Table B-1. Field Quality Assurance/Quality Control Samples.

Sample Area	Main Sample	Duplicate Sample	Split Sample
EXC-7	J1RKW9	J1RKX5	J1RKX6

Field duplicate samples are 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 sample/duplicate pair(s) for each contaminant of potential concern (COPC). Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. Relative percent differences of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The calculation brief in Appendix A provides details on duplicate pair evaluation and RPD calculation.

Split samples are collected to provide a relative measure of the 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 COPC 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 2004), is used as an initial test of the data from the splits. Only analytes that had values above five times the CRQL for both the main and split sample were compared. The calculation brief in Appendix A provides details on split pair RPD calculation. The RPD acceptance criteria for project-split samples is ≤35% (less than or equal to 35%).

The RPD calculations for the field duplicate samples are above the acceptance criteria (30%) for aluminum (45.8%), iron (31.3%), magnesium (42.3%), manganese (56.8%), silicon (44.6%), vanadium (41.2%), and zinc (30.1%). The RPD calculations for the field split samples are all below the acceptance criteria (35%). Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit (TDL), including undetected analytes. In these cases, a control limit of ±2 times the TDL is used (Appendix A) to indicate that a visual check of the data is required by the reviewer. For the field duplicate, this check was required for chromium. This check was not required for the field split. All of these results are attributed to heterogeneities in the sample matrix from which the samples were collected. A visual inspection of all of the data is also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 118-N-1 waste site verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for the 118-N-1 waste site concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes. The verification sample analytical data are stored in the Environmental Restoration project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix A.

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