WASTE SITE RECLASSIFICATION FORM		
Date Submitted: <u>10/3/07</u> Originator: <u>L. M. Dittmer</u> Phone: <u>372-9227</u>	Operable Unit(s): <u>100-DR-1</u> Waste Site Code: <u>100-D-50:5</u> Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☐ No Action ☒ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	Control Number: <u>2006-025</u>
<p>This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed Out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.</p>		
<p><u>Description of current waste site condition:</u></p> <p>The 100-D-50:5 subsite encompasses the southern process sewers formerly servicing the 183-DR coagulation and sedimentation basins and proximate surface runoff collection drains. Confirmatory investigation, sampling, and evaluation of this subsite have been performed in accordance with remedial action objectives and goals established by the <i>Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington</i> (Remaining Sites ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington. The selected action involved (1) evaluating the site using available process information, (2) demonstrating through confirmatory sampling and evaluation that cleanup goals have been met, and (3) proposing the site for a "no action" reclassification.</p>		
<p><u>Basis for reclassification:</u></p> <p>The results of confirmatory sampling of pipeline sediments and underlying soils at the 100-D-50:5 subsite demonstrated that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also showed that residual contaminant concentrations are protective of groundwater and the Columbia River. The subsite does not have a deep zone; therefore, no deep zone institutional controls are required. The basis for reclassification is described in detail in the <i>Remaining Sites Verification Package for the 100-D-50:5 Process Sewers (183-DR Sedimentation Basin Drains)</i> (attached).</p>		
<p><u>Waste Site Controls:</u></p> <p>Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒</p> <p>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.</p>		
S. L. Charboneau DOE Federal Project Director (printed)	Signature	<u>10/29/07</u> Date
J. Price Ecology Project Manager (printed)	Signature	<u>11/6/07</u> Date
N/A EPA Project Manager (printed)	Signature	Date

**REMAINING SITES VERIFICATION PACKAGE FOR THE
100-D-50:5 PROCESS SEWERS
(183-DR SEDIMENTATION BASIN DRAINS)**

Attachment to Waste Site Reclassification Form 2006-025

October 2007

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-50:5 PROCESS SEWERS (183-DR SEDIMENTATION BASIN DRAINS)

EXECUTIVE SUMMARY

The 100-D-50:5 subsite, located within the 100-DR-1 Operable Unit, consists of the southern process sewers for the 183-DR coagulation and sedimentation basins. These sewers received cooling water treatment drainage from these basins and surface runoff from storm drains south of the 183-DR facility.

Confirmatory sampling of the site was conducted on November 7 and December 28, 2005. Confirmatory samples were collected from pipeline contents and underlying soils at junction boxes and at a runoff collection basin. Results of the confirmatory sampling event are used to make decisions for reclassification of the site in accordance with the reclassification guideline TPA-MP-14 (DOE-RL 2007) process.

Evaluation of the confirmatory results indicated that the 100-D-50:5 subsite meets the remedial action objectives and the corresponding remedial action goals established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). The results of confirmatory sampling show that residual contaminant concentrations in pipeline sediments and underlying soils do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. A summary of the confirmatory evaluation against the applicable criteria is presented in Table ES-1.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Screening levels were not exceeded for the site constituents, with the exception of barium, boron, selenium, vanadium, and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of barium, selenium, and vanadium at the 100-D-50:5 subsite does not pose a risk to ecological receptors as concentrations of these constituents are below statistical Hanford Site background levels. The exceedance of soil screening values by zinc and boron concentrations at the site will be evaluated in the context of additional lines of evidence for ecological effects. A more complete quantitative ecological risk assessment will be presented in the baseline risk assessment for the river corridor portion of the Hanford Site and will be used to support the final closeout decision for the 100-D-50 waste site.

Table ES-1. Summary of Remedial Action Goals for the 100-D-50:5 Subsite.

Regulatory Requirement	Remedial Action Goals	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain 15-mrem/yr dose rate above background over 1,000 years.	Only cesium-137 was detected above background, at an activity below the direct exposure dose-equivalence lookup value.	Yes
Direct Exposure – Nonradionuclides	Attain individual COPC RAGs.	All individual COPC results are below individual direct exposure RAGs.	Yes
Risk Requirements – Nonradionuclides	Attain a hazard quotient of <1 for all individual noncarcinogens.	All individual hazard quotients associated with soil are less than 1.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogens.	The cumulative hazard quotient for the subsite (4.8×10^{-2}) is less than 1.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens.	All individual excess carcinogenic risk values are less than 1.	
	Attain a cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.	The total excess carcinogenic risk (5.3×10^{-8}) is less than 1×10^{-5} .	
Groundwater/River Protection – Radionuclides	Attain single-COPC groundwater and river protection RAGs.	Only cesium-137 was detected above background. Site-specific RESRAD modeling predicts that cesium-137 will not reach groundwater (and thus the Columbia River) within 1,000 years.	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	No alpha-emitting radionuclides were detected above statistical background levels.	
	Meet total uranium standard of 30 µg/L (21.2 pCi/L). ^c	Uranium was not detected above statistical background levels.	
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	Maximum detected results for lead and zinc in pipe sediments exceeded soil RAGs for groundwater and/or river protection. Site-specific RESRAD modeling indicates that these constituents will not reach groundwater (and therefore the Columbia River) within 1,000 years. Therefore, the residual contaminant concentrations achieve the RAOs for groundwater and river protection.	Yes

^a“National Primary Drinking Water Regulations” (40 Code of Federal Regulations 141).

^bRadiation Protection of the Public and the Environment (DOE Order 5400.5).

^cBased 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).

COPC = contaminant of potential concern RAO = remedial action objective

MCL = maximum contaminant level

RESRAD = RESidual RADioactivity (dose assessment model)

RAG = remedial action goal

REMAINING SITES VERIFICATION PACKAGE FOR THE 100-D-50:5 PROCESS SEWERS (183-DR SEDIMENTATION BASIN DRAINS)

STATEMENT OF PROTECTIVENESS

This report demonstrates that the 100-D-50:5 subsite meets the objectives for interim closure as established in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL 2005b) and the *Interim Action Record of Decision for the 100-BC-1, 100-BC-2, 100-DR-1, 100-DR-2, 100-FR-1, 100-FR-2, 100-HR-1, 100-HR-2, 100-KR-1, 100-KR-2, 100-IU-2, 100-IU-6, and 200-CW-3 Operable Units, Hanford Site, Benton County, Washington* (Remaining Sites ROD) (EPA 1999). The results of confirmatory sampling show that residual contaminant concentrations do not preclude any future uses (as bounded by the rural-residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The results also demonstrate that residual contaminant concentrations are protective of groundwater and the Columbia River. This site does not have a deep zone; therefore, no deep zone institutional controls are required.

Soil cleanup levels were established in the Remaining Sites ROD (EPA 1999) based in part on a limited ecological risk assessment. Although not required by the Remaining Sites ROD, a comparison against ecological risk screening levels has been made for the site contaminants of potential concern and other constituents. Screening levels were not exceeded for the site constituents, with the exception of barium, boron, selenium, vanadium, and zinc. Exceedance of screening values does not necessarily indicate the existence of risk to ecological receptors. It is believed that the presence of barium, selenium, and vanadium at the 100-D-50:5 subsite does not pose a risk to ecological receptors as concentrations of these constituents are below statistical Hanford Site background levels. The exceedance of soil screening values by zinc and boron concentrations at the site will be evaluated in the context of additional lines of evidence for ecological effects. A more complete quantitative ecological risk assessment will be presented in the baseline risk assessment for the river corridor portion of the Hanford Site and will be used to support the final closeout decision for the 100-D-50 waste site.

GENERAL SITE INFORMATION AND BACKGROUND

The 100-D-50 site, part of the 100-DR-1 Operable Unit, encompasses those underground pipelines associated with pre-reactor process cooling water, process wastewater, and sanitary wastewater. This site has been administratively divided into 10 subsites based on process knowledge, contaminants of potential concern (COPCs), and possible remedial actions. The 100-D-50:5 subsite encompasses the southern process sewers for the 183-DR coagulation and sedimentation basins.

The 183-DR coagulation and sedimentation basins were part of the coolant water treatment facilities for the 105-DR Reactor. The function of these facilities was to use physical and chemical treatment to condition raw river water for reactor use. The chemicals added at the 183-DR coagulation basins or at the upstream 183-DR Headhouse included sulfuric acid, lime,

chlorine, and commercial coagulants containing primarily ferrous sulfate or alum. Sodium dichromate was also added to cooling water as a corrosion inhibitor, but was injected downstream of the sedimentation basins.

The 100-D-50:5 process sewers are located on the southern side of the former 183-DR facility (Figure 1). These sewers were designed to provide underflow drainage for the 183-DR coagulation and sedimentation basins and possibly overflow drainage as well. Several surface runoff collection drains for the area south of the 183-DR facility also discharged to this sewer. The 100-D-50:5 process sewers discharged to the 100-D-50:1 process sewer collection line, which ultimately discharged to the Columbia River at the 100-D-8 outfall. Additional drainage for the 183-DR basins was also provided by higher capacity process sewers on the northern side of the 183-DR facility (100-D-50:7 subsite).

The 100-D-50:5 subsite encompasses approximately 200 m (650 ft) of pipeline: three 0.15-m (6-in.) drain lines immediately south of the former 183-DR coagulation and sedimentation basins, which discharged to a 0.30-m (12-in.) reinforced concrete collection line, trending generally north-south. A 0.30-m (12-in.) feeder line also connects a runoff collection drain (catch basin U) to the collection line.

CONFIRMATORY SAMPLING ACTIVITIES

Contaminants of Potential Concern

Contaminants of potential concern (COPCs) were identified based on process knowledge of the facilities formerly serviced by the 100-D-50:5 process sewers. The COPC list identified in the *100 Area Remedial Action Sampling and Analysis Plan (SAP)* (DOE-RL 2005a) for the 100-D-50 site includes cobalt-60, cesium-137, europium-152, europium-154, strontium-90, lead, hexavalent chromium, and metals. While process knowledge of the 100-D-50:5 subsite does not suggest historic discharge of radionuclides to the subsite, cobalt-60, cesium-137, europium-152, europium-154, and strontium-90 were identified as COPCs for the 100-D-50 site in its entirety and retained for the 100-D-50:5 subsite. Polychlorinated biphenyls (PCBs) were also identified as COPCs for the process sewers based on the potential presence of rubber gaskets and other PCB-containing materials in the water treatment facilities serviced by the pipelines. At the request of the Washington Department of Ecology, total uranium evaluation by kinetic phosphorescence analysis (KPA) was also included in confirmatory analysis.

While not considered COPCs, chlorinated pesticide and herbicide analyses were inadvertently requested for a portion of the confirmatory samples collected from the 100-D-50:5 subsite. The results of these analyses are considered within the data evaluation presented in this document. While not considered COPCs, the potential presence of volatile organic compounds was evaluated by field-screening with an organic vapor monitor during confirmatory sampling activities. No volatile organic compounds were detected at the 100-D-50:5 pipelines or underlying soil, and no further laboratory analysis was performed.

Figure 1. 100-D-50:5 Pipeline Location Map.

Confirmatory Sample Design

Historical design drawings and process knowledge were used to develop a site-specific sample design for the 100-D-50:5 subsite (WCH 2005c). Per the sampling design, test pits were excavated at a junction box on the upstream portion of the pipelines and at a runoff catch basin on the downstream portion of the pipelines (Figure 2). The junction box was observed to have a shallow layer of water below the invert of the outlet pipeline. Samples were collected from sediments within the junction box and catch basin and from soils underlying the structure or outlet pipeline.

A summary of the samples collected is presented in Table 1, and locations shown in Figure 2.

Table 1. Confirmatory Sample Summary for the 100-D-50:5 Waste Site.

Sample Location	Sample Media	Sample Number	Coordinate Locations (Field Estimate)	Depth (Field Estimate, bgs)	Lateral Dimensions of Area Sampled (Field Estimate)	Sample Analysis
Test pit 1	Sediment in manhole	J10L60	N 151032 E 573342	2.4 (8 ft)	NA	ICP metals, mercury, PCB, chlorinated pesticide, gross alpha, gross beta, GEA, and KPA
		J10L57				Hexavalent chromium
	Soil underlying manhole	J10L49		3.0 (10 ft)	1 m by 1 m (3 ft by 3 ft)	ICP metals, mercury, hexavalent chromium, PCB, gross alpha, gross beta, GEA, and KPA
Test pit 2	Sediment in manhole	J10L58	N 151109 E 573288	2.2 m (7 ft)	NA	ICP metals, mercury, PCB, chlorinated pesticide, chlorinated herbicide, gross alpha, gross beta, GEA, and KPA
		J10L55				Hexavalent chromium
	Sediment in manhole (duplicate)	J10L59				ICP metals, mercury, PCB, chlorinated pesticide, chlorinated herbicide, gross alpha, gross beta, GEA, and KPA
		J10L56				Hexavalent chromium
	Soil underlying pipeline	J10L50		2.0 m (6 ft)	1 m by 1 m (3 ft by 3 ft)	ICP metals, mercury, hexavalent chromium, PCB, gross alpha, gross beta, GEA, and KPA
Equipment blank	Silica sand	J10L51	NA	NA	NA	ICP metals and mercury

Sources: *Remaining Sites Field Sampling*, Logbooks EL-1578-7 and EL-1578-9 (WCH 2005a, 2005b).

bgs = below ground surface
GEA = gamma energy analysis

ICP = inductively coupled plasma
KPA = kinetic phosphorescence analysis

NA = not applicable
PCB = polychlorinated biphenyl

Figure 2. Confirmatory Sampling Locations at the 100-D-50:5 Pipelines.

Confirmatory Sample Results

Confirmatory sampling of the 100-D-50:5 subsite was performed on November 7 and December 28, 2005. Samples were analyzed using analytical methods approved by the U.S. Environmental Protection Agency. Comparisons of the maximum concentrations of detected COPCs in the pipelines and underlying soils against the site remedial action goals (RAGs) are summarized in Table 2. Contaminants that were not detected by laboratory analysis are excluded from this table. Calculated cleanup levels are not presented in the Model Toxics Control Act Cleanup Levels and Risk Calculations database under *Washington Administrative Code* (WAC) 173-340-740(3) for aluminum, calcium, iron, magnesium, potassium, silicon, and sodium; therefore, these constituents are not considered COPCs. Potassium-40, radium-226, radium-228, thorium-228, and thorium-232 were detected in samples collected at the site, but are not considered within Table 2. These isotopes are not related to the operational history of the 100-D-50:5 waste site, and are excluded from evaluation as COPCs based on environmental fate, decay rates, natural occurrence, and analogous site information. All of these isotopes were detected at levels below statistical background activities (based on an assumption of secular equilibrium, the background activities for radium-228 and thorium-228 are equal to the statistical background activity of 1.32 pCi/g for thorium-232 provided in DOE-RL [1996]).

The laboratory-reported results for all constituents are stored in the Environmental Restoration (ENRE) project-specific database prior to archiving in the Hanford Environmental Information System (HEIS) and are included in Appendix A.

Table 2. Comparison of Maximum Detected Contaminant Concentrations to Action Levels for the 100-D-50:5 Confirmatory Sampling Event.* (2 Pages)

COPC	Maximum Pipe Sediment Result (pCi/g)	Maximum Underlying Soil Result (pCi/g)	Generic Site Lookup Values (pCi/g)			Does the Maximum Pipe Sediment Result Exceed Lookup Values?	Does the Maximum Pipe Sediment Result Pass RESRAD Modeling?	Does the Maximum Underlying Soil Result Exceed Lookup Values?
			Shallow Zone Lookup Value	Groundwater Protection Lookup Value	River Protection Lookup Value			
Cesium-137	0.212	U	6.2 ^a	-- ^b	-- ^b	No	Yes ^b	--
COPC	Maximum Pipe Sediment Result (mg/kg)	Maximum Underlying Soil Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Maximum Pipe Sediment Result Exceed RAGs?	Does the Maximum Pipe Sediment Result Pass RESRAD Modeling?	Does the Maximum Underlying Soil Result Exceed RAGs?
			Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection			
Antimony ^d	0.91 (<BG)	U	32	5 ^e	5 ^e	No	--	--
Arsenic	3.0 (<BG)	2.5 (<BG)	20	20	20	No	--	No
Barium	106 (<BG)	69.6 (<BG)	5,600	132 ^e	224	No	--	No
Beryllium	0.34 (<BG)	0.42 (<BG)	10.4 ^f	1.51 ^e	1.51 ^e	No	--	No
Boron ^g	10.9	0.81	16,000	320	-- ^h	No	--	No

Table 2. Comparison of Maximum Detected Contaminant Concentrations to Action Levels for the 100-D-50:5 Confirmatory Sampling Event. * (2 Pages)

COPC	Maximum Pipe Sediment Result (mg/kg)	Maximum Underlying Soil Result (mg/kg)	Remedial Action Goals (mg/kg)			Does the Maximum Pipe Sediment Result Exceed RAGs?	Does the Maximum Pipe Sediment Result Pass RESRAD Modeling?	Does the Maximum Underlying Soil Result Exceed RAGs?
			Direct Exposure	Soil Cleanup Level for Groundwater Protection	Soil Cleanup Level for River Protection			
Cadmium ^d	U	0.09 (<BG)	13.9	0.81 ^e	0.81 ^e	--	--	No
Chromium	9.7 (<BG)	7.4 (<BG)	80,000	18.5 ^e	18.5 ^e	No	--	No
Cobalt	6.5 (<BG)	6.4 (<BG)	1,600	32	-- ^h	No	--	No
Copper	15.4 (<BG)	14.5 (<BG)	2,960	59.2	22 ^e	No	--	No
Lead	14.3	3.5 (<BG)	353	10.2 ^e	10.2 ^e	Yes	Yes ^c	No
Mercury	0.04 (<BG)	U	24	0.33 ^e	0.33 ^e	No	--	--
Manganese	294 (<BG)	271 (<BG)	11,200	512 ^e	512 ^e	No	--	No
Molybdenum ^g	0.23	0.24	400	8	-- ^h	No	--	No
Nickel	10.5 (<BG)	9.2 (<BG)	1,600	19.1 ^e	27.4	No	--	No
Selenium ^d	0.73 (<BG)	U	400	5	1	No	--	--
Uranium	0.870(<BG)	1.54 (<BG)	240	3.21 ^e	3.21 ^e	No	--	No
Vanadium	34.3 (<BG)	34.9 (<BG)	560	85.1 ^e	-- ^h	No	--	No
Zinc	140	32.9 (<BG)	24,000	480	67.8 ^e	Yes	Yes ^c	No
Aroclor-1242	0.015	U	0.5	0.017 ⁱ	0.017 ⁱ	No	--	--
Aroclor-1260	0.011	U	0.5	0.017 ⁱ	0.017 ⁱ	No	--	--
4,4'-DDT	0.0040	U	2.94	0.0257	0.005 ⁱ	No	--	--

* Site lookup values and RAGs are taken from the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (DOE-RL 2005b), where available, without further consideration of updated toxicity data or amendments (2001) to cleanup regulations in WAC 173-340. RAG values for those constituents that are not provided by DOE-RL (2005b) have been calculated per WAC 173-340-720, 730, and 740, Method B, 1996, in *100 Area Radionuclide and Nonradionuclide Lookup Values for the 1995 Interim Remedial Action Record of Decision*, 0100X-CA-V0046, Rev. 0, Bechtel Hanford, Inc., Richland, Washington (BHI 2004), unless otherwise noted.

^a Activity corresponding to a single-radionuclide 15 mrem/yr exposure as calculated using a generic RESRAD model (DOE-RL 2005b).

^b Site-specific RESRAD modeling was performed for cesium-137 per Footnote d of Table 2-7 of DOE-RL 2005b. Site-specific modeling shows that this contaminant will not reach groundwater, and thus the Columbia River, within 1000 years. See Appendix C, *100-D-50:5 Process Sewers RESRAD Calculation Brief for Groundwater and Columbia River Protection*, 0100D-CA-V0275, Rev. 1, Washington Closure Hanford, Richland, Washington.

^c Based on *100 Area Analogous Sites RESRAD Calculations* (BHI 2005), with a groundwater table elevation of 118 m (387 ft) and a clean zone extending from groundwater to an elevation of 140 m (459 ft).

^d Hanford Site-specific background is not available; not evaluated during background study. Value used is from *Natural Background Soil Metals Concentrations in Washington State* (Ecology 1994).

^e Where cleanup levels are less than background, cleanup levels default to background (WAC 173-340-700[4][d]) (1996).

^f Carcinogenic cleanup level calculated based on the inhalation exposure pathway per WAC 173-340-750[3], 1996 (Method B for air quality) and an airborne particulate mass-loading rate of 0.0001 g/m³ (WDOH 1997).

^g No Hanford Site-specific or Washington State background value available.

^h No cleanup level is available from the Ecology Cleanup Levels and Risk Calculations database (Ecology 2005), and no bioconcentration factor or ambient water quality criteria values are available to calculate cleanup levels (WAC 173-340-730(3)(a)(iii), 1996 [Method B]).

ⁱ Where cleanup levels are less than the RDL, cleanup levels default to the RDL (WAC 173-340-707[2] [1996] and DOE-RL 2005b).

-- = not applicable

RDL = required detection limit

BG = background

RESRAD = RESidual RADioactivity (dose assessment model)

COPC = contaminant of potential concern

U = undetected

RAG = remedial action goal

WAC = Washington Administrative Code

DATA EVALUATION

Lead was detected above soil RAGs for groundwater and river protection, and zinc was detected above the soil RAG for river protection in pipeline sediments. However, RESidual RADioactivity (RESRAD) modeling for non-radionuclides as discussed in Appendix G of the RDR/RAWP (DOE-RL 2005b) predicts that lead and zinc will not reach groundwater within 1,000 years (BHI 2005) with a groundwater table elevation of 118 m (387 ft) and a clean zone extending from groundwater to an elevation of 140 m (459 ft). Residual concentrations of lead are, therefore, protective of groundwater. The only pathway for contamination to reach the Columbia River is via groundwater migration, so lead and zinc concentrations are also protective of river water. This evaluation is based on an assumption that contamination is presently restricted to the pipeline, such that the lower boundary of contamination in the soil column is presently at an elevation of 140 m (459 ft) above mean sea level. This assumption is justified based on the analytical results for soils underlying the pipeline.

Nonradionuclide risk requirements include a hazard quotient of less than 1.0 for all individual noncarcinogens, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6} , and a cumulative excess carcinogenic risk of less than 1×10^{-5} . These risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. All individual hazard quotients were less than 1.0, and all individual cumulative excess carcinogenic risk values were less than 1×10^{-6} (Appendix B). The cumulative hazard quotient for the 100-D-50:5 subsite is 4.8×10^{-2} , and the cumulative excess carcinogenic risk value is 5.3×10^{-8} . Therefore, nonradionuclide risk requirements are met.

When using a statistical sampling approach, a RAG requirement for nonradionuclides is the WAC 173-340-740(7)(e) three-part test. However, this test is not applicable to this focused sampling approach because use of maximum detected concentration data as the compliance basis is more conservative.

DATA QUALITY ASSESSMENT

A data quality assessment (DQA) was performed to compare the confirmatory sampling approach and analytical data with the sampling and data requirements specified in the site-specific work instruction (WCH 2005c). 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) and completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process.

This DQA was performed in accordance with the site-specific data quality objectives found in the SAP (DOE-RL 2005a). To ensure quality data sets, the SAP data quality assurance requirements, as well as the data validation procedures for chemical and radiochemical analysis (BHI 2000a, 2000b), are followed, where appropriate.

A review of the sample design (WCH 2005c), the field logbooks (WCH 2005a, 2005b), and applicable analytical data packages has been performed as part of this DQA. All samples were collected per the approved sample design (WCH 2005c). Data from samples collected at the 100-D-50:5 subsite were provided by the analytical laboratories in five sample delivery groups (SDGs): J00013, J00038, K0095, K0162, and K0166. Third-party validation was performed on SDGs J00038 and K0095 (WCH 2006a, 2006b).

SDG J00013

SDG J00013 consists of one field sample (J10L55) and its associated field duplicate sample (J10L56), analyzed for hexavalent chromium. Four field samples from other waste site confirmatory sampling efforts are also included in this SDG, but are not considered within this DQA. Two matrix spike/matrix spike duplicate (MS/MSD) sets were run; one set was below criteria at 59%/57%. The other MS/MSD pair was within criteria at 79%/87%. The low recovery in the first pair is a laboratory error that was corrected by running the second pair with the field samples. The required detection limit was not met for hexavalent chromium in SDG J00013. The practical quantitation limit (PQL) is set above the actual instrument detection limit, because analytical systems are able to detect the presence of analytes at lower levels than they are able to accurately quantify them. Analytes detected and reported below their respective PQL are assigned "J" qualifiers by the laboratories to indicate the estimated nature of such data. In this case, if hexavalent chromium were present in these pipe sediment samples above the lowest RAG value, its presence would have been detected, although below the PQL. Reanalysis of these samples was also requested to achieve PQLs below RAG values, and hexavalent chromium was again not detected in any samples. However, this reanalysis was performed significantly beyond the method holding time (more than twice the specified holding time), and validation procedures state that data resulting from this reanalysis should not be used for decision-making purposes. The data reported in Appendix A are the results from the initial analysis.

SDG J00038

SDG J00038 consists of one field sample (J10L57), analyzed for hexavalent chromium. The MS/MSD recoveries were out of criteria at 1% and 4%, respectively. The MS was nondetect for hexavalent chromium and a percent recovery was calculated from the PQL, although there was no recovery. As a result of the MS/MSD recoveries, third-party validation qualified the result for sample J10L57 as rejected with an "R" flag. This qualification is consistent with the project instructions given to the third-party validator. However, the project instructions do not take reactive matrices into account. The laboratory control sample (LCS) had a recovery of 103%, and no hexavalent chromium was detected in the field sample. This combination of sample results indicates that the sample matrix is reacting with the chemical spike. The analytical system is functioning, as shown by the LCS result. The laboratory did not report any chromatographic interference, so the sample matrix is concluded to be destructively reacting with the spike. A sample matrix reactive to hexavalent chromium precludes the possibility of hexavalent chromium in the sample. Consistent with this, hexavalent chromium was not detected in either the sample or the laboratory duplicate.

Based on the preceding evaluation of the hexavalent chromium data for sample J10L57, the project has set aside the third-party validation qualification of rejected with an "R" flag. The data has been flagged in Appendix A of this document, and HEIS data will also be flagged with an explanation.

SDG K0095

SDG K0095 consists of one field sample (J10L58) and its associated field duplicate sample (J10L59), analyzed by chlorinated pesticide, herbicide, PCB, inductively coupled plasma (ICP) metals, mercury, KPA, gross alpha, gross beta, and gamma energy analyses. The chlorinated pesticide and herbicide analyses were unintentionally included in the requested analytical list on the sample chain of custody. Because the data was collected, the quality of that data has been assessed with the rest of the data from SDG K0095.

Third-party validation assigned "J" qualifiers to all of the results in SDG K0095 for the analyte toxaphene, due to a lack of laboratory quality control (QC) samples (i.e., no MS/MSD or LCS). Due to a relative percent difference (RPD) value outside of QC criteria (58%), all thorium-228 results in the SDG were also qualified as estimated with a "J." All antimony and silicon results were also assigned "J" qualifiers due to MS recoveries below QC criteria, at 57.9% and 42.7%, respectively. All detected PCB results were qualified as estimated, due to high recoveries in the MS for aroclor-1016 and aroclor-1260 at 154% and 164%, respectively. All PCB results (including nondetects) were qualified as estimated due to RPD values (43% and 44%) outside of criteria for the target compounds in the MS/MSD pair.

Analytes are routinely detected below the practical quantitation limit. By definition, a practical quantitation limit is "the lowest concentration that can be reliably measured within specified limits of precision, accuracy, representativeness, completeness, and comparability during routine laboratory operating conditions" (WAC 173-340-200). Accordingly, analytes quantitated below this threshold (aroclor-1242 in sample J10L58, aroclor-1260 in samples J10L58 and J10L59, and 4,4'-DDT in sample J10L59) are qualified with a "J" flag as estimated.

The qualification in SDG K0095 is typical of sediment samples. The "J" qualifications on data indicate an increase in the reporting errors associated with the data due to minor deficiencies in the data sets. No major deficiencies in SDG K0095 were found. Therefore, the data remains useable for decision-making purposes.

SDG K0162

SDG K0162 consists of two field samples (J10L49 and J10L50) and one equipment blank (J10L51). Samples J10L49 and J10L50 were analyzed by PCB, ICP metals, mercury, KPA, gross alpha, gross beta, and gamma energy analyses. Sample J10L51 was analyzed for ICP metals and mercury.

The analyte sodium was detected in the method blank and equipment blank at trace levels (1.4 and 8.3 mg/kg, respectively). Contamination in the method blank is not considered significant unless it is more than one-fifth of the concentration calculated in associated samples, as

determined on an analyte-by-analyte basis. For projects concerned with getting accurate trace concentrations of sodium, the equipment blank value may be considered estimated. For the purposes of decision-making at the 100-D-50:5 subsite, this result is inconsequential.

No other deficiencies were found. The data is useable for decision-making purposes.

SDG K0166

SDG K0166 consists of one field sample (J10L60), analyzed by chlorinated pesticide, PCB, ICP metals, mercury, KPA, gross alpha, gross beta, and gamma energy analyses. The chlorinated pesticide analysis was unintentionally included in the requested analytical list on the sample chain of custody. Because the data was collected, the quality of that data has been assessed with the rest of the data from SDG K0166.

In the gamma energy analysis, no results were provided for radium-228. This isotope is not considered a COPC, and is not included on the target analyte list for gamma energy analysis. Accordingly, no correction was requested from the analytical laboratory. However, both thorium-232 and radium-228 are quantitated by the laboratory based on actinium-228; therefore, the radium-228 activity for sample J10L60 may be considered to be equivalent to the thorium-232 result (undetected above 0.62 pCi/g).

In the metals analysis, the laboratory duplicate RPD values for arsenic, boron, sodium, and selenium were above QC criteria at 85.7%, 53.5%, 36%, and 31%, respectively. This is attributable to natural heterogeneity within the sample matrix, and the data remains useable for decision-making purposes.

In the pesticide analysis, the analyte toxaphene was not included in the QC samples. Data results for this analyte may, therefore, be considered estimated.

No other deficiencies were found. The data is useable for decision-making purposes.

Conclusions

Limited, random, or sample matrix-specific influenced batch QC issues such as these 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 for the 100-D-50:5 subsite found the results to be accurate within the standard errors associated with the methods, including sampling and sample handling. The DQA review for the 100-D-50:5 subsite concludes that the data reviewed is of the right type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected as a result of QC deficiencies. All analytical data were found acceptable for decision-making purposes. The confirmatory sample analytical data are stored in the ENRE Project Specific Database prior to archiving in the HEIS and are located in Appendix A.

SUMMARY FOR NO ACTION

The 100-D-50:5 subsite has been evaluated in accordance with the Remaining Sites ROD (EPA 1999), and a no action decision is supported based on the confirmatory investigation and sampling results. The analytical results from the 100-D-50:5 subsite pipe sediment and underlying soil samples were shown to meet the remedial action objectives for direct exposure, groundwater protection, and river protection. The subsite has no deep zone; therefore, no deep zone institutional controls are required.

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APPENDIX A
CONFIRMATORY SAMPLING RESULTS

Table A-1. 100-D-50:5 Confirmatory Data Results. (3 Pages)

Sample Location	HEIS Number	Sample Date	Americium-241			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
Test pit 1 manhole sediment	J10L60	12/28/05	0.20	U	0.20	0.212		0.071	0.077	U	0.077	0.15	U	0.15	0.21	U	0.21
Test pit 1 underlying soil	J10L49	12/28/05	0.12	U	0.12	0.026	U	0.026	0.029	U	0.029	0.063	U	0.063	0.092	U	0.092
Test pit 2 manhole sediment	J10L58	11/7/05	0.16	U	0.16	0.091	U	0.091	0.093	U	0.093	0.23	U	0.23	0.31	U	0.31
Duplicate of J10L58	J10L59	11/7/05	0.21	U	0.21	0.16	U	0.16	0.073	U	0.073	0.15	U	0.15	0.19	U	0.19
Test pit 2 underlying soil	J10L50	12/28/05	0.31	U	0.31	0.030	U	0.030	0.032	U	0.032	0.076	U	0.076	0.11	U	0.11

Sample Location	HEIS Number	Sample Date	Europium-155			Gross alpha			Gross beta			Potassium-40			Radium-226		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 1 manhole sediment	J10L60	12/28/05	0.17	U	0.17	2.70	U	2.9	12.1		5.6	11	U	11	0.50	U	0.50
Test pit 1 underlying soil	J10L49	12/28/05	0.087	U	0.087	7.82		3.9	19.6		5.9	1.4	U	1.4	0.534		0.049
Test pit 2 manhole sediment	J10L58	11/7/05	0.18	U	0.18	6.39		3.4	14.6		5.5	9.26		0.93	0.413		0.15
Duplicate of J10L58	J10L59	11/7/05	0.15	U	0.15	4.73		2.9	13.4		5.3	9.4		0.63	0.440		0.10
Test pit 2 underlying soil	J10L50	12/28/05	0.11	U	0.11	6.96		3.7	15.5		5.6	11.4		0.32	0.432		0.054

Sample Location	HEIS Number	Sample Date	Radium-228			Thorium-228			Thorium-232			Uranium-235			Uranium-238		
			pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA	pCi/g	Q	MDA
Test pit 1 manhole sediment	J10L60	12/28/05	--*		--*	0.36	U	0.36	0.62	U	0.62	0.21	U	0.21	6.4	U	6.4
Test pit 1 underlying soil	J10L49	12/28/05	0.752		0.12	0.747		0.033	0.752		0.12	0.12	U	0.12	3.4	U	3.4
Test pit 2 manhole sediment	J10L58	11/7/05	0.729		0.35	0.550	J	0.11	0.729		0.35	0.28	U	0.28	10	U	10
Duplicate of J10L58	J10L59	11/7/05	0.292		0.25	0.397	J	0.097	0.292		0.25	0.20	U	0.20	7.5	U	7.5
Test pit 2 underlying soil	J10L50	12/28/05	0.569		0.14	0.575		0.041	0.569		0.14	0.15	U	0.15	4.0	U	4.0

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

Note: Data qualified with C, D, and/or J are considered acceptable values.

*Radium-228 results were not reported for sample J10L60. See Data Quality Assessment section for additional detail.

C = method blank contamination (inorganic constituents)

D = diluted

HEIS = Hanford Environmental Information System

J = estimate

MDA = minimum detectable activity

PQL = practical quantitation limit

Q = qualifier

U = undetected

Table A-1. 100-D-50:5 Confirmatory Data Results. (3 Pages)

Sample Location	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
Test pit 1 manhole sediment	J10L60	12/28/05	4100		2.1	0.91		0.47	3.0		0.40	106		0.02	0.34		0.01	10.9		0.31	0.08	U	0.08
Test pit 1 underlying soil	J10L49	12/28/05	4370		2.0	0.44	U	0.44	1.8		0.37	69.6		0.02	0.42		0.01	0.81		0.3	0.09		0.08
Test pit 2 manhole sediment	J10L58	11/7/05	5380		11.6	3.1	UJ	3.1	2.6		2.6	81.7		0.15	0.13		0.08	2.1	U	2.1	0.53	U	0.53
Duplicate of J10L58	J10L59	11/7/05	4780		10.4	2.7	UJ	2.7	2.3	U	2.3	70.5		0.14	0.11		0.07	1.8	U	1.8	0.48	U	0.48
Test pit 2 underlying soil	J10L50	12/28/05	4360		1.9	0.42	U	0.42	2.5		0.36	48.5		0.02	0.41		0.01	0.53		0.29	0.08		0.07
Equipment blank	J10L51	12/28/05	43.7		1.7	0.38	U	0.38	0.46		0.32	0.92		0.02	0.03		0.01	0.26	U	0.26	0.07	U	0.07

Sample Location	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
Test pit 1 manhole sediment	J10L60	12/28/05	4580	C	1.4	8.0		0.19	4.1		0.14	15.3		0.14				11500		3.7	14.2	C	0.36
Test pit 1 manhole sediment	J10L57*														0.350	U**	0.350						
Test pit 1 underlying soil	J10L49	12/28/05	5550		1.3	5.7		0.17	6.4		0.13	13.3		0.13	0.23	U	0.23	16500		3.5	3.5		0.34
Test pit 2 manhole sediment	J10L58	11/7/05	8890		9.1	9.7		1.2	6.5		0.92	15.4		1.1				16900		24.5	14.3		2.4
Test pit 2 manhole sediment	J10L55*														3.50	U	3.50						
Duplicate of J10L58	J10L59	11/7/05	7680		8.1	9.1		1.1	5.4		0.82	13.4		0.99				14300		21.9	12.1		2.1
Duplicate of J10L55	J10L56*														3.50	U	3.50						
Test pit 2 underlying soil	J10L50	12/28/05	6350		1.3	7.4		0.17	5.7		0.13	14.5		0.13	0.22	U	0.22	15300		3.4	3.5		0.33
Equipment blank	J10L51	12/28/05	30.0		1.1	0.21		0.15	0.11	U	0.11	0.23		0.11				84.7		3.1	0.35		0.30

*Only analyte was hexavalent chromium.

**See Data Quality Assessment Section for additional discussion of data qualification.

Sample Location	HEIS Number	Sample Date	Magnesium			Manganese			Mercury			Molybdenum			Nickel			Potassium			Selenium		
			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
Test pit 1 manhole sediment	J10L60	12/28/05	2920		1.6	175		0.02	0.02		0.02	0.23		0.15	7.7		0.15	906		6.5	0.73	C	0.42
Test pit 1 underlying soil	J10L49	12/28/05	3470		1.5	271		0.02	0.02	U	0.02	0.14	U	0.14	8.3		0.14	1050		6.0	0.39	U	0.39
Test pit 2 manhole sediment	J10L58	11/7/05	3580		10.3	294		0.15	0.04		0.02	0.99	U	0.99	10.5		0.99	1150		42.3	2.7	U	2.7
Duplicate of J10L58	J10L59	11/7/05	3250		9.2	262		0.14	0.04		0.02	0.89	U	0.89	9.7		0.89	1060		37.8	2.5	U	2.5
Test pit 2 underlying soil	J10L50	12/28/05	3870		1.4	240		0.02	0.02	U	0.02	0.24		0.14	9.2		0.14	747		5.9	0.38	U	0.38
Equipment blank	J10L51	12/28/05	8.3		1.3	2.2		0.02	0.02	U	0.02	0.12	U	0.12	0.12	U	0.12	19.3		5.3	0.34	U	0.34

Sample Location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Uranium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Test pit 1 manhole sediment	J10L60	12/28/05	572		0.96	0.16	U	0.16	282		0.20	0.694		0.016	27.9		0.10	61.4	C	0.06
Test pit 1 underlying soil	J10L49	12/28/05	476		0.89	0.15	U	0.15	246	C	0.19	1.43		0.016	34.9		0.1	32.9		0.05
Test pit 2 manhole sediment	J10L58	11/7/05	558	J	6.3	1.1	U	1.1	159		1.3	0.870		0.019	34.3		0.69	140		0.38
Duplicate of J10L58	J10L59	11/7/05	620	J	5.6	0.96	U	0.96	147		1.2	0.852		0.019	28.6		0.61	119		0.34
Test pit 2 underlying soil	J10L50	12/28/05	481		0.87	0.15	U	0.15	145	C	0.18	1.54		0.016	34.8		0.1	31.7		0.05
Equipment blank	J10L51	12/28/05	48.8		0.78	0.13	U	0.13	8.3	C	0.16	--***		--***	0.09	U	0.09	1.3		0.05

***Equipment blank was not submitted for kinetic phosphorescence analysis (for total uranium).

Table A-1. 100-D-50:5 Confirmatory Data Results. (3 Pages)

Constituents	J10L60 Test Pit 1 Sediment Sample Date 12/28/05			J10L58 Test Pit 2 Sediment Sample Date 11/7/05			J10L59 Duplicate of J10L58 11/7/05		
	µg/kg	Q	PQL	µg/kg	Q	PQL	µg/kg	Q	PQL
Polychlorinated Biphenyls									
Aroclor-1016	42	U	42	91	UJ	91	81	UJ	81
Aroclor-1221	42	U	42	91	UJ	91	81	UJ	81
Aroclor-1232	42	U	42	91	UJ	91	81	UJ	81
Aroclor-1242	42	U	42	15	J	91	81	UJ	81
Aroclor-1248	42	U	42	91	UJ	91	81	UJ	81
Aroclor-1254	42	U	42	91	UJ	91	81	UJ	81
Aroclor-1260	42	U	42	9.4	J	91	11	J	81
Pesticides									
Aldrin	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
alpha-BHC	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
alpha-Chlordane	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
beta-1,2,3,4,5,6-Hexachlorocyclohexane	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
delta-BHC	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Dichlorodiphenyldichloroethane	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Dichlorodiphenyldichloroethylene	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Dichlorodiphenyltrichloroethane	1.7	UD	1.7	4.0		3.6	3.1	JD	3.2
Dieldrin	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endosulfan I	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endosulfan II	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endosulfan sulfate	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endrin	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endrin aldehyde	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Endrin ketone	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
gamma-BHC (Lindane)	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
gamma-Chlordane	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Heptachlor	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Heptachlor epoxide	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Methoxychlor	1.7	UD	1.7	3.6	UD	3.6	3.2	UD	3.2
Toxaphene	17	UDJ	17	36	UDJ	36	32	UDJ	32
Herbicides									
2,4,5-Trichlorophenoxyacetic acid				23	U	23	20	U	20
2,4-Dichlorophenoxyacetic acid				45	U	45	45	U	45
2-(2,4,5-Trichlorophenoxy)propionic acid				23	U	23	20	U	20
2-secButyl-4,6-dinitrophenol(DNBP)				23	U	23	20	U	20
4-(2,4-Dichlorophenoxy)butanoic acid				230	U	230	200	U	200
Dalapon				230	U	230	200	U	200
Dicamba				91	U	91	81	U	81
Dichloroprop				230	U	230	200	U	200
Pentachlorophenol				18	U	18	16	U	16

Constituents	J10L49 Test Pit 1 Soil Sample Date 12/28/05			J10L50 Test Pit 2 Soil Sample Date 12/28/05		
	µg/kg	Q	PQL	µg/kg	Q	PQL
Polychlorinated Biphenyls						
Aroclor-1016	15	U	15	15	U	15
Aroclor-1221	15	U	15	15	U	15
Aroclor-1232	15	U	15	15	U	15
Aroclor-1242	15	U	15	15	U	15
Aroclor-1248	15	U	15	15	U	15
Aroclor-1254	15	U	15	15	U	15
Aroclor-1260	15	U	15	15	U	15

APPENDIX B

**CALCULATION OF HAZARD QUOTIENTS AND
EXCESS CARCINOGENIC RISK VALUES**

CALCULATION COVER SHEET

Project Title 100-D Area Field Remediation **Job No.** 14655
Area 100-D/DR
Discipline Environmental ***Calc. No.** 0100D-CA-V0270
Subject 100-D-50:5 Subsite Hazard Quotient and Carcinogenic Risk Calculations
Computer Program Excel **Program No.** Excel 2003

The attached calculations have been generated to document compliance with established cleanup levels. These documents 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 Summary = 3	J. M. Capron <i>J.M. Capron</i> 4/4/06	T. M. Blakley <i>T.M. Blakley</i> 4/6/06	L. M. Dittmer <i>L.M. Dittmer</i> S.W. Clark <i>S.W. Clark</i> 4/6/06	R. A. Carlson <i>R.A. Carlson</i> By: K.E. Cook <i>K.E. Cook</i>	4/4/06
	Total = 4					

SUMMARY OF REVISION

*Obtain Calc. No. from DIS

Washington Closure Hanford			CALCULATION SHEET				
Originator:	J. M. Capron <i>JMC</i>	Date:	04/04/06	Calc. No.:	0100D-CA-V0270	Rev.:	0
Project:	100-D Area Field Remediation	Job No:	14655	Checked:	T. M. Blakley <i>TMB</i>	Date:	4/6/06
Subject:	100-D-50:5 Subsite Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 3

PURPOSE:

Provide documentation to support the calculation of the hazard quotient (HQ) and carcinogenic (excess cancer) risk values for the 100-D-50:5 subsite confirmatory sampling results. In accordance with the remedial action goals (RAGs) in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2005), 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 x 10⁻⁶ for individual carcinogens
- 4) A cumulative excess cancer risk of <1 x 10⁻⁵ for carcinogens.

GIVEN/REFERENCES:

- 1) DOE-RL, 2005, *Remedial Design Report/Remedial Action Work Plan for the 100 Areas*, DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- 2) EPA, 1994, *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*, EPA/540/R-93/081, Publication No. 9285.7-15-1, U.S. Environmental Protection Agency, Washington, D.C.
- 3) WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, 1996.
- 4) WCH, 2006, Waste Site Reclassification Form 2006-025, and Attachment *Remaining Sites Verification Package for the 100-D-50:5 Process Sewers (183-DR Sedimentation Basin Drains)*, Washington Closure Hanford, Richland, Washington.

SOLUTION:

- 1) Calculate an HQ for each noncarcinogenic constituent detected above background and compare to the individual HQ of <1.0 (DOE-RL 2005).
- 2) Sum the HQs and compare to the cumulative HQ criterion of <1.0.
- 3) Calculate an excess cancer risk value for each carcinogenic constituent detected above background and compare to the individual excess cancer risk criterion of <1 x 10⁻⁶ (DOE-RL 2005).
- 4) Sum the excess cancer risk values and compare to the cumulative cancer risk criterion of <1 x 10⁻⁵.

METHODOLOGY:

Hazard quotient and carcinogenic risk calculations were computed using the maximum detected value in soil or pipe sediment for each analyte in the confirmatory data set for the 100-D-50:5 subsite

Washington Closure Hanford			CALCULATION SHEET				
Originator:	J. M. Capron <i>JMC</i>	Date:	04/04/06	Calc. No.:	0100D-CA-V0270	Rev.:	0
Project:	100-D Area Field Remediation	Job No:	14655	Checked:	T. M. Blakley <i>TMB</i>	Date:	4/6/06
Subject:	100-D-50:5 Subsite Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	2 of 3

(WCH 2006). Of the contaminants of potential concern (COPCs) for the site, boron and molybdenum require the HQ and risk calculations because these analytes were detected and a Washington State or Hanford Site background value is not available. Lead and zinc are included because they were quantified at a concentration above their respective Washington State or Hanford Site background value. Aroclor-1242, aroclor-1260, and 4,4'-DDT are included because they were detected by laboratory analysis and cannot be attributed to natural occurrence. All other site nonradionuclide COPCs were detected below background levels. An example of the HQ and risk calculations is presented below:

- 1) For example, the maximum value for boron is 10.9 mg/kg, divided by the noncarcinogenic RAG value of 16,000 mg/kg (boron is identified as a noncarcinogen in WAC 173-340-740[3]), is 6.8×10^{-4} . Comparing this value, and all other individual values, to the requirement of <1.0 , this criterion is met.
- 2) After the HQ calculations are completed for the appropriate analytes, the cumulative HQ is 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 sum of the HQ values is 4.8×10^{-2} . Comparing this value to the requirement of <1.0 , this criterion is met.
- 3) To calculate the excess cancer risk, the maximum value is divided by the carcinogenic RAG value, then multiplied by 1×10^{-6} . For example, the maximum value for aroclor-1242 is 0.015 mg/kg; divided by 0.5 mg/kg and multiplied as indicated is 3.0×10^{-8} . Comparing this value, and all other individual values, to the requirement of $<1 \times 10^{-6}$, this criterion is met.
- 4) After these calculations are completed for the carcinogenic analytes, the cumulative excess carcinogenic risk is obtained by summing the individual values. (To avoid errors due to intermediate rounding, the individual values prior to rounding are used for this calculation.) The sum of the excess carcinogenic risk values is 5.3×10^{-8} . Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

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 $>1 \times 10^{-6}$: None
- 4) List the cumulative excess cancer risk for carcinogens $>1 \times 10^{-5}$: None.

Table 1 shows the results of the calculations for the 100-D-50:5 subsite.

Washington Closure Hanford

CALCULATION SHEET

Originator:	J. M. Capron <i>JMC</i>	Date:	04/04/06	Calc. No.:	0100D-CA-V0270	Rev.:	0
Project:	100-D Area Field Remediation	Job No:	14655	Checked:	T. M. Blakley <i>TMB</i>	Date:	4/6/06
Subject:	100-D-50:5 Subsite Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	3 of 3

Table 1. Hazard Quotient and Excess Cancer Risk Results for the 100-D-50:5 Subsite.

Contaminants of Potential Concern	Maximum Value ^a (mg/kg)	Noncarcinogen RAG ^b (mg/kg)	Hazard Quotient	Carcinogen RAG ^b (mg/kg)	Carcinogenic Risk
Metals					
Boron	10.9	16,000	6.8E-04	--	--
Lead ^c	14.3	353	4.1E-02	--	--
Molybdenum	0.24	400	6.0E-04	--	--
Zinc	140	24,000	5.8E-03	--	--
Pesticides					
DDT, 4,4'-	0.0040	40	1.0E-04	2.94	1.4E-09
Polychlorinated Biphenyls					
Aroclor-1242	0.015	--	--	0.5	3.0E-08
Aroclor-1260	0.011	--	--	0.5	2.2E-08
Totals					
Cumulative Hazard Quotient:			4.8E-02		
Cumulative Excess Cancer Risk:					5.3E-08

Notes:

^a = From WCH 2006.^b = Value obtained from WAC 173-340-740(3), Method B, 1996, unless otherwise noted.^c = Value for the noncarcinogen RAG obtained from EPA (1994).

-- = not applicable

RAG = remedial action goal

WAC = Washington Administrative Code

CONCLUSION:

This calculation demonstrates that the 100-D-50:5 subsite meets the requirements for the hazard quotient and excess carcinogenic risk as identified in the RDR/RAWP (DOE-RL 2005).

APPENDIX C

SITE-SPECIFIC RESRAD MODELING

CALCULATION COVER SHEET**Project Title:** 100-D-50:5 Process Sewers Cleanup Verification **Job No:** 14655**Area:** 100-D Area**Discipline:** Environmental ***Calculation No:** 0100D-CA-V0275**Subject:** 100-D-50:5 Process Sewers RESRAD Calculation Brief for Groundwater and
Columbia River Protection**Computer Program:** RESRAD **Program No:** Version 6.3

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 - 3 pg Attn. 1 - 1 pg Attn. 2 - 20 pg Attn. 3 - 10 pg Total - 35 pages	S. W. Clark <i>Approved</i> 06/67/07	M. W. Perrott <i>Approved</i> 06/26/07	H. M. Sulloway <i>Approved</i> 06/26/07	M. A. Buckmaster <i>Approved</i> 06/26/07	<i>Approved</i> 06/26/07
1	Cover - 1 pg Summary - 3 pg Attn. 1 - 1 pg Attn. 2 - 19 pg Attn. 3 - 10 pg Total - 34 pages	S. W. Clark <i>S.W. Clark</i> 8/28/07	M. W. Perrott <i>M. W. Perrott</i> 9/29/07	H. M. Sulloway <i>H.M. Sulloway</i>	M. A. Buckmaster <i>M.A. Buckmaster</i>	<i>8/30/07</i>
SUMMARY OF REVISION						
1	The calculation brief was replaced in its entirety to evaluate groundwater protection for cesium-137 only.					

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 <i>[Signature]</i>	Date:	8/28/07	Calc. No.:	0100D-CA-V0275	Rev.:	1
Project:	100-D-50:5 Process Sewers	Job No.:	14655	Checked:	M. W. Perrott <i>[Signature]</i>	Date:	8/28/07
Subject:	100-D-50:5 Process Sewer RESRAD Calculation for Groundwater and River Protection					Sheet No.	1 of 3

PURPOSE:

Perform RESidual RADioactivity (RESRAD) modeling to determine if confirmatory sampling soil concentrations of radionuclides at the 100-D-50:5 Process Sewers (183-DR sedimentation basin drains) are protective of groundwater and the Columbia River over a period of 1,000 years.

GIVEN/REFERENCES:

- 1) Confirmatory sampling data from Table 2 of the *Remaining Sites Verification Package for the 100-D-50:5 Process Sewers* (100-D-50:5 RSVP), Attachment to Waste Site Reclassification Form 2006-025, Rev. 0, Washington Closure Hanford, Richland, Washington.
- 2) *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP), DOE/RL-96-17, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
- 3) RESidual RADioactivity (RESRAD) computer code, version 6.3, to calculate compliance with residual radioactivity guidelines, developed for the U.S. Department of Energy by the Environmental Assessment Division of Argonne National Laboratory, Argonne, Illinois.
- 4) Sample design from the *Remaining Sites Verification Package for the 100-D-50:5 Process Sewers* (100-D-50:5 RSVP), Attachment to Waste Site Reclassification Form 2006-025, Rev. 0, Washington Closure Hanford, Richland, Washington.
- 5) Groundwater elevations from *Hanford Groundwater Monitoring for Fiscal Year 2006*, PNNL-16346, Pacific Northwest National Laboratory, Richland, Washington.

SOLUTION:

- 1) Site-specific RESRAD modeling was performed for cesium-137 based on conditions encountered at the time of remediation (per footnote d of Table 2-7 of the 100 Area RDR/RAWP) to determine if residual concentrations of cesium-137 are protective of groundwater and the Columbia River. Table 1, below, shows the elevations (NAVD88) and thickness of each soil horizon. The contaminated soil is all in the shallow zone (between the ground surface and 4.6 m [15 ft] deep). Attachment 1 shows the conceptual model and representative dimensions of soil horizons and contaminant pathways considered for groundwater and river protection modeling. Input parameters used in RESRAD modeling are shown in the "Site-Specific Parameter Summary" section of the RESRAD "Mixture Sums and Single Radionuclide Guidelines" printout in Attachment 2 to this Calculation Summary.

Washington Closure Hanford**CALCULATION SHEET**

Originator:	S. W. Clark	Date:	5/25/07	Calc. No.:	0100D-CA-V0275	Rev.:	1
Project:	100-D-50:5 Process Sewers	Job No.:	14655	Checked:	M. W. Perrott	Date:	5/25/07
Subject:	100-D-50:5 Process Sewer RESRAD Calculation for Groundwater and River Protection					Sheet No.	2 of 3

Table 1. 100-D-50:5 Waste Site Dimensions for RESRAD Modeling

Dimensions	Values
<i>Contaminated Zone Dimensions</i>	
Cover Depth	0 m
Thickness: Contaminated Zone	4.6 m
Area of Potential Contamination	495 m ²
Length Parallel to Aquifer Flow	25 m
<i>Elevations of Vadose Zone Horizons</i>	
Elevation: Surface	142.5 m
Elevation: Groundwater	118.2 m
Thickness: Uncontaminated Unsaturated Zone	19.7 m

- 2) The maximum concentration of cesium-137 at 100-D-50:5 is presented in Table 2, below. The year when the peak concentration occurs for each contaminant is determined by a preliminary RESRAD run. For the 100-D-50:5 water pathways (i.e., well water and drinking water) there were no peak years for cesium 137.

METHODOLOGY:

Runs of RESRAD version 6.3 were completed for the 100-D-50:5 Process Sewers soils using the radionuclide concentrations shown in Table 2. The RESRAD numerical output report for predicted groundwater concentrations is Attachment 3 of this calculation summary.

Table 2. Cleanup Verification Data Set

COPC	Kd of COPC, mL/g	Maximum Concentration
Cesium-137	50	0.212 pCi/g

RESULTS:**Groundwater Protection Evaluation**

The radionuclide concentrations in groundwater calculated by the RESRAD model are summarized in Table 3. Cesium-137 is not predicted to reach groundwater in the 1,000 years of the RESRAD model run. Therefore, the residual soil concentrations of cesium-137 are predicted to be protective of groundwater and (by extension) the Columbia River.

Table 3. Predicted Groundwater (Well Water/Drinking Water) Concentrations

COPCs	Concentration Units	Groundwater Concentrations at Each Time Interval (yr)									RAG
		0	1	3	10	11	30	100	300	1000	
Cesium-137	pCi/L	0	0	0	0	0	0	0	0	0	60 pCi/L

RAG = Remedial Action Goals from the 100 Area RDR/RAWP

Washington Closure Hanford**CALCULATION SHEET**

Originator:	S. W. Clark <i>SWC</i>	Date:	<i>8/25/07</i>	Calc. No.:	0100D-CA-V0275	Rev.:	1
Project:	100-D-50:5 Process Sewers	Job No.:	14655	Checked:	M. W. Perrott <i>MWP</i>	Date:	<i>8/25/07</i>
Subject:	100-D-50:5 Process Sewer RESRAD Calculation for Groundwater and River Protection					Sheet No.	3 of 3

CONCLUSIONS:

The predicted groundwater concentrations of cesium-137 within the 1,000 years of the modeling run are shown in Table 3. Concentrations of cesium-137 are zero for all time periods. Cesium-137 is not predicted to reach groundwater, and therefore, the Columbia River within 1,000 years.

ATTACHMENTS:

1. Graphic showing 100-D-50:5 Model for Groundwater and River Protection (1 page)
2. RESRAD Output: 100-D-50:5 Radionuclides Summary Report – Mixture Sums and Single Radionuclide Guidelines (19 pages)
3. RESRAD Output: 100-D-50:5 Concentration of Radionuclides, (10 Pages)

ATTACHMENT 1

```
1RESRAD, Version 6.3      T« Limit = 180 days      08/27/2007  14:32  Page  1
Summary : 100-D-50-5 RESRAD Evaluation of Cesium-137 GW Protection
File    : 100-D-50-5_GW_Protection_Rev1.RAD
```

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 AAAAAAAAAAAAAAAAAAAAAA

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Time = 0.000E+00	9
Time = 1.000E+00	10
Time = 3.000E+00	11
Time = 1.000E+01	12
Time = 1.100E+01	13
Time = 3.000E+01	14
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Attachment 2 Sheet No. 1 of 19
 Originator: S. W. Clark *SWC* Date 8/28/57
 Chk'd By M. W. Perrott *MP* Date 8/28/57
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 2
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Dose Conversion Factor (and Related) Parameter Summary

File: HEAST 2001 MORBIDITY

Menu	Parameter	Current Value	Base Case*	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)

 *Base Case means Default.Lib w/o Associate Nuclide contributions.

Attachment 2 Sheet No. 2 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 3
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Site-Specific Parameter Summary				
Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)
AAAAA				
R011	Area of contaminated zone (m**2)	4.950E+02	1.000E+04	---
R011	Thickness of contaminated zone (m)	4.600E+00	2.000E+00	---
R011	Length parallel to aquifer flow (m)	2.500E+01	1.000E+02	---
R011	Basic radiation dose limit (mrem/yr)	4.000E+00	3.000E+01	---
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---
R011	Times for calculations (yr)	1.100E+01	3.000E+01	---
R011	Times for calculations (yr)	3.000E+01	1.000E+02	---
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---
R011	Times for calculations (yr)	3.000E+02	1.000E+03	---
R011	Times for calculations (yr)	1.000E+03	0.000E+00	---
R011	Times for calculations (yr)	not used	0.000E+00	---
R012	Initial principal radionuclide (pCi/g): Cs-137	2.120E-01	0.000E+00	---
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---
R013	Cover depth (m)	0.000E+00	0.000E+00	---
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---
R013	Contaminated zone erosion rate (m/yr)	0.000E+00	1.000E-03	---
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---
R013	Contaminated zone field capacity	1.500E-01	2.000E-01	---
R013	Contaminated zone hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---
R013	Contaminated zone b parameter	4.050E+00	5.300E+00	---
R013	Average annual wind speed (m/sec)	3.400E+00	2.000E+00	---
R013	Humidity in air (g/m**3)	not used	8.000E+00	---
R013	Evapotranspiration coefficient	9.100E-01	5.000E-01	---
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---
R013	Irrigation (m/yr)	7.600E-01	2.000E-01	---
R013	Irrigation mode	overhead	overhead	---
R013	Runoff coefficient	2.000E-01	2.000E-01	---
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---
R014	Density of saturated zone (g/cm**3)	1.600E+00	1.500E+00	---
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---
R014	Saturated zone effective porosity	2.500E-01	2.000E-01	---
R014	Saturated zone field capacity	1.500E-01	2.000E-01	---
R014	Saturated zone hydraulic conductivity (m/yr)	5.530E+03	1.000E+02	---
R014	Saturated zone hydraulic gradient	1.250E-03	2.000E-02	---
R014	Saturated zone b parameter	not used	5.300E+00	---
R014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---
R014	Well pump intake depth (m below water table)	4.600E+00	1.000E+01	---
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---
R015	Number of unsaturated zone strata	1	1	---

Attachment 2 Sheet No. 3 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 4

Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection

File : 100-D-50-5_GW_Protection_Rev1.RAD

Site-Specific Parameter Summary (continued)					
Menu	Parameter	User Input	Default (If different from user input)	Used by RESRAD	Parameter Name
R015	Unsat. zone 1, thickness (m)	1.970E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.600E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.500E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	1.500E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	4.050E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	2.500E+02	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	5.000E+01	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.166E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	not used	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	not used	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	not used	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	not used	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	not used	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	not used	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	not used	1.000E+00	>0 shows circular AREA.	FS
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 2 Sheet No. 4 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 5
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Site-Specific Parameter Summary (continued)					
Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
AAAAA					
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	not used	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	7.300E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LF15
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LF16
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LW15
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LW16
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	not used	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R198	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R198	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R198	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R198	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R198	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R198	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

Attachment 2 Sheet No. 5 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 6
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Site-Specific Parameter Summary (continued)					
Menu	Parameter	User	Input	Default	Used by RESRAD
				(If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRIY(1)
R19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRIY(2)
R19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRIY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSU
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSU
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	0.000E+00	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Attachment 2 Sheet No. 6 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 7
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	5	---	---	LYMAX
TITL	Maximum number of integration points for risk	9	---	---	KYMAX

Summary of Pathway Selections

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

Attachment 2 Sheet No. 7 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 8
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Contaminated Zone Dimensions Initial Soil Concentrations, pCi/g
 Area: 495.00 square meters Cs-137 2.120E-01
 Thickness: 4.60 meters
 Cover Depth: 0.00 meters
 0

Total Dose TDOSE(t), mrem/yr
 Basic Radiation Dose Limit = 4.000E+00 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 1.100E+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 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 M(t): 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
 OMaximum TDOSE(t): 0.000E+00 mrem/yr at t = 0.000E+00 years

Attachment 2 Sheet No. 8 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 9
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)

	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.
AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA
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
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii
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

	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.
AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA
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
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii
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 2 Sheet No. 9 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 10
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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.
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
iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii
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.
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
iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii	iiiiiiiii	iiiiii
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 2 Sheet No. 10 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 11
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p) As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years Water Independent Pathways (Inhalation excludes radon)													
0	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
0	Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	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
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii
0	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
Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p) As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years Water Dependent Pathways													
0	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*
0	Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	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
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii
0	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

*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 11 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 12
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)

	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Radio-	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
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
iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii
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

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
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
iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii
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 2 Sheet No. 12 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 13
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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 = 1.100E+01 years											
Water Independent Pathways (Inhalation excludes radon)											
0	Ground		Inhalation		Radon		Plant		Meat		Soil
0	Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
	AAAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA
	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
	iiiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii
	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

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)											
As mrem/yr and Fraction of Total Dose At t = 1.100E+01 years											
Water Dependent Pathways											
0	Water		Fish		Radon		Plant		Meat		All Pathways*
0	Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
	AAAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA	AAAAAA	AAAAA
	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
	iiiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii	iiiiiii	iiiiii
	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*Sum of all water independent and dependent pathways.

Attachment 2 Sheet No. 13 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 14
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)

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

	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Radio-	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Nuclide	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+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
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 2 Sheet No. 14 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 15
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)

	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.
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
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

	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.
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
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 2 Sheet No. 15 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 16
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)													
	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil
Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA
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
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii
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
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													
	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*
Radio-	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr
AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA	AAAAAA
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
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii
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*Sum of all water independent and dependent pathways.													

Attachment 2 Sheet No. 16 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 17
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.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)

	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.
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
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

	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.
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
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 2 Sheet No. 17 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 18
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

0 Parent	Product	Thread	Fraction	DSR(j,t) At Time in Years	(mrem/yr)/(pCi/g)
(i)	(j)				
0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.100E+01	3.000E+01
1.000E+02	3.000E+02	1.000E+03			
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	0.000E+00	0.000E+00	0.000E+00

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

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
 Basic Radiation Dose Limit = 4.000E+00 mrem/yr

ONuclide	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.100E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
(i)									
0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.100E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03	
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	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	0.000E+00	0.000E+00

*At specific activity limit

0

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

ONuclide	Initial	tmin	DSR(i,tmin)	G(i,tmin)	DSR(i,tmax)	G(i,tmax)
(i)	(pCi/g)	(years)		(pCi/g)		(pCi/g)
0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.100E+01	3.000E+01	1.000E+02
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	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

*At specific activity limit

Attachment 2 Sheet No. 18 of 19
 Originator: S. W. Clark Date
 Chk'd By M. W. Perrott Date
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 2

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 19
 Summary : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Individual Nuclide Dose Summed Over All Pathways

Parent Nuclide and Branch Fraction Indicated
 ONuclide Parent THF(i) DOSE(j,t), mrem/yr
 (j) (i) t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 1.100E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA
 Cs-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
 iiii iiii iiii iiii iiii iiii iiii iiii iiii
 THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
 Parent Nuclide and Branch Fraction Indicated

ONuclide Parent THF(i) S(j,t), pCi/g
 (j) (i) t= 0.000E+00 1.000E+00 3.000E+00 1.000E+01 1.100E+01 3.000E+01 1.000E+02 3.000E+02 1.000E+03
 AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA AAAAAAAAA
 Cs-137 Cs-137 1.000E+00 2.120E-01 2.071E-01 1.977E-01 1.679E-01 1.640E-01 1.053E-01 2.058E-02 1.940E-04 1.577E-11
 iiii iiii iiii iiii iiii iiii iiii iiii iiii
 THF(i) is the thread fraction of the parent nuclide.
 ORESCALC.EXE execution time = 11.78 seconds

Attachment 2 Sheet No. 19 of 19
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 1
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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 Part IV: Concentration of Radionuclides
 ff

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= 1.100E+01	6
Time= 3.000E+01	7
Time= 1.000E+02	8
Time= 3.000E+02	9
Time= 1.000E+03	10

Attachment 3 Sheet No. 1 of 10
 Originator: S. W. Clark SWC Date 8/28/07
 Chk'd By M. W. Perrott MWP Date 8/28/07
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 2
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	2.120E-01	2.120E-01	1.944E-06	0.000E+00	0.000E+00
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	8.480E+00	8.481E+00	8.481E+00	8.481E+00	2.048E+01	4.579E+00	0.000E+00	0.000E+00
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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 3 Sheet No. 2 of 10
 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
 Calc. No. 0100D-CA-V0275 Rev. No. 1

ATTACHMENT 3

1RESRAD, Version 6.3 T< Limit = 180 days 08/27/2007 14:32 Page 3
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	2.071E-01	2.071E-01	1.899E-06	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	8.285E+00	8.285E+00	8.296E+00	8.286E+00	2.001E+01	4.474E+00	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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.

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 Chk'd By M. W. Perrott Date
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ATTACHMENT 3

1RESRAD, Version 6.3 T< Limit = 180 days 08/27/2007 14:32 Page 4
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.977E-01	1.977E-01	1.812E-06	0.000E+00	0.000E+00
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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*

Radio- Nuclide	Drinking Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	7.907E+00	7.907E+00	7.918E+00	7.908E+00	1.910E+01	4.270E+00	0.000E+00	0.000E+00
	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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 3 Sheet No. 4 of 10
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ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 5
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio-	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m*3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.679E-01	1.679E-01	1.539E-06	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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-	Drinking Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	6.716E+00	6.716E+00	6.725E+00	6.717E+00	1.622E+01	3.627E+00	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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.

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ATTACHMENT 3

1RESRAD, Version 6.3 T< Limit = 180 days 08/27/2007 14:32 Page 6
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

Concentration of radionuclides in environmental media
 at t = 1.100E+01 years

Radio-	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.640E-01	1.640E-01	1.504E-06	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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 = 1.100E+01 years*

Radio-	Drinking Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	6.561E+00	6.562E+00	6.570E+00	6.562E+00	1.585E+01	3.543E+00	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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.

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ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 7
 ConCENT : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
Radio- Nuclide	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/m**3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.053E-01	1.053E-01	9.656E-07	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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 Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
Radio- Nuclide	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	4.213E+00	4.213E+00	4.218E+00	4.213E+00	1.017E+01	2.275E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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 3 Sheet No. 7 of 10
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ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 8
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	2.058E-02	2.058E-02	1.887E-07	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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*

Radio- Nuclide	Drinking Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	8.233E-01	8.233E-01	8.244E-01	8.234E-01	1.988E+00	4.446E-01	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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.

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ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 9
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.940E-04	1.940E-04	1.779E-09	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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*

Radio- Nuclide	Drinking Water	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	7.760E-03	7.761E-03	7.771E-03	7.761E-03	1.874E-02	4.191E-03	0.000E+00	0.000E+00
iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii	iiiiii

*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.

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 Originator: S. W. Clark Date _____
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ATTACHMENT 3

1RESRAD, Version 6.3 T« Limit = 180 days 08/27/2007 14:32 Page 10
 Concent : 100-D-50:5 RESRAD Evaluation of Cesium-137 GW Protection
 File : 100-D-50-5_GW_Protection_Rev1.RAD

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

Radio- Nuclide	Contaminat- ed Zone	Surface Soil*	Air Par- ticulate	Well Water	Surface Water
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/g	pCi/g	pCi/m**3	pCi/L	pCi/L
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	1.577E-11	1.577E-11	1.446E-16	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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	Nonleafy Vegetable	Leafy Vegetable	Fodder Meat	Fodder Milk	Meat	Milk	Fish	Crustacea
	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
	pCi/L	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/kg	pCi/L	pCi/kg	pCi/kg
AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA	AAAAA
Cs-137	0.000E+00	6.309E-10	6.310E-10	6.318E-10	6.310E-10	1.524E-09	3.407E-10	0.000E+00	0.000E+00
iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii	iiiiiii

*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.

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 Originator: S. W. Clark Date _____
 Chk'd By M. W. Perrott Date _____
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